Potential use and limitations with optogenetics for therapeutic applications

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The non-native expression of light activated proteins, which serve as ion channels and pumps, shows promise for treatments and elevations of various medical disorders. To understand the potential applications and limitations in the use of light activated proteins, model animals such as rodents and Drosophila melanogaster are being used. We examined reproducible effects over time and changes in the biophysical properties of the cells they are expressed in. We used a variant of channel rhodopsin (ChR2-XXL, Na+ and Ca2+ ion channel) in neurons of larval Drosophila to investigate the acute and chronic activation. Also, we used halorhodopsin (chloride pump) to examine the proposed inhibition of cells expressing this protein and their function when cells are activated by synaptic input. We found issues with voltage gated Na+ channel inactivation from prolonged ChR2-XXL activation and enhanced synaptic excitation of cells expressing halorhodopsin. These unexpected limitations can bias one's understanding for long term use of these light activated proteins and conceptual understanding in controlling neuronal circuits.
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