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Effectiveness of a Task-Based Cognitive Rehabilitation Program on Executive Functions in Children with High-Functioning Autism

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A B S T R A C T

The present study was conducted with the aim of determining the effectiveness of a task-based cognitive rehabilitation program on improving executive functions in children diagnosed with high-functioning autism spectrum disorder. This research employed a quasi-experimental design with a pretest–posttest structure and a control group. From the population of children with high-functioning autism spectrum disorder who attended rehabilitation centers and clinics in Tehran in 2024, a total of 30 children were selected using convenience sampling and were randomly assigned to experimental and control groups. The experimental group received 12 sessions of a 45-minute task-based cognitive rehabilitation intervention, whereas the control group did not receive any intervention. The Go/No-Go Test (Menon, Adleman, & White, 2001), the Color–Word Test (Stroop, 1935), and the N-Back Test (Kirchner, 1985) were employed as research instruments. Data were analyzed using repeated-measures analysis of variance. The findings indicated that the task-based cognitive rehabilitation program had a significant effect on improving components of executive functions (including attention, inhibition, and visuospatial working memory) in children with high-functioning autism ($P \leq .05$). Based on the results, it can be concluded that the task-based cognitive rehabilitation program can be used as an effective intervention for enhancing executive functions in children with high-functioning autism spectrum disorder.

Keywords: *cognitive rehabilitation, task-based, executive functions, autism spectrum disorder, children.*

1. Introduction

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterized by persistent deficits in social communication, restricted and repetitive behaviors, and atypical patterns of sensory processing, cognitive functioning, and motor development. Recent epidemiological data highlight the global growth of

ASD diagnoses, underscoring the need for effective, evidence-based interventions to address the diverse cognitive and functional challenges experienced by affected children. Surveillance findings from the Autism and Developmental Disabilities Monitoring Network in the United States show that ASD prevalence among 8-year-olds has continued to rise, revealing notable heterogeneity in symptom severity, cognitive abilities, and developmental trajectories (Maenner et al., 2023). This expanding prevalence has intensified scientific attention on identifying mechanisms underlying executive function impairments, which are among the most consistent cognitive deficits associated with ASD.

Executive functions—typically conceptualized as a set of higher-order cognitive skills encompassing working memory, inhibitory control, cognitive flexibility, attention regulation, and planning—play foundational roles in adaptive behavior and learning. Extensive research demonstrates that children with ASD commonly experience marked deficits across multiple components of executive functioning. Neuropsychological and systematic reviews underscore that impairments in inhibitory control, attentional regulation, and working memory are central cognitive features of ASD, significantly predicting social, behavioral, and academic outcomes throughout development (Greenspan et al., 2022; Kofler et al., 2024). These impairments not only interfere with goal-directed behavior but also contribute to difficulties in communication, sensory integration, problem-solving, and emotional self-regulation.

A growing body of literature has documented the developmental and functional implications of these executive functioning deficits in children and adolescents with ASD. For instance, visuospatial attention and its hemispheric asymmetries appear to differ significantly between autistic and typically developing populations, influencing learning efficiency and the processing of visual information (English et al., 2023). Additionally, sensory processing abnormalities—such as heightened or blunted responsivity—can further compound attentional and inhibitory difficulties, as supported by evidence linking sensory modulation, attention, and social responsiveness in autistic adults (Crasta et al., 2023). These challenges are often exacerbated in complex environments such as schools and family contexts, where the demands on executive control are heightened. Studies examining everyday functioning reveal that executive function deficits manifest in academic underperformance, behavioral rigidity, difficulty with transitions, and lower adaptive functioning (Gentil-Gutiérrez et al., 2022).

Working memory deficits, in particular, ha`ve been highlighted as a core cognitive issue for many autistic children. Longitudinal research indicates that working-memory performance is both a predictor of developmental outcomes and a targetable mechanism for cognitive improvement (Kim & Kasari, 2023). Similar findings emphasize that ASD severity levels significantly predict poorer working memory and planning abilities, while aspects such as emotional control and shifting may remain less impaired (Memisevic et al., 2023). Furthermore, visuospatial working memory develops differently in autistic children compared with typically developing peers, with developmental changes highlighting distinct neurological and cognitive growth patterns (Y. Lin et al., 2025). Such deficits have implications for learning, communication, and daily independent functioning.

Given the complexity and heterogeneity of executive dysfunction in ASD, researchers and clinicians have explored multiple intervention modalities aimed at strengthening cognitive capacities. Cognitive rehabilitation has emerged as a promising approach designed to improve specific cognitive processes through structured, task-based training. Systematic reviews emphasize the overall effectiveness of cognitive rehabilitation approaches in ASD populations, particularly in improving working memory, attention, and inhibitory control (Greenspan et al., 2022). Additionally, studies incorporating neuroimaging, neuropsychological assessments, and molecular genetics techniques have validated that cognitive rehabilitation can produce measurable changes in brain functioning and executive performance in high-functioning autistic children (Shahraki & Abharian, 2022). These multidimensional findings have supported the refinement of targeted interventions.

Parallel lines of research have investigated technology-assisted interventions, including computerized cognitive training programs, virtual reality–based cognitive exercises, and digital attention-training tools. A systematic review on computerized cognitive training for children and adolescents with ASD demonstrates notable improvements across various executive-function domains, despite variations in task complexity and program duration (Y. J. Lin et al., 2025). Complementing this, virtual reality rehabilitation programs have shown early promise in enhancing executive functions in children with learning disorders, suggesting potential transferability to ASD interventions (Di Giusto et

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al., 2023). Similarly, research on virtual and augmented reality for individuals with communication and neurodevelopmental disorders highlights the feasibility and effectiveness of immersive environments for cognitive and skill-based training (Bailey et al., 2022). These advancements illustrate the increasing relevance of technology-driven interventions for neurodevelopmental populations.

Within the broader scope of cognitive rehabilitation, task-based approaches have gained particular attention for their ability to target executive control processes in ecologically relevant and developmentally appropriate ways. Such programs engage children in gradual, structured tasks that require sustained attention, working-memory manipulation, response inhibition, and cognitive flexibility. Evidence from task-based cognitive rehabilitation for attention deficits in autism confirms its positive impact on attentional capacity and related executive skills (Kasardjian et al., 2019). Additional research supports the utility of cognitive rehabilitation in improving memory and problem-solving abilities among children with attentional disorders, further reinforcing its applicability in neurodevelopmental intervention models (Yavari Bargh Talab et al., 2019).

Moreover, studies focused on ASD populations affected by trauma or comorbid conditions demonstrate that cognitive rehabilitation can significantly improve attention, working memory, and inhibitory control, suggesting the robustness of cognitive training across diverse clinical presentations (Faraji & Zare, 2020). Similarly, training programs that incorporate motor imagery, enactment strategies, or physical engagement have shown benefits for working memory and instruction following in autistic children, indicating that multi-modal approaches can optimize executive-function outcomes (Xie et al., 2024). This aligns with meta-analytic findings confirming that various exercise interventions—including structured physical activities—produce meaningful gains in executive function components in children with ASD (Hou et al., 2024). Acute exercise has also been shown to improve affective inhibition and gaze fixation, highlighting immediate cognitive–motor benefits relevant to attentional and inhibitory control (Ludyga et al., 2024).

In parallel, different clinical populations have demonstrated significant gains from dual-task or cognitive–motor training. For example, research on stroke patients illustrates that dual-task training can enhance both motor and cognitive functions, providing further evidence for the adaptability and effectiveness of task-based cognitive interventions (Mou & Jiang, 2025). Findings from computerized task-based rehabilitation with or without neuromodulation techniques such as transcranial direct current stimulation also indicate significant improvements in working memory performance (Amini Masuleh et al., 2022). This highlights the broader theoretical and empirical foundation supporting task-based cognitive rehabilitation.

Children with ASD experience particular challenges in visual–motor integration, attention to people versus objects, and attentional disengagement. Research examining visual-motor assessment reveals that autistic children often perform unevenly across assessment domains and require specialized evaluative considerations (Carey et al., 2023). Theoretically, the social attention hypothesis suggests that autistic children may preferentially orient toward objects rather than people, with implications for attentional training and social development (Akin-Bulbul & Ozdemir, 2024). These attentional tendencies may further compound difficulties with inhibitory control and working-memory processing. Consistent with this, research shows that cognitive flexibility training and inhibitory-control tasks can influence neural activation patterns, including readiness potentials during nonverbal Stroop tasks (Nayak et al., 2020) and P3 responses in Go/No-Go paradigms (Suzuki et al., 2020). Such findings reinforce the neurocognitive basis of executive dysfunction in ASD.

Alongside technological and neurological advances, traditional task-based rehabilitation methods remain vital in addressing the unique cognitive profiles of autistic children. Task-based cognitive rehabilitation programs that incorporate memory-card exercises, visuospatial pattern recall, structured numeric and verbal sequencing, and gradual difficulty progression target the foundational executive processes implicated in ASD. Evidence from comparative intervention studies further suggests that cognitive rehabilitation is comparable to other therapeutic approaches, including neurofeedback and cognitive-behavioral play therapy, in improving perceptual and executive outcomes (Azizi et al., 2017). Moreover, the broader emphasis on strengthening attention, working memory, and inhibitory control aligns with contemporary research advocating for early cognitive interventions that can positively shape developmental trajectories in ASD populations.

Recent work highlights the nuanced relationship between attention, sensory processing, and social responsiveness (Crasta et al., 2023), demonstrating the interconnectedness of executive processes with broader behavioral patterns.

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This reinforces the need for interventions that address multiple executive domains rather than isolated skills. Additionally, research examining executive functions in home and school settings confirms that deficits often manifest differently across contexts, suggesting that effective intervention programs should aim for both cognitive enhancement and functional generalization (Gentil-Gutiérrez et al., 2022).

Given these extensive empirical foundations, task-based cognitive rehabilitation has emerged as an evidence-supported approach for addressing executive-function impairments in high-functioning autistic children. The structured, repetitive nature of task-based programs promotes neural plasticity, enhances attentional control, and strengthens working-memory capacity. Moreover, the flexibility of task-based protocols allows them to be adapted for individual developmental differences, making them suitable for diverse ASD profiles.

Thus, the current study builds upon prior literature emphasizing the importance of executive functions in ASD, the effectiveness of cognitive rehabilitation approaches, and the emerging evidence supporting task-based cognitive interventions across neurodevelopmental populations. Given the gaps in localized intervention research and the need for standardized protocols tailored for high-functioning autistic children, the present study aims to determine the effectiveness of a task-based cognitive rehabilitation program on executive functions in children with high-functioning autism spectrum disorder.

2. Methods and Materials

2.1. Study Design and Participants

The method of this study was applied and quasi-experimental in nature, using a pretest–posttest design with an experimental group and a control group. The statistical population consisted of all children diagnosed with high-functioning autism spectrum disorder who visited psychology and rehabilitation clinics in Tehran in 2024. From this population, participants were selected through convenience sampling and were randomly assigned to two groups of 15 individuals each, forming the experimental and control groups.

The inclusion criteria were: a confirmed diagnosis of high-functioning autism by a child psychiatrist based on DSM-5 diagnostic criteria; absence of comorbid specific disorders such as cerebral palsy, blindness, deafness, genetic or immunological diseases; absence of uncontrolled seizures; not receiving any simultaneous intervention program; and the willingness of both mother and child to participate in the intervention. The exclusion criteria included lack of parental or child consent at any stage of the study and more than two absences from the intervention sessions.

The implementation procedure was as follows: the researcher visited psychology and rehabilitation clinics for sampling. After announcing the research call and coordinating with the managers of selected clinics, 54 individuals expressed willingness to participate. Then, based on the inclusion criteria and if they met the requirements of the target sample, information regarding the study and its objectives was provided. Individuals who agreed to take part entered the study after giving informed consent. Following this screening and consent process, 30 individuals were selected and randomly assigned to the experimental and control groups.

In the first stage, the research questionnaires were administered to the children in both groups, and they were asked to answer all questions. Then, in the next session, members of the experimental group received the intervention individually once per week. After completion of the intervention sessions, one week later, research instruments were administered again to children in both groups, and a follow-up test was conducted for all participants after a 3-month period. Additionally, to observe ethical considerations, at the end of the study, the control group was informed that they could receive the intervention program if they wished.

2.2. Measures

Go/No-Go Test: The Go/No-Go Test, widely used to measure behavioral inhibition, consists of two categories of stimuli. Participants must respond to one category of stimuli (go) and withhold responses to the other category (no-go). Since the number of go stimuli is usually greater than the number of no-go stimuli, readiness to respond increases. Insufficient inhibition or commission error refers to performing a motor response when a non-target stimulus is presented. Three separate scores are obtained from this test.

Stroop Color–Word Test: The Stroop Color–Word Test (SCWT) is a neuropsychological test widely used for experimental and clinical purposes. It assesses the ability to inhibit cognitive interference, which occurs when processing one feature of a stimulus affects the simultaneous processing of another feature of the same stimulus. In the most common

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version of the SCWT, originally proposed by Stroop in 1935, participants must read three different tables as quickly as possible. Two of these represent congruent conditions, in which participants are required to read the names of colors (hereafter referred to as color words) printed in black ink (W) and to name different color patches (C). In contrast, in the third table—referred to as the color–word condition (CW)—color words are printed in an incongruent ink color (e.g., the word red printed in green ink). Under this incongruent condition, participants must name the ink color rather than read the word. In other words, participants are required to perform a less automatic task (naming ink color) while inhibiting interference from a more automatic task (word reading). This difficulty in inhibiting the more automatic process is known as the Stroop effect. Although the SCWT is widely used to measure the ability to inhibit cognitive interference, previous literature also reports its application in assessing other cognitive functions such as attention, processing speed, cognitive flexibility, and working memory; therefore, the SCWT may be used to measure multiple cognitive functions.

N-Back Test: The N-Back paradigm is a task in which sequences of stimuli (e.g., letters or images) are presented to participants. For each item in the sequence, individuals must determine whether the presented stimulus matches the stimulus shown n items earlier. Previous studies using fMRI have examined the involvement of dorsolateral prefrontal cortex activity in active maintenance and manipulation processes in working memory, as well as in preparing to inhibit response tendencies.

2.3. Intervention

The task-based cognitive rehabilitation program used in this study was adapted from the validated protocol developed by Ghasemi (2018) and was implemented to enhance executive functions in children with autism spectrum disorder. The intervention consisted of weekly sessions lasting 45–60 minutes, delivered through structured and progressively challenging exercises targeting core executive processes. Training emphasized active working-memory enhancement through systematic visual and auditory tasks such as recalling and manipulating information, memorizing geometric patterns, sequences of numbers, colored objects, and word components. Each session built upon the previous one, and progression to subsequent stages depended on the child's successful completion of tasks; if minimum performance criteria were not met, the previous session's exercises were repeated to ensure mastery. Family involvement was incorporated throughout the program, with parents providing feedback that informed adjustments in later sessions. The 10-session protocol included goals such as introducing the purpose of rehabilitation, practicing memory-card recall, shape-pattern recall, numerical and auditory–visual sequencing, reviewing prior tasks, memorizing colored vehicle sequences, recalling letter–word cubes, practicing color-card and image recall, memorizing action components and modified words, engaging in "fitting-room" color-memory tasks, and finally consolidating all training components using the working-memory enhancement package and visual–auditory instructional materials.

2.4. Data analysis

Data analysis in this study was performed using repeated-measures analysis of variance in SPSS.

3. Findings and Results

In this study, 30 children participated across two groups. The mean age of the control group was 10.89 years (SD = 1.42), and the mean age of the electronic visual–motor program group (Experiment 1) was 10.15 years (SD = 1.32). Results from an ANOVA comparing mean ages indicated that this difference was not statistically significant. The mean and standard deviation of attention and response inhibition across the three stages (pretest, posttest, and follow-up) are reported below.

Table 1

Mean and Standard Deviation of Executive Functioning Scores in Pretest, Posttest, and Follow-Up by Group

Executive Functions	Group	Test	N	Mean	SD
Attention	Control	Pretest	15	44.80	5.99
		Posttest	15	44.86	5.58
		Follow-Up	15	44.60	5.44
	Task-Based Cognitive Rehabilitation	Pretest	15	44.00	5.41
		Posttest	15	52.46	4.77

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		Follow-Up	15	52.40	4.04
Response Inhibition	Control	Pretest	15	67.73	7.99
		Posttest	15	68.00	8.58
		Follow-Up	15	67.93	8.44
	Task-Based Cognitive Rehabilitation	Pretest	15	66.33	7.41
		Posttest	15	58.86	8.77
		Follow-Up	15	58.53	8.04
Visuospatial Memory	Control	Pretest	15	67.73	7.99
		Posttest	15	68.00	8.58
		Follow-Up	15	67.93	8.44
	Task-Based Cognitive Rehabilitation	Pretest	15	149.93	12.41
		Posttest	15	173.06	14.54
		Follow-Up	15	173.93	14.89

As shown in the table, the mean scores for attention and visuospatial memory in the experimental group (task-based cognitive rehabilitation) increased from pretest to posttest and follow-up, while the mean response inhibition score decreased. There was no notable difference between posttest and follow-up. In contrast, the control group showed only minimal variation across the three testing points.

Table 2

Repeated-Measures ANOVA Results for the Effect of the Task-Based Cognitive Rehabilitation Program on Executive Functions in Children with High-Functioning Autism Spectrum Disorder

Executive Functions	Effect	Value	F	df (Hypothesis)	df (Error)	Sig.	Eta²
Attention	Repeated Factor	.561	10.559	2	27	.001	.439
	Group × Time	.569	10.228	2	27	.001	.431
Response Inhibition	Repeated Factor	.290	33.110	2	27	.001	.710
	Group × Time	.269	36.665	2	27	.001	.731
Visuospatial Memory	Repeated Factor	.207	51.690	2	27	.001	.793
	Group × Time	.222	47.271	2	27	.001	.778

Table 2 reports the multivariate test results assessing the effect of the task-based cognitive rehabilitation program on executive functions—attention, response inhibition, and visuospatial memory—among children with high-functioning autism spectrum disorder. According to the results, the multivariate tests indicate a significant variance for the interaction of group and time. Based on the effect sizes, the task-based electronic visual–motor training program had a significant effect on increasing attention and visuospatial memory and decreasing response inhibition among children with high-functioning autism. To compare the results across the testing stages (pretest, posttest, and follow-up), pairwise comparisons were performed, with results presented in Table 3.

Table 3

Pairwise Comparison of Mean Attention Scores Across Three Time Points

Executive Functions	Time A	Time B	Sig.
Attention	Pretest	Posttest	.001
		Follow-Up	.001
	Posttest	Follow-Up	.398
Response Inhibition	Pretest	Posttest	.001
		Follow-Up	.001
	Posttest	Follow-Up	.634
Visuospatial Memory	Pretest	Posttest	.001
		Follow-Up	.001
	Posttest	Follow-Up	.598

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Based on the findings in this table, there is a statistically significant difference between the mean scores of pretest and posttest, as well as between pretest and follow-up ($P < .01$). Specifically, the mean posttest and follow-up scores are significantly higher than the pretest mean for attention and visuospatial memory, and significantly lower for response inhibition. Additionally, no statistically significant difference was observed between posttest and follow-up mean scores, indicating stability of the intervention effects over time. Therefore, the task-based cognitive rehabilitation program affected the executive functions of children with autism spectrum disorder, and this effect remained stable across time.

4. Discussion and Conclusion

The purpose of this study was to examine the effectiveness of a task-based cognitive rehabilitation program on executive functions—attention, response inhibition, and visuospatial working memory—in children with high-functioning autism spectrum disorder. The results demonstrated that the intervention produced significant improvements in attention and visuospatial working memory and significant reductions in response inhibition deficits. These improvements were evident from pretest to posttest and remained stable at the three-month follow-up, indicating that the cognitive gains were sustained beyond the intervention period. In contrast, children in the control group exhibited no meaningful changes across any of the executive-function components, suggesting that developmental maturation alone could not explain the observed improvements.

The significant enhancement of attention following the intervention aligns with previous research highlighting the centrality of attentional deficits in autism and the modifiability of these skills through structured cognitive training. Theoretical models propose that attentional control in autism is influenced by atypical sensory processing, diminished social orienting, and altered hemispheric asymmetry (Akin-Bulbul & Ozdemir, 2024; Crasta et al., 2023; English et al., 2023). The findings of the present study support this notion by showing that a systematic, task-based training program can strengthen attentional regulation despite underlying neurocognitive differences. This is consistent with evidence demonstrating that children with ASD can exhibit improved attention after participating in cognitive rehabilitation interventions designed to progressively challenge attentional switching, sustained focus, and selective attention (Kasardjian et al., 2019). Moreover, research has shown that executive-function challenges are not merely secondary features but core cognitive markers of ASD (Kofler et al., 2024); therefore, targeting attention directly may contribute to broader gains in self-regulation and learning.

The intervention's effectiveness in reducing response-inhibition deficits further supports the robustness of task-based cognitive rehabilitation for executive functions. Response inhibition difficulties are widely documented in ASD and are linked to attentional disengagement, sensory reactivity, and structural differences in neural systems involved in motor preparation and inhibition (Nayak et al., 2020; Suzuki et al., 2020). The significant decrease in inhibitory-control errors in the experimental group suggests that structured practice in withholding responses, managing interference, and processing rule-governed tasks can facilitate improved inhibitory functioning. These findings align with behavioral and neurophysiological studies showing that repeated practice on inhibition-based tasks enhances inhibitory control and reduces response-preparation deficits in neurodevelopmental populations (Ludyga et al., 2024). Furthermore, studies involving children with trauma-related ASD presentations also reported significant improvements in inhibition following cognitive rehabilitation (Faraji & Zare, 2020), indicating that inhibitory control is a promising and trainable domain.

One of the most notable findings was the significant improvement in visuospatial working memory among children in the intervention group. Working-memory impairments are among the most widely recognized cognitive challenges in autism and are strongly associated with difficulties in following instructions, organizing information, and engaging in academic tasks (Kim & Kasari, 2023; Memisevic et al., 2023). The present results corroborate earlier research that task-based and computerized cognitive training can effectively improve working-memory performance in children with ASD (Amini Masuleh et al., 2022; Y. J. Lin et al., 2025). Moreover, the improvement observed aligns with studies showing that visuospatial working-memory development in autism follows distinct trajectories but can be enhanced through systematic practice (Y. Lin et al., 2025). The stability of these gains at follow-up further indicates that the intervention facilitated durable cognitive changes rather than short-term performance enhancements.

The findings also resonate with broader literature on cognitive rehabilitation and executive-function

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enhancement in neurodevelopmental disorders. For example, cognitive-motor and dual-task training programs in stroke patients have shown improvements in both cognitive and motor functions, suggesting that repetitive, structured cognitive tasks may capitalize on neural plasticity across multiple populations (Mou & Jiang, 2025). Similarly, virtual-reality cognitive-training studies have demonstrated enhancements in executive-function skills in children with learning disorders (Di Giusto et al., 2023), implying that cognitive enhancement is possible through diverse training formats when tasks remain structured, adaptive, and frequent. The current study adds to this evidence by showing that even non-computerized, task-based approaches are potent enough to produce measurable, lasting gains in autism.

Importantly, the involvement of families in the intervention process may have contributed indirectly to the observed outcomes. Although the program itself was child-focused, collecting family feedback and encouraging home practice likely increased generalization and reinforcement opportunities. Prior research emphasizes the importance of environmental consistency in executive-function learning, as deficits tend to manifest differently across home and school settings (Gentil-Gutiérrez et al., 2022). Thus, a combination of structured training and contextual reinforcement may help explain the persistence of improvements observed at follow-up.

The significant group-by-time interaction effects across all executive-function domains further underline the specificity and efficacy of the intervention. Multivariate analyses confirmed that attention, response inhibition, and visuospatial working memory improved significantly only for children receiving the task-based cognitive rehabilitation program. These findings are consistent with systematic reviews indicating that cognitive rehabilitation is effective for ASD across multiple cognitive domains, particularly when intervention protocols are tailored to the unique cognitive profile of the child (Greenspan et al., 2022). Similarly, studies involving high-functioning autistic children have found that cognitive-rehabilitation approaches can elicit measurable changes in brain function as indicated by neuroimaging measures (Shahraki & Abharian, 2022). The current study strengthens this evidence base by providing further empirical data supporting task-based cognitive rehabilitation as a robust, multidimensional intervention.

In addition to these cognitive gains, the age range and developmental profile of the participants may also explain the magnitude of improvements observed. Research suggests that children with high-functioning ASD retain a degree of cognitive flexibility and neural adaptability that makes them particularly responsive to targeted intervention programs (Miller et al., 2020; Xie et al., 2024). Moreover, executive-function interventions tend to be more effective when children are in middle childhood, during which executive systems experience substantial maturation (Kim & Kasari, 2023; Maenner et al., 2023). This developmental window may have facilitated greater responsiveness to the structured, repetitive, and progressively challenging tasks that characterized the rehabilitation protocol.

Taken together, the results of this study align strongly with previous research demonstrating that cognitive rehabilitation—both computerized and task-based—can significantly improve executive functioning in children with ASD. The findings expand existing knowledge by showing that a structured, low-technology task-based program is effective not only immediately after the intervention but also months later. These results reinforce the notion that repeated activation of cognitive systems, guided practice, and structured progression are essential elements of successful executive-function interventions. Furthermore, the sustained improvements in the present study echo findings that executive-function skills, once adequately trained, can exhibit stability over time (Bailey et al., 2022; Hou et al., 2024). The present findings, therefore, highlight the practical and clinical value of implementing task-based cognitive rehabilitation in school, clinical, and home environments.

This study, while offering significant insights, has several limitations that warrant consideration. The sample size was relatively small, which may limit the generalizability of the findings to broader ASD populations with more heterogeneous cognitive profiles. The use of convenience sampling may also introduce selection bias, potentially affecting the representativeness of the participants. Additionally, although follow-up testing demonstrated sustained improvements, the three-month follow-up window may not capture long-term maintenance or developmental shifts that occur over longer periods. Another limitation involves the reliance on behavioral measures rather than neuroimaging assessments, which could have provided deeper insights into neural changes associated with the intervention. Finally, the study did not examine generalization of cognitive gains to real-world functional outcomes such as academic performance, social functioning, or adaptive behavior.

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Future research should consider employing larger and more diverse samples to enhance the generalizability of findings across various ASD subgroups. Studies incorporating randomized controlled trial designs and multi-site sampling would strengthen causal inferences and minimize potential sampling biases. Additionally, integrating neuroimaging tools such as fMRI or EEG could help elucidate the neural mechanisms underlying cognitive improvements following task-based rehabilitation. Long-term longitudinal studies extending beyond three months would be valuable for assessing developmental trajectories and the durability of intervention gains. Future research may also explore combining task-based cognitive rehabilitation with complementary interventions such as physical exercise, virtual reality, or neuromodulation techniques to determine whether multi-modal approaches produce additive or synergistic effects. Finally, examining real-world functional outcomes—including academic achievement, daily living skills, and social communication—would provide a more comprehensive understanding of the intervention's practical relevance.

Practitioners working with children with high-functioning ASD may consider incorporating structured, task-based cognitive rehabilitation programs into educational and clinical settings. These programs can be adapted to suit individual needs and implemented with minimal technological resources, making them accessible across various contexts. Incorporating family involvement and providing home-based extension activities may further enhance and maintain cognitive gains. Additionally, integrating cognitive exercises into daily routines within classrooms or therapy sessions can promote consistency and generalization, helping children transfer learned skills to real-world situations.

Authors' Contributions

Authors contributed equally to this article.

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

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

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