Li et al. BMC Neuroscience 2015, 16(Suppl 1):P252
http://www.biomedcentral.com/1471-2202/16/S1/P252

BMC Neuroscience

POSTER PRESENTATION Open Access

Induction and consolidation of calcium-based homo- and heterosynaptic potentiation and depression

Yinyun Li, Tomas Kulvicius, Christian Tetzlaff*

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

Synaptic plasticity serves as the physiological foundation for learning and memory [1]. While homosynaptic plasticity is associative learning or Hebbian-type plasticity, heterosynaptic plasticity reflects the synaptic change without direct stimulation, i.e. non-associative plasticity [2]. However, heterosynaptic plasticity is an important mechanism preventing run-away synaptic dynamics and offers a potential mechanism to understand memory allocation [2,3]. Experimental results show that the induction of heterosynaptic plasticity as well as homosynaptic plasticity depends on the postsynaptic calcium concentration [4]. We propose that heterosynaptic plasticity can be induced by the postsynaptic calcium dynamics which can be triggered by the back propagation of action potentials.

However, homosynaptic plasticity has an early-phase (< 3 hours) and a late-phase state (> 8 hours) [1]. Experiments show that an early-phase synaptic change can be transferred to a late-phase by the mechanisms of "synaptic tagging and consolidation" (STC) [5,6]: (i) the changed synapse get tagged and (ii) a strong activation enables in the postsynaptic neuron the synthesis of plasticity-related proteins (PRP) which are transmitted back to the tagged synapse[5,6]. We propose that the same STC mechanism consolidating homosynaptic changes are also able to consolidate heterosynaptic changes.

We combine a history spiking-dependent neuron [7] with calcium-based synaptic plasticity rule [8] and synaptic consolidation mechanism [9] to understand: (i) the mechanisms of inducing heterosynaptic plasticity by which the inactive synapse can change its weight through the postsynaptic calcium level triggered by the back propagation of the shared neuron; and (ii) of the consolidation of heterosynaptic changes based on the synaptic tagging and consolidation principle. For instance, a strong stimulus transmitted by a group of synapses induces and consolidates by the postsynaptic neuron heterosynaptic changes at other, unrelated synapses. Our study provides a further step of understanding how several mechanisms interact with each other to enable the formation of computational important long-term changes or memories.

Acknowledgements
This research is funded by from the European Communities Seventh Framework Program FP7/2007-as well as from the Germany Ministry of Science Grant to the Göttingen Bernstein Center for Computational Neuroscience.

Published: 18 December 2015

References

1. Abraham WC: **How long will long term potentiation last?** *Phil. Trans. R. Soc. Lond. B* 2003, **358**:735-744.
2. Chistiakova M, Bannon NM, Bazhenov M, Volgushev M : **Heterosynaptic plasticity: multiple mechansims and muliple roles.** *Neuroscientist* 2014, **20(5)**:483-498.
3. Rogerson T, Cai DJ, Frank A, Sano Y, Shobe J, *et al*: **Synaptic tagging during memory allocation.** *Nat Rev Neurosci* 2014, **15**:157-169.
4. Malenka RC, Kauer JA, Zucker RS, Nicoll RA: **Postsynaptic calcium is sufficient for potentiation of hippocampal synaptic transmission.** *Science* 1988, **242**:81-84.
5. Frey U, Morris R GM: **Synaptic tagging and long-term potentiation.** *Nature* 1997, **385**:533-536.
6. Sajikumar S, Navakkode S, Frey JU: **Identification of compartment-and Process-Specific Molecules Required for "Synaptic Tagging" during Long-Term Potentiation and Long-Term Depression in Hippocampal CA1.** *J Neurosci* 2007, **27(19)**:5068-5080.
7. Yamauchi S, Kim H and Shinomoto S: **Elemental spiking neuron model for reproducing diverse firing patterns and predicting precise firing times.** *Front in Comput neurosci* 2011, **5(42)**:1-15.

* Correspondence: tetzlaff@phys.uni-goettingen.de
III Institute of Physics, Department of Computational Neuroscience, Georg-August-University Göttingen, Bernstein Center for Computational Neuroscience, Göttingen, 37077, Germany

BioMed Central

© 2015 Li 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.

8. Graupner M, Brunel N: **Calcium-based plasticity model explains sensitivity of synaptic changes to spike pattern, rate and dendritic location.** *PNAS* 2012, **109(10)**:3991-3996.
9. Clopath C, Ziegler L, Vasilaki E, Buesing L, Gerstner W: **Tag-Trigger-Consolidation: A Model of Early and Late Long-Term-Potentiation and Depression.** *PLoS CB* 2008, **4(12)**:e1000248.

doi:10.1186/1471-2202-16-S1-P252
Cite this article as: Li *et al.*: Induction and consolidation of calcium-based homo- and heterosynaptic potentiation and depression. *BMC Neuroscience* 2015 **16**(Suppl 1):P252.

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