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Supervisor's evaluation of the PhD work of Tomas Barta

A quantitative description of the mechanism by which electrical and chemical signals in the brain allow information to be transmitted and processed is one of the fundamental problems in the field of computational neuroscience. At the level of individual cells, neurons convert the input signal (stimulus) into a temporal series of distinct pulses of membrane voltage (the action potentials). The functional role of this so-called neuronal code has not yet been satisfactorily elucidated, its properties and informational efficiency are the subject of intensive research.

The PhD thesis of Tomas Barta addresses the neural coding problem from two main complementary perspectives: *i)* the impact of metabolic cost constraints and inhibition on the information transmission in cortical neuronal models, *ii)* the statistical analysis of experimental data and computational modeling of the early sensory (olfactory) pathway of insect.

The thesis is based on six manuscripts that have been produced during the 4-year PhD study period. The work on the sub-topic *i)* defined above yielded two published papers in the respected first-quartile journals. The Plos Comput. Biol. (2019) paper investigates the optimal information-energetic balance by employing a class of cortical neuronal models. Among the main results are the predictions of the statistical character of post-synaptic firing rate histograms. The Phys. Rev. E. (2021) examines the effect of inhibitory input on the neuronal response reliability. The description of a novel stabilization mechanism that suppresses the postsynaptic membrane potential fluctuations represents the main result. In both cases, T. Barta is the first and corresponding author. He further significantly extended the ideas behind the two published papers into the context of recurrent spiking neuronal populations. The first manuscript (Attm. IV) shows that a shared network input together with an inhibitory feedback may achieve the optimal information-metabolic cost balance. The manuscript is currently under review in Plos Comput. Biol. Again, T. Barta is the first and corresponding author. Finally, the second draft (Attm. II) naturally

extends the Phys Rev. E. effort for neuronal populations and will be submitted soon.

His work on sub-topic *ii)* provides a detailed analysis of experimental data together with a novel finding of a transient inhibition period in insect olfactory receptor neurons (Attms. V and VI). The study (Attm. V) also includes a minimal biophysical model of the early insect pheromone reception cascade and is currently submitted to J. Neurosci.

In summary, I consider the work that Tomas Barta did during his PhD study to be of the highest quality. He has been a member of my laboratory at the Institute of Physiology since 2017, when he started to work on his diploma thesis under my supervision. Because of that, I feel entirely qualified to comment on his scientific abilities. His background in mathematics and physics enables him to be proficient in a wide range of advanced methods, and to understand the biophysical aspects of neuronal modeling quickly. His programming skills are excellent. Throughout our collaboration, Tomas has demonstrated the ability to formulate the research questions independently, look up the relevant literature and generate his own ideas to solve the problems.

Without any hesitation I recommend his PhD thesis to be admitted for the defense.

Lubomir Kostal