

Towards opto-magnetic physiology: Concepts and pitfalls of of MRI

Schwalm M.

Jubal E.R.

Stroh A.

Optogenetic functional magnetic resonance imaging (ofMRI) represents the combination of optogenetic modulation of neural circuits with high-field fMRI. ofMRI enables the monitoring of neural activity across the entire brain, while precisely controlling the activation of specific neuronal elements within the neural circuit, defined by their genetic identity, location of somata, and axonal projection targets. Those exclusive features of ofMRI open a plethora of new possibilities for the in vivo characterization of neural networks, simultaneously at local and global scale. In addition, recent advances in optical readouts of intracellular Ca²⁺ within optogenetic fMRI experiments led to all-optical interrogations within the scanner. Here, we provide a guide to applying optogenetics and optical recordings in the setting of fMRI experiments. In addition, we devise a straight forward control experiment addressing the discrimination of specific network activation through the excitation of opsins from unspecific heat effects leading to an apparent BOLD effect. Lastly, we propose a method to estimate the scope of optogenetic network modulation by combining the estimations of the number of opsin-expressing neurons and light spreading in brain tissue. © Springer

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BOLD fMRI

Ca²⁺ recordings

OfMRI

Optical recordings

Optogenetics

opsin

BOLD signal

hemodynamics

human

image processing

magnetic field

nerve cell

nerve cell network

nerve cell stimulation

neuromodulation

nonhuman

nuclear magnetic resonance imaging

optogenetic functional magnetic resonance imaging

optogenetics

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