Griffith et al. BMC Neuroscience 2015, 16(Suppl 1):P268
http://www.biomedcentral.com/1471-2202/16/S1/P268

BMC Neuroscience

POSTER PRESENTATION Open Access

A spatiotemporal model of spine calcium dynamics in the hippocampus

Thom Griffith[1*], Jack Mellor[2], Krasi Tsaneva-Atanasova[3]

From 24th Annual Computational Neuroscience Meeting: CNS*2015
Prague, Czech Republic. 18-23 July 2015

Ca^{2+}-signalling in dendritic spines is required for NMDA receptor-dependent synaptic plasticity at glutamatergic synapses in the hippocampus [1]. However, it is not clear whether plasticity induction is dependent solely on the global signal, i.e., the spine volume-averaged Ca^{2+} signal; or whether plasticity induction is also sensitive to Ca^{2+}-channel nanodomain signaling [2]. A working hypothesis of this work is that temporal and spatial variations in postsynaptic intracellular [Ca^{2+}]-fields may be significant factors governing the signalling cascades that lead to either long-term synaptic potentiation or depression. Direct measurement of [Ca^{2+}] distributions in dendritic spines is experimentally difficult but we can investigate this hypothesis using mathematical models of Ca^{2+} diffusion.

We have developed a spatio-temporal model of Ca^{2+} diffusion in three dimensions. We then study our model using finite element methods. The model allows predictions of intracellular [Ca^{2+}]-field responses to combinations of pre- and post-synaptic spikes with nanometre and millisecond spatio-temporal resolution. Our results so far indicate that Ca^{2+} signalling is highly spatially non-uniform and that Ca^{2+} signal differences between induction protocols is dependent on location within the spine. This has implications for the ultimate biological role of the Ca^{2+} signal given that the relevant receptors in the spine are organised inhomogeneously [3].

Acknowledgements
Support for this work was provided by the EPSRC, UK (EP/I013717/1).

Authors' details
[1]Department of Engineering Maths, University of Bristol, Bristol, UK. [2]School of Physiology and Pharmacology, University of Bristol, Bristol, UK. [3]Department of Mathematics, University of Exeter, Exeter, UK.

* Correspondence: thom.griffith@bristol.ac.uk
[1]Department of Engineering Maths, University of Bristol, Bristol, UK
Full list of author information is available at the end of the article

Published: 18 December 2015

References
1. Malenka RC, Bear MF: **LTP and LTD: an embarrassment of riches.** *Neuron* 2004, **44(1)**:5-21.
2. Chen Y, Sabatini BL: **Signaling in dendritic spines and spine microdomains.** *Current Opinion in Neurobiology* 2012, **22(3)**:389-396.
3. Mori MX, Erickson MG, Yue DT: **Functional stoichiometry and local enrichment of calmodulin interacting with Ca^{2+} channels.** *Science* 2004, **304(5669)**:432-435.

doi:10.1186/1471-2202-16-S1-P268
Cite this article as: Griffith *et al.*: A spatiotemporal model of spine calcium dynamics in the hippocampus. *BMC Neuroscience* 2015 **16**(Suppl 1):P268.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

BioMed Central

BioMed Central

© 2015 Griffith et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.