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The Effectiveness of Computerized Cognitive Rehabilitation on Emotional Self-Regulation and Behavioral Problems in Children with Attention-Deficit/Hyperactivity Disorder

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ABSTRACT

Objective: The current study examines the efficacy of cognitive rehabilitation approaches in managing behavioral issues and emotional self-regulation in students with attention deficit hyperactivity disorder (ADHD).

Method: Using a semi-experimental approach with a pretest and posttest control group design, the sampling frame included all students between the ages of 9-13 years with ADHD seeking counseling at a counseling center in Yazd province in Iran in the 2023-2024 academic year. A sample of thirty students was systematically selected using convenience sampling and randomly assigned to the experimental and control groups. Both the Rutter Behavioral Problems Questionnaire (RBPQ) and the Emotional Self-Regulation Questionnaire (ESRQ) were utilized to assess the variables of interest in the pretest and posttest phases. While the experimental group underwent eight one-hour sessions using the computerized cognitive rehabilitation program in weekly sessions, the control group did not receive any intervention.

Results: Analysis of the results using analysis of covariance (ANCOVA) showed that cognitive rehabilitation had a positive impact in managing behavioral problems and boosting the emotional self-regulation abilities of students with ADHD.

Conclusions As a result, computerized cognitive rehabilitation interventions are an effective approach in reducing behavioral problems and improving emotional self-regulation in students with ADHD.

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Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that primarily emerges during childhood and also crosses over into the later years of life (Conrad & Bergey, 2014) and is characterized by a persistent pattern of inattention, hyperactivity, and impulsivity, affecting approximately 5% of children and adolescents worldwide (APA, 2021; Polanczyk et al., 2014). These symptoms significantly impair daily functioning across social, academic, cognitive, behavioral, and family domains.

In Iran, ADHD has a high prevalence rate, and a lack of awareness of this disorder in parents and teachers can trigger inappropriate discipline in children at home and in school (Hassanzadeh & Samadzadeh, 2021). Parental worry also begins when children are enrolled in school. They are exposed to expectations of classroom behavior, academic achievement, and social interaction. Peer participation in learning is a common practice, but children with ADHD tend to lose concentration and get diverted by extraneous stimuli. Similarly, completing assignments at home also provides an opportunity for conflict between parent and child, especially between mothers and sons (Jalili, 2019). In addition, emotional problems and poor self-regulation are increasingly seen as central features of ADHD (Christiansen et al., 2019; Petrovic & Castellanos, 2016).

One major challenge evident in children diagnosed with ADHD is the problem associated with emotional regulation (Barkley, 2006). Emotional regulation allows modifying the emotional state by promoting adaptive behaviors to achieve a goal (Thompson, 1994) but children and adolescents with ADHD often struggle with emotional regulation, exhibiting low frustration tolerance, irritability, and emotional lability (Martin-Moratinos et al., 2025). These challenges result in an underage executive function system and high levels of social-emotional reactivity (Hashemi et al., 2010). Research has indicated that lack of emotional regulation takes place among children who have ADHD, conduct disorder, and individuals suffering from anxiety disorder (Nemati et al., 2021). A recent meta-analysis highlighted difficulties associated with ADHD in emotional lability (d=.95), emotional regulation (d=.80), empathy (d=.68), and emotion recognition or understanding (d=.64), with differences associated with gender, age, and the existence of executive dysfunction or behavioral problems (Graziano, & Garcia, 2016). Lack of emotional regulation is closely associated with social/emotional challenges. The kid who exhibits poor emotional regulation has a high likelihood of experiencing uncontrollable as well as aggressive expression of behavior in a social situation. This gives rise to rejection as well as withdrawal from social relationships (Nemati et al., 2021). Thus, the issue of poor self-regulation could be linked to behavioral concerns.

Behavioral problems pertain to manifestations of emotional and behavioral expressions that do not adhere to cultural and social standards and have a detrimental effect on family relations, educational, self-care, and social adaptation (Malekpour et al., 2022). The instances or

manifestations associated with these kinds of problems often encompass more than one situation or context, typically two or more, including both home and school. Most behavioral issues associated with these children fall generally into either internalizing or externalized behavior (Hosseini & Ashouri, 2022).

Modern theoretical frameworks point to deficits in executive function skills as an integral contributing component of ADHD (Nejati, 2010). Based on this, the use of cognitive rehabilitation has been advocated as an effective strategy to cope with the aforementioned deficits. Cognitive rehabilitation can be defined as an intervention procedure used to treat cognitively impaired people in order to ameliorate attention, memory, executive function skills, and problem-solving skills (Maqsoudlou et al., 2016). Cognitive rehabilitation includes a spectrum of interventions aimed at reducing, or compensating for, the effects of cognitive impairments and helping people develop successful strategies for coping with those problems (Maqsoudlou et al., 2016). The origin of the need for cognitive rehabilitation can be dated back to the cognitive revolution of the 1970s and the development of advancements concerning the imaging of the brain, creating a platform for the growth of such interconnected disciplines as neuropsychology and cognitive neuroscience (Eskandari-Asl & Piriyani, 2019). Cognitive rehabilitation combines the principles of cognitive psychology, neuropsychology, and behavioral psychology, making it a vital tool for understanding the structure and function of the brain (Saatchi, 2021). Norozbakhsh et al. (2021) highlighted the importance of well-designed cognitive training programs that can produce lasting improvements in the executive functions of students with learning disability. Frequent and guided cognitive trainings (such as cognitive rehabilitation) can produce structural and functional changes in the neurons responsible for functions in the brain of children with emotional and behavioral disability.

Individuals with ADHD often seek higher levels of immediate reward, which can lead to neglect tasks, dropped jobs, or incomplete treatments. Cognitive rehabilitation has emerged that are more attractive to patients, such as the use of games or video games or new technologies such as virtual reality (VR) (Peñuelas-Calvo et al., 2022; Romero-Ayuso, 2021). Children with ADHD who engaged in working memory training incorporating game elements demonstrated longer training durations, completed more sequences with fewer errors, and achieved higher scores compared to those who underwent standard cognitive training (Prins, 2011).

Computerized cognitive rehabilitation is popular cognitive rehabilitation technique that capitalizes on children's fascination with computer games and the ability to provide organized and repetitive activities through computerized systems (Nazarzadeh et al., 2023). This technique, based on research in cognitive science, uses computer games to help enhance compromised cognitive functions. The strengths of computerized cognitive rehabilitation include automatic scoring and response time measurement, which are either difficult or time-consuming to achieve in paper and pencil techniques (Soltanipour & Abahrian, 2021). When motivated, children with ADHD perform

comparably to typically developing children on most cognitive tasks and may even outperform them on engaging computer-based tasks, despite the need for sustained attention (Gallen, 2023).

Previous studies have proved that computer-based cognitive training brings about significant improvements in attention, working memory, and cognitive skills (Holmes et al., 2010; Klingberg et al., 2005). Also, Martin-Moratinos et al. (2025) found that Serious video games, when integrated into a multimodal treatment plan, can enhance outcomes for symptoms associated with ADHD. In fact, current studies suggest that by combining cognitive rehabilitation with behavioral strategies, there can be a substantial decrease in instances of behavioral issues, especially among students suffering from ADHD (Anderson et al., 2024).

Several studies have further revealed that cognitive rehabilitation procedures can help bring about significant improvements in emotional self-regulation among students suffering from ADHD, and these findings were found stable over time as reported by Martinez et al. (2023). However, despite growing evidence, limited research has simultaneously examined cognitive rehabilitation effects on both emotional self-regulation and behavioral problems in children with ADHD in the Iranian context.

With the prevalence rate of ADHD in children, the significance of emotional self-regulation and problems with behaviors within this subgroup, and the intrinsic interest of children in the use of game-based and indirect methods of learning, the research question to be addressed by the present study was as follows:

Does Computerized cognitive rehabilitation play a significant role in emotional self-regulation and problems with behaviors found within attention-deficit/hyperactivity disorder-suffering children?

Materials and Methods

Research Design

In this study, a quasi-experimental design with a pretest and posttest design, involving a control group, was applied. The aim of this study was to identify any causal effect of a computer-based cognitive rehabilitation application on emotional self-regulation and behavior problems of students suffering from ADHD.

Participants

The study participants consisted of students aged 9 to 13 years old who had received a diagnosis of ADHD. These individuals were recruited from the Imam Hossein Counseling Clinic in Yazd during the 2023–2024 academic year. A priori power analysis was conducted using G*Power software (version 3.1) to determine the minimum required sample size for ANCOVA with an effect

size of .25, alpha level of .05, and power of .80. The analysis indicated that a total sample of 28 participants was sufficient. Therefore, the sample size of 30 participants (15 per group) was considered adequate. Thus, a total of 30 students were selected via convenience sampling. Participants were subsequently randomly assigned to either an experimental or a control group, with each condition containing 15 students.

The inclusion criteria consisted of: (a) age 9-13 years, (b) high scores on the Behavioral Problems Questionnaire and low scores on the Emotional Self-Regulation Questionnaire, and (c) no ongoing psychological interventions, verified by an introductory parent interview. Exclusion criteria included: (a) more than two missed intervention sessions or (b) research questionnaires not completed. Participants were selected based on relatively similar age range and educational context to reduce potential confounding effects. Due to the use of convenience sampling, caution should be exercised in generalizing the findings beyond the studied population.

Instruments

Rutter Behavioral Problems Questionnaire (RBPQ)

The RBPQ, developed by Michael Rutter in 1967, is a widely accepted instrument in evaluating behavior. The RBPQ has two forms: Form A for parent ratings and Form B for teacher ratings. The parent-rated version of the RBPQ was administered in this study. The RBPQ has 30 questions using a 0–2 scale based on a Likert scale. The scale ranges from 0 for "not applicable" to 2 for "certainly applies." The scoring for RBPQ ranges between 0 and 60. The RBPQ has shown good psychometric qualities. Rutter et al. (1975) reported significant concordance between the instrument and psychiatric diagnoses ($p < .001$), as well as a high degree of inter-rater agreement (61.5%). Furthermore, Sharifi Daramadi (2007) confirmed the validity of the questionnaire within the Iranian context. In the current study, the internal consistency (Cronbach alpha) was calculated to be .78.

Emotion Self-Regulation Questionnaire

The ESRQ (child-adolescent version) developed Shields and Cicchetti in 1998 has 24 questions answered by the parents. The scale taps the essential aspects of emotional self-regulation as well as reactivity. These encompass emotional competence, intensity of emotion, flexibility of expression, appropriateness of expression in context, and expression of emotion. The scale relies on a four-point response scale ranging from 1 (Never) to 4 (Almost Always). The scores range from 24-96. Higher scores represent enhanced emotional self-regulation. Shields and Cicchetti (1998) found high construct validity ($r = .89$), in addition to high Cronbach alpha (.87). The questionnaire was translated and standardized by Mahmoodi et al. (2016) for the Iranian population, and its content validity was confirmed by correlating it with measures of anxiety, anger,

and depression in children. Dermavandian et al. (2021) also verified the internal consistency using item-total correlation. For the current research, Cronbach alpha was .81.

Cognitive Rehabilitation Package

The cognitive rehabilitation package utilized in this study was the Captain's Log software. This software represents one of the most extensively applied cognitive rehabilitation tools, dedicated to enhancing individuals' cognitive capabilities. It incorporates over 2,000 exercises designed to ameliorate 20 distinct cognitive skills and is employed for individuals with ADHD, learning disabilities, intellectual impairment, brain injuries, dementia and Alzheimer's disease, developmental delays, as well as mood disorders and schizophrenia. Initially introduced in 2000 by the American company Brain Train, Captain's Log cognitive rehabilitation software is designed for individuals over the age of six and encompasses varying levels of difficulty. All exercises within this software are multidimensional, focusing on more than one cognitive ability; consequently, they target both fundamental and higher-order functions. This software is designed and constructed for the cognitive rehabilitation of various executive functions based on the errorless learning model (Ravitvand & Amiri, 2020). The instrument was utilized by Kootul et al. (1996) to determine its effectiveness on ADHD disorders; its validity was confirmed, and its reliability was demonstrated through the retention of effects over a 7-month follow-up period in the study. Table 1 presents the schedule for the educational intervention sessions.

Table 1. Content of the Educational Program

Session	Target Cognitive Skills	Program Content
First	Program and educational software introduction	Familiarization with the software, the program execution environment, tasks, and instructions on how to operate them
Second	Working memory and Processing speed	A series of numbers and letters are displayed, which subjects must memorize from left to right and subsequently place in their correct positions.
Third	Working memory, Auditory processing speed, and Attention	Subjects are asked to listen to two auditory rhythms and press the green key if they are identical and the red key if they differ
Fourth	Working memory, Selective attention, and Visual processing speed, Inhibition	Several shapes with different colors are displayed. Subjects must then place each one in a grid according to a given pattern
Fifth	Working memory, Sustained attention, and Inhibition	A series of numbers is shown to the subject. Subsequently, based on a provided pattern, the numbers must be displayed in the same order as the pattern.
Sixth	Working memory, Sustained attention, and Visual processing speed	A series of shapes with different colors are displayed, which must be selected according to a given command.
Seventh	Working memory, Sustained attention, and Inhibition	A series of boxes are displayed, and subjects must identify the boxes that are different.

Session	Target Cognitive Skills	Program Content
Eighth	Working memory, Selective attention, and Inhibition	A series of shapes are displayed; subjects must memorize the quantity and color of the shapes and subsequently identify them according to the pattern

Results

Descriptive Statistics

The findings are structured properly in Table 1 below, comparing mean values and standard deviations for both behavioral problems and emotional self-regulation for the experimental and control groups before and after the intervention. As shown, the experimental group demonstrated a substantial reduction in behavioral problem scores from pretest to posttest, whereas the control group showed minimal change. In contrast, emotional self-regulation scores increased markedly in the experimental group following the intervention, while remaining relatively stable in the control group. A similar pattern was observed for emotional instability/negativity, which decreased considerably only in the experimental group.

Table 2. Descriptive statistics of behavioral problems and emotional self-regulation scores in pretest and posttest

Variable	Group	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Behavioral Problems	Experimental	41.26	5.18	29.13	4.62
	Control	40.80	5.04	39.47	5.21
Emotion Regulation	Experimental	41.93	6.12	58.20	5.74
	Control	42.13	5.89	43.06	6.01
Emotional Instability/Negativity	Experimental	53.40	6.47	37.26	5.83
	Control	52.93	6.11	51.80	6.25

Note. Higher scores on behavioral problems and emotional instability/negativity indicate greater difficulties, whereas higher scores on emotion regulation reflect better emotional self-regulation.

Assumption Testing

Prior to performing our inferential tests, we evaluated the main assumptions of normal distribution and equality of variances. The Shapiro-Wilk test was used to examine the normality of the data distribution due to the small sample size. As evident in Table 2, the results of Shapiro-Wilk tests displayed normal distribution for all variables ($p > .05$). Further, the Levene's tests supported the equality of variances in the dependent variables, thereby justifying the application of ANCOVA and MANCOVA tests.

Table 3. Tests of Assumptions for ANCOVA

Variable	Test	Statistic	p-value
Behavioral Problems	Shapiro-Wilk	.97	.21
Emotion Regulation	Shapiro-Wilk	.95	.19
Emotional Instability/Negativity	Shapiro-Wilk	.97	.21
Emotion Regulation	Levene's Test	1.13	.21
Emotional Instability/Negativity	Levene's Test	1.23	.23
Behavioral Problems	Levene's Test	5.04	> .05

Assumption of Homogeneity of Regression Slopes

This assumption requires that the relationship between the pretest and posttest scores of the research variables be linear and similar across the groups. This assumption is examined by comparing the regression slopes between the two groups and calculating the F value and its significance level. Unequal slopes indicate an interaction between the pretest and posttest, which would confound the results of the analysis of covariance (Stevens, 1996). The results for testing this assumption are presented in Table 4.

Table 4. Test of Homogeneity of Regression Slopes for Research Variables

Source	Sum of Squares	df	Mean Square	F	Sig.
Emotional Self-Regulation					
Intercept	167.85	1	167.85	739.11	.001
Group * Pretest	0.82	1	.82	1.04	.327
Total	304.60	29			
Behavioral Problems					
Intercept	134.34	1	134.34	10520.21	.001
Group * Pretest	11.81	1	3.94	.32	.851
Total	954.86	29			

Note. Group * Pretest refers to the interaction term used to test the homogeneity of regression slopes.

As shown in Table 4, the assumption of homogeneity of regression slopes was met for the variables, as the interaction between group and pretest scores was not significant (p > .05).

Assumption of Homogeneity of Variance-Covariance Matrices

In this section, the assumption of homogeneity of variance-covariance matrices was examined using Box's M test. Many parametric methods, including multivariate analysis of variance, rely on the assumption that the covariance matrices of the dependent variables are the same across all groups. This means that the covariance matrix of the dependent variables should not differ significantly between groups. To test this assumption, Box's M test is used. To confirm this assumption, the test should not be significant. If the significance level is higher than .001 (Harris, 1994)—or strictly higher than .05—it indicates that the covariance matrices are homogeneous. If

this assumption is violated, Pillai's Trace is used instead of Wilks' Lambda as the basis for analysis. The results of this test are presented in Table 5.

Table 5. Box's M Test for Homogeneity of Covariance Matrices

Box's M	F	df1	df2	Sig.
13.826	4.252	3	141120	.005

As shown in Table 5, the Box's M statistic was 13.826, and the obtained F value was 4.252. The significance level was calculated to be .005, which is less than .05 ($p < .05$). Therefore, the assumption of homogeneity of covariance matrices was rejected. Consequently, Pillai's Trace was used as the robust criterion for the multivariate analysis.

Multivariate Effects

To examine the overall effect of cognitive rehabilitation on emotional self-regulation components, a multivariate analysis of covariance was conducted. The results, presented in Table 6, indicated a statistically significant multivariate effect of group membership on emotional self-regulation after controlling for pretest scores (Pillai's Trace = .47, $F(2, 25) = 18.39$, $p < .001$, $\eta^2 = .43$).

Table 6. Multivariate Analysis of Covariance (MANCOVA) Results for Emotional Self-Regulation

Test	Value	F	df	p	..
Paaa'as Taaee	.47	18.39	2, 25	< .001	.43
lll ks'.Lamdda	.53	18.39	2, 25	< .001	.43
Hotgggggs Taaee	.88	18.39	2, 25	< .001	.43
oo y's Laggttt oo ot	.88	18.39	2, 25	< .001	.43

Univariate Analysis of Effects on Emotional Self- Regulation

After establishing that there was a significant overall effect, we undertook individual ANCOVA tests for each aspect of emotional self-regulation. As can be determined by examining Table 7, the experimental group produced a higher score than the control group on both emotion regulation and emotional instability/negativity.

Table 7. Univariate ANCOVA Results for Emotional Self-Regulation Components

Variable	Source	F	df	p	..	effect size
Emotion Regulation	Group	19.27	1, 27	< .001	.44	.86
Emotional Instability/Negativity	Group	20.14	1, 27	< .001	.45	.98

Effects on Behavioral Problems

To evaluate the impact of cognitive rehabilitation on behavioral issues, an ANCOVA test was conducted. Table 8 illustrates significant differences in behavioral problems among the groups on posttest scores, controlling for pretest scores, large effect size, $\eta^2 = .54$.

Table 8. ANCOVA Results for Behavioral Problems

Source	F	df	p	..	effect size
Group	30.53	1, 27	< .001	.54	1

Discussion

The present study was conducted to investigate the effectiveness of computerized cognitive rehabilitation on emotion self-regulation and behavioral problems in students with ADHD. The results indicated that the cognitive rehabilitation program led to a significant improvement in emotion self-regulation and a reduction in behavioral problems among the participants. These findings align with the modern theoretical frameworks discussed in the introduction, which posit that deficits in executive function are integral components of ADHD (Nejati, 2010). By targeting these underlying cognitive deficits, the intervention appears to have facilitated downstream improvements in emotional and behavioral domains.

The improvement in emotion self-regulation observed in this study can be explained through the lens of Barkley's (2006) model of ADHD, which highlights deficits in inhibition and executive functions as the root cause of emotional dysregulation. As noted, children with ADHD often struggle with low frustration tolerance, irritability, and emotional lability due to an underdeveloped executive function system (Hashemi et al., 2010; Martin-Moratinos et al., 2025). The cognitive rehabilitation exercises utilized in this study, such as working memory tasks and response inhibition drills, likely strengthened the neural circuits responsible for top-down control. By enhancing working memory and inhibitory control, the training enabled participants to delay immediate gratification, a core challenge for individuals with ADHD (Barkley, 2006), and manage their emotional states more adaptively. This supports the view that emotional regulation is an executive function that can be modified through targeted cognitive training (Thompson, 1994).

Furthermore, the reduction in behavioral problems is consistent with the literature linking emotional dysregulation to social and behavioral maladjustment. As highlighted by Nemati et al. (2021), poor emotional regulation often leads to aggressive expressions of behavior and social rejection. The findings of the current study suggest that by bolstering cognitive skills, cognitive rehabilitation helps children adhere to cultural and social standards, thereby reducing detrimental behaviors in family and educational contexts (Malekpour et al., 2022). The significant decrease in behavioral issues corroborates recent evidence suggesting that combining cognitive rehabilitation

with implicit behavioral strategies can substantially decrease behavioral problems in students with ADHD (Anderson et al., 2024).

The mechanism of change observed in this study is further supported by the principles of neuroplasticity and the specific advantages of computerized training. As mentioned in the introduction, computerized cognitive rehabilitation capitalizes on children's fascination with technology, providing organized and repetitive activities that sustain motivation (Nazarzadeh et al., 2023). This is particularly relevant for ADHD populations, who typically seek higher levels of immediate reward and struggle with sustained attention (Peñuelas-Calvo et al., 2022). The engaging nature of the "Captain's Log" software used in this intervention likely mitigated dropout risks and ensured adherence, allowing participants to perform comparably to their typically developing peers (Gallen, 2023). The automatic scoring and adaptive difficulty provided by the software offered a tailored learning environment that paper-and-pencil techniques cannot easily replicate (Soltanipour & Abahrian, 2021). Esmailzadeh et al. (2021) also demonstrated that Captain's log software is designed as one of the most widely used programs to rehabilitate and improve cognitive functions. Using this program, one can enhance the mental abilities of individuals in various fields.

The results of this study are consistent with those of previous research demonstrating the efficacy of computer-based cognitive training. For instance, the findings align with studies by Klingberg et al. (2005) and Holmes et al. (2010), who reported significant improvements in attention and working memory following computerized training. Moreover, the stability of emotional improvements noted in this study resonates with the findings of Martinez et al. (2023), who reported that gains in emotional self-regulation were stable over time. The study also supports the work of Martin-Moratinos et al. (2025), suggesting that integrating game-based cognitive tools into treatment plans enhances outcomes for ADHD symptoms.

Conclusion

In conclusion, the present study provides evidence that computerized cognitive rehabilitation is an effective intervention for improving emotion self-regulation and reducing behavioral problems in children with ADHD. By targeting core executive function deficits through an engaging and adaptive digital platform, the intervention addressed the "underage executive function system" described in the literature (Hashemi et al., 2010). These findings suggest that cognitive rehabilitation should be considered a vital component of multimodal treatment strategies for ADHD, particularly given the high prevalence of the disorder and the significant impact of emotional and behavioral issues on the quality of life of affected children and their families (Hassanzadeh & Samadzadeh, 2021). Future research should focus on long-term follow-ups to

assess the durability of these effects and explore the potential benefits of integrating such cognitive interventions with pharmacological and behavioral therapies.

Implications and Suggestions

The findings of this study hold significant implications for clinical, educational, and research domains. Clinically, the results support the integration of computerized cognitive rehabilitation as a viable non-pharmacological intervention within treatment plans for children with ADHD. Given the side effects and concerns often associated with pharmacological treatments, cognitive rehabilitation offers a safe and engaging alternative or adjunctive therapy that targets the core executive function deficits underlying the disorder. From an educational perspective, the study underscores the importance of addressing cognitive skills in the classroom. Teachers and school counselors should be aware that behavioral issues and emotional dysregulation in students with ADHD may stem from cognitive impairments. Therefore, incorporating cognitive training exercises and "brain training" games into the daily curriculum could serve as a proactive strategy to enhance self-regulation and reduce classroom behavioral problems. Furthermore, the study highlights the utility of game-based digital tools, suggesting that leveraging technology can increase motivation and adherence to treatment protocols in pediatric populations. However, The use of convenience sampling and the relatively small sample size may limit the external validity of the findings. In addition, the present study did not control for some potentially confounding variables such as medication status, ADHD subtype, IQ, and socioeconomic status.

Based on the findings and limitations of the present study, several recommendations are proposed for future research and practice. First, while this study focused on children aged 9 to 13, future investigations should explore the efficacy of computerized cognitive rehabilitation across different age groups, including adolescents and adults with ADHD, to determine if the benefits generalize across the lifespan. Second, it is recommended that future studies employ longitudinal designs with follow-up assessments extending beyond 7 months to evaluate the long-term retention of the therapeutic effects on emotion self-regulation and behavior. Third, to address the limitation of self-report bias, future research should utilize multi-informant approaches, incorporating data from parents, teachers, and objective neuropsychological measures. Furthermore, comparative studies are suggested to examine the relative efficacy of cognitive rehabilitation when combined with pharmacotherapy versus behavioral therapy alone, thereby optimizing multimodal treatment approaches for ADHD. Finally, Future studies are recommended to control factors such as medication status, ADHD subtype, IQ, and socioeconomic status more precisely and use bigger sample sizes to ensure external validity of the findings**.**

Author Contributions

Conceptualization, F.N. and N.H.; methodology, F.N.; software, F.N.; validation, F.N., N.H. and F.K.; formal analysis, F.N.; investigation, F.N.; resources, F.N.; data curation, F.N.; writing

original draft preparation, F.N.; writing, review and editing, F.N. and F.K.; visualization, F.N.; supervision, N.H.; project administration, N.H.; funding acquisition, F.N. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

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Ethical considerations

Ethical considerations were observed throughout the study. Participation was voluntary and the confidentiality of participants' information was ensured. Parents of the children were informed about the study objectives and provided consent for their children's participation.

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Conflict of interest

The authors declare no conflict of interest.

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