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Examining the Effectiveness of Cognitive-Motor Rehabilitation on the Motivation of Elementary School Students with Attention Deficit Hyperactivity Disorder

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This research aimed to explore cognitive-motor rehabilitation as well as its effectiveness on the motivation of both male and female elementary school students. The statistical population consisted of all girls and boys from two elementary schools in District 6 of Tehran along the academic year 2023-2024, In this study, a purposive sampling method was employed. A total of 30 students (15 girls and 15 boys) were randomly selected from the statistical population, which included all girls' and boys' students from two elementary schools in District 6 of Tehran. This selection was made in such a way that each student had an equal chance of being chosen After administering the IVA-2 test and Herman Academic Motivation Questionnaire in these students, cognitive-motor games were implemented, followed by a post-test. Further, in both the pre-test and post-test phases, the IVA-2 test and Herman Academic Motivation Questionnaire were given to the students, with the results of the pre-test and post-test compared, which was followed by the follow-up phase. Data analysis using SPSS 26 and ANOVA revealed that the main effects of the group (experimental and control) on academic motivation were significant. Also, the eta coefficient showed that 43.5% of the variations in academic motivation was related to the training provided through games to the participants in the study. According to the results, the mentioned cognitive-motor games allowed students to actively participate in the learning process. This type of interaction can lead to greater interest and enthusiasm for learning.

Keywords: attention deficit, cognitive skills games, hyperactivity, learning, motivation**.**

The pillars of civilization in any society are built upon its educational system, health, integrity, and efficiency of which depend on the breadth, diversity, and quality of comprehensive educational programs as well as services provided to students. Students with similar learning abilities and talents often exhibit significant differences in academic and non-academic achievement, primarily owing to variations in their motivation. Learners with high academic motivation engage more deeply with study materials and attain greater educational goals. Psychologists view motivation as a process that initiates, directs,

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and sustains behavior—the primary driving force behind human activities (Ghasemi arganeh, Pourroostaei Ardakani et al., 2021). Academic motivation is an intrinsic phenomenon affected by four factors: success (environment and external stimuli), temperament (internal state), goal (purpose, intention, and inclination), and means (tools for goal attainment) (Yousefi, Ghasemi & Firooznia, 2009, as cited in Dahghan Manshadi, Baviyeh Soltanzadeh & Hemmati, 2021). Academic achievement is a multidimensional variable linked to psychological, personality, and social factors in addition to educational issues (Aghaei, Nazari & Jalali, 2011). Positive educational variables such as academic enthusiasm, school engagement, and sense of belonging exert their effects on progress through motivational and behavioral mechanisms, including intrinsic motivation, diminished anxiety and stress, and desire for advancement (Hosseinmardi, Ghorban Shiroodi, Zarbakhshbahri & Tizdast, 2022). Supporting parents of children with special needs is equally important as addressing the children themselves (Ghazaei & Taheri, Ramezan Saatchi, 2021). Indeed, achievement motivation is a critical component of academic achievement (Rostami Sani, Mehdi & Seadatee Shamir, 2022). Accurate understanding of one's abilities enhances striving and success (Anderman, 2020). The psychosocial atmosphere of the classroom is also a critical factor, with achievement motivation involving feelings of competence and willingness to take risks for higher goals (McClelland, 1971).

Individual beliefs significantly impact success and life choices, reducing fatigue and providing energy for progress (Subatra, 2017; Javdan, 2022). Maslow's hierarchy of needs

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(1954) categorizes motivations hierarchically, whereas McClelland describes achievement motivation as stemming from the emotional conflict between hope for success and fear of failure (Austin May & Spinaz, as cited in Delir Nasir & Hosseini Nasb, 2015). Herzberg's motivational factors consist of achievement, recognition, the work itself, advancement, and growth (Acquah, et al, 2021; Gordon R. Judith et al., 1990, as cited in Acquah, Kwabena Nsiah, Naa Akushia Antie & Otoo, 2021).

Table 1
Classification of Some Theories of Achievement Motivation

Herzberg	McClelland	Alderfer	Maslow
Health	Need To Dependency	Existence	Physiological
	Need To Power	Communication	Safety and Security
Motivation	Need To the achievement	Growth	Belonging and love
			respect-Self confidence -Self -and self actualization

Gordon R. Judith et al., Management and Organizational Behavior, Allyn and Bacon, 1990, as cited in (Acquah, et al 2021).

Children play a key role in generational renewal, and identifying factors that hinder or facilitate their cognitive, social, and behavioral growth is necessary for effective education (Khadami Ashkezari & Mofradnejad, 2018). Meanwhile, a major obstacle is attention deficit/hyperactivity disorder (ADHD), characterized by inattention, hyperactivity, and impulsivity (Salari et al., 2023), often accompanied by deficits in executive functions and motor abilities (Chan, Jang & Ho, 2022). ADHD is linked to

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comorbidities and long-term adverse outcomes if untreated (Barbaresi et al., 2020; Cabral, Liu & Soares, 2020; Magnus et al., 2021). Pharmacological treatments are effective for most patients but insufficient or intolerable for some, entailing complementary interventions (Pezi et al., 2020). Approaches such as yoga have proved effective to boost attention (Mollazadeh, Gharayagh Zandi & Rostamizadeh, 2018). Also, executive functions are appraised via tasks like Go/No-Go, Stop Signal, Continuous Performance, and Stroop (Trommer, Hopner & Zicker, 1991, as cited in Nazifi, Rasoul-Zadeh Tabatabie, Azad-Fallah & Moradi, 2010).

Game-based learning and gamification hold potential for skill development and engagement (Ilić, Ivanović & Klašnja-Milićević, 2024; Seo, Kang, Kim & Jeong, 2024; Nirupa, Kumar, Poythra & William, 2024; Bi et al., 2024), though many previous serious games, including virtual reality interventions, have indicated limited efficacy (Rodrigo-Yanguas et al., 2021).

Problem Statement: In spite of extensive research on game-based interventions for children with ADHD, most studies have failed to comprehensively address core disorder improvement, environmental and cultural dependencies, potential medication reduction, individual learning needs, as well as negative effects such as competition-induced stress and anxiety. The present study aims to design and ascertain a specialized game that bridges these gaps by examining its effects on enhancing executive functions, cognitive-motor processing speed, and achievement motivation in children with ADHD.

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Method

The statistical population from the perspective of the survey research included specialists in computer games and educational technology, who were recruited for the internal evaluation and validation of the proposed framework. The statistical population employed for the external validation of the proposed framework consisted of male and female students aged 7 to 12 years with attention deficit hyperactivity disorder (ADHD), who were enrolled in the academic year 2024-2025. Thirty of these children were selected as a sample, with 15 placed in the experimental group and 15 in the control group. Note that these 30 children were selected from Imam Khomeini Hospital in Tehran after being diagnosed by a child and adolescent psychiatrist through purposive sampling, while some were diagnosed using the IVA-2 test. In this study, sampling was performed equally from both genders to ensure that the sample adequately represented the target population. Nevertheless, since the main objective of the research was to examine other variables and there was no hypothesis considering the effect of gender on the studied variables, separate statistical analyses based on gender were not performed.

In the domain of game design, interviews were conducted with a group of specialists in cognitive and educational fields who had published articles and books or had work experience in this area. After analyzing qualitative data, coding, and categorizing the content of written sources related to the elements of educational computer games, the desired codes were extracted. Further, after coding and categorizing the content of written sources related to cognitive-motor rehabilitation game

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mechanics, subcategories were extracted, whereby the main categories identified included:

1. Psychological characteristics
2. Attention and concentration
3. Executive functions
4. Processing auditory-visual stimuli
5. Academic motivation

After designing the game and obtaining approval from specialists, a pre-test was undertaken using the relevant motivation tools to determine its effectiveness, with the results analyzed further. Next, the cognitive-motor game was implemented. In this phase, the experimental group was subjected to the quality of this game, while the control group was not. The motivation tool was administered as a post-test, with the results subsequently analyzed and reviewed.

Instruments

IVA-2 Test

The IVA-2 is a computer-based test that appraises both ADHD and attention in two domains: auditory and visual. This test is suitable for individuals aged 6 to 96 years. It consists of three parts: i) the instructions; ii) practice; and iii) the main test section, which lasts for 15 minutes. All these stages are presented in Persian. Note that the IVA-2 is compatible with DSM-5. The software is capable of providing various reports and analyses of the test, all being available in the original language and English.

Academic Motivation Questionnaire

This scale was developed by Hermans (1970). The questionnaire contains 29 items rated on a 5-point Likert scale. The reliability coefficient of the questionnaire is .84. For

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calculating the validity of this questionnaire, content validity was employed, based on previous research on achievement motivation, whereby the correlation coefficient of each question with achievement-oriented behaviors was also calculated. The coefficients for the questionnaire items range from .30 to .57. Hermans (1970) utilized the Cronbach's alpha method to calculate the reliability of the academic motivation test, introducing a reliability coefficient of .84. In the main study, the questionnaire was re-administered to the trainees after three weeks, yielding a reliability coefficient of .84. In the research by Mansournia and Karimi (2019), the overall alpha of the questionnaire was found to be .795. The validity of the questionnaires was confirmed by five professors in the psychology field. For calculating the reliability coefficient of the measurement tool, Cronbach's alpha was applied. A total of 30 questionnaires were distributed among students at Azad University of Naqdeh, leading to an overall alpha of .795 for the current research.

This game is specifically designed for students with hyperactivity and attention deficits, and it can be employed alongside or without medication. The game is structured in an apartment format, with the floors containing the following: first floor 20 tokens, the second floor 20 colored cards, the third floor 20 number cards, the fourth floor 32 alphabet cards, the fifth floor 20 animal picture cards, and the sixth floor 20 coins. The components of each floor are collected in different colors.

The package includes a special timer with an alarm which measures the performance of hyperactive students with attention deficits and provides a time-out alert when the time is up. There is also a talking symbol and guide within the package that assists

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the child along the designated path. The child matches the green token from the first floor with the green colored card from the second floor, the green number from the third floor, the green letter from the fourth floor, and the green animal from the fifth floor. Once the numbers are matched, the floors are aligned based on numbers and letters (the number of numbers = the number of letters), and so on. Further, a children's song is played from the beginning to the end of the game, while the child's attention is concurrently measured.

Table 2
Steps for Designing Physical (Cognitive-motor) Games

Row	Duration (Minutes)	Goal	Game steps
1	5	Child's identification of physical play texture	Introducing the components of play to the child
2	10	Increased concentration motivation, and visual and auditory abilities	Moving Pieces and cards on the game floors matching the pieces to the cards by color, and listening to researcher
3	10	IncreasedFocus and reduced hyperactivity Ability Visual and Motivation	Homologation Cards with higher deck numbers (the number on the card written in letters with the higher deck numbers written indigits).
4	10	IncreasedFocus and speed of processing visual stimuli	Homologation Animal namewith itsimage
5	10	IncreasedFocus and reduced hyperactivity, improved and accelerated	Sort all classes by color

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6		executive functions and increasedSpeed Processing Stimuli Visual

Results

Description of Research Variables

Table 3 reports descriptive information on the academic achievement motivation variable in three measurement stages (pretest, posttest, and follow-up). In the present study, the academic achievement motivation variable was measured based on a four-option spectrum.

Comparing the mean scores of the variable of motivation for academic achievement indicated that in the cognitive-motor game group an increase occurred in the mean scores in the post-test and follow-up stages compared to the pre-test stage.

Table 3
Variable descriptive statistics Motivation for academic achievement

	Control group (n =15)		Experimental group (n =15)	
	Average	Standard deviation	Average	Standard deviation
test-Pre	52.33	8.05	53.07	8.46
test-Post	52.40	10.56	71.40	13.65
up-Follow	53.93	12.17	63.47	11.66

In order to explore the effectiveness of the cognitive-motor game, and since the results of Table 3 reveal that the average scores of academic achievement motivation in the post-test and follow-up stages in the aforementioned group have changed

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compared to the pre-test stage, the analysis of covariance test was employed. This test is utilized in two stages. In the first stage, the pre-test scores are included as a control variable in the model while the post-test scores are considered as a dependent variable. In the second stage, the post-test scores are defined as a control variable in the model with the follow-up scores being included as a dependent variable in the model. The aforementioned test has assumptions, whereby establishment of each of the assumptions has been examined below:

Normality: Assumption of normal distribution of the dependent variable in groups using the Shapiro-Wilk test. It was inspected in Table 2 with the results indicating that the test for motivation for academic achievement is not significant at the (.05) level (p-value > 0.05). This means that the distribution of this variable in the sample for both groups has been normal.

Table 4
Normality Test of the Distribution of the Variable Motivation for Academic Achievement in the Experimental and Control Groups

Group	Stage	Wilk-statistics	p -value
Test	Before the intervention	.910	.136
	After the intervention	.967	.816
Control	Before the intervention	.941	.392
	After the intervention	.966	.795

Homogeneity of variance: The results of Table 4 show that the variance of academic achievement motivation scores in the pre-test and post-test stages in the control and experimental groups has been homogeneous (p-value > .05); hence, the second assumption has also been met.

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Table 5
Test of Equality of Variance of the Motivation Variable for Academic Achievement in the Experimental and Control Groups

Stage	Variable	Levine's statistics	Degree of 1 freedom	Degree of 2 freedom	p - value
Pre-test	Motivation for academic	.293	1	28	.593
Post-test	progress	1.192	1	28	.284

Homogeneity of the slope of the regression line: Based on the test result in Table 4, the interaction between the covariate variable (pre-test) and the independent variable (grouping) has been insignificant; thus, it can be stated that this assumption has also been fulfilled in the control group and the experimental group (p-value > .05).

Table 6
Linear Regression Test of the Slope of the Variable Motivation for Academic Achievement in the Experimental and Control Groups

Variable	F-statistic	DF1	DF2	p-value
Motivation for academic achievement	1.894	1	26	.181

Normality: Assumption of normal distribution of the dependent variable in groups based on the Shapiro-Wilk test. It was tested in Table 5 with the results showing that the test for motivation for academic achievement has not been significant at the (.05) level (p-value > .05). This means that the distribution of this

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variable in the sample for both groups and along the three measurement stages has been normal.

Table 7
Normality Test of the Distribution of the Variable Motivation for Academic Achievement in the Experimental and Control Groups

Group	Stage	Wilk-statistics	p-value
Test	After the intervention	.910	.136
	up-Follow	.966	.448
Control	After the intervention	.941	.392
Group	up-Follow	.968	.838

Homogeneity of variance: The results of Table ۶ reveal that the variance of academic achievement motivation scores in the pre-test and post-test stages in the control and experimental groups has been homogeneous (p-value > .05); thus, the second assumption has also been fulfilled.

Table 8
Test of Equality of Variance of the Motivation Variable for Academic Achievement in the Experimental and Control Groups

Variable	Stage	Levine statistics	DF1	DF2	p-value
Motivation for academic achievement	Pre-test	.293	1	28	.293
	Follow-up	.340	1	28	.565

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Homogeneity of the slope of the regression line: Based on the test result in Table 9, the interaction between the covariate variable (post-test) and the independent variable (grouping) has been insignificant; therefore, it can be stated that this assumption has also been met in the control group and the experimental group (p-value > 10.05).

Table 9

Linear Regression Test of the Slope of the Variable Motivation for Academic Achievement in the Experimental and Control Groups

Variable	Fstatistic-	DF1	DF2	p value-
Motivation for academic achievement	.017	1	26	.896

Table 9 presents a significant main effect of "Group" (F (1, 27) = 4.670, p = .040, Partial η^2 = 0.147). This suggests that the difference between the two groups on the follow-up score (q Pretest) remains statistically significant even after controlling for the pre-test score (Pretest) as a covariate. This signifies that the intervention effect (in the control group) has persisted at the time of the follow-up measurement and cannot be attributed merely to pre-existing differences between the groups. Based on this finding, the intervention generated a lasting impact that endured over time, with its effect still evident and sustained at the post-intervention follow-up assessment.

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Table 10
Tests of Between-Subjects Effects
Dependent Variable: q Pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	688.694[a]	2	344.347	2.342	.115	.148
Intercept	2576.688	1	2576.688	17.526	.000	.394
Pretest	7.060	1	7.060	.048	.828	.002
Group	686.574	1	686.574	4.670	.040	.147
Error	3969.606	27	147.022			
Total	108029.000	30				
Corrected Total	4658.300	29				

[a] R Squared = .148 (Adjusted R Squared = .085)

Figure 1 compares the average academic achievement motivation scores in the control group and the experimental group in the pre-test and post-test stages.

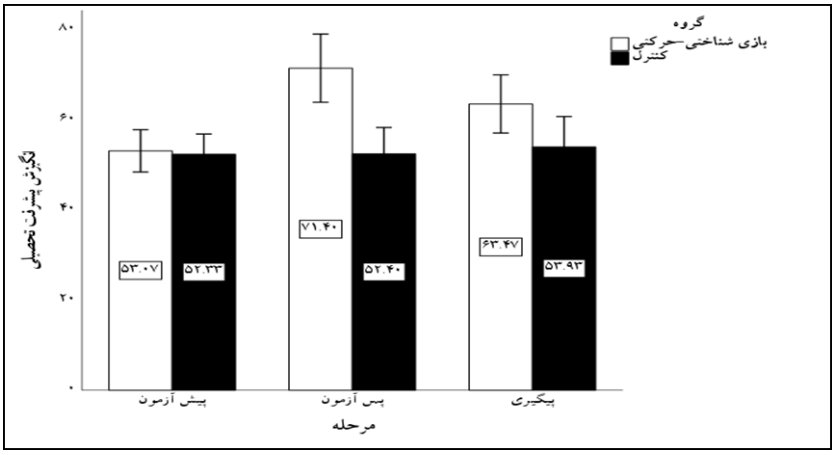


Figure 1. Comparison of academic achievement motivation in the experimental and control groups

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Discussion

The findings of the present study indicated that the designed cognitive-motor game significantly could enhance executive functions, cognitive-motor processing speed, and achievement motivation in children with ADHD, aligning with prior research. These results are in accordance with studies by Ilić, Ivanović, and Klašnja-Milićević (2024) and Seo, Kang, Kim, and Jeong (2024). They found that well-crafted games foster skill development and learning through blending entertainment with educational content, creating engaging and interactive environments. Likewise, Neerupa, Naveen Kumar, Pavithra, and John William (2024) emphasized the transformative power of innovative educational strategies, particularly gamification, which leverages game design elements such as competition, rewards, and progress to enhance student engagement, intrinsic motivation, retention, and comprehension. Further, Bi, Izadpanah, Mohammadi, and Mohammadi (2024) highlighted that game-based learning (GBL) offers opportunities for direct experience, reflection, and self-assessment, reinforcing the role of digital games as effective tools for augmenting educational quality.

The mechanisms through which cognitive-motor games affect academic motivation in children with ADHD are multifaceted. First, these games promote active engagement through combining physical movement and cognitive challenges, making learning dynamic and mitigating boredom, which is particularly beneficial for sustaining attention in ADHD. This active involvement sparks enthusiasm, as students perceive the activities as enjoyable rather than tedious. Furthermore, carefully calibrated challenges tailored to the

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child's skill level cultivate a sense of accomplishment, boosting self-confidence and reinforcing persistence, in line with motivational theories emphasizing mastery and competence. In addition, immediate feedback, such as visual or auditory rewards, establishes a positive reinforcement loop, encouraging sustained effort and lowering frustration or impulsivity often seen in ADHD. Ultimately, the supportive, low-anxiety environment fostered by these games promotes emotional regulation and a sense of safety, enabling students to approach academic tasks with greater willingness and focus.

In spite of these promising outcomes, the study had limitations. A key constraint was the limited generalizability owing to the specific sample—children with ADHD from a particular region and age group—which may not extend to diverse populations, cultural contexts, or varying ADHD severities. Further, the intervention's short duration would restrict insights into long-term effects, and reliance on performance-based or self-reported measures may introduce subjective biases.

To overcome these limitations, future studies should include larger, more diverse samples across multiple regions to ameliorate generalizability. Long-term interventions with follow-up assessments would clarify the sustainability of benefits. Also, incorporating objective measures, such as eye-tracking or motion sensors, could provide deeper insights into engagement and motor-cognitive interactions. Out suggestion is to develop games with dynamic difficulty adjustments based on real-time performance, ensuring challenges remain engaging yet achievable, as well as to integrate varied sensory elements (e.g., tactile feedback) to augment the appeal. Exploring these games

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as adjuncts to pharmacological treatments in controlled trials could also appraise their potential to lower medication reliance. Eventually, cognitive-motor games offer a compelling, engaging approach to support academic motivation and progress in children with ADHD, paving the way for more inclusive, effective educational strategies that help these students thrive.

Ethical Considerations of the Research

In this study, the participants achieved a desirable level of performance in a healthy environment filled with physical skills through continuous collaboration with researchers, leading to cognitive and functional improvements. No risks threatened the subjects, as the study was undertaken under the informed supervision of researchers and the esteemed staff. Personal information remained completely confidential and would not be published in any source; only the results of the program implementation and the performance of the subjects would be reported. Further, until the publication of this research article, the information would remain intact and then be erased. In the research design, thesis, and article, the performance of the subjects would be described without mentioning their names.

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