



The Effectiveness of Sensorimotor Rehabilitation with Transcranial Direct Current Stimulation on Response Inhibition and Risk Taking in Gifted Adolescents with Oppositional Defiant Disorder

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Abstract

The present study aimed to evaluate the effectiveness of sensorimotor rehabilitation combined with transcranial direct current stimulation (tDCS) on response inhibition and risk-taking in gifted adolescents with oppositional defiant disorder (ODD). A semi-experimental design was employed, using a pre-test-post-test approach with a control group. The statistical population consisted of gifted boys aged 12-18 with ODD in Tehran in 2024, from which 30 participants were selected through purposive sampling. The experimental group received sensorimotor rehabilitation with tDCS, applying anodic stimulation to the left dorsolateral prefrontal cortex and cathodal stimulation to the right. The Adolescent Behavioral Problems Scale, Moon and Sun Stroop Test, and Balloon Analogue Risk Task were utilized for assessment. Data were analyzed using univariate analysis of covariance. Findings indicated a significant difference in post-test results between the two groups regarding response inhibition and risk-taking, after controlling for pre-test.

Keywords: Oppositional defiant disorder, response inhibition, risk taking, sensory rehabilitation, tDCS.

Introduction

The concept of giftedness has undergone significant evolution over time, traditionally being associated with results from intelligence tests. However, recent research has demonstrated that giftedness encompasses a broader spectrum, including not only cognitive abilities but also social and emotional dimensions (Opoku et al., 2024). Many gifted children face various behavioral and emotional challenges, which can often be linked to environmental factors, individual differences, and the pressures associated with high expectations (Kowalski et al., 2021). One prevalent issue among this population is Oppositional Defiant Disorder (ODD), characterized by a pattern of angry, irritable mood, argumentative behavior, and defiance toward authority figures (Gomez et al., 2022). These challenges can hinder the potential of gifted children, making it crucial to explore effective interventions. Recent studies suggest that sensory-motor rehabilitation combined with transcranial direct current stimulation (tDCS) may offer promising benefits in improving cognitive and behavioral outcomes for children with ODD (Salimi Noveh & Andishmand, 2023). The tDCS was applied using a non-invasive device, targeting specific areas of the brain associated with impulse control and decision-

making. Ethical considerations were strictly followed, including obtaining informed consent from parents and assent from the adolescents before participation. This research aims to investigate the effects of such interventions on response inhibition and risk-taking behavior among gifted adolescents diagnosed with ODD. The hypotheses of this study were:

- Sensory-motor rehabilitation combined with tDCS will positively impact response inhibition in gifted adolescents with ODD.
- This intervention will also lead to a reduction in risk-taking behavior among these adolescents.

Method

This study employed a quasi-experimental design with a pre-test/post-test control group to assess the effectiveness of sensory-motor rehabilitation combined with (tDCS) on gifted adolescents diagnosed with (ODD). The target population consisted of 30 gifted boys aged 12 to 18 years, identified through intelligence testing and referred for behavioral assessment in schools across Tehran. Participants were selected using purposive sampling, ensuring they met the criteria for giftedness and ODD as defined by the DSM-5. Once identified, participants were randomly assigned to two groups (n1, n2 =15 each). The experimental group received an eight-session intervention that included sensory-motor rehabilitation techniques alongside tDCS, administered for 20 minutes, 2 sessions per week. The sensory-motor rehabilitation involved activities designed to enhance motor skills, coordination, and sensory processing, tailored to the individual needs of each participant. Participants were assured of confidentiality and the right to withdraw from the study at any time. Data collection involved pre-test and post-test assessments using standardized tools. The Achenbach Youth Behavior Checklist was utilized to evaluate emotional and behavioral problems, while the Stroop Moon and Sun Test (SMST) measured response inhibition. Additionally, the Balloon Analogue Risk Task assessed risk-taking behavior. Data analysis were conducted using SPSS version 26, employing ANCOVA to determine the significance of the intervention's effects on the measured outcomes, controlling for any potential confounding variables.

Tools

Achenbach Youth Behavior Checklist (AYBC): This 30-item tool assesses emotional and behavioral problems, with a reported reliability coefficient of 0.80 (Achenbach & Edelbrock, 1991). In this study, the reliability of the confrontational disobedience subscale was obtained by Cronbach's alpha method of 0.80.

Stroop Moon and Sun Test (SMST): This test includes two pages with images to measure response inhibition, showing a reliability coefficient of 0.83 (Periáñez et al., 2021). In this study, the reliability of the scale was obtained by Cronbach's alpha method of 0.73.

Balloon Analogue Risk Task (BART): A computerized test with 10 items measuring risk-taking behavior, demonstrating a reliability coefficient of 0.87 (Lejuez et al., 2002). In this study, the reliability of the scale was obtained by Cronbach's alpha method of 0.79.

Results

The results of the study indicated a significant improvement in both response inhibition and risk-taking behavior among the experimental group following the intervention. In the post-test assessments, the experimental group exhibited a notable decrease in response inhibition scores ($M = -0.17$, $SD = 0.05$) compared to their pre-test scores ($M = -0.34$, $SD = 0.04$). Regarding risk-taking behavior, the experimental group demonstrated a significant reduction in scores from the pre-test ($M = 31.53$, $SD = 1.55$) to the post-test ($M = 25.40$, $SD = 1.84$).

Table 1: Results of Univariate Covariance Analysis for Examining the Differences between Experimental and Control Groups in Variables

Variable	Source of Variation	Sum of Squares	df	Mean Squares	F	P	Eta
Response Inhibition	Pre-test	0.05	1	0.05	6.67	0.016	0.19
	Group Membership	0.15	1	0.15	19.48	0.001	0.41
	Error	0.20	27	0.00			
Risk-taking	Pre-test	31.63	1	31.63	24.95	0.001	0.48
	Group Membership	21.36	1	21.36	16.85	0.001	0.38
	Error	34.23	27	1.26			

ANCOVA results confirmed a significant group effect on response inhibition ($F(1, 28) = 19.48$, $p < 0.01$) and risk-taking behavior ($F(1, 28) = 16.85$, $p < 0.01$), indicating that the sensory-motor rehabilitation combined with tDCS significantly improved these outcomes in gifted adolescents with ODD. These findings underscore the efficacy of the intervention in addressing behavioral challenges faced by this population.

Discussion and Conclusion

This study highlights the positive impact of sensory-motor rehabilitation combined with transcranial direct current stimulation (tDCS) on response inhibition and risk-taking behavior in gifted adolescents diagnosed with (ODD). The significant improvements observed in the experimental group suggest that targeted interventions can effectively address behavioral challenges often faced by this population. The findings emphasize the importance of integrating cognitive and behavioral therapies to support gifted children, who may struggle with emotional and behavioral issues due to their unique profiles. By enhancing response inhibition and reducing risk-taking behavior, these interventions can help improve overall functioning and well-being. Additionally, investigating the underlying mechanisms of change can provide deeper insights into how these therapeutic approaches work. Overall, this study contributes valuable evidence to the field of gifted education and mental health, advocating for tailored

interventions that recognize and address the complex needs of gifted adolescents with ODD. Future research should also consider employing three separate groups to compare the effects of each intervention individually. However, one limitation of this study is the use of a combined method rather than employing three separate groups for comparison. Future research should explore the long-term effects of such interventions and their applicability across diverse populations. By addressing these methodological limitations, future studies can build on the current findings and further advance our understanding of effective interventions for gifted adolescents with ODD.

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Conflicts of Interest

The authors declare no conflicts of interest.



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