

Title: Acute Effects of Transcranial Direct Current Stimulation (tDCS) on Musical Performance: How Non-invasive Brain Stimulation Enhances Performance in Young Orchestra Instrumentalists

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Background: Musical performance requires technical precision, motor learning and control, and emotional regulation. Transcranial direct current stimulation (tDCS) has shown potential to modulate cortical excitability and enhance performance, but its effects on young musicians remain unclear.

Aim: To investigate the acute effects of tDCS on musical performance in young Brazilian orchestra instrumentalists.

Methods: In this double-blind, sham-controlled proof-of-concept trial, 14 young Brazilian orchestra musicians were randomized (1:1) into active (2.0mA; anode over the motor control area, cathode over Fp2) and sham tDCS groups for 30 minutes. Participants performed standardized musical pieces selected from Grade 5 of the Associated Board of the Royal Schools of Music repertoire at baseline, immediately after stimulation, and 2 hours post-intervention. Performances were evaluated by three blinded judges using a standardized rubric covering five domains: technical proficiency, interpretative quality, stylistic coherence, repertoire difficulty, and stage presence. Secondary outcomes included self-reported musical performance scores. Analyses employed Wilcoxon and Mann-Whitney U tests, with effect sizes calculated using Rosenthal's r . Statistical significance was set at $p < 0.05$, and analyses were performed in JASP.

Results: All 14 participants (mean age: 24.6 ± 3.2 years in the active group; 23.4 ± 3.9 in the sham group; 50% male) completed the study. Groups were matched at baseline by age and years of practice ($p = 0.69$). The active group showed significant improvements across all musical performance domains (all $p < 0.05$; $r = 0.91$), while the sham group showed no significant changes ($p > 0.05$). Self-reported performance scores in the active group increased significantly from 4.86 to 7.71 at 2 hours post-intervention ($p = 0.02$; $r = 0.84$), with no significant change in the sham group ($p = 0.31$). Between-group differences were significant ($p < 0.01$; $r = 0.75$).

Conclusion: Anodal tDCS may acutely enhance musical performance in young orchestra musicians, improving technical proficiency, interpretation, stylistic expression, repertoire execution, and stage presence. Further research is needed to explore its long-term effects.