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Comparing the Effectiveness of Cognitive Behavioral Play Therapy and Transcranial Direct Current Stimulation on Depression in Children with Attention Deficit/Hyperactivity Disorder

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ABSTRACT

Objective: Children diagnosed with attention deficit/hyperactivity disorder are subject to a range of behavioral and emotional adversities. The objective of this investigation was to evaluate the relative efficacy of cognitive behavioral play therapy and transcranial direct current stimulation on alleviating depression in children with attention deficit/hyperactivity disorder.

Methods: The present study was designed as a semi-experimental investigation employing a pre-test-post-test methodology, inclusive of a follow-up phase and a control group. The statistical sample comprised children aged between 6 to 12 years who exhibited symptoms of attention deficit/hyperactivity disorder and sought services at the Nirvana Psychological Clinic in Shiraz; from this population, 45 participants were selected and randomly allocated into two experimental groups and one control group. Participants in the first experimental group received cognitive behavioral play therapy, while those in the second experimental group underwent transcranial direct current stimulation, administered over the course of 12 sessions. The control group did not receive any form of intervention. At both the commencement and conclusion of the treatment sessions, in addition to the follow-up period, all participants across the three groups completed the children's depression questionnaire.

Results: The collected data were subjected to analysis via repeated measures analysis of variance. The findings indicated that both cognitive behavioral play therapy and transcranial direct current stimulation interventions exerted a statistically significant impact on the reduction of depressive symptoms in children with attention deficit/hyperactivity disorder during the post-test and follow-up phases ($P<0.001$). No statistically significant difference was observed between the efficacy of the two interventions ($P>0.05$).

Conclusions: Consequently, it can be concluded that both cognitive behavioral play therapy and transcranial direct current stimulation possess the potential to ameliorate depression in children diagnosed with attention deficit/hyperactivity disorder.

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Introduction

One of the most prevalent disorders observed in childhood, which has garnered significant interest from psychologists and psychiatrists, is Attention-Deficit Hyperactivity Disorder (ADHD). The estimated prevalence of this disorder ranges from 9% to 15% (1). This disorder is categorized into three primary classifications, namely the predominantly inattentive type, the predominantly impulsive type, and the combined type (2). Attention Deficit Hyperactivity Disorder may persist from childhood into adulthood, resulting in numerous symptoms and impairments in the domains of attention, activity, and impulsivity (3). This disorder is linked with challenges across various educational contexts, including academic performance, weakened familial and social relationships, diminished mental health, and substance abuse (4). Empirical research indicates that Attention Deficit Hyperactivity Disorder impacts both children and their parents, as these children exhibit heightened emotional, behavioral, and academic difficulties compared to their peers (3). Attention Deficit Hyperactivity Disorder is frequently associated with other psychiatric conditions, leading to instances where individuals with this disorder may be erroneously diagnosed with anxiety or depression (5). Findings from research suggest that the prevalence of mental disorders and associated issues, such as social isolation, anxiety, psychological distress, and symptoms of depression, is elevated among individuals with Attention Deficit Hyperactivity Disorder (6). The coexistence of depression and Attention Deficit Hyperactivity Disorder is notably frequent, with a considerable number of individuals affected by this disorder also experiencing symptoms of depression (7). Furthermore, it has been demonstrated that in patients diagnosed with Attention Deficit Hyperactivity Disorder, symptoms of depression and its associated complications, such as lack of motivation, hopelessness, and mental fatigue, can exacerbate the prognosis of this disorder, while concurrently an evaluation of the patient's performance may elevate the likelihood of academic, occupational, and professional failures (8). According to the available literature, pharmacological treatment alone seldom suffices to fulfill the therapeutic requirements of children afflicted with this disorder, necessitating the inclusion of psychological interventions (7). In this

context, it has been established that non-pharmacological therapies, such as play therapy and rehabilitation, have proven effective for a substantial proportion of children.

When linguistic expression proves insufficient for articulating the thoughts and emotions of children, practitioners resort to play therapy as a means to assist said children (9). Play therapy is deemed an appropriate intervention for young children, as play serves as the innate language of a child, who frequently encounters challenges in conveying their emotions verbally; thus, this modality enables the child to manifest their distressing feelings and internal struggles. (10). Play constitutes a voluntary activity that affords the child enjoyment and facilitates the expression of their experiences, thoughts, emotions, and desires that may evoke feelings of threat (11). This form of play establishes a connection between the child's internal thoughts and the external environment, empowering the child to exert control over external objects (12). The primary objective of cognitive-behavioral play therapy is to recognize and alter maladaptive cognitions associated with children's behaviors and emotional difficulties, serving as a versatile treatment for young children that diminishes the necessity for verbal expression and enhances reliance on experiential methodologies (13). Within this framework, cognitive transformations are conveyed indirectly through play, fostering the development of more adaptive behaviors in the child. Play therapy grounded in the cognitive-behavioral paradigm operates under the premise that individual behavior is contingent upon one's interpretation of the surrounding world (14). For play therapy to exhibit efficacy from this perspective, the activities must be meticulously structured, goal-oriented, and designed to motivate the child. A significant advantage of cognitive-behavioral play therapy, in contrast to alternative forms of play therapy, lies in its specificity of objectives and therapeutic methodologies (15). Such methodologies enable the establishment of clear therapeutic goals and offer precise strategies for their attainment. Furthermore, it appears that transcranial direct current stimulation, a technique involving direct electrical stimulation of the brain through the skull, may serve as an effective intervention for ameliorating depressive symptoms in children diagnosed with attention deficit/hyperactivity disorder. Transcranial direct current stimulation is classified as a neurotherapeutic technique that delivers a direct and mild current to cortical areas, thereby

facilitating or inhibiting spontaneous neural activity (16). Over the past decade, direct electrical stimulation of the brain has undergone extensive testing and examination, establishing itself as a non-invasive, cost-effective, and safe alternative method for modulating the excitability of the cerebral cortex by altering the resting potential of cortical neurons (17). This mild and direct current, facilitated by the connection of two electrodes with distinct poles, namely an anode and a cathode, stimulates underlying neurons at various sites on the surface of the skull (18). Stimulation via the cathode diminishes brain excitability, whereas stimulation through the anode results in an elevation of brain excitability (19). Indeed, the modulation of neuronal excitability and the adjustment of the membrane potential of surface neurons toward depolarization or hyperpolarization engenders either an increase or decrease in neuronal firing (20). The outcomes of numerous studies indicate that transcranial direct current stimulation may be effective in enhancing executive functions and ameliorating mood and psychological symptoms, including anxiety and obsessive tendencies (18-20). In light of the imperative to develop efficacious and innovative therapeutic methodologies within the realm of pediatric care for children afflicted with attention deficit/hyperactivity disorder, aimed at ameliorating their behavioral and emotional deficiencies, the current investigation juxtaposes the efficacy of cognitive behavioral game therapy against direct electrical stimulation of the cerebral cortex. The cranium was examined in relation to the alleviation of depressive symptoms in children diagnosed with attention deficit/hyperactivity disorder.

Material and Methods

The present investigation constituted a semi-experimental design characterized by a pre-test-post-test-follow-up methodology alongside a control group. The framework of this research has received endorsement from the Ethics Committee of Islamic Azad University, Arsanjan Branch, under identification number IR.IAU.A.REC.1401.001. The statistical population for this inquiry comprised all children between the ages of 6 and 12 years diagnosed with attention deficit/hyperactivity disorder who sought assistance at the Nirvana Counseling and Psychological Clinic in Shiraz during the latter half of 2018 through May 2019; from this population, 45

individuals who provided comprehensive consent for participation and met additional eligibility criteria were selected and randomly allocated to two experimental groups and one control group. For the experimental groups, either cognitive behavioral therapy or direct electrical brain stimulation was administered, while the control group received no intervention. At both the commencement and conclusion of the treatment sessions, as well as during the two-month follow-up period, participants from all three groups completed the children's depression questionnaire. The inclusion criteria for this research encompassed the following: a diagnosis of attention deficit hyperactivity disorder, willingness to engage in the research, cohabitation with parents, absence of a history involving other mental disorders, epilepsy, or convulsions, and being right-handed. The exclusion criteria were as follows: possessing any disabilities such as deafness, blindness, mental retardation, or movement coordination disorders as indicated in the case file, concurrent participation in analogous intervention programs, and absence from more than two sessions within the intervention program.

Research tools

Children's Depression Inventory: The depression inventory was designed by Smaker et al. (21), which is a 27-item self-report tool and is used to assess depression symptoms in children and adolescents. The depression questionnaire includes 5 subscales, which are: negative mood (items 1, 6, 8, 10, 11, 13), interpersonal problems (items 3, 15, 23, 24), sense of futility (item items 5, 12, 26, 27), lack of pleasure (items 4, 16, 17, 18, 19, 20, 21, 22) and low self-esteem (items 2, 7, 9, 14, 25). The items are scored based on the classification of 0 (absence of symptoms) to 2 (presence of specific symptoms). The overall score has a range of 0 to 54, and the higher the child's score, the greater the severity of depression. A score of 0 to 8 is a sign of a healthy person, a score of 9 to 19 is a sign of depression threshold, and a score of 20 and above is a sign of depression. The creators of this depression questionnaire showed that this instrument had a correlation of 0.57 with other questionnaires related to depression in childhood and adolescence, including the Reynolds Depression Scale for adolescents, which indicates its concurrent validity, and the internal consistency based on Cronbach's alpha was 0.86. They brought (21). A number of researches in Iran showed that the score of depressed children in the children's depression questionnaire is significantly higher than the score of non-depressed children in the control group, which indicates its differential validity (22).

Game therapy intervention based on cognitive behavioral methodology

The people of the first experiment group were subjected to game therapy based on cognitive-behavioral methodology in the form of 12 sessions of 30 to 40 minutes; The content of play therapy sessions is shown in the table 1.

Table 1. Game therapy protocol based on cognitive behavioral therapy

Session	Aim	Content
1-2	Acquaintance and encouragement to cooperate - increasing self-awareness skills	Showing cartoons and imaginary paintings, playing with ink, mirror, watercolor, blackboard
3-4	Improving motor skills and self-control	Playing with yarn, rosary, play dough and making human puzzles, working with sand, making sand sculptures, playing with wooden cubes
5-6	Strengthen cooperation and express emotion	Playing with cans and hearing aids, play dough, lego, finger puppets, stories and playing with balls and buckets.
7-8	Improving problem-solving and decision-making skills	Voice imitation game, crafts, darts and number and letter puzzles, copying geometric shapes, copying hidden shapes, playing with objects inside the bag
9-10	Strengthening collaborative activities and interpersonal and group communication	Bubble game, educational cards, two individual menus and playing with balloons, stringing beads, telling stories from the picture.
11-12	Awareness of behavioral signs and learning adaptive responses	Play dough, play ball and make a story, logo with pattern, play with song and story telling

Intervention of direct electrical stimulation of the brain

The subjects of the second experiment group were subjected to direct electrical stimulation of the brain in the form of 12 sessions of 30 minutes; The sessions of this intervention were implemented 3 days a week for 4 weeks. For this purpose, the anode pole of the device was placed in the posterior lateral region of the left prefrontal cortex and the cathode was placed in the posterior lateral region of the right prefrontal cortex and secured in place by special tapes. A current of one milliampere was used. During this period, the respective sponges were kept moist with 9% distilled water. During the work, possible symptoms were controlled in terms of dizziness, itching or burning, and if the child had any of these symptoms, the electrodes were checked.

Research implementation method

In order to implement this research project, at first, necessary arrangements were made with Nirvana counseling and psychological clinic in Shiraz city. In order to comply with ethics in the research, the condition of informed consent to participate in the research, the confidentiality of the participants' personal information and the possibility of withdrawing from the cooperation at each stage of the research were taken into account. Before the implementation of the project, explanations were given to the parents of the participating children in a briefing session regarding the objectives and process of the research and how to hold the meetings and their number. Also, the consent form was completed by the parents to participate in the research. The subjects of the first experimental group were subjected to game therapy based on cognitive behavioral methodology in the form of 12 sessions of 30 to 40 minutes, and the subjects of the second experimental group were subjected to direct electrical stimulation of the brain in the form of 12 sessions of 30 minutes. In this research, in order to analyze the data, SPSS version 21 software and repeated analysis of variance test were used.

Results

Based on the demographic information related to two experimental and one control groups, each of which had 15 participants; The average age of the subjects in the tDCS test group was 10.89, the play therapy group was 11.20, and the control group was 11.24 years old. 7 participants from the tDCS experimental group, 6 participants from the play therapy experimental group and 8 participants from the control group were girls. Descriptive statistics including the mean and standard deviation of the subjects' scores of the three groups in depression variables are presented in Table 2.

Table 2. Descriptive characteristics of research variables in three groups in depression variable

Variable	Group	Pretest	Posttest	Follow up
		Mean (SD)	Mean (SD)	Mean (SD)
Depression	Control	25.76 (6.21)	24.27 (5.86)	25.31 (4.84)
	tDCS	26.12 (5.28)	19.04 (5.41)	19.35 (5.20)
	Play therapy	24.87 (4.52)	17.92 (4.30)	18.51 (3.67)

As can be seen in Table 2, the average scores of depression in the post-test compared to the pre-test have changed in the two experimental groups, but in the control group these values have not changed. In the following, by using the analysis of variance test with repeated measurement, the difference of depression scores was compared according to the inter-group and intra-group position. Before that, the assumption of normality of frequency distribution of the variables was checked and the results of the Kalmogorov-Smirnov test indicated the normality of the data frequency distribution (P>0.05). The results of Levine's test showed that the presumption of homogeneity of variances was established for the depression variable (F=0.92, p=0.13). The results of the multivariate test are given in Table 3. This analysis firstly compares the linear combination of depression score in terms of time as well as the interactive effects of group and time separately.

Table 3. Results of multivariate test of depression score

Source	Wilks' lambda	F	Hypothesis DF	Error DF	P	η^2
Time	0.48	13.39	2	41	0.001	0.36
Time * Group	0.61	8.51	4	82	0.001	0.28

As shown in Table 3, there is a significant difference between the depression score in the pre-test, post-test and follow-up three times. Also, the second part of the results of this table shows that there is an interaction between the effect of group and time, and in other words, there is a significant difference in the depression score in the three times of pre-test, post-test and follow-up in the two experimental groups and the control group. After it is determined that there is a significant difference between the three implementations (pre-test, post-test and follow-up), the results of the intra-subject effects test are examined. But before that, it is necessary to test the hypothesis of the porous sphericity test - checking the homogeneity of the error covariance matrix - the results of which showed that this assumption was not met in the case of depression (P < 0.05) and based on this, the Greenhouse Geyser test was used.

Table 4. Results of repeated analysis of variance of depression score

Source	**SS**	**DF**	**MS**	**F**	**P**	**η^2**
Time	4226.22	1.42	2976.21	14.68	0.001	0.38
Time * Group	3371.48	2.84	1187.14	9.98	0.001	0.29
Groups	3105.56	2	1552.78	7.31	0.001	0.23

Table 4 shows the test of intragroup effects. As shown in the above table, the effect of time (P=0.001, F=14.68) is significant and there is a significant difference between the level of depression in pre-test, post-test and follow-up. Also, in this table, the interaction effect between time and group is also shown; This effect is significant (P=0.001, F=9.98). Therefore, the level of depression interacts with the levels of the groups. That is, the level of depression is different in different groups. Table 4 shows that there is a significant difference between the depression scores (P=0.001, F=7.31) among the groups. Taking into account the results of the intergroup test and following the statistical analysis, Bonferroni's post hoc test was also calculated, the results of which are shown in Table 5.

Table 5. Bonferroni's post hoc test results of the difference between the three groups in the three phases of the depression test

Group comparison	Mean difference	SD	P
Control-tDCS	5.57	1.32	0.001
Control-Play therapy	4.89	1.08	0.001
Play therapy- tDCS	0.84	0.41	0.216
Phase comparison	Mean difference	SD	P
Pretest-posttest	7.13	1.22	0.001
Follow – pretest	5.95	1.39	0.001
Follow up- posttest	0.57	0.25	0.53

The results of Bonferroni's post hoc test show that the difference in scores between the group of cognitive behavioral therapy and direct electrical stimulation of the brain and the control group in depression is statistically confirmed (P=0.001). However, the difference in scores between the group of cognitive behavioral therapy and direct electrical stimulation of the brain was 0.84, which was not statistically significant (P<0.05). This means that there is a significant difference between the effectiveness of cognitive behavioral therapy and direct electrical stimulation of the brain on improving depression compared to the control group, but there is no significant difference between the effectiveness of the two groups. Also, the results of Bonferroni's post hoc test to check the difference between the three stages showed that the difference between the scores of the dependent variable in the post-test and the pre-test is 7.13 and in the follow-up with the pre-test is 5.95, which is statistically confirmed (0.01/ P = 0). The difference between depression scores during follow-up and post-test was 0.57, which was not statistically confirmed (P<0.05).

Discussion

This research was undertaken with the objective of assessing the efficacy of cognitive behavioral game therapy in conjunction with direct electrical stimulation of the skull in alleviating depression among children diagnosed with attention deficit/hyperactivity disorder. The findings indicated that both cognitive behavioral play therapy and direct electrical stimulation of the skull contributed positively to the mitigation of depressive symptoms in children afflicted with attention deficit/hyperactivity disorder. These findings align with the outcomes of prior investigations. Shiroodaghaei et al. (13), in their examination of children with oppositional defiant disorder, concluded that cognitive behavioral game therapy proves effective in enhancing executive functions as well as interpersonal and social interactions within this demographic. Harris et al. (14), in their analysis of children suffering from obsessive-compulsive disorder, demonstrated that cognitive behavioral game therapy is efficacious in ameliorating the clinical manifestations of this condition and in diminishing the severity of anxiety. Varrette and colleagues (15), during their study on children with social anxiety disorder, established that cognitive behavioral game therapy effectively reduces the intensity of social anxiety while simultaneously elevating self-esteem levels among these individuals. Yamada & Sumiyoshi (18), in a comprehensive review of literature concerning direct electrical stimulation of the skull, indicated that this intervention possesses the potential to alleviate the severity of symptoms associated with mental disorders, such as depression and anxiety, through the facilitation of chemical and anatomical modifications. In their review, Salehinejad et al. (18) revealed that direct electrical stimulation of the skull can enhance and fortify neural networks and synaptic connections in individuals with attention deficit/hyperactivity disorder by promoting the neuroplastic state of the nervous system, thereby resulting in substantial improvements in cognitive and emotional performance. Furthermore, in their investigation, Friehs et al. (20) established that direct electrical stimulation of the skull can significantly elevate cognitive and behavioral inhibition, a critical factor often disrupted in numerous mental disorders.

In elucidating the efficacy of cognitive-behavioral play therapy in ameliorating depressive conditions, it is essential to articulate that cognitive-behavioral play therapy proves to be both beneficial and effective in fostering the development of social competencies and other adaptive strategies in children. In instances involving children diagnosed with attention deficit/hyperactivity disorder, learning disabilities, and academic failures, the imposition of labels and the receipt of adverse feedback from peers engenders a perception of difference from their contemporaries, exacerbating feelings of loneliness within the child. This predicament disrupts social interactions and culminates in social difficulties, diminished self-esteem, and ultimately manifests as symptoms of depression. Play therapy affords a secure environment wherein children can progressively articulate their emotions, anxieties, feelings of insecurity, aggression, and suppressed fears. The medium of play facilitates an avenue for the child to convey an illustration of their inner psyche, thereby enhancing emotional expression. It may be posited that through the manifestation of feelings or aggressive tendencies within the playroom, alongside the empathetic presence and understanding of the therapist—which holds significantly greater importance than the mere exhibition of aggressive behavior—the child acquires skills to address their needs in a socially acceptable manner. Furthermore, during play, the communication skills of children are honed, and within such a context, they are afforded the opportunity to repetitively reenact significant themes and experiences, articulate their sentiments, gain novel insights, and identify alternative strategies to address challenges. The primary objective of play therapy is to resolve any internal conflicts within the child that hinder their effective functioning within their environment. Throughout the play process, various attributes such as agility, attention, and comprehension are cultivated, contributing to the formation of the child's personality and effecting numerous transformations in their characteristics. The act of play enhances curiosity and the capacity for innovation, while also engaging the authentic emotions and experiential realities of the character involved. Collectively, cognitive-behavioral play therapy, when administered in a group context, aids the child in rectifying negative self-dialogues, augmenting self-awareness, and amending their narratives within these self-dialogues, thereby enhancing communication, conveying emotions,

receiving affirmative feedback, and embracing shortcomings across various domains. Such social and educational endeavors aimed at reinforcing certain abilities significantly impact the personal, social, and academic competencies of children grappling with attention deficit/hyperactivity disorder, potentially leading to a reduction in depressive symptoms.

In the discussion regarding the impact of direct electrical stimulation from the cranial region on the depressive symptoms in children afflicted with attention deficit/hyperactivity disorder, one hypothesis posits that various neurotransmitters, including serotonin and dopamine, are integral to mood regulation and depressive manifestations. Recent investigations indicate that subsequent to direct electrical stimulation applied to the frontal and prefrontal regions of the skull, there is an adjustment in the levels of serotonin and dopamine within the cerebral regions. Researchers believe that electrical stimulation of the prefrontal cortex activates the neurotransmitter dopamine and serotonin in this area, which is related to neural flexibility and improves emotional and cognitive performance in people (16). Also, direct electrical stimulation from the skull through the anodic pole causes stimulation improvement effects, which is associated with the regulation of glutamate and amino acid levels related to mood and cognitive activity (17). In this regard, it has been shown that anodic electrical stimulation significantly decreases GABA concentration and cathodic stimulation leads to a significant decrease in intracortical facilitation. Also, in another study, it was shown that the effects after direct electrical stimulation from the skull are associated with the regulation of serotonin, dopamine and acetylcholine levels. Among other effects of brain stimulation, we can mention the increase of regional blood flow in the brain, which is associated with the improvement of overall performance (16). The observed effects on the level of neurotransmitters and blood flow are caused by an increase in the excitability of the cortex in the frontal and left prefrontal area, because anodic stimulation by depolarizing the neuron causes a change in the resting state of the neuron and increases the excitability of that area. gives Also, research evidence shows that in patients with major depression, abnormal activity of the prefrontal cortex, which is related to executive functions; It is related to depression symptoms (18). This

point shows the role of this brain region in the physical pathology of major depression. On the other hand, it has been found that the ability of cognitive flexibility provides the possibility of simultaneously considering contradictory representations of an object or event when facing new stimuli and environmental conditions (20). Therefore, it seems that this can reduce the ability of these patients, which has been proposed in the theory of mind as one of the hypotheses of etiology in cognitive distortions; explain face; This means that therapists can increase positive mental states of patients by reducing cognitive distortions and reduce behavioral symptoms of depression and treat them (19). In general, it can be concluded that direct electrical stimulation from the skull not only causes spontaneous excitability of neurons by changing the membrane potential, but also causes neuroplastic changes by changing the function of synapses (18).

In conclusion, it may be articulated that empirical research indicates that cognitive behavioral game therapy, in conjunction with brain electrical stimulation, presents a viable and cost-effective intervention for alleviating depressive symptoms in children diagnosed with attention deficit/hyperactivity disorder. Among the constraints of the present study, there exist limitations pertaining to the sampling method, as the sample is confined to children attending a clinic in Shiraz, alongside concerns regarding the sample size. Consequently, it is recommended that future research endeavors employ random sampling techniques, encompass a broader demographic of children, and involve a more substantial number of participants.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by ethics committee of Islamic Azad University.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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