Mini Review

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Can transcranial direct current stimulation enhance brain activities?

Abstract

The transcranial Direct Current Stimulation (tDCS) has increasingly purposive treatments for neurorehabilitation. It is inexpensive, easy to administer after well trained, portable, and home used design considered as the most cost effective and good compliance therapy. It can either enhance or suppress cortical excitability by a weak and constant direct current applied to the brain. It has effect for several hours after the stimulation, depending on several factors. It can modulate brain networks and enhance brain activities. More researches are upcoming in various indications and stimulation protocols.

Keywords: transcranial direct current stimulation (tdcs), brain activities

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Introduction

Transcranial Direct Current Stimulation (tDCS) has increasingly purposive treatments for neurorehabilitation, compared to other noninvasive neuromodulations. It is inexpensive, easy to administer after well trained, portable, and home used design considered as the most cost effective and good compliance therapy. It can either enhance or suppress cortical excitability by a weak and constant direct current applied to the brain. It has effect for several hours after the stimulation, depending on several factors. Three different stimulation types are as the followings; (1) anodal stimulation, the anodal electrode (+) and the reference electrode are applied over the lesioned brain area and the contralateral orbit, respectively. It effects subthreshold depolarization, producing neural excitation.; (2) cathodal stimulation, the cathode (−) and the reference electrode are applied over the non-lesioned brain area and the contralateral orbit, respectively. It effects subthreshold polarization, suppressing neural activity.; (3) Dual tDCS, anodal and cathodal stimulation, the anodal electrode (+) and the cathodal electrode (−) are applied over the lesioned and non-lesioned brain, respectively. In clinical use, two (or more) electrodes are applied over the scalp with the current flowing from the anodal to the cathodal electrode. The strength of electrical currents cannot produce an action potential.[1,2] The factors influence neural activity including the state of the brain during stimulation at rest or stimulation and relearning with a task in the meantime, and even the time of the day. There are increasing evidences of tDCS effect on the whole brain networks by stimulating just one brain region.[3] The positive clinical effects of tDCS in various disorders are caused by the complex interactions between the associated brain network and the area of stimulation. Interestingly, stimulation at the dorsolateral prefrontal cortex (DLPFC), have shown the effectiveness for several conditions. On the other hand, different area of stimulation for the same disorder have shown to have similar results. These new evidences may indicate an underlying neural network for disorders and may suggest network stimulation as a new stimulation protocol.[3]

Current evidences do not recommend Level A (definite efficacy) for any indication. Level B recommendation (probable efficacy) is revealed for: (i) anodal electrode applied at the left primary motor cortex (M1) and cathodal electrode applied at the right orbitofrontal area in fibromyalgia; (ii) anodal electrode applied at the left dorsolateral prefrontal cortex (DLPFC) and cathodal electrode applied at the right orbitofrontal area in major depressive episode without drug resistance; (iii) anodal and cathodal electrode applied at the right and left DLPFC, respectively in addiction/craving. Level C recommendation (possible efficacy) is revealed for anodal electrode applied at the left M1 or contralateral to pain side and cathodal electrode applied at the right orbitofrontal area in chronic lower limb neuropathic pain secondary to spinal cord lesion.[4]

However, Level B recommendation (probable inefficacy) is extended to the absence of clinical effects of: (i) anodal electrode applied at the left temporal cortex and cathodal electrode applied at the right orbitofrontal area in tinnitus; (ii) anodal electrode applied at the left DLPFC and cathodal electrode applied at the right orbitofrontal area in drug-resistant major depressive episode.[4]

Recent evidences show that there are dosage-dependent effects of tDCS and maintenance treatment should be carried out in short intervals.[5] There are positive outcome studies combining tDCS with additional interventions such as cognitive-behavioral therapy, cognitive remediation, physiotherapeutic training and other relearning tasks in stroke.[6] Moreover, application of M1 tDCS for three or five consecutive days can improve motor sequence learning in healthy subjects.[7] The effects of tDCS depend on complexity and the level of patients ‘ abilities. The individual performance is greater improvement if doing relearning tasks during stimulation. These findings are useful for enhance daily bimanual activities in neurorehabilitation.[8]

The home used tDCS aims for cognitive enhancement, pain modulation or increasing endurance for physical training. The home used tDCS are commercially available from a variety of manufacturers at low budget. It causes various risks, ranging from adverse effects to an interaction with concomitant treatment or even a lack of appropriate therapy which may lead to deterioration of serious clinical conditions. Therefore, quality monitoring is important and using telerehabilitation.[9]

Conclusion

tDCS can modulate brain networks and enhance brain activities. It is inexpensive, easy to administer after well trained, portable, and home used design considered as the most cost effective and good compliance therapy. The new evidences for the effectiveness of different areas of brain stimulation for one disorder as well as evidences for the effectiveness of one area of brain stimulation for different disorders lead to network stimulation as a novel stimulation protocol. More researches are upcoming in various indications and stimulation protocols.

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Conflict of interest

Author declares that there is no conflict of interest.

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