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# Effectiveness of Cognitive-Emotional-Social Training of Working Memory on Attention Bias, Executive Functions, and Academic Performance of Students with ADHD

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A B S T R A C T

**Objective:** Children with Attention Deficit/Hyperactivity Disorder (ADHD) suffer from numerous complications, leading to significant psychological and social costs. Therefore, this study aimed to evaluate the effectiveness of cognitive-emotional-social training of working memory on attention bias, executive functions, and academic performance of students with ADHD.

**Methods and Materials:** This quasi-experimental study utilized a pretest-posttest and follow-up design with a control group. A total of 32 children were purposefully selected and randomly assigned to two groups of 16 participants each. Participants were assessed before, after the intervention, and one month later using questionnaires measuring attention bias, executive functions, and academic performance. The intervention group received cognitive-emotional-social training of working memory. Data were analyzed using repeated measures analysis of variance.

**Findings:** The results indicated a significant improvement in attention bias, executive functions, and academic performance in the intervention group compared to the control group.

**Conclusion:** According to the obtained results, cognitive-emotional-social training of working memory is effective in improving attention bias, executive functions, and academic performance of students with ADHD.

***Keywords:*** *Cognitive-Emotional, Attention Bias, Executive Functions, Academic Performance, Attention Deficit/Hyperactivity Disorder.*

## 1. Introduction

Attention Deficit/Hyperactivity Disorder (ADHD) is among the most common behavioral disorders, with a higher prevalence in boys compared to girls. The prevalence of this disorder has been estimated to range between 6.5% and 38% in recent review studies (Gerhand & Saville, 2022; Grimm et al., 2018). In Iran, the prevalence

ranges from a minimum of 0.95% to a maximum of 17% (Nejati, 2021). Existing research identifies attention disorders as primary symptoms of cognitive deficits associated with hyperactivity (Barkley, 2013). Attention problems manifest as lack of concentration, abandoning tasks halfway, frequent changes in activities, sluggishness, failure to return to unfinished tasks, and increased errors in monotonous and tedious tasks (Tatar & Cansız, 2022). One attention-related issue is attention bias, which is the tendency to selectively attend to personally relevant information alongside neutral information. Cognitive processes like cognitive bias can have detrimental effects on human behavior in various situations, particularly stressful ones (Bulut et al., 2024). Some researchers attribute attention problems to hyperactivity disorder, while others point to executive function deficits as the cause of this disorder. Barkley first proposed a theory suggesting that deficits in executive cognitive functioning lead to symptoms of ADHD (Barkley, 2013). Researchers have reported that these children show difficulties in executive cognitive functions compared to typical children. Executive cognitive functions, with three core components: inhibition, working memory, and cognitive flexibility, have a strong correlation with essential social abilities such as attention, language, and perception (Jangmo et al., 2019).

Initially, this disorder was considered a childhood disease with minimal impact on adult functioning, leading to limited efforts toward its treatment (Barkley, 2013; Bulgarelli & Molina, 2016). However, recent studies have shown that hyperactivity can persist into adolescence and adulthood (60%). The negative effects of hyperactivity on individual, social, and academic dimensions continue into adulthood in various forms (Gerhand & Saville, 2022). Studies indicate that academic performance in these children is lower than that of their peers (Gerhand & Saville, 2022; Holmes et al., 2010; Jangmo et al., 2019).

Researchers believe that behavioral and even neurological problems in children can lead to emotional and social issues in addition to cognitive problems (Ronald et al., 2021; Shechner et al., 2012; Tatar & Cansız, 2022), necessitating the use of more comprehensive educational packages for training and rehabilitation (Gnanavel et al., 2019). The cognitive-emotional-social training package for working memory, encompassing various dimensions, can be effective in improving the condition of children with ADHD (Bulgarelli & Molina, 2016; Fleming et al., 2017). This study aimed to answer the question: Does cognitive-emotional-social training of working memory affect attention bias, executive functions, and academic performance in students with ADHD?

## 2. Methods and Materials

### *2.1. Study Design and Participants*

This experimental study with a quasi-experimental, pretest-posttest-follow-up design and a control group was approved by the Ethics Committee of Islamic Azad University, Sari Branch, with code IR.IAU.SARI.REC.2023.162. All participants were assessed before and after the intervention using standard tools for attention bias, executive functions, and academic performance. The effectiveness of the intervention was then evaluated by comparing the experimental and control groups at different stages of the study. The research population included all first-year secondary school students in Tehran. The sample size was determined using G*Power software, with 16 participants per group, totaling 32 participants. The effect size was derived from Khaksarian et al. (2020) as 0.56, with an alpha error level of 0.05 and a confidence level of 95%. Cluster random sampling was used, initially selecting one of the 22 districts of Tehran randomly. Then, a list of schools was obtained, and four schools were randomly selected. Sampling continued until the required number of samples was reached. The final sample (34 participants) was randomly assigned to two groups of 16 each.

Inclusion criteria included scoring above the cutoff on the Conners ADHD questionnaire, the willingness of the child and parents to participate, living with both parents, being male, and receiving a diagnosis of one of the three types of ADHD (inattentive, hyperactive-impulsive, or combined). Exclusion criteria included having intellectual, developmental, physical, or severe psychological disorders, missing more than one training session, failing the previous term's exams (to control for learning disabilities), and having a previous diagnosis of learning disabilities or oppositional defiant disorder.

### *2.2. Measures*

#### *2.2.1. ADHD*

To diagnose ADHD, the parent and teacher forms of the Conners' Rating Scales were used. The parent form has 48 items and identifies five factors: conduct problems, learning problems, psychosomatic issues, impulsivity, hyperactivity, and anxiety. Symptoms are rated on a 4-point scale from 0 (never) to 3 (very much). The teacher form complements the

parent scale and assesses hyperactivity, conduct problems, emotional overreaction, anxiety-passivity, social unresponsiveness, and daydreaming-inattention. The initial validity and reliability of the questionnaire were confirmed in Conners' study (Nejati, 2021).

### 2.2.2. *Cognitive Functions and Attention Bias*

Stroop Test: Developed by Stroop in 1935 to evaluate selective attention and cognitive flexibility, this test has various versions, including Dodrill's (1987), Golden's (1987), and Graf's (1995) versions. This study used the card version similar to Stroop's original word-reading test, consisting of four cards (w, word reading; c, color naming; cw, word reading without regard to color; and a fourth card, color naming without regard to the written word). Each card has 25 stimuli arranged in 5 rows and 5 columns. Participants are asked to look at each card and respond from left to right as quickly and accurately as possible. The test measures reaction time and errors, with reliability reported at 88% for the first two cards and 80% for the third and fourth cards. The test is useful for measuring both automatic and controlled processing, with cards one and two measuring automatic processing and cards three and four measuring controlled processing. The test has been translated and validated for the Iranian population by Najarian and Barati (Bulut et al., 2024; Nejati, 2021).

### 2.2.3. *Academic Performance*

The parent form, developed by Gioia et al. (2000), assesses behaviors related to executive functioning in children aged 5-18 years, based on parents' and teachers' ratings. It includes 86 items across eight clinical scales: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. Higher scores indicate greater executive dysfunction. The internal consistency and test-retest reliability are high, with the parent form showing a range of 0.80 to 0.98 for clinical samples and 0.80 to 0.97 for normative samples. The Persian version was validated by Naeimi et al. (2015). The original version is recognized for its good psychometric properties, clear administration, and is a reliable tool for clinicians. Shokri et al. (2021) reported Cronbach's alpha of 0.87 to 0.94, indicating high internal consistency (Abikoff et al., 2013; Hossain et al., 2022; Rahmani et al., 2024; Roghani et al., 2022).

## 2.3. *Intervention*

### 2.3.1. *Cognitive-Emotional-Social Training of Working Memory*

The intervention protocol consists of a structured, eight-session program designed to enhance cognitive, emotional, and social functioning in children with ADHD. Each session is meticulously planned to target specific skills through engaging and developmentally appropriate activities. The program begins with an introduction and orientation to establish a foundational understanding and rapport. Subsequent sessions progressively introduce complex tasks aimed at improving working memory, attention, response inhibition, and emotional regulation through a variety of games and exercises such as "Sit/Stand," "Laugh/Don't Laugh," and "Statue/Move." These activities are designed to be both enjoyable and challenging, fostering cognitive flexibility and self-regulation. Emotional regulation strategies and problem-solving skills are also integrated into the sessions to provide a holistic approach to managing ADHD symptoms. The program culminates in an integration and review session, where children consolidate their learned skills and receive feedback, while parents are involved to ensure continuity and reinforcement of these skills at home. This comprehensive and multi-faceted approach aims to provide children with the tools they need to improve their attention, memory, emotional control, and overall academic performance (Chambers et al., 2010; Fleming et al., 2017; Gooch et al., 2016; Nejati, 2021).

Session 1: Introduction and Orientation

The initial session focuses on building rapport between the therapist and the participants. The goals, structure, and rules of the sessions are explained to both children and their parents. Basic cognitive-emotional exercises are introduced to familiarize the children with the format. Activities include simple games designed to assess baseline attention and memory skills, such as matching pairs and simple reaction time tasks. The session ends with a discussion on the importance of attention and memory in daily activities.

Session 2: Sit/Stand and Laugh/Don't Laugh

This session introduces the "Sit/Stand" and "Laugh/Don't Laugh" games to enhance self-control and cognitive flexibility. Children are instructed to perform or inhibit specific actions based on verbal cues, promoting working memory and response inhibition. For instance, children must stand when the therapist says "Sit" and sit when the therapist says "Stand." This exercise is repeated with increasing



JARAC Assessment and Research in Applied Counseling
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complexity, incorporating sequences of actions to challenge the working memory further.

Session 3: Statue/Move

In this session, the "Statue/Move" game is introduced, focusing on improving self-regulation and sustained attention. Children are instructed to freeze like a statue when a specific signal is given and move when another signal is presented. The complexity of the signals is gradually increased to enhance cognitive processing speed and flexibility. Visual and auditory cues are used interchangeably to train multi-sensory integration and attention.

Session 4: Numerical Memory and Visual Memory Games

This session targets numerical and visual working memory enhancement. Children engage in games that require them to remember and reproduce sequences of numbers and patterns. Activities include "Simon Says" with numbers and shapes, where children must recall and repeat sequences presented by the therapist. This helps to strengthen their ability to hold and manipulate information in their working memory.

Session 5: Jump Up, Lower Hand, Raise Foot Game

In this session, children participate in the "Jump Up, Lower Hand, Raise Foot" game, designed to improve response inhibition and reduce impulsivity. Children are given conflicting visual and auditory signals and must perform the correct action based on the type of signal. For example, they may need to jump up when hearing a whistle or lower their hand when seeing a red card. This helps enhance their ability to process and respond appropriately to stimuli.

Session 6: Emotional Regulation Training

This session focuses on teaching emotional regulation strategies. Through role-playing and guided discussions, children learn to identify and manage their emotions. Activities include "Emotion Charades," where children act out different emotions and discuss appropriate responses to various emotional situations. The session also includes relaxation techniques like deep breathing and progressive muscle relaxation to help manage stress and anxiety.

Session 7: Problem-Solving Skills and Coping Strategies

In this session, children are taught structured problem-solving skills and coping strategies. Activities include scenario-based role-plays where children must navigate social conflicts or challenging situations using problem-solving steps. The therapist guides them through identifying the problem, brainstorming possible solutions, evaluating the options, and implementing the best solution. This session aims to enhance their executive functions and adaptive coping mechanisms.

Session 8: Integration and Review

The final session integrates all the skills learned in previous sessions. Children participate in comprehensive games and activities that require them to use their enhanced attention, memory, and emotional regulation skills. The therapist reviews the progress made by each child and provides feedback. Parents are involved in this session to discuss strategies for reinforcing these skills at home. The session concludes with a celebration of the children's achievements and a plan for maintaining the skills learned.

### *2.4. Data analysis*

Data collected before, after, and one month post-intervention were scored and analyzed using SPSS version 20. Descriptive statistics (mean, standard deviation, frequency) and inferential statistics (repeated measures ANOVA) were used to analyze the hypotheses.

## 3. Findings and Results

This section reports the demographic findings, including the age of the participants, and the ages of their mothers and fathers. The age of children in the intervention and control groups was 10.78 ± 0.80 and 11.13 ± 0.74, respectively, with no significant difference between the two groups. The participants in both the intervention and control groups were similar in terms of educational grade. The majority of the mothers had a high school diploma.

**Table 1**

*Descriptive Statistics for Reaction Time, Number of Errors, Executive Functions, and Academic Performance (Mean and Standard Deviation)*

| Variable | Group | Pre-test M (SD) | Post-test M (SD) | Follow-up M (SD) |
|---|---|---|---|---|
| Reaction Time (seconds) | | | | |
| Word Reading | Intervention | 15.32 (1.45) | 10.78 (1.20) | 10.53 (1.18) |
| | Control | 15.29 (1.40) | 14.98 (1.35) | 15.00 (1.38) |
| Color Naming | Intervention | 18.67 (1.80) | 12.65 (1.45) | 12.45 (1.40) |



JARAC Assessment and Research in Applied Counseling
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| | | | | |
|---|---|---|---|---|
| | Control | 18.54 (1.78) | 18.34 (1.75) | 18.38 (1.77) |
| Word Color | Intervention | 20.33 (1.65) | 14.55 (1.35) | 14.32 (1.30) |
| | Control | 20.29 (1.63) | 20.00 (1.60) | 20.02 (1.62) |
| Reading Words Without Color | Intervention | 19.98 (1.70) | 15.32 (1.50) | 15.10 (1.45) |
| | Control | 19.94 (1.68) | 19.65 (1.65) | 19.68 (1.67) |
| Number of Errors | | | | |
| Word Reading | Intervention | 5.55 (0.75) | 2.32 (0.55) | 2.25 (0.50) |
| | Control | 5.58 (0.70) | 5.50 (0.68) | 5.52 (0.70) |
| Color Naming | Intervention | 6.45 (0.80) | 2.98 (0.60) | 2.90 (0.58) |
| | Control | 6.40 (0.78) | 6.32 (0.75) | 6.34 (0.77) |
| Word Color | Intervention | 7.12 (0.85) | 3.25 (0.65) | 3.18 (0.63) |
| | Control | 7.08 (0.82) | 7.00 (0.80) | 7.02 (0.81) |
| Reading Words Without Color | Intervention | 6.90 (0.75) | 3.12 (0.55) | 3.05 (0.53) |
| | Control | 6.85 (0.72) | 6.78 (0.70) | 6.80 (0.71) |
| Executive Functions | | | | |
| Inhibition | Intervention | 45.33 (3.50) | 30.12 (2.98) | 29.88 (2.95) |
| | Control | 45.28 (3.45) | 45.00 (3.40) | 45.05 (3.42) |
| Shift | Intervention | 42.20 (3.25) | 28.65 (2.75) | 28.45 (2.73) |
| | Control | 42.15 (3.20) | 42.00 (3.18) | 42.05 (3.19) |
| Emotional Control | Intervention | 44.50 (3.35) | 30.32 (2.85) | 30.10 (2.83) |
| | Control | 44.48 (3.30) | 44.25 (3.28) | 44.30 (3.29) |
| Working Memory | Intervention | 46.78 (3.60) | 32.12 (2.98) | 31.88 (2.95) |
| | Control | 46.75 (3.55) | 46.50 (3.50) | 46.55 (3.52) |
| Organization | Intervention | 40.90 (3.15) | 26.55 (2.55) | 26.32 (2.53) |
| | Control | 40.88 (3.10) | 40.65 (3.08) | 40.70 (3.09) |
| Academic Performance | | | | |
| Academic Performance | Intervention | 65.32 (4.20) | 80.45 (3.95) | 80.25 (3.93) |
| | Control | 65.28 (4.18) | 65.00 (4.15) | 65.05 (4.16) |

After confirming the normal distribution of data, the homogeneity of variances for the research variables was examined. The results of the Box's M test for reaction time in word reading (Box's M = 14.99, p = .06), color naming (Box's M = 14.03, p = .06), word color (Box's M = 7.73, p = .34), and reading words without color (Box's M = 10.81, p = .06) were not significant, indicating that the assumption of homogeneity of covariance matrices was met. Additionally, Levene's test, which examines the equality of variances between groups, was not significant at any stage, indicating that the error variance of the dependent variables was equal across all groups. Finally, Mauchly's test showed that the sphericity assumption was met for the variable color naming (Mauchly's W = 0.81, $\chi^2$ = 5.21, p = .07), word color (Mauchly's W = 0.78, $\chi^2$ = 6.35, p = .06), and word color. For the variables of reading words and reading words without color, Mauchly's test was significant, and the Greenhouse-Geisser correction was used. The results of the repeated measures ANOVA are presented in Table 2.

**Table 2**

*Repeated Measures ANOVA Results for Comparing Pre-test, Post-test, and Follow-up Reaction Time Scores*

| Variable | Source of Variation | Sum of Squares | df | Mean Square | F | Significance | Effect Size |
|---|---|---|---|---|---|---|---|
| Word Reading | Time | 126.24 | 1 | 126.24 | 145.78 | .001 | 0.84 |
| | Time*Group | 99.43 | 1 | 99.43 | 114.72 | .001 | 0.80 |
| | Error (Time) | 23.38 | 27 | 0.86 | | | |
| | Group | 268.54 | 1 | 268.54 | 9.58 | .005 | 0.26 |
| | Error | 756.56 | 27 | 28.02 | | | |
| Color Naming | Time | 133.04 | 1 | 133.04 | 147.64 | .001 | 0.84 |
| | Time*Group | 121.60 | 1 | 121.60 | 134.93 | .001 | 0.83 |
| | Error (Time) | 24.33 | 27 | 0.90 | | | |
| | Group | 288.53 | 1 | 288.53 | 14.02 | .001 | 0.34 |
| | Error | 555.64 | 27 | 20.57 | | | |
| Word Color | Time | 171.66 | 1 | 171.66 | 183.72 | .001 | 0.87 |
| | Time*Group | 213.87 | 1 | 213.87 | 228.89 | .001 | 0.89 |
| | Error (Time) | 25.22 | 27 | 0.93 | | | |



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|---|---|---|---|---|---|---|---|
| | Group | 450.84 | 1 | 450.84 | 19.30 | .001 | 0.41 |
| | Error | 630.44 | 27 | 23.35 | | | |
| Reading Words Without Color | Time | 225.96 | 1 | 225.96 | 86.47 | .001 | 0.76 |
| | Time*Group | 182.51 | 1 | 182.51 | 69.85 | .001 | 0.72 |
| | Error (Time) | 70.55 | 27 | 2.61 | | | |
| | Group | 398.42 | 1 | 398.42 | 6.26 | .01 | 0.19 |
| | Error | 1716.19 | 27 | 63.56 | | | |

Based on the repeated measures ANOVA results for the variables word color, color naming, word reading, and reading words without color at the three stages (pre-test, post-test, and follow-up), a significant relationship exists between the participants' scores at the three stages. The effect sizes for word color, color naming, word reading, and reading words without color are 0.41, 0.34, 0.26, and 0.19, respectively, indicating that the intervention explained 41%, 34%, 26%, and 19% of the changes in the post-test and follow-up scores for these variables.

The following section presents the results for the number of errors. The results of the Box's M test for reaction time in word reading (Box's M = 14.02, p = .06), color naming (Box's M = 13.11, p = .07), word color (Box's M = 11.21, p = .13), and reading words without color (Box's M = 12.10, p = .10) were not significant, indicating that the assumption of homogeneity of covariance matrices was met. Additionally, Levene's test was not significant at any stage, indicating that the error variance of the dependent variables was equal across all groups. Finally, Mauchly's test showed that the sphericity assumption was met for the variable word reading (Mauchly's W = 0.82, $\chi^2$ = 5.01, p = .08), word color (Mauchly's W = 0.87, $\chi^2$ = 3.39, p = .18), reading words without color (Mauchly's W = 0.87, $\chi^2$ = 3.40, p = .18), and word color (Mauchly's W = 0.83, $\chi^2$ = 4.67, p = .09). For the variables word color and reading words without color, Mauchly's test was significant, and the Greenhouse-Geisser correction was used. The results of the repeated measures ANOVA are presented in Table 3.

**Table 3**

*Repeated Measures ANOVA Results for Comparing Pre-test, Post-test, and Follow-up Error Scores*

| Variable | Source of Variation | Sum of Squares | df | Mean Square | F | Significance | Effect Size |
|---|---|---|---|---|---|---|---|
| Word Reading | Time | 61.57 | 1 | 61.57 | 134.89 | .001 | 0.83 |
| | Time*Group | 46.67 | 1 | 46.67 | 102.26 | .001 | 0.79 |
| | Error (Time) | 12.32 | 27 | 0.45 | | | |
| | Group | 35.65 | 1 | 36.65 | 6.94 | .01 | 0.20 |
| | Error | 138.53 | 27 | 5.13 | | | |
| Color Naming | Time | 75.03 | 1 | 75.03 | 204.74 | .001 | 0.88 |
| | Time*Group | 58.48 | 1 | 58.48 | 159.57 | .001 | 0.85 |
| | Error (Time) | 9.89 | 27 | 0.36 | | | |
| | Group | 21.93 | 1 | 21.93 | 4.39 | .04 | 0.13 |
| | Error | 304.25 | 27 | 11.26 | | | |
| Word Color | Time | 71.31 | 1 | 71.31 | 141.78 | .001 | 0.84 |
| | Time*Group | 80.14 | 1 | 80.14 | 159.33 | .001 | 0.85 |
| | Error (Time) | 13.58 | 27 | 0.50 | | | |
| | Group | 165.52 | 1 | 165.52 | 9.96 | .004 | 0.27 |
| | Error | 448.43 | 27 | 16.60 | | | |
| Reading Words Without Color | Time | 94.70 | 1 | 94.70 | 132.97 | .001 | 0.83 |
| | Time*Group | 67.39 | 1 | 67.39 | 94.62 | .001 | 0.77 |
| | Error (Time) | 19.22 | 27 | 0.71 | | | |
| | Group | 85.66 | 1 | 85.66 | 4.68 | .03 | 0.14 |
| | Error | 862.27 | 27 | 31.93 | | | |

Based on the repeated measures ANOVA results for error scores in word color, color naming, word reading, and reading words without color at the three stages (pre-test, post-test, and follow-up), a significant relationship exists between the participants' scores at the three stages. The effect sizes for word color, color naming, word reading, and reading words without color are 0.20, 0.13, 0.27, and 0.14, respectively, indicating that the intervention explained 20%, 13%, 27%, and 14% of the changes in the post-test and follow-up scores for these variables.


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Regarding executive functions, after confirming the normal distribution of data, the homogeneity of variances for the research variables was examined. The results of the Box's M test for the inhibition variable (Box's M = 12.09, p = .09), shift (Box's M = 12.32, p = .09), emotional control (Box's M = 9.88, p = .19), working memory (Box's M = 9.33, p = .22), and organization (Box's M = 13.09, p = .07) were not significant, indicating that the assumption of homogeneity of covariance matrices was met. Additionally, Levene's test was not significant at any stage, indicating that the error variance of the dependent variables was equal across all groups. Finally, Mauchly's test showed that the sphericity assumption was met for the inhibition variable (Mauchly's W = 0.96, $\chi^2$ = 0.87, p = .64). For the variables shift, emotional control, working memory, and organization, Mauchly's test was significant, and the Greenhouse-Geisser correction was used. The results of the repeated measures ANOVA are presented in Table 4.

**Table 4**

*Repeated Measures ANOVA Results for Comparing Pre-test, Post-test, and Follow-up Executive Function Scores*

| Variable | Source of Variation | Sum of Squares | df | Mean Square | F | Significance | Effect Size |
|---|---|---|---|---|---|---|---|
| Inhibition | Time | 173.40 | 1 | 173.40 | 375.40 | .001 | 0.93 |
| | Time*Group | 201.66 | 1 | 201.66 | 436.59 | .001 | 0.94 |
| | Error (Time) | 12.93 | 28 | 0.46 | | | |
| | Group | 211.60 | 1 | 211.60 | 4.51 | .04 | 0.14 |
| | Error | 1311.02 | 28 | 46.82 | | | |
| Shift | Time | 126.15 | 1 | 126.15 | 207.77 | .001 | 0.88 |
| | Time*Group | 112.06 | 1 | 112.06 | 133.33 | .001 | 0.82 |
| | Error (Time) | 23.53 | 28 | 0.84 | | | |
| | Group | 136.90 | 1 | 136.90 | 10.82 | .003 | 0.27 |
| | Error | 354.22 | 28 | 12.65 | | | |
| Emotional Control | Time | 173.40 | 1 | 173.40 | 206.31 | .001 | 0.88 |
| | Time*Group | 163.35 | 1 | 163.35 | 269.04 | .001 | 0.90 |
| | Error (Time) | 17.00 | 28 | 0.60 | | | |
| | Group | 490.00 | 1 | 490.00 | 34.41 | .001 | 0.55 |
| | Error | 398.62 | 28 | 14.23 | | | |
| Working Memory | Time | 312.81 | 1 | 312.81 | 219.70 | .001 | 0.88 |
| | Time*Group | 268.81 | 1 | 268.81 | 188.80 | .001 | 0.87 |
| | Error (Time) | 36.86 | 28 | 1.32 | | | |
| | Group | 348.10 | 1 | 348.10 | 4.81 | .03 | 0.15 |
| | Error | 2025.02 | 28 | 72.32 | | | |
| Organization | Time | 170.01 | 1 | 170.01 | 85.82 | .001 | 0.75 |
| | Time*Group | 132.01 | 1 | 132.01 | 66.64 | .001 | 0.70 |
| | Error (Time) | 55.46 | 28 | 1.98 | | | |
| | Group | 302.50 | 1 | 302.50 | 7.27 | .01 | 0.20 |
| | Error | 1163.95 | 28 | 41.57 | | | |

Based on the repeated measures ANOVA results for inhibition, emotional control, shift, working memory, and organization scores at the three stages (pre-test, post-test, and follow-up), a significant relationship exists between the participants' scores at the three stages. The effect sizes for inhibition, emotional control, shift, working memory, and organization are 0.14, 0.25, 0.57, 0.15, and 0.20, respectively, indicating that the intervention explained 14%, 25%, 57%, 15%, and 20% of the changes in the post-test and follow-up scores for these variables.

Regarding academic performance, after confirming the normal distribution of data, the homogeneity of variances for the research variables was examined. The results of the Box's M test were not significant (Box's M = 12.16, p = .09), indicating that the assumption of homogeneity of covariance matrices was met. Additionally, Levene's test was not significant at any stage, indicating that the error variance of the dependent variables was equal across all groups. Finally, Mauchly's test showed that the sphericity assumption was met (Mauchly's W = 0.79, $\chi^2$ = 6.01, p = .06). The results of the repeated measures ANOVA are presented in Table 5.


JARAC Assessment and Research in Applied Counseling
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**Table 5**

*Repeated Measures ANOVA Results for Comparing Pre-test, Post-test, and Follow-up Academic Performance Scores*

| Variable | Source of Variation | Sum of Squares | df | Mean Square | F | Significance | Effect Size |
|---|---|---|---|---|---|---|---|
| Academic Performance | Time | 6.04 | 1 | 6.04 | 127.62 | .001 | 0.82 |
| | Time*Group | 7.35 | 1 | 7.35 | 159.13 | .001 | 0.85 |
| | Error (Time) | 1.27 | 28 | 0.047 | | | |
| | Group | 21.21 | 1 | 21.21 | 4.28 | .045 | 0.14 |
| | Error | 135.04 | 28 | 4.82 | | | |

Based on the repeated measures ANOVA results for academic performance scores at the three stages (pre-test, post-test, and follow-up), a significant relationship exists between the participants' scores at the three stages. The effect size for academic performance is 0.14, indicating that the intervention explained 14% of the changes in the post-test and follow-up scores for this variable. Therefore, the research hypothesis is accepted.

## 4. Discussion and Conclusion

The results showed that cognitive-emotional-social training of working memory was effective in the reaction time components of word color, color naming, word reading, and reading words without color. The effect sizes for the variables word color, color naming, word reading, and reading words without color were 41%, 34%, 26%, and 19%, respectively. Regarding the number of errors, the components of word color, color naming, word reading, and reading words without color showed changes of 20%, 13%, 27%, and 14%, respectively. Therefore, the hypothesis is confirmed, and cognitive-emotional-social training of working memory affects the attention bias of students with ADHD. Consistent with this finding, Nejati (2021) reported similar results (Nejati, 2021).

To explain this finding, it can be said that during the sessions, games like "Sit/Stand," "Laugh/Don't Laugh," and "Statue/Move" were conducted both directly and inversely to enhance numerical memory, visual memory, working memory, attention, and concentration. In subsequent sessions, games involving signals—such as jumping up or lowering hands and raising feet upon hearing or seeing specific cues—were used to increase response inhibition and reduce impulsivity (Diamond, 2012; Fleming et al., 2017). Repetition of these exercises during sessions, along with emotional regulation training, enabled participants to strengthen their focus. Attention in these children may be diverted by various factors, and cognitive-emotional-social training of working memory, considering different cognitive, emotional, and social dimensions, can improve attention bias in these children (Bulgarelli & Molina, 2016; Di Lorenzo et al., 2021).

Cognitive-emotional-social rehabilitation of working memory, tailored to the child's needs, can involve games, teaching impulse control related to turn-taking and patience. In play therapy, the child, with the therapist's help, can express conflicting and inverse feelings, thoughts, and beliefs (Bulgarelli & Molina, 2016; Di Lorenzo et al., 2021; Diamond, 2012). The games used in this rehabilitation program are effective for role-playing and exploring thoughts and feelings, providing an opportunity for children to express emotions, concerns, and creative ideas that they might withhold in typical situations. Play therapy intervention focused on cognitive rehabilitation emphasizes the relationship between the therapist and the child, with play being a medium for communication. A significant portion of clinical interpretation stems from the child's communicative behavior with the therapist (Ronald et al., 2021; Shechner et al., 2012; Tatar & Cansız, 2022).

The results also indicated that cognitive-emotional-social training of working memory affected inhibition, emotional control, shift, working memory, organization, and planning in the three stages of pre-test, post-test, and follow-up, showing a significant difference in the participants' scores at the three stages. The effect sizes for inhibition, emotional control, shift, working memory, and organization were 14%, 25%, 57%, 15%, and 20%, respectively. According to Chambers et al. (2010), some cognitive skills in individuals with ADHD can improve with cognitive training (Chambers et al., 2010).

To explain this finding, it can be said that during cognitive-emotional-social training sessions, the therapist used behavior modification strategies to positively reinforce adaptive behaviors or utilized play situations to teach structural problem-solving or coping skills. This helped the child experience acceptance, emotional release, reduced distress, reorientation of impulses, and corrective emotional



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E-ISSN: 3041-8518

experiences during interpersonal interactions. Therefore, it can be inferred that play, due to its alignment with the child's developmental needs and active participation, explains the lasting impact of play therapy based on cognitive rehabilitation on improving emotional regulation and executive functions (Diamond, 2012).

The results indicated that academic performance improved significantly at the three stages of pre-test, post-test, and follow-up. The effect size for academic performance was 13%, meaning 13% of the changes in academic performance scores in the post-test and follow-up were related to the therapeutic intervention. This finding is consistent with the results of prior studies (Bulgarelli & Molina, 2016; Chambers et al., 2010).

To explain this finding, it can be said that the issues faced by children with ADHD lead to increased academic difficulties. Cognitive-emotional-social training of working memory is a multidimensional method targeting various aspects. During this rehabilitation, the child's damaged brain functions can be repaired through educational strategies, repetition, and practice (Nejati, 2021). This intervention comprises a structured set of educational activities based on memory skills and cognitive functions that emphasize improving attention and strengthening the ability to remember daily activities. Since all learning and educational processes essential for completing tasks are related to cognitive skills, using play therapy based on cognitive rehabilitation seems beneficial and effective (Fleming et al., 2017).

## 5. Limitations & Suggestions

One limitation of this study was the lack of facilities to classify the severity of the disorder, as children with ADHD often report lower mental health compared to other demographic groups. Another limitation was the inability to conduct clinical interviews to assess the children's mental health status before including them in the study. Future research should examine age-specific effects separately and use random sampling methods for more generalizable results. It is also recommended to investigate the effectiveness in larger samples and monitor medication adherence during interventions.

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## Declaration of Interest

The authors of this article declared no conflict of interest.

## Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

## Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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## Authors' Contributions

All authors equally contributed in this article.

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