

POSTER PRESENTATION

Open Access

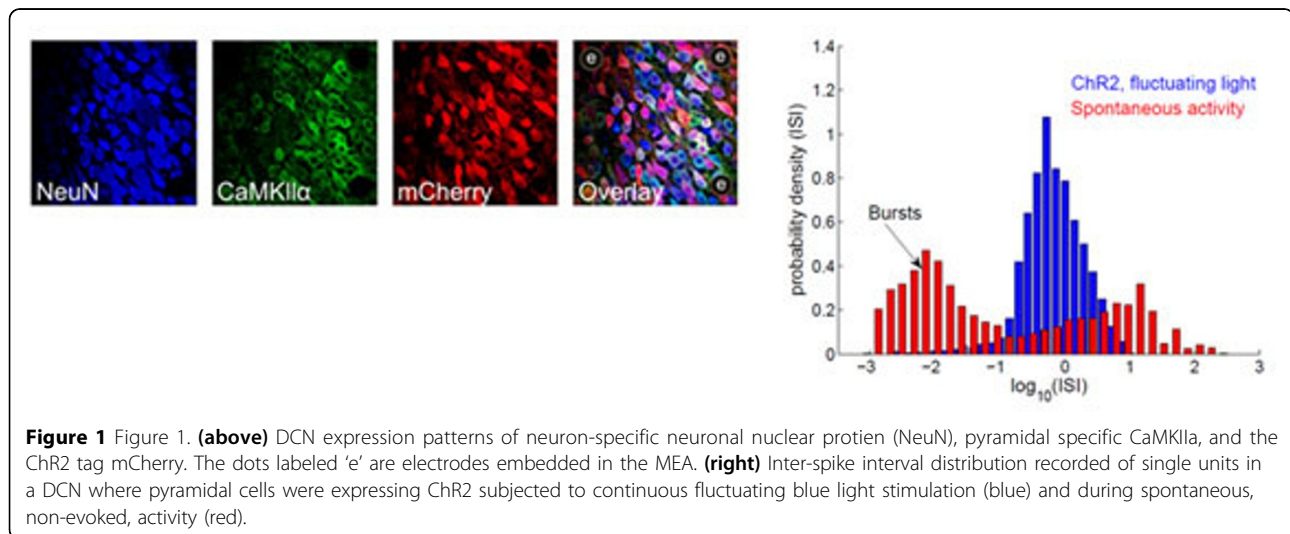
Amplitude modulated photostimulation for probing neuronal network dynamics

Jonathan P Newman^{1*†}, Tatjana Tchumatchenko^{2†}, Ming-fai Fong^{1,3}, Steve M Potter¹

From Twenty First Annual Computational Neuroscience Meeting: CNS*2012
Decatur, GA, USA. 21-26 July 2012

Sensory input arrives in the cortex in the form of dynamic synaptic currents to populations of neurons. How cortical neurons encode and transmit these inputs ultimately determines the cognitive and behavioral response of the animal. Therefore, a number of theoretical studies have attempted to explain the cortical population response in model neuronal networks [1]. Yet, there are few experimental platforms for studying the dynamical rate responses in large living networks that match the manipulability of computational models. As a result, most experimental studies examining cortical input response properties are confined to independent or single neurons, e.g. [2].

Optogenetic techniques in dissociated cultured networks (DCNs) that are grown on multielectrode arrays (MEAs) offer an opportunity to test key aspects of network response dynamics. However, controlling the spontaneous activity of DCNs and imposing a specific irregular activity pattern is challenging [3]. Here, we report that continuous fluctuating light stimulation has several major effects on DCNs that express Channelrhodopsin-2 (ChR2): (1) it inhibits network-wide bursting and leads to a unimodal interspike interval distribution of single units (figure 1) that resembles those observed *in vivo* [4]; (2) the single unit response to light fluctuations is temporally reliable and stable for prolonged periods of time; (3) the correla-



* Correspondence: jnewman6@gatech.edu

† Contributed equally

¹Department of Biomedical Engineering, Georgia Tech and Emory University, Atlanta, GA, 30332/ 30322, USA

Full list of author information is available at the end of the article

tion between light and population firing can be > 0.6 for light fluctuations that have a 50 msec time constant; and (4) using a generalized linear framework we show that the linear response kernel can be used to predict the firing activity of neurons that are driven by light stimuli.

These results indicate that amplitude modulated optogenetic stimulation with LEDs is an efficient tool for providing correlated input currents to thousands of pyramidal cells embedded in DCNs while recording spiking activity in hundreds of individual neurons using an MEA. Because DCNs can be created with specified proportions of different cell types and allow easy pharmacological access, this technique opens a new level of control over living neuronal populations for testing theories of cortical response properties and small signal representation under different network parameter regimes.

Author details

¹Department of Biomedical Engineering, Georgia Tech and Emory University, Atlanta, GA, 30332/ 30322, USA. ²Center for Theoretical Neuroscience, Department of Neuroscience, Columbia University College of Physicians and Surgeons, New York, NY 10032-2695, USA. ³Department of Physiology, Emory University School of Medicine, Atlanta, GA, 30303, USA.

Published: 16 July 2012

References

1. Dayan P, Abbott LF: *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems*. Cambridge: MIT Press; 2001.
2. Tchumatchenko T, Malyshev A, Wolf F, Volgushev M: **Ultrafast Population Encoding by Cortical Neurons**. *J. Neurosci* 2011, **31**:12171-12179.
3. Wagenaar D, Pine J, Steve M, Potter S: **An extremely rich repertoire of bursting patterns during the development of cortical cultures**. *BMC Neuroscience* 2006, **7**:11, doi:10.1186/1471-2202-7-11.
4. Bereshpolova Y, Stoelzel CR, Zhuang J, Amitai Y, Alonso J-M, Swadlow HA: **Getting drowsy? Alert/Nonalert transitions and visual thalamocortical network dynamics**. *J. Neurosci* 2011, **31**:17480-17487.

doi:10.1186/1471-2202-13-S1-P71

Cite this article as: Newman *et al.*: Amplitude modulated photostimulation for probing neuronal network dynamics. *BMC Neuroscience* 2012 **13**(Suppl 1):P71.

**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

