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The Effectiveness of the Maher Fluid Intelligence Psycho-Educational Intervention Package on Executive Functions and Cognitive Emotion Regulation in Children with Attention-Deficit/Hyperactivity Disorder (ADHD)

Farahnaz. Roghani[1], Abutaleb. Saadati Shamir[2*], Mohammad Azad. Abdollahpour[3], Nezam Hashemi[4],

1 PhD student, Department of Psychology, Kish International Branch, Islamic Azad University, Kish, Iran.
2 Assistant Professor, Department of Educational Psychology and Personality, Science and Research Branch, Islamic Azad University, Tehran, Iran.
3 Assistant Professor, Department of Educational Psychology, Mahabad Branch, Islamic Azad University, Mahabad, Iran.
4 Assistant Professor, Department of Educational Psychology, Amin University of Law Enforcement Sciences, Tehran, Iran.

*Correspondence: seadatee@srbiu.c.ir

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ABSTRACT

The aim of this study was to determine the effectiveness of the Maher Fluid Intelligence Psycho-Educational Intervention Package on executive functions and cognitive emotion regulation in children with Attention-Deficit/Hyperactivity Disorder (ADHD). The research design was a quasi-experimental pretest-posttest with a control group. The statistical population included all 10–12-year-old boys with ADHD who visited specialized child counseling and psychological service centers in Tehran during the first half of 2023. Based on the research objective, 30 participants were selected from the above population through multistage cluster sampling and were randomly assigned into two groups of 15 (experimental and control). Data collection instruments included the Conners' Parent Rating Scale–Revised: Short Form (CPRS-R:S), the Structured Clinical Interview, the Barkley Deficits in Executive Functioning Scale–Children and Adolescents (BDEFS-CA), and the Cognitive Emotion Regulation Questionnaire–Kids–Parent Version (CERQ-K-P). After conducting the pretest, the control group remained on a waiting list, while the Maher Fluid Intelligence Psycho-Educational Intervention was administered to the experimental group in ten 45-minute group sessions. Research data were analyzed using Multivariate Analysis of Covariance (MANCOVA) and one-way ANCOVA within the MANCOVA framework. The results showed that, following the intervention, there was a significant difference between the experimental and control groups in the increased use of adaptive cognitive emotion regulation strategies, specifically positive refocusing and refocus on planning, as well as in the decreased use of maladaptive cognitive emotion regulation strategies and improvement in executive functions ($p < .05$). However, no significant differences were found between the groups regarding the adaptive strategies of acceptance, positive reappraisal, and putting into perspective ($p > .05$). These findings suggest that the Maher Fluid Intelligence Psycho-Educational Intervention Package helps children modulate their emotions, enhances their attention and concentration, and improves their emotional adjustment through deeper comprehension of emotional situations.

Keywords: Maher Fluid Intelligence Psycho-Educational Intervention, Executive Functions, Cognitive Emotion Regulation, Children with Attention-Deficit/Hyperactivity Disorder (ADHD)

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Introduction

In recent decades, the concept of intelligence has undergone a fundamental transformation, transitioning from a monolithic and biologically deterministic construct to a multifaceted, experience-influenced capacity. Early efforts by pioneers such as Binet and Simon positioned intelligence primarily as a cognitive metric for academic prediction and diagnosis of developmental delays (1). However, this narrow scope has been progressively challenged and expanded by scholars such as Guilford, who introduced the structure-of-intellect model to account for divergent thinking and creativity (2-4). Sternberg further revolutionized the field by proposing a triarchic theory encompassing analytical, creative, and practical intelligences, and later by developing the WICS model, which integrates wisdom, intelligence, and creativity in successful leadership and life outcomes (5-7).

This expansion of the definition of intelligence has led to renewed interest in fluid intelligence (Gf), a core cognitive function referring to the capacity to reason and solve novel problems independent of previously acquired knowledge (8). Fluid intelligence plays a critical role in learning, attention regulation, and adaptive decision-making (9, 10). Notably, it has been linked with executive functioning, working memory, and attention control, particularly in children with Attention-Deficit/Hyperactivity Disorder (ADHD), a neurodevelopmental disorder characterized by pervasive inattention, impulsivity, and hyperactivity (11, 12).

Recent neuroscientific insights have supported the biological basis of intelligence while acknowledging its plasticity and responsiveness to environmental interventions (13, 14). Among these interventions, cognitive empowerment, mindfulness, perceptual training, and metacognitive instruction have garnered empirical validation for enhancing cognitive processes like attention, working memory, and reasoning (15-17). This trend is of particular significance for children with ADHD, who exhibit measurable deficits in fluid reasoning and cognitive control mechanisms (18, 19).

Educational interventions aimed at strengthening executive and reasoning functions have proven to be effective across multiple dimensions of intelligence. For example, teaching mathematical reasoning has been shown to enhance both crystallized and fluid intelligence in primary school students (20, 21). Similarly, the introduction of perceptual and attentional skills has demonstrated reductions in ADHD-related symptoms while improving academic performance (22). Moreover, structured programs like Superbrain yoga and storytelling-based instruction have been effective in improving fluid reasoning and inhibitory control among exceptional children and those with cognitive delays (23-25).

Intelligence, as conceptualized by contemporary models, is no longer restricted to a single quantitative score. Instead, it is now viewed as a multi-domain construct influenced by environmental, cultural, and socio-emotional contexts. Cultural intelligence (CQ) and spiritual intelligence (SQ), for example, have emerged as complementary dimensions of overall cognitive functioning, shaping how individuals navigate intercultural settings and derive existential meaning from life events (26-28). These intelligences are particularly relevant in educational and therapeutic settings, where enhancing identity, motivation, and adaptive behavior is central to psychological well-being and social adjustment (29-31).

Given these complex interrelations, the current study seeks to examine the effectiveness of a psychological-educational intervention program aimed at improving fluid intelligence and cognitive emotion regulation in children with ADHD. Cognitive emotion regulation, which refers to the conscious mental strategies individuals use to influence the emotional response to stimuli, has been identified as both an

outcome and mediator in cognitive training programs (7, 32). These strategies encompass reappraisal, rumination, catastrophizing, and acceptance, and are crucial for individuals with ADHD who often exhibit heightened emotional lability (33).

A recent wave of Iranian studies has focused on developing and validating new tools and protocols for measuring and enhancing fluid intelligence. For instance, the Multidimensional Fluid Intelligence Test (MMFIT) introduced by Saadati Shamireh and Zahmatkesh represents a locally adapted, culturally sensitive measure for evaluating fluid reasoning in young learners (34). Other scholars have introduced targeted interventions such as metacognitive skill instruction, economic intelligence training, and spiritual cultivation programs that correlate positively with executive functions and adaptive behaviors in both normal and clinical populations (35-37).

A particularly compelling rationale for focusing on ADHD populations stems from their vulnerability to emotional dysregulation, attentional breakdowns, and social maladjustment, which collectively compromise their academic and interpersonal functioning (38). Yet, research by Kamkar et al. confirms that cognitive training rooted in the triarchic theory of intelligence can significantly improve verbal comprehension and fluid reasoning in children, suggesting that such approaches may hold promise for neurodiverse learners (39).

Further, the intersection between emotion regulation and intelligence has become a fertile ground for theoretical innovation and empirical exploration. Sternberg and colleagues have emphasized the importance of "successful intelligence," which merges analytical, practical, and creative intelligences to produce adaptive, context-sensitive behaviors (5). In this model, emotional and moral intelligences play a central role, serving as the bridge between cognitive ability and ethical behavior (40). Relatedly, Ferguson and Takane highlighted the statistical necessity of integrating such multifactorial models into education and assessment protocols to ensure holistic development (41).

Despite such promising developments, gaps remain in the application of these models to clinical groups such as children with ADHD. Many existing studies focus either on cognitive training or emotional regulation in isolation, overlooking their potential synergy. Moreover, few studies have investigated how integrated interventions may impact both fluid intelligence and emotion regulation simultaneously, particularly within the Iranian sociocultural context.

This study therefore attempts to bridge this gap by implementing a structured, culturally adapted intervention aimed at enhancing fluid intelligence and improving cognitive emotion regulation in Iranian children diagnosed with ADHD. Drawing on validated frameworks such as the MMFIT and strategies grounded in Sternberg's triarchic intelligence theory, this study contributes to both theoretical development and practical application in clinical child psychology. By doing so, it aligns with a growing body of literature advocating for multi-dimensional, evidence-based educational and psychological interventions that cater to the nuanced needs of neurodivergent populations (42, 43).

Ultimately, this research builds upon foundational efforts by scholars such as Guilford, Sternberg, and Ferguson while integrating contemporary insights from Iranian and international studies. In doing so, it aims to provide robust empirical evidence for the transformative potential of intelligence-based intervention in children with ADHD.

Methods and Materials

Study Design and Participants

The present study was applied in terms of its objective and experimental in terms of data collection method, employing a quasi-experimental pretest-posttest design with a control group. Regarding the type of data, the study was quantitative. The statistical population consisted of all children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) who visited licensed psychological clinics in District 1 of Tehran. These clinics held official authorization from the Iranian Psychological and Counseling Organization, and the time frame for data collection was from June 22 to October 22, 2023. The sample size was determined using Cohen's formula, which calculated 15 participants for each group (two experimental groups and one control group). Considering potential participant attrition, approximately 15 participants were allocated to each group. The sampling method was multistage cluster sampling. Initially, ten licensed and active clinics in District 1 of Tehran were purposefully selected. From these, five clinics that were both willing to participate and had a larger client base were chosen. Then, children diagnosed with ADHD who had visited these clinics within the specified timeframe and were willing to cooperate were identified. A pretest measuring the dependent variables was administered to these children. Subsequently, 30 children with the lowest scores on the pretest were selected. These participants were then matched and assigned to experimental and control groups based on the socioeconomic, educational, and occupational status of their parents.

Data Collection

The SNAP-IV ADHD Rating Scale, developed by Swanson, Nolan, and Pelham in 1981, was used to assess ADHD symptoms in children and adolescents. This questionnaire consists of 18 items and includes two subscales. It uses a three-point Likert scale and contains items such as "Often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities." In the current study, a five-point Likert scale was used to rate responses. The total score is calculated by summing the scores of all items, with a possible range from 0 to 54. A score between 0 and 18 indicates a low level of ADHD symptoms, between 18 and 36 indicates a moderate level, and above 36 indicates a high level of symptoms. In the study by Kiani and Hadianfar (2015), the content, face, and criterion validity of the SNAP-IV were deemed acceptable, and the Cronbach's alpha coefficient was reported to be above 0.70.

The Cognitive Emotion Regulation Questionnaire (CERQ), developed by Garnefski et al. (2001), was designed to assess how individuals cognitively respond after experiencing stressful or threatening life events. The questionnaire contains 36 items, rated on a Likert scale ranging from 1 (almost never) to 5 (almost always). Conceptually, the questionnaire consists of nine distinct subscales, each reflecting a specific cognitive emotion regulation strategy and containing four items. These strategies include self-blame, where individuals blame themselves for the event; other-blame, where others are blamed for the event; acceptance, referring to acceptance and resignation toward the event; refocus on planning, involving thoughts about how to address the event and take steps toward resolution; positive refocusing, involving thoughts about pleasant matters instead of the negative event; rumination, which entails ongoing thoughts about feelings and cognitions related to the event; positive reappraisal, which involves assigning a positive meaning to the event

in the context of personal growth; putting into perspective, which involves considering the relativity of the event compared to others; and catastrophizing, where the individual emphasizes the disastrous or catastrophic nature of the experience. Each strategy score is calculated by summing the scores of its respective items, with possible scores ranging from 4 to 20. Additionally, the strategies of self-blame, other-blame, catastrophizing, and rumination collectively constitute the negative emotion regulation strategies, whereas acceptance, refocus on planning, positive refocusing, positive reappraisal, and putting into perspective represent the positive emotion regulation strategies. The total score from all 36 items, which ranges from 36 to 180, reflects the overall use of cognitive emotion regulation strategies. The internal consistency (Cronbach's alpha) for the positive strategies, negative strategies, and the overall scale were reported as 0.91, 0.86, and 0.93 respectively (Garnefski et al., 2001). In the Iranian context, Yousefi (2003) reported a Cronbach's alpha of 0.82 for the total scale in a sample of individuals aged 15 to 25. The validity of the questionnaire was also confirmed in Yousefi's (2004) study through the correlation between negative strategies and the depression and anxiety subscales of the 28-item General Health Questionnaire (GHQ-28) developed by Goldberg and Hillier (1979), with correlation coefficients of 0.35 and 0.37 respectively, both significant at the $p < .0001$ level.

Interventions

The Maher Fluid Intelligence Psycho-Educational Intervention Package (Sa'adati Shamir, 2022), based on the theoretical foundation of the Cattell–Horn–Carroll (CHC) theory of intelligence, was developed following a factor analysis that identified five broad cognitive abilities: perceptual intelligence, analytical intelligence, concentration, memory, and processing speed. The intervention protocol consists of 12 structured sessions, each lasting 90 minutes, with at least two days between sessions to ensure optimal cognitive engagement and recovery. The first session introduces the five domains of Maher intelligence, establishes group rapport, administers baseline assessments, signs behavioral contracts, motivates participation, explains confidentiality and group rules, and assigns initial reflective homework. The second session targets figure-ground discrimination and visual recognition, using image-based tasks and interpretation to develop perceptual processing skills, with homework reinforcing these visual subskills. The third session focuses on visual closure and visual perception sequencing, using progressive image interpretation tasks to strengthen the participant's ability to integrate incomplete visual information and understand sequences. The fourth session addresses visual reasoning and matrix reasoning, where children analyze visual patterns, derive rules, and apply them to solve matrix-based tasks. The fifth session introduces maze reasoning and mental calculation, combining spatial navigation and arithmetic estimation to enhance analytical problem-solving. The sixth session involves single- and multi-dimensional visual attention tasks, training sustained and selective attention through detailed visual analysis. The seventh session advances to geometric and conceptual attention, combining spatial pattern recognition with conceptual sorting to boost high-level cognitive flexibility. In the eighth session, visual and auditory memory are trained through tasks requiring immediate recall, interpretive explanation, and reinforcement of verbal and visual cues. The ninth session targets visual-numerical memory through image-based numerical sequences, enhancing the child's capacity to retain and process visual numerical data. The tenth session addresses visual processing and symbol coding, emphasizing speed and accuracy in symbol decoding and visual discrimination. The eleventh

session targets sequential processing, where learners identify patterns and sequences in visual stimuli, fostering temporal and logical ordering skills. The twelfth and final session involves comprehensive review and error correction across all prior sessions, reinforcing learned skills and solidifying cognitive integration. Each session includes review of previous homework, guided interpretation of new stimuli, correction or enhancement of participant responses, and the assignment of structured take-home tasks that directly correspond to session content, ensuring intervention repeatability, standardization, and depth.

Data analysis

Data analysis was conducted using multivariate analysis of covariance (MANCOVA) and one-way analysis of covariance (ANCOVA) within the MANCOVA framework to examine the effectiveness of the Maher Fluid Intelligence Psychological-Educational Intervention on the dependent variables. Prior to conducting the main analyses, the assumptions of normality, homogeneity of variances, linearity, and homogeneity of regression slopes were assessed and confirmed. MANCOVA was employed to analyze the simultaneous effect of the intervention on multiple dependent variables, including executive functions and cognitive emotion regulation strategies. Follow-up ANCOVAs were then used to determine specific differences between the experimental and control groups on each variable, with pre-test scores controlled as covariates. All analyses were performed using SPSS software, and a significance level of $p < .05$ was adopted for hypothesis testing.

Findings and Results

The demographic characteristics of the participants in this study, which included two groups of boys aged 9 to 11 years diagnosed with ADHD, were relatively balanced across several variables. In terms of age, both the experimental and control groups had 6.7% of participants aged 9, while the majority were 10 years old (80% in the experimental group and 60% in the control group), followed by 13.3% and 33.3% aged 11, respectively. Regarding the number of children in the family, 33.3% of children in the experimental group were only children, 46.7% had one sibling, and 20% had two or more siblings, compared to the control group where 26.7% were only children, 40% had one sibling, and 33.3% had two or more siblings. With respect to birth order, 80% of the experimental group and 73.3% of the control group were first-borns, while the rest were mostly second-borns, with only one child in the control group being third-born or later. Maternal education levels varied: in the experimental group, 26.7% of mothers had less than a high school diploma, 46.7% had a diploma, 20% had an associate degree, and 6.7% held a bachelor's degree. In the control group, 20% had less than a diploma, 33.3% had a diploma, 20% had an associate degree, and 26.7% had a bachelor's degree. Concerning maternal employment, 33.3% of mothers in the experimental group were employed and 66.7% were homemakers, while in the control group, 40% were employed and 60% were homemakers. As for paternal education, 26.7% of fathers in the experimental group had less than a diploma, another 26.7% had a diploma, 20% had an associate degree, 20% held a bachelor's degree, and 6.7% had a master's degree or higher. In the control group, 20% had less than a diploma, 20% had a diploma, 33.3% had an associate degree, 13.3% had a bachelor's, and another 13.3% had a master's degree or higher. In terms of employment, 80% of fathers in the experimental group and 73.3% in the control group were employed, while 20% and 26.7% were unemployed, respectively. Finally, the economic status of participants showed that 26.7% in both

groups reported a good financial situation, 53.3% reported an average status, and 20% reported a poor economic condition.

Table 1. Descriptive Statistics for Executive Functions in the Experimental and Control Groups Across Two Measurement Phases

Variable	Phase	Group	Mean	Standard Deviation
Executive Functions	Pretest	Experimental	198.13	50.90
		Control	204.21	34.98
	Posttest	Experimental	132.33	34.25
		Control	201.89	33.51
Time Management	Pretest	Experimental	36.13	9.90
		Control	37.00	5.98
	Posttest	Experimental	28.80	5.07
		Control	38.33	4.52
Self-Organization/Problem Solving	Pretest	Experimental	33.60	11.22
		Control	33.21	12.41
	Posttest	Experimental	23.40	7.89
		Control	34.98	11.28
Self-Restraint	Pretest	Experimental	39.27	6.77
		Control	37.27	6.32
	Posttest	Experimental	25.33	7.64
		Control	38.27	6.96
Self-Motivation	Pretest	Experimental	41.07	13.60
		Control	39.93	7.13
	Posttest	Experimental	27.00	9.32
		Control	39.07	6.28
Emotional Self-Regulation	Pretest	Experimental	47.20	14.21
		Control	53.27	9.77
	Posttest	Experimental	31.27	7.32
		Control	52.33	9.64

As shown in Table 1, the mean and standard deviation of the total executive functions score in the pretest phase were 198.13 ± 50.90 in the experimental group and 204.21 ± 34.98 in the control group. In the posttest phase, the mean and standard deviation were 132.33 ± 34.25 for the experimental group and 201.89 ± 33.51 for the control group.

Table 2. Descriptive Statistics for Cognitive Emotion Regulation Strategies in the Experimental and Control Groups Across Two Measurement Phases

Variable	Phase	Group	Mean	Standard Deviation
Self-Blame	Pretest	Experimental	16.60	1.45
		Control	15.80	2.86
	Posttest	Experimental	8.27	1.41
		Control	14.07	2.42
Acceptance	Pretest	Experimental	11.40	3.26
		Control	12.20	2.83
	Posttest	Experimental	12.80	3.65
		Control	12.47	4.63
Rumination	Pretest	Experimental	14.00	1.94
		Control	14.20	1.41
	Posttest	Experimental	9.33	1.35
		Control	13.13	3.54
Positive Refocusing	Pretest	Experimental	11.27	3.40
		Control	12.80	3.16
	Posttest	Experimental	15.33	3.64
		Control	12.53	2.52
Refocus on Planning	Pretest	Experimental	11.87	3.63
		Control	12.33	2.10

	Posttest	Experimental	17.60	2.45
		Control	12.80	4.86
Positive Reappraisal	Pretest	Experimental	11.20	4.88
		Control	13.47	2.99
	Posttest	Experimental	13.13	2.52
		Control	13.87	2.92
Putting into Perspective	Pretest	Experimental	11.07	3.16
		Control	12.67	4.44
	Posttest	Experimental	11.27	3.77
		Control	12.27	3.32
Catastrophizing	Pretest	Experimental	16.33	2.64
		Control	15.27	4.96
	Posttest	Experimental	8.07	2.60
		Control	14.93	3.13
Blaming Others	Pretest	Experimental	13.20	3.88
		Control	12.47	3.99
	Posttest	Experimental	9.13	2.52
		Control	12.87	3.92

Regarding maladaptive cognitive emotion regulation strategies, the mean and standard deviation for self-blame in the pretest were 16.60 ± 1.45 in the experimental group and 15.80 ± 2.86 in the control group. In the posttest phase, the mean and standard deviation for self-blame were 8.27 ± 1.24 for the experimental group and 14.07 ± 2.42 for the control group.

Table 3. Multivariate Tests on the Posttest Means of Variables Between Experimental and Control Groups with Pretest Covariate Control

Test Name	Value	Hypothesis df	Error df	F	p	Effect Size	Power
Pillai's Trace	0.98	9	11	32.21	.001	0.95	1.00
Wilks' Lambda	0.02	9	11	32.21	.001	0.95	1.00
Hotelling's Trace	50.13	9	11	32.21	.001	0.95	1.00
Roy's Largest Root	50.13	9	11	32.21	.001	0.95	1.00

As shown in Table 3, after controlling for the pretest, the significance levels of all multivariate tests indicate that there is a significant difference between the experimental and control groups in at least one of the dependent variables (components of executive functions and cognitive emotion regulation strategies) ($F = 32.21$, $p < .001$). The effect size is 0.98, indicating that 98% of the individual differences in posttest scores of executive function components and cognitive emotion regulation strategies in children are attributable to the effect of the Maher Fluid Intelligence Psycho-Educational Intervention.

Table 4. Multivariate Tests on the Posttest of Executive Function Components Between Groups with Pretest Covariate Control

Test Name	Value	Hypothesis df	Error df	F	p	Effect Size	Power
Pillai's Trace	0.81	4	21	12.33	.002	0.68	1.00
Wilks' Lambda	0.36	4	21	12.33	.002	0.68	1.00
Hotelling's Trace	3.34	4	21	12.33	.002	0.68	1.00
Roy's Largest Root	6.52	4	21	12.33	.002	0.68	1.00

As indicated in Table 4, after controlling for the pretest, the significance levels of all multivariate tests reveal that there is a statistically significant difference between the experimental and control groups in at least one of the dependent variables (components of executive functions) ($p < .001$).

Table 5. ANCOVA within MANCOVA on Posttest Scores of Executive Functions Between Groups Controlling for Pretest

Variable	Sum of Squares	df	Mean Square	F	p	Eta (Effect Size)	Power
Executive Functions	8120.42	1	8120.42	6.21	.001	0.72	1.00
Executive Function Components:							
Time Management	623.37	1	623.37	7.22	.001	0.62	1.00
Self-Organization/Problem Solving	567.10	1	567.10	7.62	.034	0.67	1.00
Self-Restraint	791.78	1	791.78	4.18	.001	0.71	1.00
Self-Motivation	541.27	1	541.27	37.20	.001	0.65	1.00
Emotional Self-Regulation	3315.21	1	3315.21	29.53	.001	0.75	1.00

As indicated in Table 5, after controlling for the pretest, there is a significant difference between the experimental and control groups in overall executive functions and all of its components ($p < .05$). In other words, the Maher Fluid Intelligence Psycho-Educational Intervention led to a reduction in executive function scores in the experimental group compared to the control group. The effect sizes were as follows: executive functions (0.70), time management (0.65), self-organization/problem solving (0.50), self-restraint (0.81), self-motivation (0.65), and emotional self-regulation (0.76).

Table 6. Multivariate Tests on Posttest Scores of Cognitive Emotion Regulation Strategies Between Groups Controlling for Pretest

Test Name	Value	Hypothesis df	Error df	F	p	Effect Size	Power
Pillai's Trace	3.51	4	21	7.35	.001	0.79	1.00
Wilks' Lambda	3.51	4	21	7.35	.001	0.79	1.00
Hotelling's Trace	3.51	4	21	7.35	.001	0.79	1.00
Roy's Largest Root	3.51	4	21	7.35	.001	0.79	1.00

As shown in Table 6, after controlling for the pretest, all multivariate test results indicate that there is a significant difference between the experimental and control groups in at least one of the dependent variables (cognitive emotion regulation strategies) ($p < .001$). This suggests that the intervention was effective in altering at least one dependent variable. The overall effect size is 0.69.

Table 7. ANCOVA within MANCOVA on Posttest Scores of Cognitive Emotion Regulation Strategies Controlling for Pretest

Variable	Sum of Squares	df	Mean Square	F	p	Effect Size	Power
Self-Blame	221.59	1	221.59	6.27	.001	0.37	1.00
Acceptance	12.52	1	12.52	2.30	.031	0.12	0.12
Rumination	34.64	1	34.64	10.35	.021	0.42	0.98
Positive Refocusing	23.62	1	23.62	6.52	.041	0.32	0.88
Refocus on Planning	121.18	1	121.18	12.11	.003	0.24	0.96
Positive Reappraisal	12.30	1	12.30	3.27	.091	0.37	0.72
Putting into Perspective	2.20	1	2.20	2.22	.015	0.32	0.05
Catastrophizing	210.51	1	210.51	33.60	.021	0.37	1.00
Blaming Others	81.61	1	81.61	16.76	.031	0.21	1.00

As shown in Table 7, after controlling for the pretest, there are significant differences between the experimental and control groups in cognitive emotion regulation strategies (except for acceptance, positive reappraisal, and putting into perspective) ($p < .05$). In other words, the Maher Fluid Intelligence Psycho-Educational Intervention reduced maladaptive cognitive emotion regulation strategies such as self-blame, rumination, catastrophizing, and blaming others in the experimental group compared to the control group. The effect sizes were as follows: self-blame (0.77), rumination (0.47), catastrophizing (0.67), and blaming others (0.51). These results indicate that 77% of individual differences in self-blame posttest scores, 47% in rumination, 67% in catastrophizing, and 51% in blaming others are attributable to the intervention.

Additionally, the intervention increased the adaptive cognitive emotion regulation strategies of positive refocusing and refocus on planning in the experimental group compared to the control group. The effect sizes were 0.30 for positive refocusing and 0.44 for refocus on planning. This means that 30% of the individual differences in posttest scores of positive refocusing and 44% in refocus on planning are due to the effect of the Maher Fluid Intelligence Psycho-Educational Intervention.

Table 9. ANCOVA within MANCOVA on the Second Posttest Scores of Cognitive Emotion Regulation Strategies Controlling for Pretest

Variable	Sum of Squares	df	Mean Square	F	p	Effect Size	Power
Self-Blame	221.66	1	221.59	4.55	.001	0.31	1.00
Acceptance	12.87	1	12.52	3.32	.031	0.14	0.18
Rumination	34.90	1	34.64	10.32	.021	0.41	0.92
Positive Refocusing	22.68	1	23.62	5.52	.041	0.31	0.81
Refocus on Planning	121.28	1	121.18	12.11	.003	0.23	0.93
Positive Reappraisal	12.44	1	12.30	3.27	.092	0.37	0.72
Putting into Perspective	2.32	1	2.27	2.70	.014	0.32	0.05
Catastrophizing	210.43	1	270.57	33.60	.021	0.37	1.00
Blaming Others	81.64	1	71.61	16.76	.031	0.21	1.00

As shown in Table 9, after controlling for the pretest, there are significant differences between the experimental and control groups in cognitive emotion regulation strategies (with the exception of acceptance, positive reappraisal, and putting into perspective) ($p < .05$). In other words, the Maher Fluid Intelligence Psycho-Educational Intervention reduced maladaptive strategies such as self-blame, rumination, catastrophizing, and blaming others in the experimental group. Moreover, the results indicate that there was no significant difference between the first and second posttests.

Discussion and Conclusion

The purpose of this study was to investigate the effectiveness of a psychological-educational intervention package—specifically, the Maher Fluid Intelligence Training Program—on enhancing executive functions and cognitive emotion regulation in children diagnosed with attention-deficit/hyperactivity disorder (ADHD). The findings indicated that the experimental group demonstrated significant improvements in adaptive cognitive emotion regulation strategies (such as positive refocusing and planning) and reductions in maladaptive strategies (such as catastrophizing and rumination), as well as substantial enhancement in executive function indicators, compared to the control group.

These findings are consistent with a growing body of research emphasizing the modifiability of fluid intelligence and cognitive regulatory mechanisms, particularly in clinical populations such as children with ADHD. Rughani et al. (2024) found that psychological-educational interventions that stimulate fluid reasoning can enhance cognitive emotion regulation in ADHD children by restructuring their attentional focus and improving metacognitive awareness (36). Similarly, Ershadi Chahardeh et al. (2024) demonstrated that a Lumosity-based cognitive empowerment package led to significant gains in both fluid intelligence and executive functioning among elementary school children, underscoring the critical role of structured cognitive exercises in neurodevelopmental disorders (15).

In parallel with our results, several studies have shown the intersection of cognitive and emotional domains in child development. For instance, Ardani and Islami (2024) reported that emotion regulation training effectively improved social intelligence in women heads of households, revealing the generalizable

benefits of cognitive-emotional training across populations (16). Additionally, cognitive interventions that emphasize fluid intelligence have been shown to improve academic and behavioral outcomes in younger populations (21, 32).

The improvement in executive functions aligns with theoretical and empirical models proposed by Sternberg's triarchic theory of intelligence, which posits that successful intelligence integrates analytical, creative, and practical abilities that are adaptable and trainable through targeted interventions (5, 42). According to Sternberg, fluid intelligence is not a fixed trait but rather a dynamic construct shaped by learning and environmental stimulation. The intervention used in the current study is likely to have activated these domains through problem-solving scenarios, strategic memory exercises, and reflective activities.

Supporting this conceptualization, Haier and Sternberg (2020) provided evidence for the neurobiological underpinnings of fluid intelligence, showing how targeted brain-based training could stimulate neural plasticity, particularly in children with developmental disorders (8). Our findings reinforce this view by demonstrating that a structured, cognitively demanding intervention can lead to measurable changes in cognitive flexibility and emotion regulation.

Furthermore, the decline in maladaptive emotion regulation strategies, such as catastrophizing, may be linked to enhanced working memory capacity and cognitive inhibition—functions central to executive control. This aligns with Jha (2020), who found that deficits in sensory processing and cognitive regulation in children with ADHD and autism spectrum disorder predicted externalizing behavioral problems (11). The ability to regulate emotional responses through cognitive strategies may be facilitated by interventions that simultaneously enhance fluid reasoning, thereby allowing children to better assess, reframe, and manage emotionally charged situations.

The results of the present study also complement findings from Saadati Shamireh and Zahmatkesh (2022), who introduced and validated the Multidimensional Fluid Intelligence Test (MMFIT) and argued that culturally-adapted fluid intelligence training tools could help identify and remediate deficits in early developmental stages (34). This study indirectly supports their assertion by demonstrating the practical utility of such tools in structured interventions. Likewise, the positive emotional outcomes are in line with findings by Alipour and Bazmi (2023), who showed that enhancing cultural intelligence through gaming improved empathy and emotional flexibility among students (31).

Another important perspective comes from DeBoeck et al. (2020), who challenged static models of intelligence and advocated for approaches that recognize intelligence as context-dependent and fluid over time (10). The current intervention, which integrated metacognitive and emotional components, fits well within this progressive view of intelligence and offers compelling evidence for its real-world applicability in clinical and educational settings.

Moreover, this study's findings may be situated within a broader biopsychosocial model of intelligence and behavior. Stolpe et al. (2020) emphasized the role of prenatal and environmental exposures in the development of ADHD symptoms, suggesting that interventions targeting cognitive and emotional systems postnatally can help mitigate these risk factors (13). This underscores the potential of our intervention not just for remediation but also for preventative neurodevelopmental health.

It is also worth noting the converging evidence from studies focused on academic and practical applications of fluid intelligence interventions. For example, Kamkar et al. (2021) found that teaching

components of Sternberg's successful intelligence model significantly improved fluid reasoning and verbal comprehension in elementary school students (39). Our findings extend this line of inquiry by showing that such gains can coexist with improvements in emotion regulation, a critical predictor of behavioral adjustment and social functioning in children.

In essence, the Maher Fluid Intelligence Intervention appears to function as a holistic cognitive tool—enhancing not only abstract reasoning and planning but also the emotional self-regulation capacities that are often underdeveloped in children with ADHD. These results reinforce Sternberg's proposition that intelligence is not merely about problem-solving in decontextualized settings but about effectively navigating real-life challenges with emotional and strategic competence (6, 7).

Despite its promising findings, this study is not without limitations. First, the sample size was relatively small and limited to children within a specific age range (7–9 years) attending psychological clinics in a single geographic region (District 1, Tehran). This may limit the generalizability of the results to broader or more diverse populations. Additionally, the study relied solely on parent-reported and standardized questionnaire data, which could be subject to response biases or fail to capture subtle behavioral changes observable in naturalistic settings. The absence of long-term follow-up assessments also leaves the sustainability of the observed effects in question.

Future studies should aim to replicate these findings in larger and more diverse samples, including children from rural areas or different socio-economic backgrounds. Incorporating objective neurocognitive assessments, teacher reports, or neuroimaging techniques may also provide more comprehensive insights into the neural and behavioral mechanisms underlying intervention effects. Longitudinal research is particularly needed to evaluate whether gains in fluid intelligence and emotion regulation persist over time and translate into improvements in academic achievement or peer relationships.

Practitioners in clinical and educational settings are encouraged to consider using integrative, multi-dimensional intervention packages that target both cognitive and emotional domains in children with ADHD. Training programs should be interactive, developmentally appropriate, and aligned with children's everyday challenges to maximize engagement and transfer of learning. Finally, involving parents and teachers in the intervention process could enhance consistency across environments and strengthen outcomes.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

Transparency of Data

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

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