

POSTER PRESENTATION

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Dynamical switching between different hippocampal rhythms

Anastasia I Lavrova^{1,3*}, Ekaterina A Zhuchkova^{2,3}, Susanne Schreiber^{2,3}, Lutz Schimansky-Geier^{1,3}

From Twentieth Annual Computational Neuroscience Meeting: CNS*2011
Stockholm, Sweden. 23-28 July 2011

The hippocampal circuit can exhibit network oscillations in different frequency ranges (“gamma” - 30-80 Hz; “theta” - 4-12 Hz; as well as “theta/gamma” or a bursting regime) both *in vivo* and *in vitro* and switch between them [1]. These different oscillatory modes facilitate memory storage in the hippocampus and memory consolidation [2,3]. The hippocampal neuronal network consists of various types of connected cells that differ in morphology and functional properties, which allows them to provide oscillations with different periods, amplitudes, and phase shifts [1]. Dynamical switching between various rhythms is likely to depend on the local network structure of the neurons.

Our goal is to investigate how coupling strength and delayed propagation influence synchronization and switching between different oscillatory states in minimal neuronal networks. To this end, we constructed a simple model of neurons comprising two fast-spiking and two slow-spiking cells, respectively. Cells are synaptically connected in an all-to-all manner, with exception of the two slow-spiking cells. The network is described by coupled FitzHugh-Nagumo equations that well reproduce the dynamical behavior of different cells types: their periods, amplitudes, and phase shifts.

The model allows us to analyze the influence of synaptic strengths on the network synchronization and dynamical switching between theta, gamma, and bursting regimes. In particular, we perform a thorough bifurcation analysis and identify parameters of synaptic connections that can efficiently induce switches in the network activity. We show that depending on the coupling strengths between slow- and fast-spiking cells, abrupt changes between different rhythms can occur, similar to experimental observations.

* Correspondence: aurebours@googlemail.com

¹Institute for Physics, Humboldt-Universität zu Berlin, Berlin, 12489, Germany
Full list of author information is available at the end of the article

Acknowledgments

This work was supported by the BMBF (BCCN Berlin, BPCN).

Author details

¹Institute for Physics, Humboldt-Universität zu Berlin, Berlin, 12489, Germany.
²Institute for Theoretical Biology, Humboldt-Universität zu Berlin, Berlin, 10115, Germany. ³Bernstein Center for Computational Neuroscience, Berlin, 10115, Germany.

Published: 18 July 2011

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doi:10.1186/1471-2202-12-S1-P284

Cite this article as: Lavrova et al.: Dynamical switching between different hippocampal rhythms. *BMC Neuroscience* 2011 **12**(Suppl 1):P284.

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