



Sickness, Social Isolation, and a Solution: A Brief Exploration of COVID-19 Related Depression and Transcranial Direct Current Stimulation

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ABSTRACT

The COVID-19 pandemic has illuminated a need for accessible, home-based therapies for mental health. In an era of social distancing, lockdowns, and declining global mental health, one promising candidate is transcranial Direct Current Stimulation (tDCS). tDCS is a non-invasive, portable, targeted brain stimulation technique that uses electrical currents to modulate cortical excitability. It has been heavily explored as a treatment for major depressive disorder (MDD) and other mental health issues in recent years. However, before such a treatment may become widespread, certain research questions must be addressed, and safety outcomes must be thoroughly evaluated. This article aims to provide a brief overview of tDCS, the COVID-19 pandemic's impact on mental health, and tDCS' potential to be used in such a situation. The article also explores some of the drawbacks and challenges that lie in the way of tDCS being normalized as a mental health therapeutic.

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Introduction

The World Health Organization (WHO) declared COVID-19 to be a Public Health Emergency of International Concern (PHEIC) in late January of 2020, and only a few short months later in mid March, it became a global pandemic. Governments around the world began responding by taking measures to limit social contact in hopes of reducing transmission and curbing the spread

of the virus. China, where the outbreak was first reported, took early and aggressive measures by implementing travel restrictions, shutting down public transport, closing public spaces, prohibiting large gatherings, and giving a stay-at-home self-quarantine order [1]. Many other countries soon adopted similar pursuits and continue to hold alternating periods of loosened and heightened restrictions as COVID-19 cases slow and surge. However, the psychological costs of quarantine are high; social isolation has previously been linked with depression, stress, and negative mood [2, 3]. Indeed, in Canada alone, there was a 13 percentage point decrease in the amount of Canadians who self-reported as having good mental health, down from 68% in 2019 to 55% in July 2020 [4]. Youth aged 15-24 specifically report the most drastic declines, down from 60% pre-pandemic to 40% in July 2020 [4]. In the United States, the rates of depressive symptoms increased three-fold post-pandemic [5]. Humans are social beings, and our interactions with others are important for positive health outcomes, both physical and mental [6]. To be deprived of these interactions can have adverse effects on psychological well-being, something that is now becoming apparent across Canada and the globe.

How then, can the increasing number of individuals requiring psychological help access mental healthcare resources in an era of social isolation such as this one? One answer may lie in the prospect of at-home treatments such as transcranial Direct Current Stimulation (tDCS), a non-invasive and painless targeted brain stimulation technique that is being explored as a treatment option for multiple neuropsychiatric conditions, including depression. A constant, low-intensity current, typically 0.5-2.0 mA, flows through two conductive electrodes that are placed onto the head of a patient, using a specified area of the brain to complete the circuit. The stimulation can either be anodal- acting to excite neuronal activity or cathodal- acting to inhibit neuronal activity. Anodal stimulation works to depolarize neuronal membranes which then increases the probability that the neurons will undergo action potentials and fire, while cathodal stimulation hyperpolarizes neuronal membranes, decreasing the probability that they will fire. In the treatment of depression, tDCS aims to combat left dorsolateral prefrontal cortex (DLPFC) underactivity - an imbalance that is hypothesised to be one of the biological causes of depression - through anodal stimulation and thus the increase of cortical activity in the area. tDCS may be administered alone or in conjunction with other psychological therapies and medications; however, results of tDCS and pharmacotherapy have been varied, either enhancing tDCS effects or abolishing them, and more research is required [7].

Clinical Efficacy of tDCS

Numerous studies have demonstrated the effectiveness of tDCS. A study by Fregni et al. (2006) following 10 patients with major depressive disorder (MDD) showed positive results and improvement of depressive symptoms after five 10-minute long sessions of 1 mA anodal tDCS where patients in the active treatment group experienced a 60% reduction in Hamilton Depression Rating Scale (HDRS) scores [8]. Comparatively, patients in a placebo (sham) treatment only experienced an HDRS reduction of 10% [8]. Boggio et al. (2008) found similar antidepressant effects in a clinical trial consisting of 40 patients with MDD where after ten 20-minute long sessions of 2 mA anodal tDCS, there was a 40.4% reduction in HDRS scores for those in the active treatment group, while patients in the sham treatment group only experienced an HDRS reduction of 10.4% [9]. The effects experienced by those in the active treatment group persisted for one month after the tDCS sessions had ended [9]. In another trial of 64 depressed

patients who underwent fifteen 20-minute long sessions of 2 mA anodal tDCS, Loo et al. (2012) found a 28.4% improvement in Montgomery-Asberg Depression Rating Scale (MADRS) scores for the active treatment group, compared to only a 15.9% improvement in the sham group [10]. A meta-analysis of these studies as well as sixteen others found similar results, where active tDCS treatments were superior to sham in reducing depressive symptoms [11]. Overall, the increased improvements of the active groups in these studies shows promising potential of tDCS as a treatment for MDD.

Advantages of tDCS

tDCS is inexpensive, non-invasive, and the equipment is reusable and easy to replace. The cost of a basic consumer-grade tDCS device could be as low as 100USD. Perhaps most importantly and most relevant to our current global climate, however, is the potential for tDCS to be used at home. The manufacture of portable tDCS devices could eliminate the need for visits to clinics and would allow for the maintenance of social distancing guidelines. However, it is important to note that this would require thoroughly training a patient in the proper usage of tDCS, something that may be tricky or cumbersome for some users and discourage them from continuing with treatment.

As well, tDCS may offer an alternative course of action for patients with treatment-resistant depression who have failed to find relief in conventional clinical therapy and psychotropics. 30% of patients with depression do not see substantial results from traditional therapies [12, 13]. Indeed, Palm et al. (2009) found modest improvement of treatment-resistant depression in a patient after 16 tDCS sessions [14]. tDCS efficacy is, however, lowered in those with treatment-resistant depression [11]. tDCS also offers the advantage of having minimal side effects compared to drug treatments such as SSRIs which have been linked with causing sexual dysfunction, weight gain, nausea, anxiety, and other unpleasant side effects [15]. Many patients also find the prescribed doses of their medications to be inadequate or aggressive, something that may be caused by the individual variation in drug metabolism [16]. The challenges associated with drug therapies can become intolerable for some patients and lead to treatment discontinuation. Other individuals, such as pregnant or breastfeeding women, may not be able to take medications at all without risking harm to their developing fetus or child. tDCS, which is localized to the brain, could theoretically be offered as an alternative in such a case as well; however, this is an area requiring more research as safety outcomes for this group have not yet been evaluated [17, 18].

Safety and Other Considerations

However, tDCS is not entirely free from side effects. Most commonly, mild itching and tingling has been reported. Patients have also experienced temporary skin irritation, headaches, burning, and lesions due to dry electrode sponges [19]. However, no serious adverse effect has been reported nor have there been any irreversible injuries [19]. Brain lesions were only induced in rats when they were delivered a charge density two orders of magnitude higher than the charge density currently administered to humans [20]. tDCS sessions involving vulnerable individuals such as those with geriatric depression, children with cerebral palsy, and post-stroke aphasia patients also supported safety [21, 22, 23]. Repeated exposure to the treatment has also been

shown to be safe; depressed patients who underwent over 100 sessions displayed no serious adverse effects [24].

A notable phenomenon has also been found with tDCS, certain tasks involving motor and a cognitive activity performed during stimulation can interfere with and abolish the effects of tDCS. In one study, completing a questionnaire such as a math quiz or pushing a ball resulted in modified tDCS efficacy [25]. The cognitive task resulted in motor cortex excitability lower after anodal stimulation and higher after cathodal stimulation while the motor task lowered motor cortex excitability after both anodal and cathodal stimulation [25]. If the effects of tDCS can be abolished through specific states of a participant during stimulation, this could be problematic - especially when considering the usage of home-based tDCS. Patients facing distractions or simply experiencing certain cognitions could have the effects of their tDCS treatment nullified. Once again, this is why potential users must be thoroughly trained and educated before beginning treatment. These findings also open the door for more future research to be done. Much is still not understood about tDCS, and the effects of interference found in this study as well as others have not been discussed enough [26].

Conclusion

tDCS is promising for the future of accessible mental healthcare and neurotherapeutics, something that is required now in this era of social isolation more than ever. However, despite the COVID-19 induced mental health crisis and the growing need for social-distancing-safe resources, tDCS as a novel treatment currently lacks FDA-approval and is still surrounded by stigma and uncertainties. More research, work, and education must be done before such a therapy may become a wide-spread treatment route for depression. Specifically, safety outcomes for vulnerable groups such as pregnant women, the effects of tDCS in conjunction with certain medications, and potential challenges for home-based users should be assessed. The interference effect is also an area that must be looked into further and addressed through coming research. As stated by Horvath et al. (2014), “rather than seeing [issues] as a detriment to the field, we should use them to guide future research and exploration” [26].

Declarations

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