POSTER PRESENTATION



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Long-term effects of weak electrical stimulation on active neuronal networks

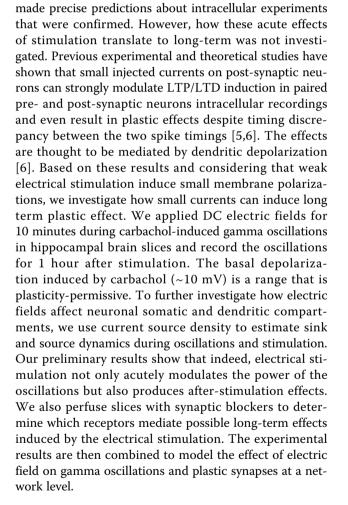
Davide Reato^{*}, Marom Bikson, Lucas C Parra

From Twenty Second Annual Computational Neuroscience Meeting: CNS*2013 Paris, France. 13-18 July 2013

Transcranial direct-current stimulation induces cortically sub-millivolt electric fields that modulate brain activity and induce long-term (plastic) effects measurable as improved cognitive and behavioral performances in human experiments [1]. However, the basic mechanisms by which a weak electric field can induce long term effects are not clear yet. This is a limitation for developing more targeted stimulation protocols or to maximize the outcome of the stimulation. In particular, considering that 1 V/m electric field can polarize the neuronal membrane at most 0.2 mV [2], it is still a mystery how such a small voltage fluctuation can mediate any significant long-term effect. Here we combine experiments in rat brain slices and computational models of neuronal networks to determine how fields can induce long-term effects. Our hypothesis is that basal neuronal depolarization and network activity are required to amplify the effects of the electric field and so to mediate plasticity. Network activity can be induced in hippocampal rat slices by applying carbachol, a cholinergic agonist [3]. The coherent network activity can be measured extracellularly in the high beta/low gamma frequency band. The activity persists for many hours and is generated from the interplay of excitation of pyramidal neurons and inhibitory feedback. We have previously characterized the effects of fields on gamma oscillations during stimulation [4]. Gamma power is modulated depending on the frequency and amplitude of the stimulation. A computational model based on Izhikevich's single neuron dynamics describing synaptically connected excitatory and inhibitory neurons was parameterized based on the results of the extracellular recordings in slices. The model explained the effects of the electric field on firing rate and spike timing and

* Correspondence: davide.reato@gmail.com

Department of Biomedical Engineering, The City College of the City University of New York, New York, NY, 10031, USA



Acknowledgements

This work is funded by a Collaborative Research in Computational Neuroscience grant (USA-German Collaboration in Computational Neuroscience, grant number NIH-R01-MH-092926-03).

Published: 8 July 2013



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doi:10.1186/1471-2202-14-S1-P308

Cite this article as: Reato *et al.*: **Long-term effects of weak electrical stimulation on active neuronal networks**. *BMC Neuroscience* 2013 14 (Suppl 1):P308.

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