Investigating the Neuromodulatory Effects of Transcutaneous Spinal Direct Current Stimulation on Manual Dexterity and Cerebral Excitability

[1]**Marielle C. Diaz** BS; Oluwole Awosika, MD, MSCR; Colin Drury, MS
[1]University of Cincinnati College of Medicine
[2]Department of Neurology and Rehabilitation Medicine. University of Cincinnati College of Medicine

Introduction: Stroke is the leading cause of adult-onset chronic disability in the United States. A majority of severe stroke survivors are left with inadequate upper extremity function. It has been established that the primary motor cortex is responsible for fine motor skills in humans, and is typically affected after a stroke. Direct Current Stimulation (DCS) is a non-invasive form of electrical stimulation that has previously been shown to modulate the primary motor cortex in healthy individuals and stroke patients. In this study, we test a form of DCS termed transcutaneous spinal direct current stimulation (tsDCS) to investigate whether this stimulation approach could enhance the effects of manual dexterity training. Manual dexterity was measured using a grooved pegboard (GPB).
Methods: 54 healthy right-handed individuals, 18-40 years old, were enrolled into this double-blinded, randomized control, parallel design. The aim of this study was to determine if right-handed individuals could improve the manual dexterity in their left hand, and if this improvement was dependent on the type of tsDCS received. Participants were randomized into one of three groups: cathodal(-), anodal(+), or sham(=) tsDCS. TsDCS was concurrently administered with manual dexterity training. The primary outcome was the effect on the left hand (non-dominant) immediately post-training and 24hrs post-training. The secondary outcomes were the effect on the right hand (dominant). Completion times for the GPB were collected pre-training, immediately post-training and 24 hours after training.
Results: All groups demonstrated improvement with GPB completion immediately post training: 4.72 ± 3.34 (cathodal stimulation), 5.00 ± 3.53 (anodal stimulation), 5.12 ± 3.63 (sham stimulation), with no between group differences. For the left hand (trained-non-dominant), the cathodal and sham tsDCS groups showed a decline in predominance forgetting from post-training to 24 hours post training. For the left hand, the anodal tsDCS group, stayed the same or showed slight improvement in their time score from post-training to 24 hours post training. For the dominant -right hand), all 3 tsDCS groups continued to improve from post-training to 24 hours post training.
Conclusion: Our preliminary findings suggest that right handed individuals can be trained to improve manual dexterity of the left non-dominant hand with practice; however, there was a trend towards forgetting (regression) at 24hrs post-training (sham and cathodal). In contrast, our results suggest that anodal (+) tsDCS facilitated retention at 24hrs, although not reaching a level of significance. Unexpectedly, although the right (dominant hand) was not directly trained, all groups demonstrated improvement in GPB completion times immediately and at 24hrs post training. The mechanism of phenomenon may be related to interhemispheric interactions mediated by the corpus callosum.
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