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Comparison of the Effectiveness of Captain's Log Computerized Cognitive Rehabilitation and CogniPlus Cognitive Rehabilitation Software on Working Memory and Cognitive Accuracy in Male Elementary School Students with Dyslexia

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ABSTRACT

Purpose: The objective of this study was to compare the effectiveness of Captain's Log computerized cognitive rehabilitation and CogniPlus cognitive rehabilitation software on working memory and cognitive accuracy in male elementary school students with dyslexia.

Methods and Materials: This research employed a quasi-experimental design with a pretest–posttest and control group along with a two-month follow-up. The statistical population consisted of all male elementary school students with dyslexia attending learning disorder counseling centers in Tehran. Using purposive sampling based on inclusion and exclusion criteria, 45 students were selected and randomly assigned into three groups: Captain's Log training (n = 15), CogniPlus training (n = 15), and control (n = 15). Each intervention group participated in 15 training sessions. Cognitive outcomes were assessed using the N-back working memory test and the IVA-2 test of attention and accuracy. Data were analyzed using mixed-design ANOVA and Bonferroni post hoc tests.

Findings: The results showed significant main effects of intervention across time for working memory scores ($F = 25.61$, $p < .001$, $\eta^2 = 0.38$) and for visual and auditory accuracy components (visual accuracy: $F = 40.12$, $p < .001$, $\eta^2 = 0.49$; auditory accuracy: $F = 7.10$, $p = .005$, $\eta^2 = 0.15$). Significant interaction effects between group and stage indicated that both Captain's Log and CogniPlus produced greater improvements than the control group ($p < .001$). Bonferroni post hoc comparisons revealed significant differences between both intervention groups and the control group in posttest and follow-up stages ($p < .01$), while no significant differences emerged between Captain's Log and CogniPlus ($p > .05$). The two-month follow-up indicated that treatment effects were sustained over time.

Conclusion: Both Captain's Log and CogniPlus computerized cognitive rehabilitation programs are effective interventions for enhancing working memory and cognitive accuracy in students with dyslexia, with improvements that persist beyond the training period.

Keywords: *Captain's Log computerized cognitive rehabilitation, CogniPlus cognitive rehabilitation software, working memory, cognitive accuracy*

1. Introduction

Learning disorders, particularly dyslexia, are among the most prevalent neurodevelopmental difficulties faced by children in the early stages of schooling. Dyslexia affects children's ability to decode, comprehend, and produce written language, leading to persistent academic struggles and reduced self-esteem if not addressed early and effectively (Shivyari et al., 2022). Over the past two decades, advances in neuroscience, educational psychology, and technology have prompted the development of structured interventions such as cognitive rehabilitation programs, computerized training, and multisensory approaches, which aim to compensate for or remediate deficits in memory, attention, and executive functions (Shabbanali Fami et al., 2022). These interventions provide new opportunities for supporting students with specific learning disabilities, including dyslexia, by targeting the underlying cognitive mechanisms that contribute to reading and learning difficulties (Ranjbar et al., 2022).

Computerized cognitive rehabilitation has gained special attention because it integrates evidence-based neuropsychological principles with adaptive, engaging, and repeatable computerized tasks (Kim et al., 2022). Unlike traditional classroom-based methods, such programs provide individualized training, instant feedback, and systematic difficulty adjustments, which are essential for children with dyslexia who often display heterogeneous cognitive profiles. Importantly, interventions in this domain do not only focus on improving reading accuracy but also aim at strengthening working memory, attention, problem-solving, and executive functions, all of which are critical for academic success (Gharashi & Abdi, 2022).

A growing body of research underscores the significance of cognitive rehabilitation for children with dyslexia and related learning difficulties. For instance, Farghaly et al. (Farghaly et al., 2022) demonstrated that second-grade students with dyslexia in Egypt significantly improved their reading and cognitive skills after undergoing a computerized intervention program, highlighting the potential of technology-based tools in diverse educational contexts. Similarly, Ahmadabadi et al. (Ahmadabadi et al., 2022) compared computer-based rehabilitation training with concept mapping instruction and found notable improvements in attention, concentration, and reading comprehension, underscoring the versatility of such methods across different instructional approaches. These findings resonate with broader international evidence supporting technology-assisted learning for children with developmental learning disorders.

Domestic studies have also reinforced these observations. For example, Mirzaei et al. (Mirzaei et al., 2021) reported that computer-based rehabilitation significantly enhanced working memory and problem-solving skills among secondary school students, while Hamedali et al. (Hamedali et al., 2021) confirmed the effectiveness of rehabilitation therapy on working memory, concentration, and attention in adolescents. These results suggest that computerized programs, in particular, offer a promising alternative to traditional therapeutic approaches, as they not only strengthen essential cognitive processes but also sustain students' motivation through interactive, game-like interfaces.

At a neurocognitive level, Basharpoor et al. (Basharpoor et al., 2021) provided evidence linking changes in frontal EEG coherence in theta, alpha, and beta bands to improved executive functions, implying that cognitive rehabilitation may produce measurable neurophysiological changes underlying functional improvements. Such results align with findings by Costa et al. (Costa et al., 2020), who reviewed spatial orientation tasks as diagnostic tools for mild cognitive impairment, highlighting the relevance of cognitive tasks for both assessment and intervention in populations with compromised cognitive functioning. Together, these studies support the theoretical premise that structured training in working memory, attention, and executive control can lead to far-reaching academic and behavioral benefits.

The widespread applicability of computer-based rehabilitation is further evidenced by studies in populations beyond dyslexia. For example, Almulla et al. (Almulla et al., 2021) demonstrated that computerized programs improved visual perception skills in preschool children with specific learning difficulties, while Gharashi and Abdi (Gharashi & Abdi, 2022) found improvements in planning and working memory among cochlear-implanted children, indicating that cognitive rehabilitation has the flexibility to be adapted across diverse developmental and sensory impairments. These findings reveal the multidimensional potential of computerized cognitive rehabilitation as a universal tool for cognitive enhancement.

Evidence from systematic reviews adds further support. Ranjbar et al. (Ranjbar et al., 2020) conducted a comprehensive review of domestic research and confirmed the efficacy of computer-based interventions in enhancing executive functions in children, reinforcing the cumulative

E-ISSN: 2980-9681

benefits of structured computerized training. More recent analyses, such as the meta-analytic study by Shabbanali Fami et al. (Shabbanali Fami et al., 2022), further validated the effectiveness of cognitive rehabilitation—both computer-based and classical—on the cognitive performance of children with learning disabilities in Iran, providing high-level empirical justification for these interventions.

The diversity of approaches within computerized cognitive rehabilitation highlights the importance of comparing different software and techniques. Abbasi Feshmi et al. (Abbasi Feshmi et al., 2020) compared cognitive rehabilitation with neurofeedback and demonstrated that both approaches were effective in improving executive functions in children with dyslexia, though through different mechanisms. Similarly, Khaleghi et al. (Khaleghi et al., 2023) compared task-based and computer-based rehabilitation in children with epilepsy, showing improvements in cognitive flexibility, thus broadening the evidence base for computerized interventions across clinical conditions. These comparative designs are critical in determining the relative efficacy, feasibility, and sustainability of various training modalities.

Recent innovations emphasize not only academic but also socio-emotional outcomes of rehabilitation. Georgoula and Koustriava (Georgoula & Koustriava, 2024) reported that computerized cognitive training enhanced social-communication and behavioral skills in adolescents with intellectual disabilities, illustrating the broader applicability of such tools beyond narrow academic skills. Likewise, Gohari et al. (Gohari et al., 2025) demonstrated that computer-based cognitive rehabilitation significantly reduced social isolation among elderly individuals with death anxiety, suggesting the intervention's relevance across the lifespan. These findings highlight the versatility of cognitive rehabilitation in addressing not only core cognitive deficits but also associated psychosocial dimensions.

Emerging technologies have further expanded the scope of cognitive training. Mitsea et al. (Mitsea et al., 2023) reviewed brain–computer interfaces for mindfulness training, emphasizing their potential in developing metacognitive, emotional, and attention regulation skills. This development aligns with a broader shift toward integrating digital mindfulness and cognitive rehabilitation techniques, enabling more holistic approaches to cognitive and emotional regulation. The implication is that cognitive rehabilitation, particularly when supported by emerging technologies, can serve as a foundation for lifelong learning and adaptation in dynamic environments.

The Iranian context also provides valuable insights into these interventions. For example, Shivyari et al. (Shivyari et al., 2022) compared cognitive rehabilitation and multisensory learning strategies in bilingual students with dyslexia and found both effective, but with differential impacts on reading performance. Similarly, Ranjbar et al. (Ranjbar et al., 2022) used Memory Club software to improve planning and organizational functions in children with reading disorders, confirming the adaptability of such programs for specific deficits. Shamshiri et al. (Shamshiri et al., 2025) further extended these findings by comparing computer-based rehabilitation with cognitive–behavioral play therapy, showing significant improvements in executive functions among dyslexic students, thereby situating computerized rehabilitation alongside psychosocial interventions as equally viable tools for cognitive enhancement.

Other interventions also underscore the complementary potential of rehabilitation and skill-building strategies. Hosseinpour Pakzad and Farhadi (Hosseinpour Pakzad & Farhadi, 2023) demonstrated the benefits of cognitive–behavioral play therapy in reducing computer game addiction, aggression, and academic stress in children, while Jabarzadeh Chaharbrod et al. (Jabarzadeh Chaharbrod et al., 2023) found self-instruction training effective in strengthening executive functions and cognitive inhibition among students with special learning disorders. These studies highlight the importance of integrating rehabilitation approaches with behavioral and instructional interventions, thereby enriching the therapeutic toolbox for addressing learning disabilities.

Despite the variety of approaches and populations studied, a consistent conclusion emerges: computer-based cognitive rehabilitation programs are effective in enhancing working memory, executive functioning, reading performance, attention, and psychosocial outcomes across developmental, educational, and clinical contexts. Nevertheless, there remains an ongoing need to identify which specific programs yield the most significant improvements for dyslexic students and to explore the extent to which these benefits are sustained over time. The present study contributes to this growing body of evidence by comparing the effectiveness of Captain's Log computerized cognitive rehabilitation and CogniPlus cognitive rehabilitation software on working memory and cognitive accuracy in male elementary school students with dyslexia.

E-ISSN: 2980-9681

2. Methods and Materials

2.1. Study Design and Participants

The present study, in terms of the nature of data, is quantitative; in terms of purpose, it is applied; and in terms of data collection, it is quasi-experimental, using a pretest–posttest design with experimental and control groups along with a 2-month follow-up. The statistical population in this research included all male elementary school students with dyslexia who attended counseling centers for learning disorders in Tehran.

To form three groups using purposive sampling (considering inclusion and exclusion criteria), application letters were first sent to several counseling and psychology service centers in Tehran to identify male elementary school students with dyslexia referred for treatment and introduce them for participation in this study. A total of 45 students were assessed to confirm the inclusion and exclusion criteria. The inclusion criteria were: age between 9 and 12 years and a diagnosis of reading disorder. The exclusion criteria were: lack of informed consent and participation in parallel therapeutic programs. During the evaluation sessions, the students were examined according to the specified criteria, and then 15 students were randomly assigned to the first experimental group, 15 students to the second experimental group, and 15 students to the control group. The three groups formed in this manner were similar, and measurement of the dependent variables for both experimental groups was performed simultaneously. In addition, the follow-up phase was conducted two months after the posttest for all three groups.

The sample size was estimated based on G*Power software, considering a three-group repeated measures design, an alpha error of .05, test power of .80, and effect size of 0.40, which yielded a sample size of 45 participants.

2.2. Measures

N-Back Working Memory Test. The N-Back working memory test was first introduced by Kirchner (1958). In this test, the individual responds to a stimulus, for example, a number, if it matches the preceding stimulus. Stimulus presentation and responses continue until the stimulus set ends. This test is widely used to measure working memory and has both visual and auditory sensory modalities. Memory scores and reaction times are calculated separately for each modality (Owen, 2008). Busch et al. (2008) reported a reliability of 78% for this test. In Iran, Taghizadeh et al. (2014) and Mirzaei et al. (2021) used this test in their studies and confirmed its reliability.

IVA-2 Test. This test is a type of continuous performance test and is a specialized instrument for identifying indices of attention and accuracy. It is normed and applicable for individuals aged 6 to 96 years. The general instruction for the test is: "Click whenever you see or hear the number one." This psychological test is fully computerized, and the participant is monitored during administration by a clinical specialist trained in administering the test. The administration time is 20 minutes, divided among different stages. The test was developed by Sanford and Turner in 1994 and designed based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). The test can diagnose and differentiate various types of attention deficit hyperactivity disorder (ADHD) in individuals over the age of six. Sanford and Turner examined test–retest reliability and reported a coefficient of .75, indicating satisfactory reliability. Construct validity for the four-factor structure of the test was confirmed through factor analysis.

In the initial phase (warm-up), the basic instructions are presented, and in case of errors (e.g., holding the mouse button too long or double-clicking for one stimulus), reminders are provided. This stage starts with visual stimuli and then presents 10 auditory stimuli, lasting about two minutes. In the second stage (practice), the participant is instructed to click the mouse when seeing or hearing the number one and refrain from clicking when seeing or hearing the number two. If the participant responds incorrectly, the program provides a verbal warning. The duration of this stage varies depending on performance and the number of warnings received. The main test stage is divided into two parts: the main test, lasting 13 minutes, and the relaxation stage (similar to the initial phase), lasting two minutes. In the main test, 500 visual and auditory stimuli are presented without any warnings or feedback. The final two minutes (relaxation stage) involve 10 visual and 10 auditory stimuli.

The results obtained from this test are divided into three domains: attention (raw scores separately for visual and auditory), response inhibition (raw scores separately for visual and auditory), and sustained attention (raw scores separately for visual and auditory).

2.3. Intervention

The Captain's Log cognitive training software is a computerized program designed to enhance and develop a

E-ISSN: 2980-9681

wide range of cognitive skills through diverse training modules and exercises, systematically organized into three major domains: attention skills training, problem-solving skills training, and working memory training. This program is applicable for individuals above 5 years of age and is characterized by being computer-based, multi-level, and game-like, with training exercises specifically aimed at improving attention and concentration, self-regulation, processing speed, memory, hand–eye coordination, basic numerical concepts, and foundational problem-solving, while also being accessible for home use (Mellali et al., 2023). The protocol is structured across three stages and fifteen sessions. In the first stage (moderate difficulty), session one begins with orientation and attention-enhancement exercises such as Eagle, Cat's Play, Smart Detective, Eye, Mouse Hunt, and Happy Trails. Session two continues with visual perception improvement exercises including Puzzle Power, Remember the Alamo, Car Eureka, Code Cracker, and Where is My. In session three, the focus is on working memory training through tasks like Pop-N-Zap, Great Escape, Pick Quick, Dart, and Seek & Hide. Session four emphasizes reading improvement tasks such as What's Pop, Figure it Out & Conceptor, Pick Missing, and The Ugly Duckling. Session five involves reviewing the software-generated reports, identifying the participant's weaknesses, and assigning repetitive practice on games related to those weak areas. In the second stage (difficult level), session six escalates the cognitive attention training to a harder level, session seven elevates visual perception tasks, session eight increases the difficulty of working memory tasks, and session nine advances reading skills training; in session ten, weaknesses identified by the software are addressed through targeted exercises. In the third stage (with distractors), session eleven begins with advanced attention tasks with added visual distractors, session twelve continues with higher-level visual perception tasks under distractor conditions, session thirteen emphasizes working memory training with distractors, and session fourteen integrates advanced reading tasks in distractor conditions. Finally, in session fifteen, weaknesses are once again identified through software reports and addressed systematically, ensuring a tailored approach to each participant's cognitive development.

CogniPlus is a computerized cognitive rehabilitation program designed based on research findings in the fields of neuroscience and psychology, developed by the Schuhfried Company using the Vienna Test System framework, and delivered through interactive game-like modules targeting multiple cognitive domains, particularly in children (Hagovska & Olovcová, 2016). Participants were asked to apply skills learned in daily life within training sessions. The intervention consisted of 15 training sessions, each lasting 45 minutes and held twice weekly. Each session targeted four aspects of attention—sustained (alertness and vigilance), focused, selective, and divided—each trained for 10 minutes. Task difficulty was automatically adjusted according to participants' performance, with verbal reinforcement provided upon success and progression to more challenging levels. The training tasks were structured as follows: (1) Sustained Attention included two components: Alertness, in which participants reacted quickly by pressing a key when a motorcycle encountered an obstacle on the road; Form A trained daytime alertness with external visual and auditory warning cues, while Form B trained nighttime alertness without external cues. Each form included 18 difficulty levels determined by progressively reduced reaction times. Vigilance involved highway driving simulations where participants pressed a button upon seeing the brake light of a car ahead, with 30 difficulty levels based on reaction time. (2) Focused Attention required participants to control a boat on a lake while exposed to distractors such as bird sounds, buzzing, or waves, and respond only to predefined relevant stimuli while ignoring others. This task had three formats: detecting visual stimuli among distractors, detecting auditory stimuli among distractors, and responding to relevant stimuli regardless of distractor modality, with difficulty adjusted by varying the number of distractors. (3) Selective Attention simulated driving a wagon through a tunnel where relevant and irrelevant stimuli suddenly appeared; participants had to respond only to relevant stimuli. Feedback included thunder sounds and flashing lights for late or missed responses, and a red light for responding to irrelevant stimuli. Three formats were used: visual, auditory, and combined, with 15 difficulty levels. (4) Divided Attention placed participants in the role of an airport security officer monitoring multiple screens while simultaneously attending to loudspeaker announcements, requiring responses to problems by pressing a reaction key. If a participant failed to respond properly, the incident was logged and displayed until corrected. This task had 15 difficulty levels, with difficulty manipulated by increasing the number of screens to monitor. Overall, the CogniPlus protocol provided a systematic and multi-dimensional cognitive training program, progressively challenging participants' attentional processes in an adaptive and engaging computerized environment.

E-ISSN: 2980-9681

2.4. Data Analysis

In this research, the collected data were analyzed at two levels. (a) At the descriptive level, mean and standard deviation indices were used to examine the research variables in the sample. (b) At the inferential level, considering the scale of measurement and statistical assumptions, mixed analysis of variance (mixed ANOVA) was used to test the hypotheses.

3. Findings and Results

Descriptive indices (mean and standard deviation) of working memory and cognitive accuracy scores in the experimental groups (interventions based on Captain's Log computerized cognitive rehabilitation and CogniPlus cognitive rehabilitation) and the control group at the pretest, posttest, and follow-up stages are presented below.

Table 1

Mean and Standard Deviation of Working Memory and Cognitive Accuracy Scores by Assessment Stage in Groups

Group	Variable	Index	Pretest	Posttest	Follow-up
Captain's Log Computerized Cognitive Rehabilitation	Working Memory (Correct N-back Responses)	Mean	41.20	55.20	57.60
		SD	10.61	10.61	8.92
CogniPlus Cognitive Rehabilitation	Working Memory (Correct N-back Responses)	Mean	42.00	58.40	57.60
		SD	11.71	11.29	10.01
Control	Working Memory (Correct N-back Responses)	Mean	40.40	39.20	39.20
		SD	9.30	9.68	9.68
Captain's Log Computerized Cognitive Rehabilitation	Visual Accuracy	Mean	88.60	106.40	109.40
		SD	14.56	9.81	9.81
CogniPlus Cognitive Rehabilitation	Visual Accuracy	Mean	92.00	100.40	99.00
		SD	8.83	7.07	6.41
Control	Visual Accuracy	Mean	89.60	87.60	86.80
		SD	9.06	8.35	6.05
Captain's Log Computerized Cognitive Rehabilitation	Auditory Accuracy	Mean	89.40	99.20	103.00
		SD	15.54	9.34	11.71
CogniPlus Cognitive Rehabilitation	Auditory Accuracy	Mean	93.80	98.40	101.40
		SD	11.83	12.10	12.10
Control	Auditory Accuracy	Mean	93.40	91.00	88.80
		SD	11.04	11.21	9.79

As observed, the mean scores in the Captain's Log and CogniPlus groups increased at the posttest stage compared to the pretest. Based on the results in Table 1, it can be concluded that Captain's Log and CogniPlus computerized cognitive rehabilitation interventions improved working memory scores and cognitive accuracy components in male students with dyslexia.

Table 2

Mixed ANOVA of Working Memory Scores Using Greenhouse-Geisser Correction

Variable	Factors	SS	df	MS	F	Sig	Eta²
Working Memory	Within-group	3006.40	1.31	2299.15	25.61	0.001	0.38
	Test × Group Interaction	1926.40	2.62	736.61	8.20	0.001	0.28
	Between-groups	4652.80	2.00	2326.40	11.82	0.001	0.36

The results in Table 2 show that for the within-group factor, the calculated F for the effect of stages (pretest, posttest, and follow-up) on working memory scores was significant at the 0.05 level ($p < .05$). Therefore, there is a significant difference among the mean working memory scores across the three stages. The Bonferroni post hoc test indicated that the differences between pretest and posttest, as well as pretest and follow-up, were significant ($p < .05$). However, the difference between posttest and follow-up was not significant ($p > .05$), suggesting that working memory scores remained stable at follow-up.

Regarding the interaction between stage and group, the calculated F was significant ($p < .05$), indicating that the trend of changes in working memory differed across the

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Captain's Log, CogniPlus, and control groups. Furthermore, for the between-group factor, the calculated F was significant at the 0.05 level ($p < .05$), indicating significant differences among the three groups in overall working memory scores.

Table 3

Bonferroni Post Hoc Test for Pairwise Comparison of Mean Working Memory Scores

Variable	Compared Groups	Mean Difference	Standard Error	Sig
Working Memory	Captain's Log – CogniPlus	-1.33	2.96	0.99
	Captain's Log – Control	11.73	2.96	0.001
	CogniPlus – Control	13.07	2.96	0.001

The results in Table 3 indicate that both Captain's Log and CogniPlus computerized cognitive rehabilitation interventions significantly improved working memory scores compared to the control group ($p < .05$). However, there was no significant difference between the Captain's Log and CogniPlus groups ($p > .05$).

Table 4

Mixed ANOVA of Cognitive Accuracy Components Using Greenhouse-Geisser Correction

Variable	Factors	SS	df	MS	F	Sig	Eta²
Visual Accuracy	Within-group	2018.80	1.25	1613.21	40.12	0.001	0.49
	Test × Group Interaction	2443.60	2.50	976.33	24.28	0.001	0.54
	Between-groups	4253.20	2.00	2126.60	10.44	0.001	0.33
Auditory Accuracy	Within-group	734.53	1.40	526.19	7.10	0.005	0.15
	Test × Group Interaction	1341.07	2.79	480.34	6.48	0.001	0.24
	Between-groups	1264.53	2.00	632.27	4.04	0.04	0.19

The results in Table 4 show that for the within-group factor, the calculated F for the effect of stages (pretest, posttest, and follow-up) on cognitive accuracy components was significant at the 0.05 level ($p < .05$). Thus, significant differences existed among mean scores of visual and auditory accuracy across the three stages. Bonferroni post hoc tests indicated that the differences between pretest and posttest, as well as pretest and follow-up, were significant ($p < .05$). However, the difference between posttest and follow-up was not significant ($p > .05$), indicating stability of treatment effects over time.

The interaction effect (stage × group) was also significant ($p < .05$), showing that changes in cognitive accuracy scores differed among the three groups. Furthermore, the between-group factor was significant ($p < .05$), indicating significant differences among the Captain's Log, CogniPlus, and control groups in overall cognitive accuracy scores.

Table 5

Bonferroni Post Hoc Test for Pairwise Comparison of Cognitive Accuracy Scores

Variable	Compared Groups	Mean Difference	Standard Error	Sig
Visual Accuracy	Captain's Log – CogniPlus	4.33	3.01	0.47
	Captain's Log – Control	13.47	3.01	0.001
	CogniPlus – Control	9.13	3.01	0.003
Auditory Accuracy	Captain's Log – CogniPlus	-0.67	3.72	0.99
	Captain's Log – Control	6.13	3.72	0.015
	CogniPlus – Control	6.80	3.72	0.009

The results in Table 5 demonstrate that both Captain's Log and CogniPlus computerized cognitive rehabilitation interventions significantly improved cognitive accuracy scores compared to the control group ($p < .05$). However, no significant difference was found between the Captain's Log and CogniPlus groups ($p > .05$).

E-ISSN: 2980-9681

4. Discussion and Conclusion

The findings of the present study demonstrated that both *Captain's Log* computerized cognitive rehabilitation and *CogniPlus* cognitive rehabilitation software significantly improved working memory and cognitive accuracy among male elementary school students with dyslexia. Compared to the control group, which showed no meaningful improvement, the two intervention groups exhibited substantial gains in working memory (N-back performance), as well as visual and auditory accuracy scores, with effects that remained stable at the two-month follow-up. Interestingly, while both programs produced significant improvements, there was no statistically significant difference in the degree of progress between them, suggesting that both rehabilitation approaches were similarly effective.

These results align with prior evidence highlighting the benefits of computer-based cognitive rehabilitation in children with dyslexia and other learning disorders. For example, Ranjbar et al. (Ranjbar et al., 2022) reported that computerized cognitive rehabilitation using the *Memory Club* software enhanced planning and organizational skills in children with reading disorders, confirming that interventions targeting working memory and executive functions are crucial in remediating dyslexic profiles. Similarly, Ahmadabadi et al. (Ahmadabadi et al., 2022) found that computer-based rehabilitation training significantly improved attention, concentration, and reading comprehension, which resonates with the improvements in cognitive accuracy observed in this study. The results also support the conclusions of Shabbanali Fami et al. (Shabbanali Fami et al., 2022), who conducted a meta-analytic review showing that both computer-based and classical cognitive rehabilitation interventions are effective in improving the cognitive performance of children with specific learning disabilities.

The present findings further corroborate research highlighting the potential of computerized interventions across diverse contexts. Farghaly et al. (Farghaly et al., 2022) demonstrated the effectiveness of a computerized program for Egyptian second-grade students with dyslexia, who showed significant improvements in reading skills, mirroring the benefits observed here on memory and accuracy. Likewise, Mirzaei et al. (Mirzaei et al., 2021) reported enhancements in working memory and problem-solving abilities among students receiving computer-based cognitive rehabilitation, underscoring the broader applicability of such programs across cognitive domains. Together, these findings reinforce the argument that computer-based training can bridge the gap between cognitive deficits and educational performance for children with dyslexia.

The positive outcomes of this study also resonate with findings in populations beyond dyslexia. For instance, Gharashi and Abdi (Gharashi & Abdi, 2022) demonstrated improvements in planning and working memory of cochlear-implanted children following cognitive rehabilitation, suggesting that such programs are effective across a wide spectrum of developmental challenges. Similarly, Khaleghi et al. (Khaleghi et al., 2023) found that both task-based and computer-based rehabilitation improved cognitive flexibility in children with epilepsy, further extending the evidence base for the generalizability of computer-based cognitive training. These outcomes emphasize that the mechanisms underpinning cognitive rehabilitation—such as repeated exposure to adaptive, structured tasks and feedback-driven learning—are effective regardless of the specific diagnostic label.

At a broader theoretical level, these results can be interpreted within the framework of executive function development and neuroplasticity. Basharpoor et al. (Basharpoor et al., 2021) showed that improvements in executive functions are reflected in changes in EEG coherence across theta, alpha, and beta bands in the frontal cortex, suggesting a neurophysiological basis for the observed behavioral gains. Such findings imply that the working memory and cognitive accuracy improvements seen in the present study may be supported by measurable brain-level changes induced by structured, computerized rehabilitation tasks. Costa et al. (Costa et al., 2020) similarly emphasized that cognitive tasks, such as spatial orientation measures, can serve both diagnostic and rehabilitative purposes, highlighting the overlap between assessment and intervention in cognitive neuroscience.

The fact that both *Captain's Log* and *CogniPlus* produced similar results is consistent with studies demonstrating that the format of cognitive rehabilitation—whether delivered through specific software packages or alternative methods—may be less critical than the shared principles underpinning them. Shivyari et al. (Shivyari et al., 2022) compared cognitive rehabilitation with multisensory learning strategies in bilingual students with dyslexia and reported that both approaches were effective in improving reading performance, albeit through different mechanisms. Likewise, Abbasi Feshmi et al. (Abbasi Feshmi et al., 2020) found that both neurofeedback and cognitive rehabilitation improved executive functions in children with dyslexia, showing that multiple intervention modalities can converge toward similar positive outcomes.

This study's results also fit within a broader trend emphasizing the use of technology-based interventions for enhancing both cognitive and psychosocial outcomes. Georgoula and Koustriava (Georgoula & Koustriava, 2024) demonstrated that computerized cognitive training improved social-communication and behavioral skills in adolescents with intellectual disabilities, while Gohari et al. (Gohari et al., 2025) reported reductions in social isolation and death anxiety among elderly individuals following computer-based cognitive rehabilitation. These findings suggest that the benefits of such programs extend beyond the strictly academic or cognitive domains, influencing emotional and social functioning as well. Although this study focused on cognitive measures, it is possible that the observed improvements in memory and accuracy may also indirectly benefit students' self-confidence and classroom participation.

The inclusion of follow-up testing in this study adds to its contribution by demonstrating that the benefits of both interventions persisted over two months. This stability is consistent with Shamshiri et al. (Shamshiri et al., 2025), who reported that computer-based cognitive rehabilitation produced lasting improvements in executive functions among students with dyslexia. Sustained effects were also observed by Hamedali et al. (Hamedali et al., 2021), who found long-term benefits in memory and attention among adolescents receiving rehabilitation therapy. Such findings reinforce the argument that cognitive rehabilitation does not merely produce short-term performance gains but fosters durable changes in cognitive functioning.

Another important interpretation of these results relates to the adaptability and engagement offered by computer-based programs. Almulla et al. (Almulla et al., 2021) emphasized that computerized interventions significantly enhanced visual perception skills in preschool children with learning difficulties, attributing part of their effectiveness to the interactive, game-like environment that motivates children to persist with tasks. This aligns with the present study, where students appeared to remain engaged across the 15 sessions of training. Likewise, Mitsea et al. (Mitsea et al., 2023) highlighted the potential of brain–computer interfaces in mindfulness training for developing metacognitive, emotional, and attention regulation skills, pointing to future opportunities for integrating innovative digital modalities with rehabilitation approaches.

Finally, the results also resonate with broader perspectives in intervention science, which advocate for integrating multiple approaches to address learning disabilities. Hosseinpour Pakzad and Farhadi (Hosseinpour Pakzad & Farhadi, 2023) demonstrated that cognitive–behavioral play therapy effectively reduced aggression and academic stress in children, while Jabarzadeh Chaharbrod et al. (Jabarzadeh Chaharbrod et al., 2023) showed that self-instruction training enhanced executive functions and cognitive inhibition among students with special learning disorders. These studies, along with the present findings, emphasize that interventions for dyslexia and learning disabilities should not be viewed as mutually exclusive but rather as complementary strategies tailored to individual needs.

In sum, the present findings provide strong support for the efficacy of computerized cognitive rehabilitation programs in improving working memory and cognitive accuracy in children with dyslexia. Both *Captain's Log* and *CogniPlus* proved effective, and their benefits were sustained over time, confirming the relevance of such programs as evidence-based tools for addressing learning difficulties in school-aged populations.

Despite the promising results, this study is not without limitations. First, the sample size was relatively small (45 participants), which may limit the generalizability of the findings to broader populations. While the purposive sampling and random assignment strengthened internal validity, larger and more diverse samples are needed to confirm the robustness of the effects. Second, the study focused exclusively on male elementary school students with dyslexia in Tehran, which restricts the applicability of the findings to other age groups, genders, or cultural contexts. Third, the study measured cognitive outcomes using standardized tests but did not directly assess improvements in real-world academic performance, such as reading fluency or classroom achievement, which are critical indicators of functional success. Finally, the follow-up period was limited to two months; longer-term assessments are necessary to determine the durability of the observed improvements and whether booster sessions might be required to maintain gains.

Future research should aim to expand on these findings in several ways. Studies with larger and more heterogeneous samples—including both genders, different age groups, and varied cultural and linguistic contexts—would provide more

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comprehensive insights into the generalizability of cognitive rehabilitation effects. Future studies should also incorporate longitudinal designs with extended follow-up periods to evaluate the stability of gains over six months, one year, or longer. Moreover, it would be valuable to compare computerized cognitive rehabilitation with other evidence-based interventions, such as multisensory training, mindfulness-based cognitive therapy, or blended approaches that combine technology with classroom instruction. Finally, research should move beyond laboratory-based measures of memory and accuracy to include ecologically valid outcomes, such as improvements in classroom participation, self-regulation, academic performance, and psychosocial adjustment.

From a practical perspective, the findings underscore the importance of incorporating computer-based cognitive rehabilitation into educational and therapeutic settings for children with dyslexia. Schools and learning centers can adopt such programs as part of individualized education plans, ensuring that interventions target both cognitive deficits and broader learning needs. Teachers and therapists should receive training in implementing these programs, interpreting progress reports, and integrating results with classroom instruction. Policymakers should also consider supporting the integration of cognitive rehabilitation technologies within public education systems, thereby increasing accessibility for all students, including those in under-resourced settings. Finally, parents can play a critical role by encouraging their children to engage with such programs at home, thereby reinforcing the transfer of cognitive skills from structured sessions to daily life.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

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