Resource Summary Report

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Channelrhodopsin-2 enables optical activation of neurons

RRID:SCR_008833
Type: Tool

Proper Citation

Channelrhodopsin-2 enables optical activation of neurons (RRID:SCR_008833)

Resource Information

URL: http://edboyden.org/05.09.boyden.html

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Description: Laser tool that enables neurons to be optically silenced by pulses of yellow light, the light-activated chloride pump halorhodopsin (Halo), in a paper entitled Multiple-color optical activation, silencing, and desynchronization of neural activity, with single-spike temporal resolution. Temporally precise, noninvasive control of activity in well-defined neuronal populations is a long-sought goal of systems neuroscience. We adapted for this purpose the naturally occurring algal protein Channelrhodopsin-2, a rapidly gated light-sensitive cation channel, by using lentiviral gene delivery in combination with high-speed optical switching to photostimulate mammalian neurons. We demonstrate reliable, millisecond-timescale control of neuronal spiking, as well as control of excitatory and inhibitory synaptic transmission. This technology allows the use of light to alter neural processing at the level of single spikes and synaptic events, yielding a widely applicable tool for neuroscientists and biomedical engineers. The quest to determine how precise neural activity patterns mediate computation, behavior, and pathology would be greatly aided by a set of tools for reliably activating and inactivating genetically targeted neurons, in a temporally precise and rapidly reversible fashion. Having earlier adapted a light-activated cation channel, 1channelrhodopsin-2 (ChR2), for allowing neurons to be stimulated by blue light, we searched for a complementary tool that would enable optical neuronal inhibition, driven by light of a second color. Here we report that targeting the 1codon-optimized form of the light-driven chloride pump halorhodopsin from the archaebacterium Natronomas pharaonis (hereafter abbreviated Halo) to genetically-specified neurons enables them to be silenced reliably, and reversibly, by millisecond-timescale pulses of yellow light. We show that trains of yellow and blue light pulses can drive high-fidelity sequences of

hyperpolarizations and depolarizations in neurons simultaneously expressing yellow light-driven Halo and blue light-driven ChR2, allowing for the first time manipulations of neural synchrony without perturbation of other parameters such as spiking rates. The Halo/ChR2 system thus constitutes a powerful toolbox for multichannel photoinhibition and photostimulation of virally or transgenically targeted neural circuits without need for exogenous chemicals, enabling systematic analysis and engineering of the brain, and quantitative bioengineering of excitable cells.

Abbreviations: Channelrhodopsin-2 enables optical activation of neurons

Resource Type: production service resource, service resource, material service resource, resource

Defining Citation: PMID:17375185

Keywords: hardware, instrument, equipment

Funding: Anonymous donor ;
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Resource Name: Channelrhodopsin-2 enables optical activation of neurons

Resource ID: SCR_008833

Alternate IDs: nlx_144630

Old URLs: http://channelrhodopsin.org

Record Creation Time: 20220129T080249+0000

Record Last Update: 20250503T060038+0000

Ratings and Alerts

No rating or validation information has been found for Channelrhodopsin-2 enables optical activation of neurons.

No alerts have been found for Channelrhodopsin-2 enables optical activation of neurons.

Data and Source Information

Source: SciCrunch Registry

Usage and Citation Metrics

We found 3 mentions in open access literature.

Listed below are recent publications. The full list is available at RRID.

Zhou L, et al. (2021) Photosynthesis acclimation under severely fluctuating light conditions allows faster growth of diatoms compared with dinoflagellates. BMC plant biology, 21(1), 164.

Liu X, et al. (2021) Chlorophyll fluorescence as a light signal enhances iron uptake by the marine diatom Phaeodactylum tricornutum under high-cell density conditions. BMC biology, 19(1), 249.

Ellefsen KL, et al. (2015) Spinning-Spot Shadowless TIRF Microscopy. PloS one, 10(8), e0136055.