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40 Hz Light Flicker Promotes Learning and Memory via Long Term Depression in Wild-Type Mice

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Abstract

Background: 40 Hz light flicker is a well-known non-invasive treatment that is thought to be effective in treating Alzheimer's disease. However, the effects of 40 Hz visual stimulation on neural networks, synaptic plasticity, and learning and memory in wild-type animals remain unclear.

Objective: We aimed to explore the impact of 40 Hz visual stimulation on synaptic plasticity, place cell, and learning and memory in wild-type mice.

Methods: c-Fos+ cell distribution and in vivo electrophysiology was used to explore the effects of 40 Hz chronic visual stimulation on neural networks and neuroplasticity in wild-type mice. The character of c-Fos+ distribution in the brain and the changes of corticosterone levels in the blood were used to investigate the state of animal. Place cell analysis and novel location test were utilized to examine the effects of 40 Hz chronic visual stimulation on learning and memory in wild-type mice.

Results: We found that 40 Hz light flicker significantly affected many brain regions that are related to stress. Also, 40 Hz induced gamma enrichment within 15 min after light flickers and impaired the expression of long-term potentiation (LTP), while facilitated the expression of long-term depression (LTD) in the hippocampal CA1. Furthermore, 40 Hz light flicker enhanced the expression of corticosterone, rendered well-formed place cells unstable and improved animal's learning and memory in novel local recognition test, which could be blocked by pre-treatment with the LTD specific blocker Glu2A-3Y.

Conclusion: These finding suggested that 40 Hz chronic light flicker contains stress effects, promoting learning and memory in wild-type mice via LTD.

Keywords: 40 Hz; Alzheimer's disease; gamma; stress; synaptic plasticity.

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