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The Effectiveness of a Timly Cognitive Intervention Package on the Cognitive and Academic Performance of Students with Specific Learning Disorders

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ABSTRACT

Background: Early detection and intervention can lead to successful future educational experiences for at-risk children and reduce the negative consequences of learning disorders. This study was conducted to develop a timely intervention package for first-grade students with specific learning disorders and examine its effects on their cognitive performance.
Methods: The method employed in this study was quasi-experimental, utilizing a post-test and pre-test design with a control group. The statistical population consisted of first-grade Bojnord students referred to specific learning disorder centers. Thirty-two first-grade students referred to specific learning disorder centers were selected using an available sampling method and then randomly divided into experimental and control groups. During the pre-test stage, both groups underwent the fourth version of the Wechsler IQ Scale, the Behavior Rating Inventory of Executive Function, and researcher-made spelling, reading, and arithmetic abilities tests. Afterward, students in the experimental group received cognitive interventions over 16 sessions. After the intervention, post-tests were conducted for the control and experimental groups. Data obtained from the study were analyzed using analysis of covariance.
Results: The results indicated that the experimental group obtained higher scores than the control group in the post-test reading, spelling, and mathematics evaluations. However, the experimental group had lower executive function scores than the control group.
Conclusion: The results suggest that the designed cognitive package effectively reduces executive function problems and improves reading, spelling, and math performances.

Introduction

Specific learning disorder in children is a developmental neurological disorder that affects the brain's ability to perceive or process verbal or nonverbal information effectively. This disorder is characterized by persistent problems in learning academic skills that begin in early childhood and are inconsistent with the child's intelligence ability [1]. In a meta-analytical study, the prevalence of learning disorders in primary school students in Iran was 4.58% [2]. Additionally, in North Khorasan, the prevalence rates of reading, writing, and mathematics disorders were reported to be 3.39%, 4.71%, and 6.9%, respectively [3].

The information processing model comprehensively explains how learning occurs in individuals with learning disorders and offers valuable suggestions for improving students' learning strategies. According to this model, various units, including input, processing, output, and executive function, within the context of the emotional environment play crucial roles in the learning process, and their performance is interrelated. Specific learning disorder manifests through different types of defects in

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these units. Sensory-perceptual problems are associated with input defects, memory, and organization issues are linked to processing defects, writing and speech problems are related to output defects, and metacognitive problems arise from defects in executive functions [4].

Numerous studies have been dedicated to investigating the cognitive impairments experienced by children with learning disorders. Notably, deficiencies in executive functions, such as self-regulation, organization, and goal-oriented behavior, significantly increase the risk of educational challenges among these children [5].

In a longitudinal study conducted by Morgan et al. [6], which followed first- to third-grade children, it was discovered that executive dysfunctions during the early years of schooling elevate the risk of academic problems in later years. The study identified three specific types of executive functions closely associated with academic achievement: (a) Working memory, which involves the capacity to store and manipulate information in the short term. (b) Cognitive flexibility refers to the ability to shift attention between different aspects of a task. (c) Inhibition entails the ability to delay initial and immediate responses to a task [7].

The hypothesis of working memory impairment posits that working memory serves as a specific risk factor for academic problems [8]. Previous studies have demonstrated that children with mathematic disorders experience limited working memory capacity [9].

Empirical evidence regarding the deficits of cognitive flexibility shows some inconsistency. While it has been reported that deficits in cognitive flexibility can predict academic failure, they may not be as severe as deficits in active memory [6]. However, some other studies have failed to confirm the association of cognitive flexibility deficits with academic difficulties. One potential explanation for these conflicting findings is that cognitive flexibility limitations may impact children's success in later grades. For instance, it has been noted that cognitive inflexibility was associated only with advanced academic skills that are not typically acquired in elementary school [10].

Disinhibition in children can result in an inability to ignore irrelevant information during classroom activities, leading to disregard, impulsive, or agitated behaviors. Deficits in inhibition may elevate the risk of recurrent problems in children. Specifically, low inhibition has been found to predict less success in mathematics [11]. Previous studies have consistently shown that children with math disabilities exhibit difficulties in inhibition [9].

Studies suggest that high-quality early programs can positively affect cognitive development, academic performance, and career achievement in adulthood [12]. The early intervention approach is particularly well-suited for preschool and first-year primary school children, focusing on providing a high-quality learning environment [4]. During early childhood, the nervous system, sensory organs, and motor skills are more flexible, making them highly responsive to environmental stimuli and reinforcements, which aids in repair and integration activities. Consequently, interventions aimed at enhancing these abilities can be highly beneficial in preventing the development of disabilities [13]. Numerous studies have demonstrated that cognitive interventions effectively improve the executive functions of children with specific learning disorders [14-16].

Researchers believe that working memory is a flexible cognitive function that can be enhanced through training exercises [17-19]. Olsen et al. [19] reported that improved working memory function is associated with high activity in the frontal and parietal areas of the brain. Thus, working memory training can potentially bring about neurological changes in the brain. Similarly, Bushquel et al. [17] demonstrated that memory-related exercises can increase blood flow to brain areas associated with the memory network.

Recent studies have shown a growing interest in enhancing working memory capabilities through computer-based cognitive training interventions [20-23]. For instance, Gary et al. [20] conducted a study to assess the effectiveness of the CogMed working memory computer training program on working memory, attention, and academic achievement among adolescents with severe learning disorders and ADHD. They reported significant improvements in both auditory working memory and visual-spatial working memory.

Mazzacappa and Buckner [21] combined working memory training programs "RoboMemo" and "CogMed" in a daily school curriculum and observed that one-third of participants showed improved memory performance. The intervention group demonstrated enhanced spatial-visual memory.

In another study, Mirmahdi, Heidari, and Nobakht [22] confirmed the positive effects of puzzle and simulation games in computer-based training on working memory and spatial-visual perception in students with specific learning disorders.

Furthermore, a separate study demonstrated that cognitive computer training in the school environment significantly enhanced auditory working memory abilities in students with learning difficulties [23]. These findings collectively highlight the potential of computer-based interventions for improving working memory in individuals with learning disorders.

Another group of studies has investigated the effectiveness of cognitive interventions on academic performance. Hill, Serpel, and Faison [24] conducted a study to evaluate the effectiveness of the LearningRx program and its computer version, Brainskills, both in the laboratory and school settings. The results showed that after three weeks of training in the school environment, students demonstrated significant progress in all cognitive measurements and math performance. The experimental groups scored higher in cognitive performance in the laboratory environment, but there was no significant difference in mathematical performance between the experimental and control groups.

However, it is worth noting that while evidence supports the effectiveness of cognitive training and games for rehearsed assignments, the effects of cognitive training are often limited to those specific assignments, and there is limited evidence regarding the impact on unrelated tasks and long-term effects [25]. This finding suggests that while cognitive interventions may show promising results in certain areas, their generalizability and long-term effects need further investigation.

Given the crucial significance of early intervention for specific learning disorders and the existing discrepancies regarding the effectiveness of cognitive interventions in enhancing academic achievement and reducing cognitive deficits, this study aims to explore the effectiveness of timely intervention packages in improving cognitive and academic performance among children with learning disorders.

Methods

Considering that this study has explored the effectiveness of an early intervention cognitive package on the cognitive and academic performance of students with specific learning disorders, a quasi-experimental method was employed, utilizing a post-test and pre-test design with a control group.

Participants

This study's statistical population comprised all first-grade students with specific learning disabilities in Bojnord. The study sample was selected from first-grade students referred to the Center for Learning Disorders in Bojnord. The research received ethical approval from the Department of Education research group in North Khorasan.

Thirty-two children with learning disorders whose parents provided completed consent forms were included in the study and randomly assigned to either the control or experimental group. The inclusion criteria involved having an IQ score of 85 and above, no significant hearing or vision issues, a school referral due to poor academic performance, and a diagnosis of a specific learning disorder. Exclusion criteria included pervasive developmental disorders, blindness, deafness, and an IQ below 85.

The learning disorder was diagnosed using the fourth version of the Wechsler scale for children. Pre-test and post-test academic assessments were conducted for both groups, including spelling, reading, and math tests. Additionally, parents completed a behavioral rating inventory of executive functions. The intervention package was implemented over 16 sessions for the experimental group.

Tools

Wechsler Intelligence Scale for Children-fourth edition (WISC-IV): The scale used in this study is the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). This scale assesses overall intellectual performance and includes general verbal comprehension, perceptual reasoning, working memory, and processing speed indexes. The reliability coefficients for these indexes have been reported to range from 0.94 for verbal comprehension to 0.88 for processing speed [26]. The WISC-IV has been found to have good validity, as it correlates with other intelligence scales such as the Wechsler Preschool Scale - Third Edition, Wechsler Adult Intelligence Scale - Third Edition, Wechsler Individual Progress Scale, Children's Memory Scale, and Emotional Intelligence Questionnaire Bar-On [26].

In Iran, the WISC-IV was standardized, and the retest reliability coefficients for subscales ranged from 0.65 for visual concepts to 0.94 for vocabulary. The reliability coefficients for verbal comprehension, perceptual reasoning, working memory, and processing speed were 0.88, 0.83, 0.82, and 0.80, respectively. Furthermore, the correlation between verbal comprehension and processing speed with Raven matrix IQ was reported to be 0.39 and 0.40 [27]. These findings indicate the reliability and validity of the WISC-IV in assessing intellectual performance and its various components.

Behavioral rating inventory of executive functions (BRIEF): The questionnaire used in this study is the Behavior Rating Inventory of Executive Functions (BRIEF), which was designed by Gioia et al. [28] for children between the ages of 5 and 18 years. The BRIEF consists of 86 items, and respondents rate each item on a three-point Likert scale (never, sometimes, and often). There are separate teacher and parent reporting forms for this questionnaire. The BRIEF assesses various aspects of executive functions through its subscales, which include inhibition, shifting and emotional control, planning, initiation, working memory, material organization, and monitoring. The sum of scores from these subscales provides an overall measure of general executive functions.

For the parent form of the BRIEF, the internal consistency of the subscales ranges from 0.80 to 0.59, while the retest reliability of the subscales with an average interval of two weeks falls between 0.76 and 0.85. In Iran, the psychometric properties of the BRIEF have been examined, revealing a high internal consistency of 0.98 for the total score and ranging from 0.75 to 0.92 for all subscales [29]. These findings confirm the reliability and validity of the BRIEF as a tool for assessing executive functions in children.

Arithmetic Ability Test: The test used in this study is based on the numerical processing model and is commonly used to diagnose mathematical disorders. It consists of three parts: numerical comprehension (involving tasks such as counting, numerical comparison, matching, reading and writing numbers, using mathematical symbols, and sorting numbers), numerical production (which includes addition, subtraction, multiplication, and division of single digits), and numerical calculation (involving calculations with multi-digit numbers).

The arithmetic ability test is a standardized test with a reference group and the total scores on this test sum up to 100. The test's internal consistency has been reported to be 0.92 [30]. In Iran, the internal consistency of this test was found to be 0.95 [31]. These high internal consistency values indicate that the test provides reliable and consistent results, making it a valuable tool for assessing mathematical abilities and identifying mathematical disorders in children.

Researcher-made spelling test for the first grade: In this study, sentences of moderate difficulty were chosen from the second part of the Persian alphabet teaching book for first-grade students. The selected section contained a total of 30 words. The participants then dictated these sentences, and the number of correctly written words was recorded. The test was prepared in pre-test and post-test forms to assess the participants' progress.

The content validity of the test was confirmed by first-grade teachers who reviewed the test to ensure that it appropriately measured the desired skills and knowledge. This validation process ensures that the test accurately assesses the learning objectives and content areas relevant to the first-grade curriculum.

Researcher-made reading test for the first grade: n this study, sentences with a moderate difficulty level were carefully chosen from the second part of the Persian alphabet teaching book for first-grade students. The selected section contained a total of 65 words. Participants were then asked to read the text, and the number of correct words read was recorded. The pre-test and post-test tests were designed to assess the participants' progress. First-grade teachers confirmed the content validity of the test to ensure the test's accuracy and appropriateness.

Cognitive Package of Timely Intervention: The cognitive package was specifically designed by researchers to enhance the cognitive performance of first-grade students with specific learning disabilities., Its validity was confirmed by experts in cognitive development and learning disorders to ensure the effectiveness and accuracy of the package. The exercises within this package were thoughtfully designed to target and improve various cognitive skills, including attention, concentration, visual-motor coordination, spatial relationships, working memory, inhibition, flexibility, planning, and organization. Table 1 presents a detailed overview of the exercises included in each session of the cognitive package.

Results

The study's results indicated that the participants' age range was between 6.6 to 8.1 years, with a mean age of 7.6 years and a standard deviation of 0.48. Among the participants, 59.4% were boys, while 40.6% were girls. Most participants (59.4%) had more than one learning disorder; 25% had a writing disorder, 12.5% had a reading disorder, and 3.1% had a mathematics disorder.

An independent t-test was employed to investigate the differences between the control and experimental groups in the pre-tests. The assumptions for the independent t-test, including normality of data distribution, the existence of two independent groups, equal sample sizes in the two groups, and equality of variance between the groups based on Levene's test, were observed and met, allowing for the appropriate use of the independent t-test in this analysis.

Table 2 indicates that based on the independent t-test, there were no significant differences between the experimental and control groups concerning intelligence, reading, spelling, mathematics, and executive functions before the intervention. As the research method employed in this study was a pre-test and post-test with a control group, the appropriate statistical method for analyzing the data was the analysis of covariance (ANCOVA).

Table 1: Exercises for each session

Session	Task	Goal
First and second	Finding differences, finding target stimuli, finding irrelevant shapes, painting, and cutting	Strengthen visual search, focused attention, and eye-hand coordination
Third and fourth	Finding shadows of shapes, painting, and cutting, storytelling, connecting dots based on pattern	Strengthen visual search, focused attention, eye-hand coordination, spatial relationships, working memory
Fifth	Counting target stimuli, storytelling, connecting dots based on pattern, finding multiple target stimuli	Strengthen focused attention, spatial relationships, working memory, divided attention
Sixth	Finding unrelated items, tracking mazes, building towers, storytelling	Strengthen visual search, object recognition, focused and divided attention, planning, flexibility and inhibition, spatial relationships, working memory
Seventh	Sorting by size, tracking maze, building the tower, separating shape from background, storytelling	Strengthen focused and divided attention, working memory, planning, and organizing, flexibility and inhibition, spatial relationships, visual-motor perception coordination
Eighth	Tracking maze, building a tower, separating shapes from the background, storytelling, matching numbers, finding letters	Strengthen focused and divided attention, working memory, planning, and organizing, flexibility and inhibition, spatial relationships, visual-motor perception coordination
Ninth and tenth	Finding unrelated pieces, Sorting the jigsaw puzzle, tracking the maze, separating shapes from the background, joining pieces, matching numbers, finding letters	Strengthen focused and divided attention, visual-motor coordination, spatial visualization, perceptual speed-manipulation, flexibility, inhibition, planning, organizing, working memory,
Eleventh	Finding unrelated pieces of a puzzle, Sorting the jigsaw puzzle, joining pieces, coding, trial macking, matching sign	Strengthen focused and divided attention, visual-motor coordination, spatial visualization, perceptual-manipulative speed, flexibility, inhibition, planning, organizing, working memory
Twelfth	Finding unrelated pieces of a puzzle, Sorting the jigsaw puzzle, joining pieces, coding, trial macking, matching sign, block design	Strengthen focused and divided attention, visual-motor coordination, spatial visualization, perceptual-manipulative speed, flexibility, inhibition, planning, organizing, working memory
Thirteenth	Finding unrelated pieces of a puzzle, Sorting the jigsaw puzzle, block design, Remembering parts of the image	Strengthen focused and divided attention, visual-motor coordination, spatial visualization, perceptual-manipulative speed, flexibility, inhibition, planning, organizing, working memory
Fourteenth to sixteenth	Remembering parts of the image, Remembering the paths, Remembering the location and number of shapes	Strengthen focused and divided attention, working memory, the spatial relationship

Table 2: Differences between control and experimental groups in the pre-test variables

Variables		M	Std	Leven test (p)	T-test (p)
Total Intelligence	Experimental	84.43	18.76	0.42 (0.52)	-1.07 (0.29)
	Control	91.81	20.03		
Reading	Experimental	8.18	11.75	0.005 (0.94)	-0.14 (0.88)
	Control	8.87	14.37		
Spelling	Experimental	3.75	5.15	0.19 (0.65)	-0.40 (0.68)
	Control	4.62	6.96		
Mathematic	Experimental	15.35	8.46	0.003 (0.95)	0.72 (0.47)
	Control	13.18	8.66		
Executive functions	Experimental	135.50	20.16	1.09 (0.030)	-0.30 (0.76)
	Control	137.81	22.87		

M: Mean; Std: Standard deviation

Table 3: Mean and standard deviation of executive functions in pre-test and post-test by groups

Variables	Experimental group				Control group			
	Pre-test		Post-test		Pre-test		Post-test	
	mean	Std	mean	Std	mean	Std	mean	Std
Total executive functions	135.50	20.16	95.50	29.72	137.81	22.87	126.12	33.87
Inhibition	20.81	2.58	14.93	4.56	21.37	2.82	19.43	4.92
Shifting	15.31	2.86	10.68	3.57	15.81	3.69	14.50	4.63
Emotional control	14.62	2.82	10.50	3.34	14.56	2.78	13.43	3.65
Initiative	13.68	2.75	10.31	3.17	13.18	2.81	12.43	3.40
Working memory	20.12	3.72	14.25	4.61	21.25	4.04	19.43	5.65
Planning	24.93	3.23	16.87	5.71	25	3.52	22.68	6.25
Organization of material	10.31	1.94	7.31	2.12	10.62	2.06	9.50	2.31
Monitoring	15.68	2.27	10.62	3.48	16	2.30	14.68	3.96

The assumptions for conducting ANCOVA include having a relative or distance scale for the continuous variable (pre-test scores), independence of observations, homogeneity of variances, homogeneity of regression slopes (the relationship between the covariate and the independent variables should be the same for both groups), and linearity of the correlation between the covariate and the independent variables.

The assumptions of covariance (ANCOVA) analysis were evaluated for the total score of executive functions. The assumption of normality of the dependent variable distribution was not met, as evidenced by the significant values of the Kalmograph-Smironov test statistics ($z=0.21$, $P<0.001$). Despite the non-fulfillment of this assumption, ANCOVA was still used due to its robustness and the lack of a powerful parametric statistical method that controls for the effects of covariance variables.

The assumption of homogeneity of variances between the two groups was observed in all subtests, as indicated by the non-significance of the Levene test ($f=0.16$, $P>0.69$). Moreover, the assumption of homogeneity of regression slopes, which refers to the equality of the relationship between the covariate (pre-test) and the independent variable (group) for both groups, was met, given the non-significance of the values related to F ($f=0.34$, $P>0.56$).

Finally, the assumption of linearity correlation between the covariate variable (pre-test) and the independent variable was also met, as evidenced by the significance of the F values ($f=34.57$, $P<0.0001$). These findings suggest that the data is appropriate for conducting ANCOVA, and despite violating the normality assumption, the results can still be valid and reliable.

Table 3 presents the post-test scores for total executive function problems and their components, comparing them to the pre-test scores in the experimental and control groups. The results indicate a decrease in scores for total executive function problems and their components in both groups after the intervention. However, this decrease was more significant in the experimental group than in the control group.

Specifically, in the experimental group, there was a significant decrease in the total score of executive function problems ($f=13.13$, $P<0.001$), as well as in the scores for inhibition ($f=8.27$, $P<0.007$), shifting ($f=13.27$, $P<0.001$), emotional control ($f=14.96$, $P<0.001$), initiation ($f=16.71$, $P<0.0001$), working memory ($f=9.41$, $P<0.005$), planning ($f=14.71$, $P<0.001$), organization of material ($f=8.78$, $P<0.006$), and monitoring ($f=16.14$, $P<0.0001$).

The assumptions of covariance (ANCOVA) analysis were evaluated for reading, spelling, and mathematics variables. The mathematic variable exhibited a normal distribution ($f=0.15$, $P>0.06$), meeting the normality assumption. However, the normality assumption for the distribution of reading and spelling variables was not met, with significance values of $f=0.18$, $P<0.006$ and $f=0.17$, $P<0.02$, respectively.

Regarding the assumption of equal variances, the Levene test indicated that it was not observed in the reading and spelling variables ($f=10.26$, $P<0.03$ and $f=16.50$, $P<0.0001$, respectively), while it was met in the mathematic variable ($f=0.40$, $P>0.72$).

Despite violating some assumptions, ANCOVA was still used due to its robustness and the lack of a powerful parametric statistical method that controls for the effects of the covariate variable. The interaction between the covariate (pre-test) and the independent variable (group) was not significant ($f=0.79$, $P>0.37$ for reading, $f=0.89$, $P>0.35$ for spelling, and $f=0.92$, $P>0.34$ for mathematics), indicating the homogeneity of regression slopes for these variables.

Table 4: Mean and standard deviation of academic achievement tests in groups

Variables	Experimental group				Control group			
	Pre-test		Post-test		Pre-test		Post-test	
	mean	Std	mean	Std	mean	Std	mean	Std
Spelling	3.75	5.15	11.25	8.37	4.62	6.96	7	7.53
Reading	8.18	11.75	21.87	17.13	8.87	14.37	12.75	15.43
Mathematic	15.35	8.46	26.18	11.32	13.18	8.66	19.18	10.11

Additionally, the assumption of linearity correlation between the independent and covariate variables was met in reading (f=106.65, P<0.0001), spelling (f=76.09, P<0.0001), and mathematics (f=72.03, P<0.0001). These results suggest that despite some deviations from the assumptions, the data were suitable for ANCOVA analysis, and the results can still be valid and reliable.

Table 4 illustrates that in both the control and experimental groups, the post-test scores for spelling, mathematics, and reading increased compared to the pre-test scores. However, notably, the increase was significantly greater in the experimental group.

The results of the analysis of covariance (ANCOVA) further confirmed these findings, indicating a significant difference between the experimental and control groups in the post-test scores for reading (f=13.27, P<0.001), spelling (f=11.96, P<0.02), and mathematics (f=5.04, P<0.03). This finding demonstrates the effectiveness of the cognitive package intervention in improving the participants' performance in reading, spelling, and mathematics compared to the control group.

Discussion

The primary objective of this study was to investigate the impact of the cognitive package of timely interventions on enhancing the cognitive and academic performance of students with specific learning disorders. The results demonstrated that the cognitive training provided in the intervention effectively strengthened the executive functions of the students with specific learning disorders. These findings align with previous research, further supporting the effectiveness of cognitive training interventions in this population.

The current study's results are consistent with Arghavani et al. [15] and Dehghani and Hekmatian Fard [16], both of whom reported positive effects of cognitive training on children with specific learning disorders. Furthermore, Scionti et al.'s [14] meta-analysis also supported the effectiveness of cognitive training for children at risk, further corroborating the present study's outcomes.

The study's findings are in line with several other investigations as well. Gray et al. [20] confirmed that a computer training program positively impacted adolescents' working memory and attention. Holmes et al. [18] observed that cognitive training based on working memory improved the working memory capacity in children. Mezzacappa and Buckner [21] evaluated the integration of working memory training into a school's daily curriculum and found that it effectively increased working memory capacity in school children. Similarly, Wiest et al. [23] observed significant improvements in auditory working memory among students with learning disorders after receiving computer-based cognitive training in a school environment.

Several studies have emphasized the role of working memory flexibility and its potential for improvement through training exercises. Changes in working memory capacity have been observed following cognitive training, and these changes have been associated with alterations in brain activity.

Olesen et al. [19] conducted a study that revealed a positive relationship between increased working memory function and heightened activity in the frontal and parietal areas of the brain. These brain regions play critical roles in a person's working memory capacity. The findings suggest that cognitive training exercises can lead to neurological changes in the brain, particularly in areas associated with working memory function.

Similarly, Buschkuehl et al. [17] investigated the neurological effects of short-term training on working memory. Their study demonstrated that after a training course, there was a noticeable increase in the activity of the frontal and parietal areas of the brain. This finding supports the notion that cognitive training interventions can elicit changes in brain activity, potentially contributing to enhanced working memory capabilities.

The cognitive package used in this study employed a variety of tasks specifically designed to enhance working memory and attention in students with specific learning disorders—these tasks aimed to directly target and improve the active memory capacity of the participants.

Tasks such as storytelling, memorizing paths, memorizing the location of images, memorizing landscape details, and memorizing various shapes were included to challenge and exercise working memory directly. These exercises encouraged the students to manipulate and retain information actively, enhancing their working memory.

Moreover, the cognitive package also incorporated tasks that aimed to boost attention and concentration in the participants. Tasks such as finding differences between two images, identifying hidden shapes, distinguishing irrelevant shapes from relevant ones, coloring images, coding, and trial-making were designed to train and improve the students' attention and concentration skills.

Research by Ghalamzan et al. [32] supported the effectiveness of attention-based games in enhancing memory and learning performance in children. This finding further supports the rationale behind including attention-enhancing tasks in the cognitive package used in this study.

By combining working memory and attention training exercises, the cognitive package sought to provide a comprehensive approach to address the cognitive challenges faced by students with specific learning disorders. The package's design aimed to improve these crucial cognitive functions, ultimately enhancing the participants' cognitive and academic performance. Tasks such as storytelling, memorizing paths, memorizing the location of images, memorizing landscape details, and memorizing various shapes were included to challenge and exercise working memory directly.

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The cognitive tasks included in the cognitive package, such as puzzles, mazes, coding, sign matching, and building a tower, enhance attention, concentration, processing speed, and a range of other cognitive skills. These tasks can positively impact skills such as inhibition, cognitive flexibility, shifting, planning, organizing materials, and monitoring.

As students' performance improves during the training sessions and they experience success in completing these tasks, their self-concept may strengthen. They may become more confident in their abilities, which can positively affect their emotional control and motivation to be proactive in their learning.

The importance of these cognitive skills is further supported by previous research, which indicates that students with well-developed attention control, shifting, and response inhibition tend to have better academic performance. Conversely, students with weaker skills, such as attention deficits, may face challenges and difficulties in academic areas [33].

The increase in activity observed in the parietal and frontal lobes due to cognitive training is significant, considering the close association of these brain areas with learning and attentional disorders [34]. It is reasonable to expect that cognitive training can improve academic performance for children with learning disorders [35]. The findings of this study support this hypothesis, as using the cognitive package enhanced academic achievement in spelling, reading, and mathematics for students with specific learning disorders.

Cognitive training can indirectly impact academic performance by developing cognitive skills and learning-related behaviors. Previous studies show that the effects of working memory training programs have extended to various academic skills [18]. Improvements in working memory capacity can lead to enhanced academic performance in children.

Theoretically, enhancing cognitive skills in the classroom should facilitate better student learning experiences. Not only does it positively influence academic performance, but it also supports attitudinal changes such as improving self-efficacy and the value of academic achievement.

This study has several limitations that should be considered when interpreting the results. One notable limitation is the lack of control over the disruptive variable of the trainer's attention. As the experimental group received cognitive interventions and the control group did not, the trainer's attention in the intervention sessions could influence the results. The trainer's attention may have acted as a confounding variable, affecting the outcomes differently for the experimental and control groups.

Furthermore, another study limitation is related to the data collection tools. The use of researcher-made spelling and reading tests, due to the lack of standardized tests for the first-grade level, raises concerns about the reliability and validity of these tools.

Future research should consider investigating the role of demographic factors, such as age and socioeconomic status, as potential moderators of the intervention programs' effects to gain a more comprehensive understanding of the intervention's effects.

Conclusion

The results of this study provide promising evidence of the effectiveness of the designed cognitive package of timely interventions in reducing executive dysfunctions and improving math, spelling, and reading performances among first-grade students with specific learning disabilities. These findings support the recommendation for the continued use and implementation of this cognitive package in future interventions targeted at children with specific learning disorders.

Additionally, considering the positive impact of the cognitive package on cognitive skills and academic performance, it is suggested that the exercises included in the package be integrated into preschool textbooks. Early intervention is crucial for children at risk of developing specific learning disorders.

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