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Effectiveness of Self-regulatory Educational Package for Improving Attention and Working Memory in Elementary Students with ADHD

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ABSTRACT

Objective: This study examined the effectiveness of a self-regulatory educational package on improving working memory and attention in elementary school children with attention deficit/hyperactivity disorder (ADHD) in Kashan.

Methods: A quasi-experimental design with three phases (pre-test and post-test) was used, involving two groups (self-regulatory training and Dawson & Guare's executive skills training). A total of 30 second-grade children were purposefully selected based on defined inclusion and exclusion criteria. The N-Back task and IVA test were employed to assess working memory and attention, respectively, with reliability confirmed through Cronbach's alpha. Data were analyzed using multivariate and univariate covariance analyses in SPSS28.

Results: Findings revealed that the self-regulatory educational package produced significant and sustained improvements in working memory and attention among children with ADHD across all test phases in comparison with Dawson & Guare's executive skills training ($p < 0.05$).

Conclusions: These results suggest that the educational package can serve as a practical tool for teachers and therapists to enhance attention and working memory in children with ADHD.

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Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common behavioral disorders in childhood. Children with ADHD represent a heterogeneous group, differing significantly in the severity of symptoms, their pervasiveness across settings, and comorbidities with other conditions such as externalizing behavioral problems and conduct-related difficulties (Luo et al., 2019; Sharma & Couture, 2014). The prevalence of ADHD is estimated to range between 5% and 10% among school-aged children, with the highest diagnostic rates occurring between ages 7 and 10 (Zgodic et al., 2023). ADHD is also considered a neurodevelopmental disorder, with nearly two-thirds of cases persisting into adulthood (Jafari et al., 2023; Vos & Hartman, 2022).

For diagnosis, symptoms must be present for at least six months, occur in at least two different contexts (e.g., home and school), appear before the age of 12, and cause significant impairment in key areas of life such as social interactions and academic performance (Mohr-Jensen et al., 2019). Children with ADHD often struggle with initiating and maintaining attention to incoming information and are easily distracted (Dobrean et al., 2021). ADHD is typically classified into three main subtypes: predominantly inattentive, predominantly hyperactive-impulsive, and combined type. In the inattentive type, difficulties with attention are particularly pronounced—for example, failing to pay close attention to details, making careless mistakes in schoolwork or other tasks requiring focus, having trouble sustaining attention during activities, not seeming to listen when spoken to directly, and frequently losing belongings (Nigg, 2015; Rostami et al., 2021; Svenaeus, 2014).

Attention plays a fundamental role in cognitive, social, and communicative functioning (Mohr-Jensen et al., 2019). Among children with ADHD, attention-related impairments encompass selective attention, sustained attention, shifting attention, and divided attention. Inability to sustain focus on a specific task is a hallmark symptom (Darvishi et al., 2021).

Working memory, another crucial cognitive construct, has been recognized as both a predictor and causal factor in learning disabilities. It goes beyond simple short-term storage, representing a dynamic system responsible for maintaining and manipulating task-relevant information during cognitive activities (Khorasani Zadeh et al., 2018). Working memory is considered a central component of cognitive psychology and, more recently, cognitive neuroscience (Constantinidis & Klingberg, 2016). Although working memory capacity is often regarded as relatively stable, its

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deficits have been strongly linked to ADHD, as proposed in the theoretical models of Barkley and Rapport. Impairments in attention and working memory are among the most critical cognitive deficits observed in individuals with ADHD (Kofler et al., 2020). Several studies have confirmed this association, showing that working memory can be strengthened through targeted training (Khorasani Zadeh et al., 2018). For instance, Kofler et al. (2020) demonstrated an inverse relationship between impulsive behaviors and working memory performance in children with ADHD. Similarly, Fenesy and Lee (2019) highlighted that weaknesses in attention and working memory represent core challenges for children with ADHD, adversely affecting both their academic achievement and social functioning.

Consequently, in addition to pharmacological treatments, psychological approaches and interventions—such as the Dawson and Guare program—have been developed to enhance executive skills (Dawson & Guare, 2012). This program emphasizes training in areas such as task initiation, memory, attention regulation, planning, behavior and emotion control, time management, and problem-solving (Ebrahimi et al., 2016). The package provides both preventive and interventional benefits, employing strategies such as setting daily goals, resisting procrastination, fostering task completion, strengthening emotional regulation, and improving working memory through planning aids and reminders (Ghasemi et al., 2020).

In the present study, the self-regulatory educational package was designed by combining Dawson et al. (2024) framework with storytelling principles that promote emotional regulation, alongside culturally adapted play-based activities. This integrated approach not only incorporates game-based interventions but also utilizes storytelling as a means to enhance engagement and learning. The effectiveness of this package was compared with Dawson and Guare's validated program.

Given the reported prevalence of ADHD in Iran—ranging from 0.95% to 17%, with an average of 7.8% (Hamzehnejadi et al., 2021)—the need for effective educational and therapeutic strategies is evident. Accordingly, the present study aimed to examine the effectiveness of a self-regulatory educational package in improving working memory and attention among elementary school children with ADHD in Kashan.

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Material and Methods

This study employed a quantitative, quasi-experimental design to investigate the effectiveness of a self-regulatory educational package on working memory in children with attention-deficit/hyperactivity disorder (ADHD). The design included three phases (pre-test and post-test) with two groups (an experimental group receiving the self-regulatory training and a group receiving Dawson & Guare's executive skills training).

The statistical population comprised all elementary school children (grades 4–6) diagnosed with ADHD who attended diagnostic centers under the supervision of the Kashan Department of Education during the summer of 2023. A purposive sampling method was used to select 30 children (ages 10–12), who were randomly assigned to groups, each with 15 participants.

Instruments

Conners' Teacher Rating Scale for ADHD (CTRS-T): To identify ADHD symptoms, Conners' Teacher Rating Scale (38 items) (Conners, 1989) was administered. The scale assesses three domains: classroom behavior (items 1–21), group participation and cooperation (items 22–29), and attitude toward authority figures (items 30–38). Scores range from 0 to 114, with scores above 57 indicating the presence of ADHD symptoms. Higher scores reflect greater symptom severity. The reliability of the scale has been reported as $\alpha = 0.90$ (Conners, 1989), $\alpha = 0.85$ in Iran (Institute for Cognitive Science Studies), and $\alpha = 0.76$ in a study by Shahim et al. (2008). In the present study, Cronbach's alpha was 0.861.

Working Memory Test (N-Back): The *N-Back* task, originally introduced by Miller et al. (2009), was used to measure working memory. This test requires participants to determine whether a current visual stimulus matches one presented *n* steps earlier (here, $n = 1$). The task involves both storage and manipulation of information, making it an established measure of working memory performance. Reliability coefficients reported in previous studies range from 0.54 to 0.84, and its construct validity as a working memory measure has been well documented (Miller et al., 2009).

Integrated Visual and Auditory Continuous Performance Test (IVA+): The IVA+ test is a computerized 13-minute measure designed to evaluate attention and response control, based on DSM-IV diagnostic criteria. It consists of 500 visual and auditory stimuli, each presented for 1.5 seconds, requiring participants to either respond or withhold responses (response inhibition). The test is suitable for individuals aged 6 years and above. The IVA+PLUS version (2004)

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demonstrates high sensitivity (0.92) and predictive accuracy (0.89) in diagnosing ADHD. Test–retest reliability has shown significant positive correlations across its 22 scales, confirming strong reliability and validity for assessing attention deficits (Ghasemi et al., 2020).

Educational Packages

Two training packages were used:

Self-Regulatory Educational Package (developed by the researchers): This program incorporated both storytelling and play-based activities, structured to strengthen attention, emotional regulation, and working memory. Table 1 presents the components of the self-regulatory package.

Table 1. Components of the self-regulatory package

Session	Aim	Content
1	Familiarity and introduction	Getting to know the group members and each other, stating the rules for participating in the group, stating the goals of the training course, conducting a pre-test
2	Story recall)using storytelling(	In this session, the trainer reads a story that includes 30 phrases and 10 questions. The subject is asked to listen carefully to the story and recall the story. Part two of the training: a) Throwing the ball into the basket (in order to reduce attention deficit), b) Collecting the specified colored balls. Part three of the training: Teaching emotion recognition through games and stories. Presenting the assignment
3	Attention enhancement (finding differences in images)	The trainer prepares a book or notebook containing 12 pairs of pictures. The pictures have between 5 and 10 differences and the students must find these differences. Part 2 of the training: Jumping into squares with specific numbers (the child first hears the instructor's command and then executes it (attention shifting). Part 3 of the training: Training in emotional feedback, presenting the task
4	Attention enhancement and inhibition (color word story)	Colored word story: The student first reads from a story. Then reads it for the second time and this time, whenever he comes to a green word, instead of reading that word once, and whenever he comes to red words, he taps the table twice with a pen. Part 2 of the training: Play sit and walk in a straight and reverse way (the child first hears the instructor's command and then executes it (attention shifting). Part 3: Training in anger and how to control it (stopping), presenting the task
5	Attention enhancement and memory (making sentences with words)	The instructor writes between 4 and 5 words on each card and gives it to the student. After memorizing the words, the student must make a sentence on the back of the card that uses at least 3 of the words on the card in that sentence. Part 2 of the training: Remembering names after Their definition. Part Three of the Training: Teaching Anxiety and How to Manage It, Presenting the Task
6	Visual memory enhancement and accuracy, recalling the location of objects	۱۰slides are displayed on a screen. The child is asked to look at them carefully and then explain them with his eyes closed. Then the child must find those images among the cards. Part Two of the Training: Recalling the Location of Objects. The trainer arranges a number of objects on the table and asks the child to look at them. Then, in the child's absence, he rearranges them and asks the child to recall their previous location. Part Three of the Training: Teaching Interpersonal Conflict Resolution (Using the Traffic Light Technique), Presenting the Task
7	Attention enhancement auditory memory and auditory sequence	In the auditory memory exercise, a word is said to the child that he must repeat. Then two words are said that the child must repeat. And in the same way, the number of words is added, when they reach a four-word word, a nonsense word is added to the vocabulary. Part Two: Auditory Sequence Memory Exercise: The child is told a word that he must Repeat it, then pronounce the same word incompletely and ask the child to complete it. The child is asked to state a list of words that have been read to him in order. The student throws the ball against the wall after hearing the number 1 and on hearing the number 2, the ball on the ground.

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		The third part of the training: Teaching the skill of courage (the story "No Firm"), presenting the task
8	Attention enhancement visual memory and visual sequence	Presenting a picture to the person (for a few seconds), and asking the person what was in the picture. Presenting three to five words to the person and asking them to name them. The trainer puts out some cards and asks the child to look at them for a few seconds and then closes his eyes. The trainer changes the location of the cards and asks the person to explain the changes. Then he wants him to state the order of the previous cards Part two: Presenting two sets of pictures on a page, comparing the shapes on both sides by the child and telling the pictures that are stuck in the pictures on the right. Part three: Teaching empathy, presenting the task
9	Attention enhancement of auditory and visual verbal memory span	The trainer in The forward digit memory task asks the child to repeat the digits in the order they hear them. In the backward digit memory task, the teacher asks the child to repeat the digits from the last to the first. In the visual memory task, the teacher asks the child to repeat the pictures of the cards he has seen in order. Quickly showing several cards and turning them over, the person must choose similar cards. Part 2 of the training: Teaching children to solve problems, presenting the task.
10	Final activities to end the sessions	Telling a story and retelling it by children (to measure their attention and working memory), games related to increasing the level of cooperation in children (playing chairs and far or near activity). Celebration of the end of the sessions

Dawson & Guare's Executive Skills Training Program: Based on the program described in *Executive Skills in Children and Adolescents: A Practical Guide to Assessment and Intervention* (Dawson et al., 2024), this intervention included 12 weekly group sessions (60 minutes each). Table 2 summarizes the session content.

Table 2. Summary of Dawson & Guare's Executive Skills Training sessions

Session	Content
1	Introducing the therapists and children to each other and stating the rules and duties of each member, then paying attention to the children's desired activities to create a friendly relationship and a sense of security for the children.
2	Performing the inverted theater activity and the tower building activity.
3	Performing the ball rolling activity with music and doing things without using the thumb.
4	Performing the waves of joy activity and playing the chair game.
5	Reviewing previous sessions and doing the red and black card activity.
6	Performing the polar bear chase show and the "Rostam said" activity.
7	Performing the mirror image activity and the freeze activity with music (become a statue).
8	Performing the wolf in the air game with the ball and playing the animal game.
9	Performing the appropriate gesture activity and playing the ball and words activity.
10	Performing the lay lay game and the lamp, scissors, knife, fork activity.
11	Performing the "Don't follow the trainer" activity and the animal's name guessing game.
12	Performing the sock game and identifying objects, reviewing previous sessions and distributing post-test questionnaires.

Results

Following the implementation of the self-regulatory educational package, the effectiveness of the intervention on students' working memory and attention was examined. Table 3 presents the means and standard deviations of the dependent variables (working memory and attention) for the

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experimental group (self-regulatory training) and the control group across the pre-test, post-test, and follow-up phases.

Table 3. Means and standard deviations of variables in the self-regulation and Dawson & Guare's Program groups across pre-test, post-test, and follow-up phases

Component	Group	Pretest		Posttest		Follow-Up	
		Mean	SD	Mean	SD	Mean	SD
Working memory (N-Back)	Self-regulation	72.53	6.66	94.27	6.82	94	6.12
	Dawson & Guare's Program	73.34	6.75	73.20	6.89	73.13	6.60
Attention	Self-regulation	54.07	9.87	91.40	12.82	91.07	12.70
	Dawson & Guare's Program	54	8.58	53.80	8.61	53.67	8.93

Multivariate Analysis of Covariance (MANCOVA): To assess the effectiveness of the self-regulatory educational package on the main dependent variables (attention and working memory) between the pre-test and post-test phases, a multivariate analysis of covariance (MANCOVA) was conducted.

Table 4. Results of multivariate analysis of covariance (MANCOVA) for attention and working memory

Test	Value	F	P	Eta square
Pillai's Trace	0.957	171.843	0.001	0.957
Wilks' Lambda	0.043	171.843	0.001	0.957
Hotelling's Trace	22.414	171.843	0.001	0.957
Roy's Largest Root	22.414	171.843	0.001	0.957

As shown in Table 4, after controlling for pre-test scores, the significance levels of all tests indicated a meaningful difference between the experimental and control groups in at least one of the dependent variables ($F = 171.843$, $p < .001$). To determine which variables contributed to these differences, separate univariate ANCOVAs were conducted for attention and working memory. Effect size calculations ($\eta^2 = .96$) indicated that 96% of the variance in post-test scores for attention and working memory could be attributed to the self-regulatory training program.

Table 5. Results of univariate ANCOVA for attention and working memory

Variable	Source	SS	DF	MS	F	P	Eta square	Power
Attention	Pretest	779.191	1	779.191	8.84	0.006	0.261	0.816
	Group	5432.52	1	5432.52	61.69	0.001	0.712	1
	Error	2201.47	25	88.05				
Working memory	Pretest	721.21	1	721.21	35.71	0.001	0.588	1
	Group	1776.25	1	1776.25	87.95	0.001	0.779	1
	Error	504.85	25	20.19				

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According to Table 5, after controlling for pre-test scores, significant differences were observed between the experimental and control groups on both variables: attention ($F = 61.692$, $p < .001$, $\eta^2 = .712$) and working memory ($F = 87.959$, $p < .001$, $\eta^2 = .779$). This suggests that the intervention accounted for 71% of the variance in attention and 78% of the variance in working memory scores at post-test. In summary, the self-regulatory educational package significantly improved attention and working memory in elementary school children with ADHD between the pre-test and post-test phases.

Discussion

The aim of this study was to examine the effectiveness of a structured self-regulation educational package on improving working memory and attention in elementary school children with attention-deficit/hyperactivity disorder (ADHD) in Kashan.

Based on the results of the covariance analysis for the variable working memory in the post-test, it can be concluded that self-regulation training had a significant effect on the enhancement of working memory in children with ADHD. These findings are consistent with those of previous studies by Hamzehnejadi et al. (2021), Darvishi et al. (2021), Mosaiebi and Mirmahdi (2017), and Ghasemi et al. (2020).

Working memory constitutes the core of many cognitive processes and is strongly related to executive functioning. It refers to a set of processes that allow individuals to hold and manipulate information temporarily while performing tasks such as encoding and retrieval (Miller et al., 2018). Since every cognitive task requires information to pass through working memory, limitations in its capacity restrict immediate access to information, thereby impairing cognition. However, research has demonstrated that working memory can be strengthened through targeted training (Aghasaleh et al., 2024; Baddeley & Hitch, 1994). Thus, improvements observed in this study can be attributed to the repeated exercises embedded in the self-regulation training package. The effectiveness of the intervention can also be explained through principles of neuroplasticity and recovery. The brain is a dynamic organ with the capacity for extensive neurocognitive reorganization throughout life. Behavioral changes are underpinned by structural modifications in the brain, particularly at dendritic and synaptic levels. Cognitive abilities can be enhanced through structured and repeated tasks, while systematic stimulation fosters functional improvements at the

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neuronal level. Functional recovery often involves recruiting adjacent cortical areas or homologous regions in the opposite hemisphere. Therefore, the observed behavioral outcomes (i.e., enhanced working memory) result from complex interactions of bottom-up and top-down processes, as well as intra- and inter-hemispheric influences (Shipstead et al., 2012).

In addition, the observed improvements in attention can be attributed to the near-transfer effects of working memory training. Solberg Nes et al. (2009) argued that working memory tasks demand considerable attention, thereby providing repeated opportunities to practice concentration. Continuous stimulation of attentional networks through such exercises facilitates cognitive capacity and leads to improvements in both attention and inhibitory control.

The educational package used in this study incorporated diverse cognitive training activities targeting working memory, including: sentence construction tasks, name-recall exercises, visual memory reinforcement (e.g., recalling details from images), object-location recall, auditory and sequential memory training, as well as verbal and visual span tasks (e.g., forward and backward digit span, card recognition, and picture sequencing). In all tasks, children were required first to encode and retain information, then to manipulate it to produce correct responses. Since such tasks demand selective attention to facilitate encoding into sensory and working memory, they enhance both working memory span and attentional control. This mechanism may explain the observed improvement in working memory.

For the variable attention, results of covariance analysis at post-test and follow-up stages also confirmed the effectiveness of self-regulation training. These findings are aligned with prior research, including Hamzehnejadi et al. (2021), Reid et al. (2005), Strehl et al. (2006) and Guderjahn et al. (2013).

Difficulties in sustaining goal-directed activity constitute one of the most prominent executive deficits among children with ADHD, with sustained attention being their primary difficulty (Barkley, 1997). Interventions that provide structured opportunities to train attentional processes have been shown to improve attentional capacity. Repeated and structured cognitive exercises stimulate attentional systems, leading to lasting changes in cognitive capacity and underlying neural activity. This is consistent with evidence supporting the effectiveness of cognitive rehabilitation in improving deficits in attention and working memory among children with ADHD.

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From a theoretical perspective, the observed effects can be explained by mechanisms of brain plasticity:

Synaptic modification, whereby neural pathways involved in normal learning are also engaged in children with ADHD, enabling improved performance. Training can lead to dynamic changes in neural structure and function, facilitating acquisition and application of new cognitive skills.

Neural circuit reorganization, where structured sensory input and cognitive training promote synaptic reorganization. Cognitive rehabilitation exercises, therefore, improve ADHD symptoms by leveraging underlying neuroplastic mechanisms.

Since sustained attention is typically impaired in children with ADHD, repetitive and monotonous tasks often result in performance decline. The variety, novelty, and game-based structure of the exercises in the self-regulation package likely contributed to maintaining engagement and enhancing attentional control. Examples include storytelling (30 phrases with 10 questions to enhance sustained attention), ball-tossing games, color-based object collection, animated film analysis (e.g., “Inside Out” for emotional state recognition), spot-the-difference puzzles (for alternating attention), square-jump exercises (for auditory-visual attention), and maze solving (for sustained visual attention). Additionally, homework assignments reinforced practice beyond the classroom, further consolidating attentional gains. The playful nature of the tasks ensured motivation, and motivation, in turn, enhanced attention.

Taken together, these findings highlight the effectiveness of the self-regulation training package in strengthening both working memory and attention in elementary school children with ADHD. Although the findings support the effectiveness of the self-regulation package, several limitations must be acknowledged. First, the study was conducted on a relatively small sample in Kashan city, which limits the generalizability of the results. Second, the research relied heavily on behavioral assessments and did not employ neuroimaging or physiological measures that could provide deeper insight into brain-level changes. Third, the intervention focused on short-term outcomes, and therefore the long-term sustainability of improvements in attention and working memory remains uncertain. Future research is recommended to replicate this study with larger and more diverse populations, employ longitudinal designs to assess lasting effects, and integrate objective neurocognitive measures. In addition, incorporating parental involvement and teacher-based

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strategies could strengthen the ecological validity of the training package and support the daily application of acquired skills in natural learning environments.

Data availability statement

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

Ethics statement

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

Author contributions

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

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Conflict of interest

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

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