Neurobiological effects of noninvasive brain stimulation

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Introduction

Noninvasive brain stimulation (NIBS) techniques - repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS) - have been reported to be beneficial in several neuropsychiatric disorders.

Therapeutic effects appear to be related to changes in cortical synaptic transmission similar to the long term potentiation/long term depression (LTP/LTD) phenomena.

NIBS after-effects usually last only a few minutes and more likely reflect forms of short-lived activity-dependent modulation of synaptic efficacy.

It is thus conceivable that long-lasting therapeutic effects require additional regulatory mechanisms at cellular and network level.

Main Findings

Long-term potentiation (LTP) and depression (LTD) phenomena by itself are insufficient in explaining the early and long term changes taking place after short episodes of NIBS.

Early modifications of synaptic function are need to the therapeutic effects of NIBS, including:

- gene activation/regulation (induction of IEGs)
- changes in Ca²⁺ dynamics
- modulation of AMPAr/NMDAr expression
- modulation of neurotransmitter release
- modified network properties (changed inhibition and homeostatic glial function)

Long-term modifications include:

- modulation of neurotrophins release (BDNF, NGF)
- modulation of glial function (gliotransmitter release, Glu/GABA homeostasis, glial activation)
- modulation of neuroinflammatory responses (microglial activation, release of inflammatory mediators)

References: