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Applications of Neurofeedback in Diagnosing and Treating Cognitive Impairments in Iranian Children and Adolescents with Neurodevelopmental Conditions: A Systematic Review

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Abstract

Objective: Attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and specific learning disorder (SLD) are some of the most common neurodevelopmental disorders (NDDs) impacting a child's education and social behavior. There has been a growing interest in neurofeedback as a noninvasive method of using self-regulation to increase cognitive performance in children with NDD. The current systematic review evaluates the effectiveness of using neurofeedback either as a stand-alone or in combination with other methods to improve cognitive, academic, behavioral, and neurophysiological outcome measures in Iranian children and adolescents with neurodevelopmental conditions including ADHD, ASD, and SLD.

Materials & Methods: A systematic search was conducted using the PRISMA-2020 guidelines in Iranian databases for studies published between 2015 and 2025. The inclusion criteria included quantitative research studies conducted on Iranian children and adolescents with

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neurodevelopmental conditions under 18 years of age with ADHD, ASD, and SLDs utilizing Neurofeedback technology. Of the total of 63 studies included in the analysis, 38 were focused on ADHD, 20 on SLDs, and 5 on ASDs. The studies evaluated a total of 2148 subjects with ADHD, ASDs, and/ or SLDs. Two independent reviews conducted the extraction of data and the assessment of quality for each study selected for inclusion in the analysis.

Results: Researchers found that after receiving neurofeedback training, participants exhibited improvement in cognitive and executive function (sustained attention, working memory, cognitive flexibility, inhibition) and academic achievement (reading, writing, and mathematics), behavioral improvements (reduced symptoms of hyperactivity, impulsivity, aggression), as well as significant neurophysiological changes (brain wave activity). Intervention combinations of neurofeedback with cognitive rehabilitation, transcranial direct current stimulation (tDCS), or play therapy have demonstrated superior and more lasting results than neurofeedback alone. Nevertheless, there were methodological limitations to the studies conducted, including small sample sizes, no use of sham controls, short-term follow-up periods, and limited generalization (primarily conducted on boys aged 7-12).

Conclusion: Neurofeedback therapy has great potential as an alternative intervention for the treatment of cognitive impairment and other symptoms associated with ADHD, SLD, and ASD in children in Iran, particularly when individualized and integrated with other forms of treatment. Although the research is limited by methodological limitations, the results suggest that there is a potential for using neurofeedback therapy to promote brain plasticity and, therefore, improve cognition. The design of large-scale, randomized controlled clinical trials with sham groups, multiple ethnicities, longer duration of treatment, and established protocols should be the next step in establishing clinical use of neurofeedback therapy for children with ADHD, SLD, and ASD in Iran.

Keywords: Neurofeedback, Neurodevelopmental disorders, ADHD, SLD, ASD, Iranian children and adolescents, Systematic review

1. Introduction

Neurodevelopmental disorders (NDDs) are recognized as being important in mainstream psychiatry (Shah et al., 2022). NDDs typically significantly affect the patients and their families, occurring when developmental processes are disrupted by different genetic and environmental influences (Khodosevich & Sellgren, 2023). NDDs are a diverse collection of conditions marked by developmental difficulties during infancy or childhood, or at any point in a person's life span (Antolini & Colizzi, 2023; Ismail et al., 2024) in the areas of personal, social, educational, or work-related capabilities; encompassing attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and specific learning disorder (SLD), among others (Mullin et al., 2013). ADHD is characterized by persistent problems of inattention, hyperactivity, and impulsivity (Sharif et al., 2025; Valaei Sharif et al., 2024), the first symptoms of which can be observed in childhood (Pedersen et al., 2024) and it frequently continues into adulthood (Biederman et al., 2000), is linked to detrimental effects across multiple areas, such as relationships with peers, academic success, job performance, social and familial adjustments (Barkley & Fischer, 2019) employment situations, and earnings (Pelham et al., 2020). SLD is a widely occurring condition that encompasses a diverse range of challenges related to acquiring academic skills in reading, mathematics, and writing. ASDs encompass a wide range of neurodevelopmental conditions that affect an individual's ability to engage socially, communicate effectively, and exhibit specific behaviors (Cui et al., 2023; Hirota & King, 2023). These characteristics vary significantly among individuals, illustrating the concept of a "spectrum" (Uljarević et al., 2020). In general, it can be said that ADHD, SLD, and ASD are closely related to each other, and all of them can affect students' academic performance and behavioral problems (Joyner & Wagner, 2020; Moll et al., 2020; Rutter, 1982).

The prevalence rates of nonspecific neurodevelopmental disorders (NDDs) among children and adolescents aged 0 to 18 years differ significantly among various populations. A recent systematic review assessing the prevalence of nonspecific neurodevelopmental disorders according to DSM-5 revealed considerable variability (ranging from 4.7% to 88.5%), primarily due to differences in methodology and the influence of social contexts (Francés et al., 2022). In high-income nations such as the United States and Canada, it is estimated that nonspecific neurodevelopmental disorders impact between 7% and 15% of children (Boyle et al., 2011; Halfon et al., 2012), while in low- and middle-income countries, the prevalence is around 7.6 per 1000 individuals (Bitta et al., 2018). According to an analysis of data from the Global Burden of Disease study up to 2013, the overall prevalence of ADHD in children was determined to be 5.4% (Cortese et al., 2023). Prevalence estimates for ADHD in children differ by age group; a review of studies conducted before 2020 indicated a prevalence rate of 7.6% among children aged 3–11 and 5.6% in adolescents aged 12–18 (Salari et al., 2023). In a population-centric prevalence assessment conducted in the United States, the reported prevalence of SLD among children aged 3 to 17 years was determined to be 9.7% (Altarac & Saroha, 2007). Epidemiological data indicate that the prevalence of ASD in the USA is 18.5 per 1,000 children under 8 years of age (Yang et al., 2023).

As the primary challenges in these disorders are related to cognition, defining them accurately is crucial to ensure effective management. Cognition involves the mental functions and abilities

that allow individuals to perceive, think, and understand their environment (Hoffman, 2018). The cognitive domain includes different facets of mental functioning that can be assessed to gauge a person's cognitive abilities. These domains are structured hierarchically, with lower levels focusing on fundamental sensory and cognitive processes, while higher levels deal with aspects of executive functioning and cognitive control (Nigg, 2017). Cognitive function is typically understood in relation to functional areas, depending on specific tasks being performed. These areas are organized hierarchically and interconnected, spanning from fundamental sensory and perceptual processes to higher-order executive functions and cognitive control (Harvey, 2019). Cognitive functions are critical to the daily lives of individuals and represent the fundamental mental capabilities required to perform various activities of daily living. These capabilities encompass attention, memory, learning, perceptual motor skills, executive functioning, and language (Bufano et al., 2024). Various elements can adversely affect cognitive abilities, including prolonged stress exposure, which can lead to neuronal loss, particularly in the hippocampus. This condition is influenced by elevated glucocorticoid levels, which lead to cognitive difficulties (McEwen & Sapolsky, 1995).

Different approaches, such as medication, behavioral modification, and biofeedback methods, are available to enhance cognitive function in neurodevelopmental disorders (MacIntosh et al., 2017; Valaei Sharif & Ghasemzadeh, 2024). Technology-driven interventions in neuroscience clinics include a range of procedures, such as biofeedback, virtual reality, and neurofeedback, which can be identified as leading non-invasive tools for regulating brain functions (Marzbani et al., 2016). Neurofeedback Treatment is a widely used treatment, especially for ADHD (Kouijzer et al., 2013; Krynauw & Pedro, 2018). NFT entails providing patients with feedback about their brain function through visual or auditory signals, allowing them to gain control over their brain activity and adjust it to achieve specific goals (Sherlin et al., 2011). In addition, research on the impact of NFT on individuals diagnosed with ASD indicates that improvements in social interactions and electrophysiological responses have been observed in multiple studies (Lofthouse et al., 2012). Several studies have also reported positive effects of neurofeedback on SLD. These improvements include improvements in learning (Fernández et al., 2016; Fernández et al., 2007), improvements in cognition (main article itself), improvements in reading skills (Jacobs, 2006), and specifically English reading (Thornton & Carmody, 2005). A critical review of the neurofeedback literature in Iran demonstrates several important methodological limitations. First, a strong imbalance was observed in the research landscape, as most studies have focused on ADHD in relation to neurofeedback compared to other neurodevelopmental disorders. This is evidenced by the number of systematic reviews dedicated specifically to this disorder (Rahmani et al., 2022). Moreover, many primary studies conducted in Iran are burdened by methodological deficiencies. Issues identified from reviews covering the body of work include incomplete data reporting, such as participant demographics, neurofeedback protocols, and session parameters (Rahmani et al., 2022). This lack of detailed reporting is a crucial limitation of replication efforts and meta-analyses. Third, review studies related to the Iranian context are often limited by the small number of high-quality studies that can be included, which can impact the reliability and generalizability of their findings (Salehinejad et al., 2019).

Therefore, our goal in this review was to identify opportunities and challenges in this area by reviewing studies conducted in Iran. Also, almost all of the systematic review studies conducted

have focused on only one or two areas of these disorders (ADHD, SLD, and ASD) (Alkhawaldeh & Saleem Khasawneh, 2023; Patil et al., 2022; Zhong et al., 2025) although these three disorders have many commonalities that necessitate the need to examine them together (Goharrizi et al., 2024; Himmelmeier & Werheid, 2024; Nooripour et al., 2024; Rezaee et al., 2025; Westwood et al., 2025). In this study, we aimed to cover all of the above elements and take a more holistic view of the effects of neurofeedback intervention by focusing on three disorders: ADHD, SLD, and ASD. Our primary objective was to assess and summarize studies that investigated the effects of neurofeedback on these conditions, highlighting important aspects such as demographic factors (including age and sex), study design (such as participant numbers, protocols utilized, total sessions, and length of each session), research environment, and benefits of neurofeedback. Regarding specific objectives, the following can be mentioned: (a) Identify the types of neurofeedback and protocols used for cognitive assessment and rehabilitation. (b) Identify the challenges and barriers to the use of neurofeedback in Iran. (c) Identify knowledge gaps in this area. (d) Prepare a basis for future research. We examined studies from the past decade to obtain a more comprehensive and contemporary understanding of this subject, then discussed the main findings, limitations, and recommendations of each study to emphasize future research requirements and the potential challenges in this field.

2. Materials and Methods

This systematic review evaluated the role of neurofeedback in the diagnosis and rehabilitation of cognitive disorders in Iranian children and adolescents with neurodevelopmental conditions. A systematic search of academic databases was conducted to collect scholarly articles and peer-reviewed journals. The major databases searched were Magiran, Noormags, SID, Irandoc, and Ensani. The search strategy was developed using the PICO framework (Population: Iranian children and adolescents with neurodevelopmental conditions including ADHD, SLD, ASD; intervention: neurofeedback; comparison: none or standard care; outcome: cognitive assessment or rehabilitation outcomes) (Paglialunga & Melogno, 2025; Schardt et al., 2007). The keywords included neurofeedback, cognitive assessment, cognitive rehabilitation, cognitive impairment, neurodevelopmental disorders, children, Iran, ADHD, ASD, and SLD. These terms were combined using Boolean operators (AND, OR) to ensure comprehensive and accurate search results. The reference lists of the included studies were manually searched to identify additional relevant studies. The review protocol was developed according to the PRISMA 2020 guidelines (Page et al., 2021). This systematic review adhered to the PRISMA checklist for the complete and transparent reporting of systematic reviews. Study selection, data extraction, and quality assessment were performed independently by two reviewers, and discrepancies were resolved through discussions. Articles were screened by removing duplicates, reviewing abstracts, and assessing full texts for eligibility. The selected studies were coded for systematic data extraction purposes.

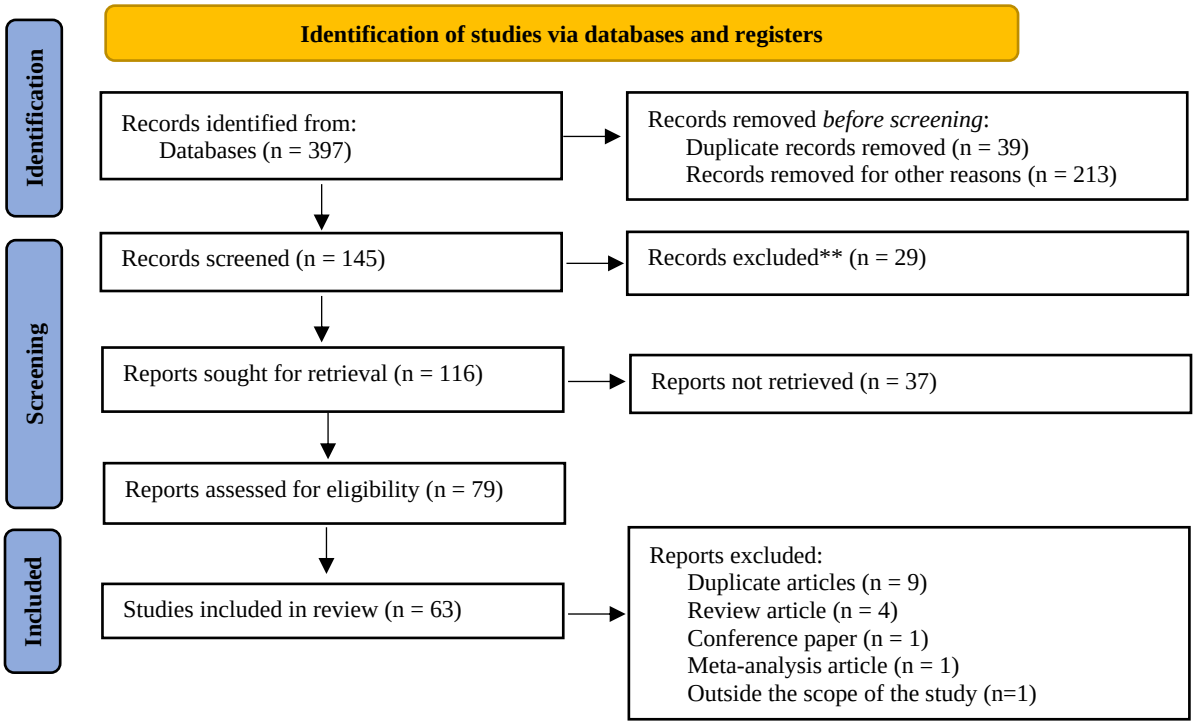

Figure 1. *PRISMA Flow Diagram of Study Selection Process*

Inclusion/Exclusion Criteria: The inclusion criteria were quantitative studies published between 2015 and 2025, focusing on children and adolescents (under 18 years, boys and girls) with cognitive disorders (e.g., ADHD, ASD, or SLD) in Iran, using neurofeedback in cognitive assessment or rehabilitation, published in Persian or English in peer-reviewed journals. Studies should provide clear details on hypothesis formulation, sampling methods, valid assessment tools, and statistical analysis. The exclusion criteria were theoretical studies, reviews, case reports, editorials, or studies not meeting the inclusion criteria; irrelevant samples (e.g., individuals over 60 years); low-quality studies (e.g., lacking valid or reliable assessment tools); and unpublished studies or gray literature. The quality of the selected studies was systematically appraised based on seven criteria adapted from the Newcastle-Ottawa Scale: (1) scientific reliability and source, (2) research design, (3) clarity in outcomes and discussion, (4) topical appropriateness, (5) reliability and validity, (6) transparency and ethics, and (7) quality of references.

Data Gathering: All compiled data were coded and organized in a tabular format to facilitate easy comparison and examination, enabling the identification of trends. Data, including study characteristics, methodology, and outcomes, were systematically extracted and categorized based on the predefined themes. The collected data were subjected to qualitative and descriptive analyses to provide an in-depth understanding of the application and evaluation of neurofeedback in cognitive rehabilitation. Sensitivity analyses were conducted to assess the robustness of the findings by excluding low-quality studies from the analysis. Potential publication bias was considered by searching Iranian databases to minimize language bias. The

results were synthesized based on three themes: types of neurofeedback technology, intervention effectiveness, and barriers to implementation. This thematic structure allows for structured reporting and analysis of factors related to neurofeedback.

3. Result

In this study, 63 articles were reviewed regarding the effect of neurofeedback on ADHD, SLD, and ASD. Of these, 38 dealt with ADHD, 20 with SLD, and five with ASD. The findings were analyzed at two levels: quantitative and qualitative analysis. At the first level, comprehensive descriptive information was extracted to summarize the study's characteristics and enable systematic comparison. At the second level, a qualitative synthesis was conducted to explore key findings, limitations, and recommendations for future research.

Section One

To provide a comprehensive overview of the research landscape, we extracted detailed descriptive information from the 63 included studies and organized it into a table for disorders (ADHD, SLD, and ASD) (Appendix Table 1). This table summarized study characteristics, intervention protocols, and methodological context. The data from this table were used for a systematic analysis to identify trends and patterns in Iranian neurofeedback research.

Participant Characteristics: Several studies have been conducted on rehabilitation, not assessment. The total **number of participants** in these 63 articles was 2042 (ADHD: 1348, SLD: 560, and ASD: 134). The **average age** of the participants in the studies, broken down by the disorders studied, is as follows: ADHD: 9.64 years (eight out of 38 studies did not state the age of the participants, generally between 6 to 18 years old, with the highest frequency being in the age range of 7 to 12 years old), SLD: 9.73 years (four out of 20 studies did not state the age of the participants, generally ranging from 7 to 16 years old, with the highest frequency being for the age range of 7 to 12 years old), and ASD: 8.8 years (the age of the participants was stated in all five studies, generally between the ages of 6 and 12, with the highest frequency being in the age range of 7 to 12). One of the limitations in calculating the average age of the participants was the lack of transparency in the age distribution of the participants, as most studies did not state specific data on this matter, and only the age range was stated in general terms.

Setting, Research Design, Assessment Tools: Most of these studies were conducted in clinical **settings**, although educational (including schools) and community settings were also observed, but accounted for a smaller share of the studies. Most studies in this area use single-group quasi-experimental and experimental designs for their **research design** (ADHD: 62% of studies, SLD: 45% of studies, and ASD: 80% of studies). In addition, the **assessment tools** used in the studies included neuropsychological and cognitive assessment tools (e.g. Rosvold's Continuous Performance Test, N-Back Test, Wechsler Intelligence Scale for Children, Stroop Test, Wisconsin Card Sorting Test, Raven's Progressive Matrices and Goodenough-Harris Draw-a-Person Test), behavioral and emotional assessment tools (e.g. SNAP-IV, Child Behavior Checklist, Child Symptom Inventory-4, Behavior Rating Inventory of Executive Function and Yale-Brown

Obsessive-Compulsive Scale), academic and learning-specific assessment tools (e.g. Researcher-made Spelling Test, Reading test and checklist, Phonological test and Learning Disability Evaluation Scale), and visual-motor and visual-perceptual assessment tools (e.g. Bender Gestalt Test and the Frostig Visual Perception Test).

Neurofeedback Strengths: As seen in Figure 2, some of the reportedly most important advantages of neurofeedback were shown for all three groups. For ADHD, these were seen to primarily target core cognitive and neurological impairments, while other advantages, such as being non-invasive and engaging, were seen less often. In SLD, being non-invasive and safe was seen to be most prominent, followed by the possibility of directly targeting core impairments and fostering neuroplasticity. In the case of ASD, being complementary and targeted was seen as most frequent, followed by the facilitation of neuroplasticity and engaging delivery. While all three benefited from neurofeedback, there were some differences seen in the pattern of advantages depending on the disorder.

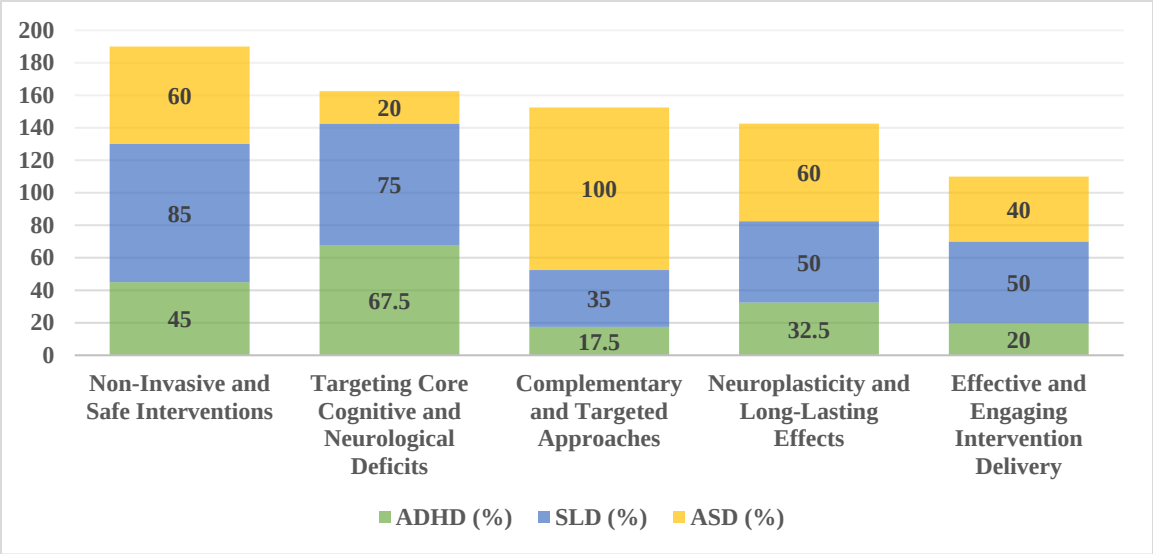

Figure 2. *Frequency distribution of items mentioned for the strengths of the neurofeedback intervention*

Neurofeedback Study Objectives and Outcomes: Analysis of the 63 included studies showed that the objectives primarily reflected what researchers intended to examine before implementing the neurofeedback intervention. These aims were distributed across several domains, most commonly involving cognitive functions in children with SLD, ADHD, and ASD, along with academic and learning goals particularly emphasized in SLD studies. Some studies focused on behavioral and emotional targets—especially within the ADHD and ASD groups—while others aimed to evaluate comparative or combined interventions (notably in SLD and ADHD). A smaller subset centered on neurophysiological mechanisms or sought to explore improvements in social functioning, particularly in ASD populations. In contrast, the outcomes reported in these studies represent the empirical variables used to evaluate the actual effects of neurofeedback. Across the literature, the intervention was assessed in nine major domains,

ranging from cognitive, behavioral, emotional, academic, and social outcomes to more specialized areas such as neurophysiological changes, perceptual–motor and sensory performance, daily functioning, and creativity. These outcome categories reflect the measurable effects examined post-intervention and are summarized numerically in Table 1 and illustrated in Figure 3.

Table 1. *Study Objectives and Neurofeedback Outcomes by Diagnostic Group*

	Category / Outcome	ADHD (%)	SLD (%)	ASD (%)
Objectives	Cognitive Functions	32	21	33
	Academic & Learning Outcomes	-	33	-
	Behavioral Outcomes	23	-	-
	Emotional Outcomes	23	-	33
	Comparative & Combined Interventions	26	21	-
	Neurophysiological Outcomes	-	-	33
	Social Functions	-	-	22
Outcomes / Effects	Cognitive Outcomes	32	41.6	40
	Behavioral Outcomes	47	7.6	20
	Emotional Outcomes	47	7.6	20
	Academic & Learning Outcomes	4	30	-
	Social Outcomes	-	7.6	40
	Neurophysiological Outcomes	6	3.8	60
	Perceptual-Motor & Sensory Outcomes	4	15	-
	Daily Functioning Outcomes	-	-	20
	Creativity Outcomes	2	-	-

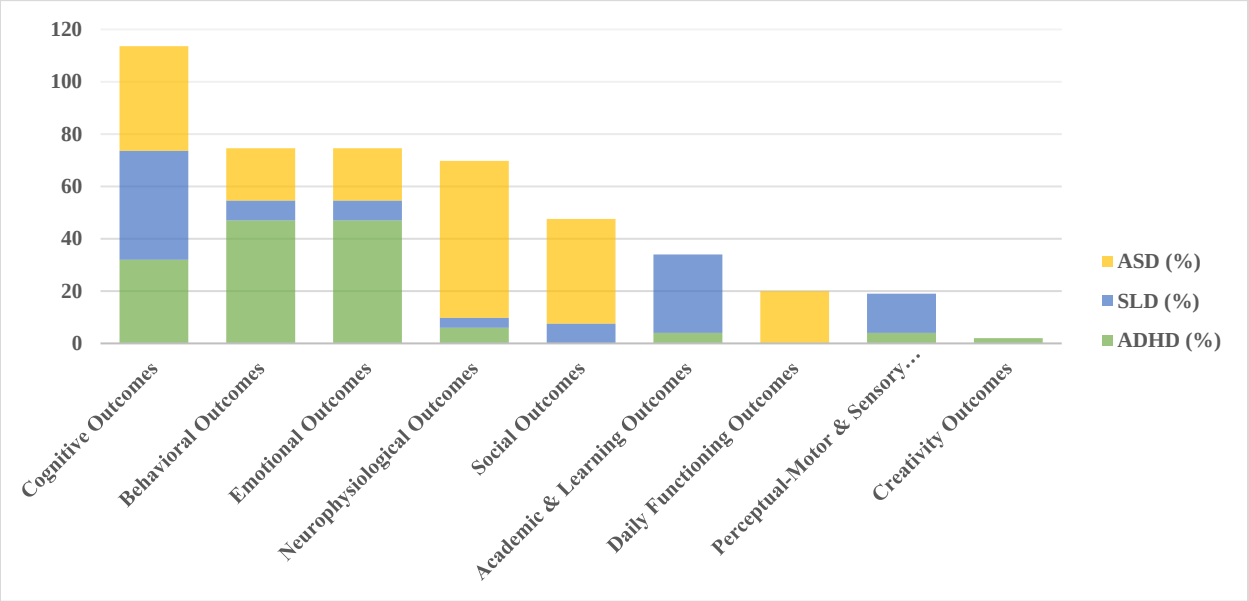

Figure 3. *Areas affected by neurofeedback therapy*

Neurofeedback Program Details: The protocols used in studies investigating the effectiveness of neurofeedback can be categorized into five general groups: Theta/Beta Ratio Reduction (SLD, ADHD), SMR Enhancement (SLD, ADHD), Alpha-related Protocols (SLD, ADHD, ASD), Specific Wave Suppression/Modulation (SLD, ADHD, ASD), and General or Symptom-Based Protocols (ASD). In addition, neurofeedback interventions were performed 2 to 3 times a week in most studies, and the number of sessions by disorder was as follows: ADHD: average 26.52 sessions (between 10 and 50 sessions), SLD: average 20.15 sessions (between 10 and 30 sessions), and ASD: average 20.25 sessions (between 15 and 30 sessions). The duration of the sessions was as follows: ADHD: average 44 minutes (between 30 and 60 minutes), SLD: average 39.85 minutes (between 30 and 50 minutes), and ASD: average 50.62 minutes (between 45 and 60 minutes).

Section 2

Following the descriptive analysis, a qualitative synthesis was performed to deepen the understanding of neurofeedback applications in Iranian children and adolescents with these disorders. This synthesis focused on evaluating the effectiveness of interventions, identifying reported limitations of the studies, and proposing recommendations for future research to address gaps in the current literature. The findings of this analysis provide insights into the practical and scientific implications of neurofeedback in Iran's context.

A. Key Findings

The key findings of this systematic review demonstrated that neurofeedback, both as a standalone intervention and in combination with complementary therapeutic modalities,

produced positive, evidence-based treatment effects across cognitive, academic, neurophysiological, and behavioral domains of functioning in neurodiverse Iranian children and adolescents diagnosed with ADHD, SLD, or ASD. This qualitative synthesis summarizes the dominant treatment outcomes for neurofeedback and integrated approaches, reflecting neuroplasticity effects consistent with previous studies, while also identifying opportunities for future investigation into the therapeutic application of neurofeedback. A schematic overview of these key findings is presented in Figure 4.

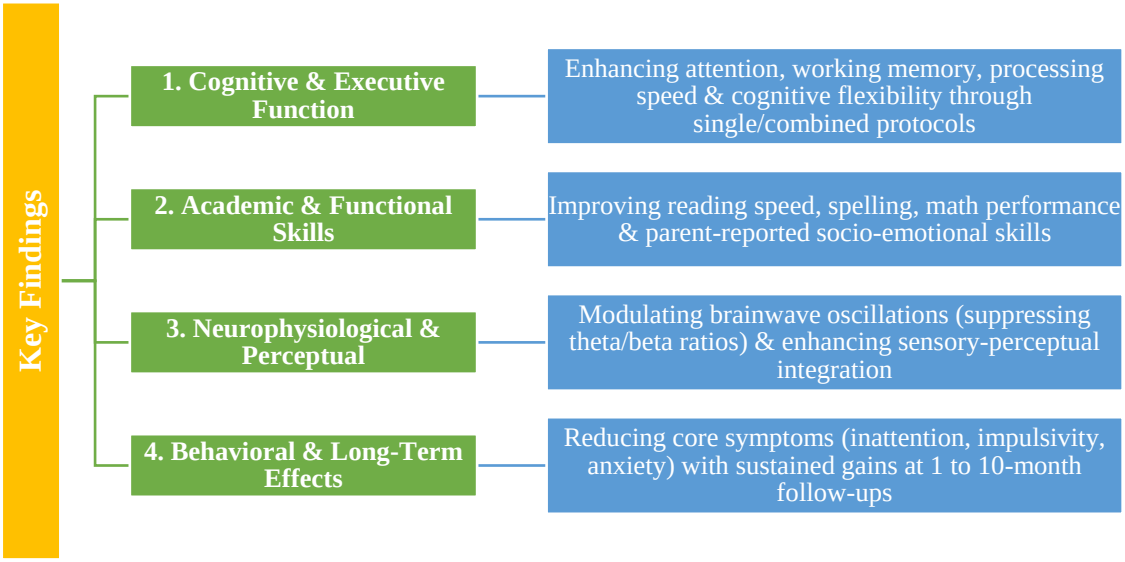

Figure 4. *Key findings from the literature reviews*

1. Cognitive and Executive Function Improvements: Neurofeedback, often combined with other interventions, significantly enhances cognitive and executive functions. Documented improvements include active memory, perceptual reasoning, and verbal comprehension (61)[1], phonological awareness, working memory (35), numerical reasoning, concentration (30), behavioral regulation, metacognition, and intelligence scores (37, 41). In studies that included a sham/control group, neurofeedback demonstrated superiority in attention, inhibition, and intelligence compared to sham/controls (29, 37), while combined approaches broadened executive gains (33, 41). However, no significant superiority was found for neurofeedback, cognitive rehabilitation, or play therapy over controls in working memory or emotional control, with equivalent effectiveness across these modalities (27, 41, 42). Additionally, one study examining ADHD subtypes reported no notable differences in cognitive improvement between subtypes (3). Regarding intervention formats, combined approaches (e.g., neurofeedback with cognitive rehabilitation, tDCS, or cognitive games) consistently outperformed single interventions, yielding broader gains in cognitive mastery, processing speed, and various attention subtypes, including general, selective, focused, and divided auditory/visual attention

[1] These numbers present each article index number.

(33, 34, 48, 50, 52, 57, 59). Neurofeedback alone also enhanced visual attention (consistency, vigilance, focus), cognitive creativity, and attention types, with game-based formats showing additional benefits (11, 21, 25, 52, 56, 63). Specific cognitive benefits extended to joint attention in high-functioning boys with sustained effects at 1- and 2-month follow-ups (44), as well as perceptual reasoning, verbal comprehension, phonological awareness, numerical reasoning, and perceptual age in spatial relationships (30, 35, 46, 61). In contrast, applied behavioral analysis (ABA) outperformed neurofeedback in certain cognitive skill gains (47). Across the reviewed studies, neurofeedback interventions—particularly when combined with complementary modalities—consistently improved core cognitive and executive functions (Figure 4). Key enhancements encompassed sustained attention and concentration (1, 8, 10, 11, 15, 21, 22, 25, 47, 57, 59), working memory (35, 48, 50, 57, 59), cognitive flexibility and processing (3, 30, 52), inhibition and emotional control (7, 22, 29, 33), planning, organization, and monitoring (22, 34, 41, 59), as well as overall executive functions and intelligence scores (29, 30, 37, 41).

2. Academic and Functional Skill Improvements: Interventions significantly enhanced academic and functional skills across SLD, ADHD, and ASD. Key academic improvements included reading speed, writing (spelling/dictation), mathematics skills, math exam scores, numerical calculation, memory, academic achievement, and overall reading, writing, and mathematics performance (29, 35, 38, 43, 53, 60, 61, 62). However, two studies found no significant effect on reading accuracy or its components, such as testing issue marks and naming images, with the authors suggesting that more than 15 sessions may be required to achieve accuracy improvements due to the complexity of reading tasks (26, 29). In direct comparison, the Davis method outperformed neurofeedback in word reading, word chains, reading comprehension, and fluency (43). Regarding intervention formats, combined interventions (e.g., neurofeedback with other modalities) yielded greater and more sustained academic gains compared to single-modality approaches (60). Beyond academic outcomes, neurofeedback and combined approaches also demonstrated strengths in improving social functioning, social intelligence, cognitive empathy, socioemotional skills (including perspective-taking and positive reappraisal), emotional creativity, verbal communication, environmental attention, independence, and social interaction, as reported by parent reports (2, 46, 55, 63). In terms of daily living activities, both neurofeedback and ABA interventions improved performance compared to control groups, although ABA exhibited superior effectiveness in this specific domain (47).

3. Neurophysiological and Perceptual Improvements: Interventions effectively target neurophysiological and perceptual processes across SLD, ADHD, and ASD, with key enhancements encompassing brainwave modulation, sensory-perceptual integration, and visual-motor perception (5, 12, 16, 20, 27, 32, 40, 44, 46). Regarding brainwave patterns, neurofeedback modulates neural oscillations through various protocols: some approaches increase alpha/theta rhythms while suppressing beta waves in the parietal cortex (61), whereas others increase beta and decrease theta activity to enhance focus (28). More broadly, neurofeedback decreases theta, theta/beta, and theta/alpha ratios while increasing beta, sensorimotor rhythm (SMR), or alpha activity (5, 12, 16, 20), with game-based formats similarly reducing theta/beta ratios (56). Mu-rhythm neurofeedback specifically increased alpha while decreasing theta and beta in high-functioning boys (44), although general neurofeedback protocols have shown reductions in delta, theta, alpha, beta, and SMR/theta ratios, with changes not always reaching statistical significance

due to individual variability (46). In the domain of perceptual skills, visual-motor perception improved significantly in SLD and dyslexia, encompassing overall visual perception, eye-motor coordination, figure-ground discrimination, shape constancy, spatial position, and spatial relations in math disabilities, as measured by the Bender-Gestalt and Frostig Developmental Tests (36). Cognitive rehabilitation, neurofeedback, and cognitive-behavioral play therapy all enhanced visual-motor perception compared to control groups, with no significant differences in effectiveness among these modalities (40). Additionally, SPARK and neurofeedback interventions enhanced sensory integration across tactile, vestibular, and proprioceptive domains (19), while combined neurofeedback with cognitive games improved cognitive flexibility and selective attention, as measured by the Wisconsin Card Sorting Test and Stroop Test (52).

4. Behavioral and Long-term Intervention Effects: Interventions significantly reduced core symptoms and yielded sustained behavioral improvements across SLD, ADHD, and ASD, with effects persisting for 1 to 10 months at follow-up assessments (1, 2, 4-7, 9, 10, 13, 14, 16-18, 20, 22, 24, 25, 35, 41, 44-46, 48-51, 55, 58-60, 62, 63). The durability of improvements varied across intervention protocols: combined interventions (62) and cognitive rehabilitation with neurofeedback (41) sustained cognitive and executive gains at two-month follow-ups, while genuine neurofeedback-maintained improvements in intelligence and attention for up to 10 months (37). In comparative analyses, neurofeedback excelled in cognitive functions, whereas Pariad exercises demonstrated superiority in visual-motor coordination and parent-child relationships (33). Additionally, one study (39) provided only a field description within Clinical Psychology, Neuropsychology, and Special Education contexts. Regarding intervention efficacy, combined approaches consistently outperformed single interventions in reducing inattention, impulsivity, and overall symptom severity, with sustained benefits over time (49, 50, 54, 58-60). Neurofeedback surpassed pharmacotherapy in improving attention and executive functions, although pharmacotherapy showed better outcomes for cognitive slowness (7, 22). In some comparisons, yoga and SPARK interventions occasionally exceeded neurofeedback in symptom reduction and sensory integration outcomes. Beyond symptom reduction, interventions promoted emotional regulation, emotional processing, and neuroplasticity across multiple studies (5, 6, 10, 17-19, 22). Specifically, SPARK, neurofeedback, and their combination decreased salivary cortisol levels, with the combined approach showing the greatest reduction, followed by neurofeedback and then SPARK (43). Sustained joint attention and long-term cognitive effects further indicated lasting neuroplastic changes (44-46). In terms of behavioral symptom reduction, interventions led to decreases in aggression (verbal, relational, and physical), anxiety, conduct problems, thought problems, obsessive-compulsive symptoms, and both internalizing and externalizing behaviors (3, 4, 6, 7, 9, 12-14, 16, 20-22, 24, 26-28). Neurofeedback specifically reduced anxiety and emotional/behavioral symptoms as measured by the CSI-4, while also improving behavioral regulation according to the Conners' Rating Scale (45, 46).

B. Limitations

Although the findings of this systematic review provide valuable insights into the effectiveness of neurofeedback, several methodological and contextual limitations must be considered when interpreting the results. First, the quality and rigor of the included studies were suboptimal, characterized by weak control group designs, lack of randomization, and insufficient blinding,

which may introduce bias and limit causal inference. Second, while most studies assessed short-term outcomes, the scarcity of long-term prospective data restricts our understanding of the durability and sustainability of intervention effects over extended periods. Third, regarding generalizability, the specific characteristics of the study populations—primarily Iranian children and adolescents with distinct sociocultural and economic backgrounds—may limit the applicability of findings to other neurodiverse populations in different settings. Fourth, considerable heterogeneity in neurofeedback protocols and the integration of complementary approaches complicates direct comparisons across studies and raises questions about the most appropriate treatment modalities. A comprehensive overview of these limitations is presented in Figure 5.

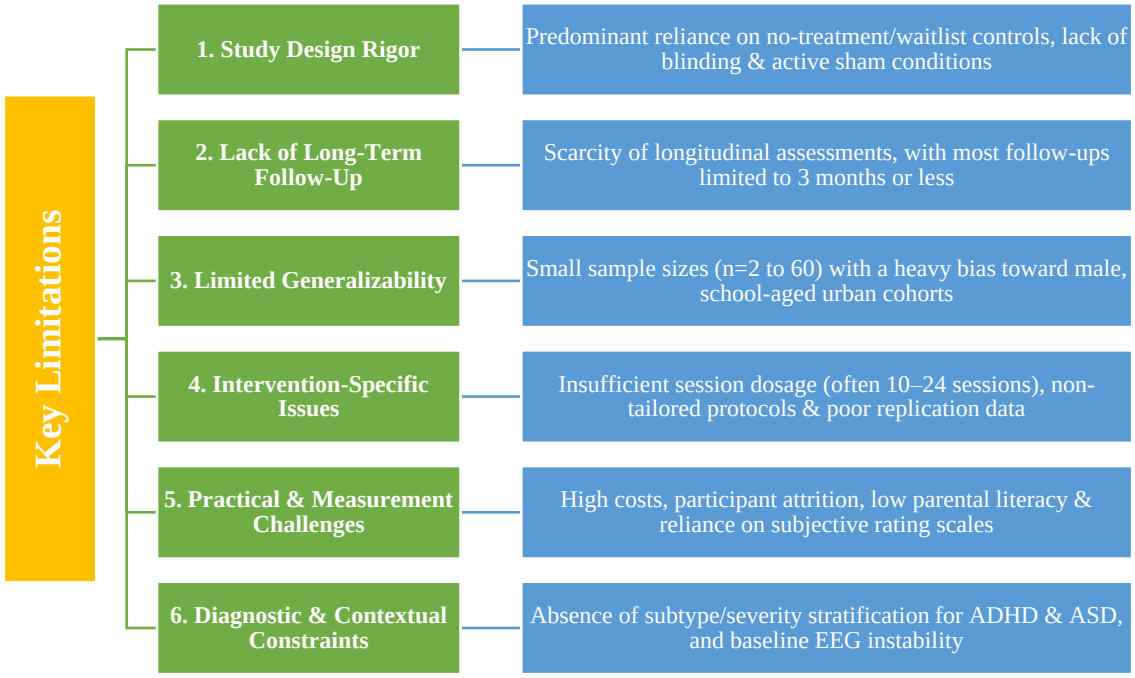

Figure 5. *Key limitations in the reviewed literature*

1. Insufficient Study Design Rigor: A significant limitation across neurofeedback studies in Iranian children and adolescents with neurodevelopmental conditions including SLD, ADHD, and ASD is the insufficient rigor of study designs. The predominant reliance on no-treatment or waitlist control groups, without incorporating sham/placebo conditions, fails to isolate specific neurofeedback effects from non-specific factors such as placebo effects, therapeutic attention, novelty, participant expectations, and natural maturation (1-4, 6, 12, 16-18, 26, 28, 30, 36, 44, 48, 50-52, 59, 60, 63). Furthermore, the use of weak single-subject designs (e.g., AB or ABAB) or quasi-experimental designs without separate control groups cannot adequately rule out practice effects or researcher-related biases (28, 41, 61). Another critical methodological concern is the absence of blinding procedures. The lack of assessor blinding introduces potential detection bias (37), while the absence of blinding for participants, clinicians, or parent raters' risks both expectation bias and assessor bias (7, 12, 63). Additionally, the lack of active control groups (e.g.,

comparison with medication or other established interventions) and the absence of detailed, standardized protocols limit the specificity of findings and reduce replicability across studies (3, 7, 16-18, 56, 59, 60). Finally, unclear descriptions of alternative activities provided to control groups complicated the accurate attribution of outcomes to the neurofeedback interventions themselves (44).

2. Lack of Long-Term Follow-Up: A major methodological limitation across the reviewed studies is the lack of adequate long-term follow-up assessments, which substantially restricts the ability to evaluate the durability of cognitive, academic, behavioral, and neurophysiological improvements following interventions (64). The predominant reliance on immediate post-intervention assessments leaves critical questions unanswered regarding the sustained impact on key outcomes such as reading speed, attention, visual-motor skills, and other cognitive gains (26, 27, 30, 32, 36, 41, 61). Furthermore, when follow-ups were conducted, they were typically short in duration (≤3 months), which is insufficient to confirm the longevity of neuroplastic changes or the persistence of intervention effects (24, 31, 63). Consequently, the absence of extended longitudinal data prevents definitive conclusions regarding the long-term persistence of joint attention improvements, sustained emotional regulation, or enduring changes in stress biomarkers such as cortisol levels (44, 45, 62).

3. Limited Generalizability Due to Sample Characteristics: The generalizability of findings across the reviewed studies is significantly constrained by several sample-related limitations. First, sample sizes were consistently small, ranging from 2 to 60 participants, which reduces statistical power and increases the risk of bias (1, 3, 4, 8-10, 12, 16-26, 30, 36-38, 40-43, 45, 46, 48, 50-52, 54-61, 63). Additionally, the use of non-random or convenience sampling methods, combined with recruitment restricted to limited geographic regions (primarily cities such as Tehran, Isfahan, Ardabil, and others), further compromises the representativeness of the samples and restricts the applicability of results to broader populations. A particularly notable demographic limitation is the predominant focus on male elementary school students, which systematically excludes females, older age groups, and other developmental stages (28, 32, 37, 40). The inclusion criteria heavily favored males aged 7 to 12 years, thereby limiting the relevance of findings to females, adolescents, adults, or individuals with comorbid conditions (1, 2, 4, 17, 22, 24, 25, 51, 56). In several studies, the samples were further restricted to small groups of high-functioning males (ranging from 5 to 15 participants) recruited from specific regions, which severely limits the applicability of results to females, other age groups, or individuals with lower levels of functioning (44, 47).

4. Intervention-Specific Limitations: Several intervention-specific limitations across the reviewed studies impair replicability and clinical utility, including insufficient dosage, partial efficacy, non-tailored protocols, and poor documentation (9, 10, 26, 30, 36, 42, 45, 52, 54, 56, 59, 62). Regarding dosage inadequacy, protocols with only 15 sessions failed to improve complex skills such as reading accuracy (26), while the typical range of 10 to 24 sessions was often insufficient for achieving meaningful improvements in impulsivity and cognitive flexibility (9, 10, 52, 54, 56, 59). When interventions required resource-heavy combinations—such as 24 sessions delivered three times per week—feasibility concerns arose, particularly in real-world clinical settings (48). In terms of outcome specificity, several studies reported only subscale-level gains

without addressing higher-order cognitive functions (30), and the use of generic tools such as San Smart or play therapy limited the targeted impact of interventions (36, 42). Furthermore, a narrow outcome focus—for example, concentrating exclusively on cognitive mastery—resulted in the neglect of broader symptom domains (50). Protocol-related issues also complicated interpretation: unequal session numbers across groups and excessive protocol complexity confounded results and made comparisons difficult (42, 62). Finally, the absence of clearly specified session counts and frequencies in some studies prevented accurate replication and hindered the clarification of optimal dosage parameters (63).

5. Practical and Measurement Challenges: Several practical and measurement challenges across the reviewed studies undermine both the validity and feasibility of findings. Key practical challenges include high costs, extensive time requirements, and substantial personnel needs, which collectively limit the scalability of interventions in real-world settings (34). Additionally, participant dropout was identified as a significant concern, as it may introduce bias and skew outcome interpretations (32, 58, 59, 63). The burden of lengthy protocols—such as those requiring up to 50 sessions—further hinders adoption and participant adherence (9). Moreover, variable environmental conditions and unequal session numbers across participants added noise to the data and complicated between-group comparisons (20, 51). Low parental literacy and limited child endurance were also reported as barriers to adherence, particularly in demanding protocols (20). In terms of measurement limitations, the use of subjective or overly narrow assessment tools compromised the comprehensiveness of findings. For instance, relying solely on single reading measures or the BRIEF (Behavior Rating Inventory of Executive Function) failed to capture broader cognitive and behavioral gains beyond the targeted domains (41, 43). Similarly, the Goodenough-Harris Drawing Test likely underestimated social cognition improvements, as it may not be sensitive to subtle socioemotional changes (46). Furthermore, the wide variability in participant responses complicated statistical analyses and reduced the reliability of between-group comparisons (46). The prolonged duration of some studies introduced additional risks, including participant fatigue and loss of assessment accuracy over time (47). Finally, uncontrolled confounding variables—such as prior treatment history and family-related factors—further compromised the internal validity of several studies (2, 4, 8, 11, 14, 15, 18, 19, 21-23, 32, 39-41, 43, 52, 54, 57-59, 63).

6. Diagnostic and Contextual Limitations: No uniform diagnostic or contextual limitations were observed across all three diagnostic groups (SLD, ADHD, and ASD). However, critical constraints were identified specifically in studies involving ADHD and ASD, while no explicit limitations of this nature were reported for SLD studies. For ADHD and ASD samples, several diagnostic and contextual issues compromised the validity and interpretability of findings. First, prior contradictory evidence—such as the findings reported by Arnold et al.—highlights the presence of inconsistent results within the literature (1). Second, the use of weak or non-standardized diagnostic systems undermined the accuracy of participant classification and reduced the reliability of group comparisons (55). Third, several studies failed to control for critical physiological and environmental confounders, including nutrition, sleep patterns, and physiological states, which may influence neurofeedback outcomes (14, 15). Additionally, unmanaged novelty bias—whereby participants respond differently due to the novelty of the intervention rather than its specific effects—was noted as a potential confound (11, 17). Another

significant limitation was the lack of subtype differentiation, which prevented the identification of differential responses among distinct clinical subgroups (18). Furthermore, baseline EEG instability, attributed to factors such as participant fatigue or electrode location variability, introduced measurement noise and reduced the reliability of neurophysiological assessments (56). In terms of outcome interpretation, high inter-individual variability across participants led to non-significant changes in brainwave patterns and intelligence scores, complicating the detection of true intervention effects (46). Finally, the absence of subtype or severity stratification in sample analyses obscured the identification of differential responsiveness to interventions, limiting the clinical utility of findings (46).

C. Recommendations

Based on the evidence synthesized in this systematic review, the following strategic recommendations are proposed to guide future clinical application and scientific validation of neurofeedback approaches for neurodiverse individuals. First, future research should prioritize improving study design rigor by implementing high-quality randomized controlled trials (RCTs) that incorporate rigorous blinding strategies and active control groups. Second, long-term follow-up studies with appropriate temporal windows are essential to capture the sustainability of neuroplastic effects over extended periods. Third, expanding sample diversity through multi-center approaches and including participants from varied socioeconomic backgrounds will enhance external validity and generalizability. Fourth, investigating the additive or synergistic effects of combining neurofeedback with other therapeutic modalities—under appropriate controlled conditions—is critical for identifying optimal treatment protocols. Finally, continued refinement of measurement and intervention protocols is necessary to ensure accuracy, reproducibility, and clinical utility. A summary of these recommendations is presented in Figure 6.

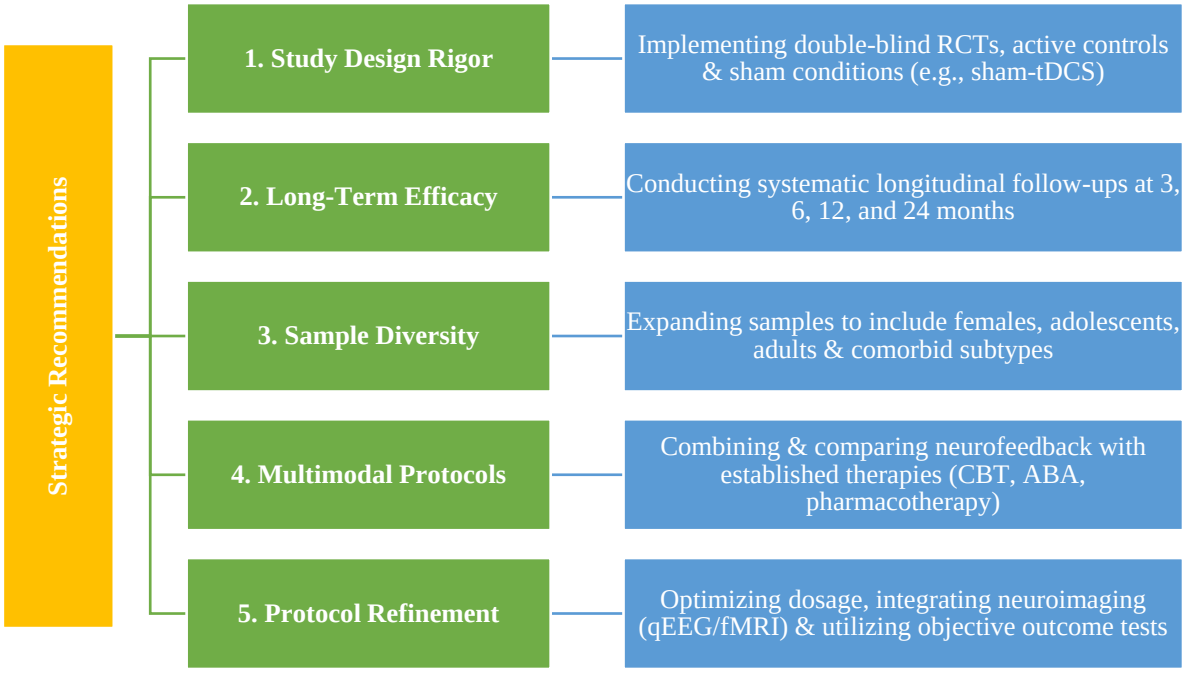

Figure 6. *Recommendations based on the reviewed literature*

1. Enhancing Study Design Rigor: Future neurofeedback research should prioritize rigorous methodological frameworks to strengthen causal inference and enhance clinical validity. First, randomized controlled trials (RCTs) incorporating sham neurofeedback or combined sham conditions (e.g., sham-tDCS combined with sham-neurofeedback) are essential to isolate specific treatment effects from non-specific influences such as placebo, therapeutic attention, novelty, and participant expectations (1, 2, 4, 6, 9, 26, 28, 32, 36, 38, 44, 50-52, 61, 63). Replicating findings in larger RCTs with adequate sample sizes will improve statistical power and enhance the generalizability of results to broader populations (8, 17, 18, 22, 23, 46, 57, 58, 60, 61). Additionally, incorporating multiple control arms—such as sham-tDCS combined with sham-neurofeedback, neurofeedback-only, and tDCS-only—alongside multiple baseline designs across participants, settings, or behaviors in single-case studies, will further strengthen causal inference (28, 61). To enhance validity and reduce bias, experimental designs should employ random sampling methods and include active control groups (e.g., pharmacotherapy or other established interventions), which will bolster both clinical relevance and external validity (8, 17, 18, 23, 24, 41, 57, 58, 60). Blinded evaluators—including teachers and clinicians—should be utilized to minimize rater bias and ensure more objective outcome assessments (7). Furthermore, expanding control group sizes and integrating sham neurofeedback conditions within RCTs will improve the robustness of effect isolation and increase the reliability of between-group comparisons (46).

2. Assessing Long-Term Effects: Future neurofeedback studies should incorporate systematic long term follow up assessments to evaluate the durability of cognitive, behavioral, academic, and neurophysiological gains, thereby establishing clinical utility and informing sustainable treatment protocols. To this end, follow ups at 3-, 6-, 12-, and 24-months post intervention are recommended, with extension to at least one year considered essential for determining the persistence of improvements in reading speed, spelling, dictation, visual perception, and executive functions—particularly when combined neurofeedback and cognitive training approaches are employed (1, 2, 6, 7, 9, 16, 17, 19-22, 26-28, 30, 32, 36, 39, 40, 42, 45, 46, 48, 50-53, 55, 57-61). Longitudinal designs with extended follow up periods are needed to confirm sustained benefits in attention, cognitive flexibility, behavioral regulation, and academic performance across both neurofeedback and multimodal intervention protocols (1, 2, 6, 7, 9, 16, 17, 19-22, 48, 50-53, 55, 57-60). Furthermore, follow up assessments at 6, 12, and 24 months are particularly critical to assess the persistence of improvements in joint attention, emotional regulation, social functioning, and stress biomarkers, providing essential evidence of long-term neuroplasticity (45, 46).

3. Expanding Sample Diversity and Generalizability: Future neurofeedback research should prioritize larger and more diverse samples to enhance statistical power and improve the generalizability of findings. Samples should include both male and female participants across a wide range of age groups, neurodevelopmental subtypes, functioning levels, and socioeconomic and geographic regions (1, 2, 8, 9, 16-25, 28, 32, 34, 36-43, 45, 46, 50-52, 54-61, 63). Specifically, inclusion criteria should be extended to individuals with dyscalculia, those with comorbid ADHD, and even non-clinical populations, using larger samples to improve applicability across clinical boundaries and diverse educational contexts (34, 38, 41-43, 61). A critical priority is moving beyond the predominant focus on male, school aged, high functioning, and urban samples.

Future studies should actively include adolescents, adults, all clinical subtypes, and participants from rural or underserved communities. Such expansion will substantially strengthen the external validity and clinical relevance of neurofeedback protocols across broader populations (1, 2, 8, 9, 16-25, 44, 50-52, 54-60, 63).

4. Combining and Comparing Interventions: Future neurofeedback research on Iranian children and adolescents with neurodevelopmental conditions including with SLD, ADHD, and ASD should systematically compare and combine interventions with established therapies to identify optimal synergistic protocols and clarify their relative efficacy (1, 2, 4, 7, 16, 20-22, 26, 29, 39, 41, 43, 44, 60). Combining neurofeedback with traditional reading interventions, play therapy, cognitive rehabilitation, or behavioral therapies may enhance outcomes in reading speed, accuracy, and co-occurring cognitive deficits. At the same time, direct comparative trials against pharmacotherapy or specialized educational methods are needed to establish clinical superiority and cost effectiveness (26, 29, 30, 38-41, 43). Head-to-head comparisons of neurofeedback with medication, cognitive behavioral therapy (CBT), parent management training, or verbal self-instruction should be prioritized. Additionally, multimodal combinations—such as neurofeedback with CBT, cognitive games, mindfulness, or SPARK—may uncover additive or synergistic benefits, with extension to other neurodevelopmental conditions further broadening clinical relevance (1, 2, 4, 6, 7, 9, 16, 19-25, 51, 58-60, 63). Combining neurofeedback with ABA or social skills training as complementary approaches, particularly within special education frameworks, holds promise for improving cognitive, social, and daily living skills. Comparative effectiveness studies against ABA alone are essential to guide evidence based, integrated treatment planning (44, 45, 47).

5. Improving Measurement and Intervention Protocols: Future neurofeedback research in Iranian children and adolescents with neurodevelopmental conditions including SLD, ADHD, and ASD should refine intervention protocols and measurement strategies through several complementary approaches. First, optimizing dosage, electrode placement, and brainwave targets—alongside incorporating multimodal neuroimaging (qEEG, fMRI) with standardized behavioral assessments—will establish mechanistic links and enhance outcome precision (2, 4, 7, 9, 10, 20, 21, 26, 32, 36, 37, 48, 50, 52, 54-56). Exploring higher dosages or alternative protocols (e.g., coherence training, alpha/theta, alpha-up) and varying electrode placements may improve efficacy in complex domains such as reading accuracy (26, 30, 36, 37, 39, 41-43, 62). Determining the optimal session frequency, duration, and neurofeedback parameters (e.g., frequency bands, game-based formats) is critical for maximizing cognitive and behavioral outcomes. To strengthen validity and applicability, researchers should employ multiple validated assessment tools, evaluate alternatives to San Smart software (e.g., n-back training), monitor home-based practice, and conduct replicated case studies with teacher training on working memory (26, 30, 36, 37, 39, 41-43, 62). Integrating neuroimaging (fMRI, qEEG) to elucidate neural mechanisms, supplementing self-reports with objective measures (e.g., CPT, teacher ratings, academic grades), and controlling confounders (nutrition, sleep, socioeconomic status) will yield more robust, generalizable findings. Additionally, ethical oversight and school-based sensory-motor programs will support feasible, scalable implementation (2, 4, 7, 9, 10, 16-21, 23, 48, 50, 52-58, 63). Furthermore, investigating targeted EEG protocols—such as Mu-rhythm or social cognition–relevant frequencies—and alternative electrode configurations may enhance neurofeedback

specificity. Using comprehensive intelligence batteries beyond the Goodenough-Harris test and stratifying by ASD subtype and severity will better capture individual cognitive and functional responses (44, 46).

4. Discussion

This study has reviewed 65 studies published over the last ten years on the effectiveness of Neurofeedback for treating children in Iran with ADHD, SLD, and ASD. The overall results indicate that regardless of whether Neurofeedback was administered alone or in combination with other types of therapy, children experienced consistent improvements across all four major areas: Cognitive and Executive Functioning (e.g., sustained attention, working memory, inhibition, flexibility); Academic Achievement (e.g., Reading Comprehension, Written Expression, Math Performance); Neurophysiological Indicators/Markers (e.g., Brainwave Modulation, Sensory Integration); Behavioral Regulation/Control (e.g., decreased impulsivity, aggression, emotional difficulties); and Improvements in Social and Functional Skills. All of the results were supported by observable brain activity changes and were organized into four major categories to demonstrate the therapeutic potential of Neurofeedback as well as the contextual factors that contribute to its efficacy in Iran.

1. Cognitive and Executive Function Improvements

Attention is one of the cognitive functions that has been shown to be improved, and neurofeedback in particular (often in combination with other interventions) can significantly improve sustained attention. This finding is consistent with other studies, where in one study the effect appeared to be a reduction in omission errors due to modulation of brain activity, such as a reduction in theta/beta ratio or an increase in frontal beta, which reduced inattention (Chiu et al., 2022). Neurofeedback also regulates the balance of attentional networks (top-down vs. bottom-up) and builds sustained attention in the general population (Krell et al., 2023). Neurofeedback leads to long-term potentiation (LTP) of vital executive networks, thereby improving top-down, activity-dependent cognitive control (Sitaram et al., 2017). It also improves working memory (94). This finding is consistent with other studies, where improvements in complex cognitive tasks (such as n-back and task switching) due to increased alpha power allow the brain to suppress distracting sensory information (inhibition) to maintain focus on memory (Jiang et al., 2022). Furthermore, changes in how the brain manages difficult tasks occur because neurofeedback training strengthens connections between different brain regions (especially in the theta band) (Nawaz et al., 2023). Improvements in cognitive flexibility are also consistent with other findings from a review of studies. In fact, neurofeedback increases cognitive flexibility by training self-regulation of brain activity, and sustained changes are maintained for up to a year as individuals learn to monitor and regulate their brain activity, leading to improvements in related cognitive abilities (Klutz, 2023). Increased performance in planning has also been observed as a result of neurofeedback, which is consistent with the results of other research, such that neurofeedback changes the EEG to normal patterns and improves cognitive planning in students with attention deficit planning disorder (Habibollahi et al., 2016; Hashemian Nejad et al., 2015). Improvements in sustained attention from game-based neurofeedback directly target

sustained attention and translate into improvements in specific learning behaviors, particularly Planning and Organization (Krell et al., 2023).

Neurofeedback can also improve executive functions. This is consistent with the results of other studies, where neurofeedback with a duration of more than 1260 minutes has stronger effects on inhibitory control and compensates for deficits by strengthening neural networks (Louthrenoo et al., 2022; Zhong et al., 2025). Different theta/beta neurofeedback protocols affect neural mechanisms of response inhibition; So that increasing beta waves enhances focus and accurate processing of sensory information, provided that theta waves are not suppressed, so that the brain can still recognize and manage contradictions and errors in complex tasks (Bluschke et al., 2022; Neuhäußer et al., 2023). In the field of emotional control, EEG- and BCI-based neurofeedback helps individuals regulate their emotions towards specific states (positive, negative, or neutral), so that regulating brain areas reduces anxiety and improves emotional control (Huang et al., 2021). It is worth noting that, despite the above results, some of the studies we reviewed found no significant improvement in working memory or emotional control with neurofeedback, and the control groups were equally effective. In one study, the lack of a significant difference with the control group indicates that the performance improvement is not due to changes in brain waves, but rather to psychological and environmental factors (placebo effect) such as suggestion, belief in the treatment, and the practice of sitting and focusing; while many people in the main group do not actually succeed in changing their brain waves but still improve (Vollebregt et al., 2014). In the context of using combined interventions with neurofeedback, the use of neurofeedback with cognitive rehabilitation or tDCS in cognitive mastery, including working memory and processing speed, produces better results than the use of neurofeedback alone.

2. Academic and Functional Skill Improvements

In terms of the impact of neurofeedback on academic and functional skills, our research results show an improvement in reading speed. These results are consistent with other research, such that 20 sessions of neurofeedback (decreasing Delta-Theta bands and increasing Beta in children with dyslexia) led to significant improvements in reading (López-Zamora et al., 2025). Also, Neurofeedback can improve by increasing processing speed and reducing mental clutter, but it does not directly target left hemisphere patterns (such as grapheme-phoneme mapping), and has little or no effect on accuracy and reading. This is indicative of the “specificity of the intervention” (Shaywitz & Shaywitz, 2005). The results also show that neurofeedback can improve the writing process, which is consistent with the results of other research. For example, a study with a neurofeedback protocol based on individual EEG showed improvement in writing skills by identifying and correcting abnormal frequencies (slow/fast) in writing-specific areas (Walker, 2012). Another study, combining SMR and EMG, showed improvement in writing along with other skills. In fact, increasing SMR in sensorimotor areas improves dictation and writing by enhancing attention and motor stability (Breteler et al., 2010). Neurofeedback can also improve math skills, math test scores, numerical calculations, and memory. One study showed that neurofeedback (in combination with tDCS over the parietal cortex) produced significant improvements in understanding details and generalities in math. The presentation of audio/visual signals at appropriate times aligned brain patterns with the math lesson (Zandkarimi

et al., 2022). The important thing is that neurofeedback should not be used alone; combining it with methods such as cognitive-behavioral therapy (CBT) to manage behavior, cognitive training to strengthen mental skills, or even medications such as methylphenidate (Ritalin) produces much better results (Zhong et al., 2025). Neurofeedback can also be used to improve academic achievement. In a study after 20 50-minute neurofeedback sessions (7-10 weeks), significant increases in the next semester's grade point average (GPA) and IQ scores were observed compared to the control group, as neurofeedback corrected EEG abnormalities such as decreased theta (4-8 Hz) in the central and frontal regions (Mohammadi et al., 2023). The documented changes in social functioning, including cognitive empathy, perspective-taking, and communication skills, for both ADHD and ASD, suggest that interventions effectively influence the core neuro-functional systems for socialization. The observed improvements in social skills are likely to be mediated by the regulation of brain rhythms (such as the mu rhythm) and the strengthening of circuits associated with social cognition (medial prefrontal cortex and temporoparietal junction), suggesting neuroplasticity in the core symptoms of neurodevelopmental disorders (Frith & Frith, 2003). Another study also reported significant improvements in social functioning after 30 neurofeedback sessions; it reduces negative symptoms that directly interfere with social functioning. These symptoms are associated with hypofrontality (reduced prefrontal cortex activity) (Dwivedi & Banerjee, 2025). Neurofeedback can improve reading speed and computation through a bottom-up mechanism and strengthening of basic capacities (processing speed and reduced mental fatigue) (Shaywitz & Shaywitz, 2005), but it does not directly target left hemisphere-specific patterns (such as grapheme-phoneme mapping), spelling rules, semantic networks of words, or mathematical conceptual logic; therefore, to improve accuracy and specific academic skills, direct (top-down) training methods are more effective or should be combined with neurofeedback (Ashburn et al., 2024; Pando-Naude et al., 2021).

3. Neurophysiological and Perceptual Improvements

The results of the studies indicate a positive effect of neurofeedback on brainwave modulation and regulation. These results are consistent with the results of other studies that state that the neurofeedback protocol (20 sessions of 40 minutes) suppresses the theta/alpha ratio (Amiri, 2022), which is also consistent with the results of other studies (Fernández et al., 2016; Wigton & Krigbaum, 2019). Neurofeedback is also effective for the modulation of cognition and selective attention through an SMR session that improves selective attention neurofeedback through dynamic brain-heart interplay (Bouny et al., 2022; Enriquez-Geppert et al., 2017). Also, the improvement of sensorimotor processes as a result of neurofeedback can be adopted from the results of our review. The results of other studies also support this. Neurofeedback targets hippocampal-cortical networks that are associated with sensory properties (visual, multimodal) and CAP4 (co-activation of sensory cortices + VAN/SN) (Clancy et al., 2024). Also, in several studies, neurofeedback (especially alpha-theta protocols) was associated with improvements in sensorimotor integration, hand-eye coordination, and shape recognition. These findings suggest that optimal sensory integration may be a prerequisite for better performance in basic academic skills such as reading and mathematics, although the number of these studies is limited and requires further investigation (Barnes & Raghubar, 2014; Klimesch, 2012; Varela et al., 2001). Neurofeedback can also influence the diversity and limitations of protocols. For personalization,

because ADHD children vary in severity of symptoms, age, or comorbidities (such as anxiety), protocols must be tailored to the needs of each child. For example, one child may benefit from a Theta/Beta protocol, but another may need an MR (Sensorimotor Rhythm) protocol on the central region of the head (Zhong et al., 2025). Neurofeedback provides real-time feedback on EEG bands, which allows for individualized training, although this diversity reduces comparability (Tosti et al., 2024).

4. Behavioral and Long-term Intervention Effects

Neurofeedback interventions can produce dramatic behavioral improvements that are sustained over time. These treatments produce real changes in the brain, not just temporary fixes, likely due to changes in how the brain networks responsible for self-control function and possibly even their structure (Jolles & Crone, 2012; Klingberg, 2010). The fact that the treatments can also return levels of stress hormones, such as salivary cortisol, to normal supports this idea. This theory links the changes in the brain to control of the hypothalamic-pituitary-adrenal (HPA) axis. This supports the larger idea that neurodevelopmental disorders are not fixed (Lutzky Saute et al., 2014; Shaw et al., 2006). Also, other studies emphasize that reducing the theta/beta ratio and EMG levels in ADHD children led to a reduction in inattention symptoms (Bakhshayesh et al., 2011; Bazanova et al., 2018). In addition, in low beta protocols, improved inhibitory performance in the Iowa Gambling Task was also observed (Vasquez et al., 2014). It can be claimed that no single treatment is the best option for neurodevelopmental disorders; the effectiveness of each treatment depends on the target area (Cortese et al., 2018). Combining several interventions usually gives the best results, because these disorders are multidimensional and combined approaches can create a synergistic effect and better prepare the brain for learning functional skills (Chan et al., 2016); therefore, the treatment plan must be fully personalized and multifaceted (Wolraich et al., 2019). The base principle is that for best results, we put together a mix of interventions that target an individual's unique set of deficits across the neurobehavioral spectrum, from basic brain function to real-world application (Cuthbert & Insel, 2013). Despite these issues, some studies have mainly compared neurofeedback with medication, reporting their combined use and similar effects (Fuchs et al., 2003; Rossiter & Vaque, 1995), while another study showed the superiority of medication (Ogrim & Hestad, 2013). In these studies, a large part of the therapeutic effect is due to the inevitable combination of neurofeedback with psychosocial factors and placebo effects, which may be the main reason for the improvement.

Limitation

While our systematic review suggests promising effects of neurofeedback and combined interventions in children with ADHD, ASD, and SLD, several methodological, practical, and contextual limitations must be considered when interpreting these findings. First, economic and organizational constraints—including high financial costs associated with imported neurofeedback equipment, which may be subject to sanctions—preclude the conduct of pilot clinical trials needed to determine the added value of each intervention alone or in combination. Additionally, the substantial number of sessions required for effective treatment, combined with lack of insurance coverage, renders the service accessible primarily to higher socioeconomic groups. Moreover, due to urbanization, service provision remains centralized in major cities,

leaving rural families with limited access to neurofeedback interventions. Second, significant heterogeneity in treatment protocols (e.g., Theta/Beta vs. SCP training) and assessment tools across studies sometimes yields inconsistent results, complicating direct comparisons and synthesis of findings. This variability is further exacerbated by the absence of a nationally coordinated regulatory authority governing certification processes and standardization of clinical procedures. Consequently, substantial variation in training programs and practitioner expertise diminishes the quality of care delivered—particularly for complex disorders such as ASD, which demand highly customized treatment based on thorough evaluation techniques like QEEG that require specialized expertise which cannot be uniformly ensured. This lack of standardization significantly impacts the ability to generate replicable results, and as a result, the scientific community remains skeptical about the effectiveness of neurofeedback techniques. Third, the current state of evidence for neurofeedback in Iran remains in a developmental stage, plagued by methodological shortcomings including inadequate sample sizes and absence of appropriate control groups. These limitations make it difficult to isolate specific treatment effects from nonspecific variables such as placebo effects, particularly in pediatric populations. Furthermore, public polarization persists: neurofeedback is sometimes perceived as a "cure-all" that neglects holistic treatment modalities, while simultaneously being met with skepticism among healthcare practitioners regarding its alleged effectiveness relative to other established treatment modalities such as pharmacotherapy.

Recommendations

A top-down, policy-driven approach is necessary to address the economic and structural barriers identified in this review. First, we strongly recommend that professional bodies actively work to include evidence-based neurofeedback protocols in the portfolio of services covered by public and private insurance companies. This should be achieved by presenting policymakers with a robust body of evidence generated both internationally and locally. Such policy change would yield multiple benefits: (a) reducing patient co-payment and enabling low-income groups to access this therapeutic technology; (b) removing neurofeedback from the category of alternative or purely commercial treatments and integrating it into mainstream medical and psychological services; (c) compelling professional bodies to formulate precise treatment protocols and preventing the implementation of arbitrary or unscientific interventions; and (d) ensuring a guaranteed revenue stream for clinics and specialists while increasing client uptake, with insurance coverage reducing dropout rates and thereby supporting the financial stability of service providers. Furthermore, establishing a national registry for neurofeedback patients would enable long-term outcome monitoring and inform future health policy. Second, correcting cultural and social misconceptions requires a dual-pronged approach. On one hand, professional organizations should provide balanced, evidence-based education about what neurofeedback is, how it works, and what it can realistically achieve within a comprehensive, multimodal treatment plan—rather than presenting it as a standalone cure. On the other hand, interdisciplinary education should be strengthened by introducing modules on the principles and evidence base of neuromodulation into the curricula of medical students, psychology graduates, and special education teachers. This would foster a better-informed and collaborative professional community capable of appropriately referring children and providing integrated care that

combines neurotechnological, behavioral, and educational interventions. Third, in the research arena, it is important to note that the current body of neurofeedback research on neurodevelopmental disorders—particularly ADHD, SLD, and ASD—is unbalanced, with a disproportionate concentration of studies on ADHD compared to SLD and, especially, ASD. To address this gap, future research should prioritize: (a) modifications to intervention protocols; (b) emphasis on randomized controlled trials (RCTs) and long-term follow-up studies; and (c) inclusion of larger and more diverse samples to enhance generalizability and clinical applicability.

5. Conclusion

This systematic review suggests that neurofeedback is an effective, non-invasive, and neuroplasticity-based treatment for Iranian children and adolescents with neurodevelopmental conditions, including ADHD, SLD, and ASD. The application of common neurofeedback protocols—such as theta/beta ratio reduction and sensorimotor rhythm (SMR) enhancement—either alone or in combination, significantly improved cognitive-executive, academic, behavioral, and neurophysiological functioning, with effects persisting for several months post-intervention. Multimodal neurofeedback approaches yielded additional benefits beyond single-modality interventions, suggesting synergistic effects when multiple protocols are applied simultaneously and when protocols are personalized according to each child's qEEG profile. However, several limitations must be acknowledged. Notably, the research landscape in Iran reveals a disparity, with a disproportionate focus on ADHD compared to ASD and SLD, where rigorous studies remain scarce. The majority of studies suffer from methodological shortcomings, including small sample sizes, absence of active or sham control groups, insufficient follow-up periods, and limited demographic and geographic diversity—all of which restrict the generalizability of findings. Furthermore, structural barriers impede widespread neurofeedback implementation in Iran, including high costs, lack of insurance reimbursement, centralization of services in major cities, and the absence of national standardization and regulatory oversight. Neurofeedback should be viewed as one component of a comprehensive treatment plan for mental health conditions, best combined with other evidence-based modalities such as pharmacotherapy, counseling, educational interventions, and behavioral therapies to achieve optimal outcomes. As neurofeedback continues to gain popularity, future research must prioritize large-scale studies employing rigorous methodologies, longitudinal follow-up designs, and diverse populations—including young women, older adults, and individuals from disadvantaged socioeconomic backgrounds—using standardized protocols to enhance the credibility and generalizability of the field. Finally, to ensure equitable access to neuroscience-based therapies regardless of income, age, or gender, it is essential to implement insurance coverage for neurofeedback services, establish a large pool of qualified practitioners, and develop a national registry for certified neurofeedback practitioners and services. Collectively, these steps will address many of the unresolved questions surrounding neurofeedback and establish it as a legitimate and accessible treatment alternative for children with mental health conditions in Iran.

Author Contributions:

Conceptualization, S.G. and P.G.; Methodology, S.G., P.G., and F.S.F.; Investigation, F.S.F. and F.S.; Data curation, F.S.F.; Formal analysis, F.S.; Visualization, F.S.F.; Writing—original draft preparation, F.S.F. and F.S.; Writing—review and editing, S.G., P.G., F.S.F., and F.S.; Project administration, S.G. and P.G.; Supervision, S.G. and P.G. All authors have read and agreed to the published version of the manuscript.

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Ethical considerations

All procedures were conducted in accordance with ethical research standards. The authors ensured complete avoidance of data fabrication, falsification, plagiarism, or selective reporting. Data were drawn exclusively from published, peer-reviewed sources, and the review adhered to principles of transparency and reproducibility (e.g., following PRISMA guidelines where applicable).

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Conflict of interest

The authors declare no conflict of interest.

6. Appendix

Table 1. *Summary of Study Characteristics, Intervention Protocols, and Methodological Context*

Index	Article	City	Setting	Study Design	Number of Participants	Disorder	Age (years)	Intervention Details	Session Protocol	Dependent Variables	Key Protocol Features
1	(Dashtbozorgi et al., 2017)	Varamin	Clinic	QEPP	30 (15/15)	ADHD	–	NFT	12 sessions, 60 min	Sustained Attention, Working Memory	↑ Beta, ↓ Theta
2	(Nooripour et al., 2020)	Tehran	Clinic	QEPP	16 (8/8)	ADHD	14–18	NFT	32 sessions (16 weeks), 30 min	Cognitive Empathy, Emotion Regulation	Alpha/Theta protocol
3	(Nourizade et al., 2015)	Tehran	Clinic	QE	12 (6/6)	ADHD	7–14	NFT	40 sessions (14 weeks), 60 min	Cognitive Processing	↓ Alpha/Theta, ↑ Beta
4	(Baghban Kazerani et al., 2016)	Tehran	Clinic	QEPP	40 (20/20)	ADHD	7–12	NFT	30 sessions (10 weeks)	Aggressive Behavior	Theta/Beta reduction, Beta suppression, SMR enhancement
5	(Hasanshahi & Yousefi, 2019)	Shiraz	Clinic	QEPP	30 (15/15)	ADHD	8–13	NFT	30 sessions (15 weeks), 45 min	Sustained Attention, qEEG	↑ Beta, ↓ Theta
6	(Teymouri et al., 2021)	Mashhad	Clinic	QEPP	17	ADHD	7–12	NFT	24 sessions (8 weeks), 60 min	Attention Problems, Externalizing Behaviors, Aggression, Rule-Breaking	–
7	(MOHAMMADI & Hosini, 2018)	Isfahan	Clinic	QEPP	45	ADHD	7–14	NFT	40 sessions, 30 min	Attention, Impulsivity	↑ SMR, ↓ Beta2 & Theta
8	(Kianizadeh et al., 2021)	Mashhad	Clinic	QEPP	14 (7/7)	ADHD	–	NFT	30 sessions (10 weeks)	Executive Functions	Alpha protocol

9	(Bigdeli et al., 2015)	Tehran	Clinic	EPP	30 (15/15)	ADHD	7–10	NFT	50 sessions, 30 min	Attention, Impulsivity	↑ SMR, ↓ Beta2 & Theta
10	(Moin et al., 2018)	Khorramabad	Society	QEPP	10	ADHD	–	NFT	10 sessions	Executive Functions	↑ Beta, ↓ Theta
11	(Goodarzi & Behzadi, 2024)	Tehran	Clinic	QEPP	30 (15/15)	ADHD	6–11	NFT	30 sessions (10 weeks), 50 min	Visual Attention, Concentration	–
12	(Rajabi, 2015)	Ardabil	University	QEPP	34 (16/18)	ADHD	–	NFT	20 sessions (7–10 weeks), 40 min	Brainwave Amplitudes, Sustained Attention	10-channel protocol
13	(Yousefi Afrashteet al., 2021)	Qazvin	Clinic	QEPP	30 (15/15)	ADHD	7–9	NFT	20 sessions (10 weeks)	ADHD Symptoms, Aggressive Behavior	–
14	(Niknasab et al., 2019)	Tehran	Clinic	QEPP	30 (15/15)	ADHD	5–12	NFT	20 sessions (10 weeks), 60 min	ADHD Symptoms	Beta (monopolar), SMR (bipolar)
15	(Oraki et al., 2015)	–	Clinic	QEPP	8	ADHD	6–11	NFT	10 sessions	Working Memory	10-channel, ↑ Alpha
16	(Niknasab et al., 2018)	Tehran	Clinic	QEPP	45 (15/15/15)	ADHD	5–12	NFT	20 sessions (10 weeks), 60 min	ADHD Symptoms	Beta (monopolar), SMR (bipolar)
17	(Ghasemzadeh et al., 2018)	Tehran	Clinic	QEPP	24 (12/12)	ADHD	10–14	NFT	33 sessions (11 weeks), 30 min	OCD Symptoms, Aggressive Behavior	Alpha/Beta protocol
18	(Aliloo et al., 2017)	Mashhad	Clinic	SCS	3	ADHD	8–	NFT	40 sessions (10 weeks)	ADHD Symptoms	–

						9				
19	(Botshekan et al., 2022)	Isfahan	Clinic	QEPP	60 (15/15/15/15)	ADHD	9–11	NFT	40 sessions (10 weeks), 45 min	Sensory Integration	Beta & SMR training
20	(Gharibi et al., 2017)	Sanandaj	Clinic	QEPP	60 (20/20/20)	ADHD	8–9	NFT	24 sessions (12 weeks)	ADHD Symptoms	↑ Beta & SMR, ↓ Beta & Theta
21	(Ziabakhsh et al., 2019)	Karaj	Clinic	QEPP	50 (17/16/17)	ADHD	–	NFT	12 sessions (6 weeks), 41 min	Sustained, Selective, Focused, Divided, Alternating Attention (Auditory/Visual)	Beta training
22	(Hedayati Shalkouhi et al., 2022)	Rasht	Clinic	QEPP	36 (12/12/12)	ADHD	8–12	NFT	30 sessions (10 weeks), 45 min	Executive Functions	↑ Beta, ↓ Theta
23	(BotShekan et al., 2021)	Isfahan	Clinic	QEPP	60 (15/15/15/15)	ADHD	–	NFT	40 sessions (10 weeks)	Emotion Regulation	Beta & SMR training
24	(Tabrizi et al., 2020)	Isfahan	Clinic	QEPP	48 (16/16/16)	ADHD	7–12	NFT	30 sessions (10 weeks), 45 min	Impulsivity	–
25	(Tabrizi, 2020)	Isfahan	Clinic	QEPP	48 (16/16/16)	ADHD	7–12	NFT	30 sessions (10 weeks), 45 min	Attention Problems	–
26	(Ghaemi et al., 2016)	Mashhad	Clinic	QEPP	15	SLD	7–10	NFT	15 sessions	Reading Speed, Accuracy	↑ Beta, ↓ Theta
27	(Noshad & Azizi,	Tabriz	Clinic	EPP	30 (15/1	SLD	7–	NFT	20 sessions,	Attention, Working	↑ Beta, ↓

	2023)				5)		11		30–45 min	Memory, Visual-Motor Perception	Theta
28	(Golestan et al., 2022)	Abyek	Clinic	SCS (AB)	5	SLD (Dysgraphia)	9	NFT	20 sessions (10 weeks), 45 min	Dictation Performance	↑ Beta, ↓ Theta
29	(Sabaghi et al., 2017)	Torbat-e Heydarieh	Clinic	QEPP	36 (18/18)	SLD (Dyslexia)	7–12	NFT	20 sessions (5 weeks), 40 min	Cognitive Abilities, Academic Achievement	Alpha & SMR training
30	(Azadi et al., 2017)	Isfahan	Clinic	QEPP	15	SLD	7–12	NFT	20 sessions (7–10 weeks), 45 min	WISC-IV Performance	↑ Alpha, ↓ Beta, SMR training
31	(Soltani, 2018)	Tehran	Clinic	QE	10	SLD (Dyscalculia)	8–10	NFT	20 sessions, 30 min	Executive Functions	Beta training
32	(Zarenezhad et al., 2020)	Tehran	Clinic	QEPP	33 (16/17)	SLD (Dyslexia)	8–11	NFT	20 sessions, 45 min	Cognitive Problems, Visual-Motor Perception	↑ Alpha, ↓ Theta, SMR training
33	(Sheri et al., 2023)	Tehran	Clinic	QEPP	45 (15/15/15)	SLD	–	NFT	–	Parent-Child Relationship, Executive Functions, Visual-Motor Coordination	–
34	(Sheri et al., 2022)	Tehran	Clinic	QEPP	30 (15/15)	SLD	7–12	NFT	16 sessions (7 weeks), 30–45 min	Executive Functions, Cognitive Flexibility, Attention	↑ SMR & Beta, ↓ Theta
35	(Mousanezhad Jeddi et al., 2016)	Tabriz	Clinic	SCS	4	SLD (Dyslexia)	7–9	NFT	20 sessions (10 weeks), 40 min	Phonological Awareness, Working Memory	19-channel Alpha/Beta/Delta/Theta
36	(Rahimi et al., 2015)	Karaj	Clinic	QEPP	20 (10/1	SLD (Dysc	10	NFT	28 sessions (10 weeks),	Visual Perception,	↑ Beta, ↓ Theta

				0)	alculia)	–12		30–45 min	Brainwave Activity	
37	(Rajabi et al., 2015)	Ardabil	Clinic	EPP	31 (16/15)	SLD (Dyslexia)	8–11	NFT	20 sessions (7–10 weeks), 30 min	Intellectual Performance, Attention, ADHD Symptoms	10-channel, ↓ Delta/Theta
38	(Behzadi et al., 2015)	Karaj	Clinic	QEPP	20 (10/10)	SLD (Dyscalculia)	10–12	NFT	28 sessions, 30–45 min	Numerical Calculation, Numerical Memory	↑ Beta, ↓ Theta
39	(Farid et al., 2021)	Maragh e	Clinic	QEPP	30 (10/10/10)	SLD	8–12	NFT	20 sessions (10 weeks), 45 min	Executive Functions	↑ Beta, ↓ Theta
40	(Azizi et al., 2017)	Tabriz	Clinic	QEPP	60 (15/15/15/15)	SLD	–	NFT	20 sessions, 45 min	Visual-Motor Perception	–
41	(Abbasi Fashami et al., 2020)	Tehran	Clinic	QEPP	36 (12/12/12)	SLD (Dyslexia)	8–12	NFT	30 sessions (10 weeks), 45 min	Executive Functions	↑ Beta, ↓ Theta
42	(Azizi et al., 2020)	Tabriz	Clinic	QEPP	60 (15/15/15/15)	SLD	7–10	NFT	20 sessions (7 weeks), 30–45 min	Working Memory	↑ Beta, ↓ Theta
43	(Azami & Haj Sadeghi, 2017)	Ahvaz	Clinic	QEPP	45 (15/15/15)	SLD (Dyslexia)	9	NFT	20 sessions	Reading Performance	↑ Alpha, ↓ Theta, SMR training
44	(Nazari et al., 2021)	Bojnord	Clinic	QEPP	30 (15/15)	ASD	6–8	NFT	30 sessions, 45–60 min	Joint Attention, Brainwave Activity	↑ Alpha, ↓ Theta & Beta
45	(Karami Mal Amiri, 1403)	Kermanshah	School	QEPP	30 (15/15)	ASD	7_1	NFT	–	Cognitive Abilities, Anxiety	5-channel, ↑ Beta, ↓ Theta

						1				
46	(Alizadeh et al., 2024)	Mashhad	Clinical/School	QEPP	5	ASD	8–9	NFT	15 sessions (6 weeks), 60 min	Neuropsychological Abilities, Brainwave Activity	2-channel protocol
47	(Mohammadi et al., 2020)	Ardabil	Clinic	QEPP	45 (15/15/15)	ASD	7–12	NFT	20 sessions (10 weeks), 45 min	Cognitive, Social, Daily Living Skills	↑ Beta/SMR, ↓ Theta
48	(Fereshte Alidadi Taifeh et al., 2019)	Tehran	Clinic	QEPP	100 (25/25/25/25)	ADHD	6–12	NFT + Cognitive Rehabilitation	CR: 14 sessions, 30 min; NFT: 10 (5 weeks), 40 min; Combined: 24, 40+30 min	Working Memory	QEEG-guided
49	(Sheikh et al., 2022)	Kish	School	QEPP	20 (10/10)	ADHD	7–9	NFT + Physical Activity	24 sessions, 45 min	Motor Function, Anxiety, Sleep	↑ SMR, ↓ Beta & Theta
50	(Almasi et al., 2021)	Ardabil	Society	QEPP	33 (11/11/11)	ADHD	–	NFT + tDCS	NFT: 20 (10 weeks), 30 min; tDCS: 10 (5 weeks), 10 min	Cognitive Dominance	4-channel protocol
51	(Rajabi & Moradi, 2018)	Bushehr	School	QEPP	20 (10/10)	ADHD	8–12	NFT + Cognitive Games	20 sessions (8 weeks), 45 min	Conduct Problems	40-channel Beta & SMR training
52	(Moradi & Rajabi, 2022)	Bushehr	School	QEPP	20 (10/10)	ADHD	8–12	NFT + Cognitive Games	20 sessions (8 weeks), 45 min	Cognitive Flexibility	19-channel Beta (monopolar), SMR (bipolar)
53	(Fereshteh Alidadi Taifeh et al., 2019)	Tehran	Clinic	QEPP	100 (25/25/25/25)	ADHD	6–12	NFT + Cognitive Rehabilitation	CR: 14, 30 min; NFT: 10 (5 weeks), 40 min; Combined: 24	Academic Achievement	QEEG-guided
54	(Torabi et al., 2021)	Tehran	Clinic	QEPP	48 (12/1	ADHD	7–	NFT + Selecte	NFT: 24 (8 weeks), 60	Attention, Impulsivity	Beta training (monopolar)

				2/12/12)		11	d Exercise	min; Combined: 24 (8 weeks), 60 min		
55	(Rashidipour et al., 2017)	Meibod	Clinic	QEPP	48 (12/12/12/12)	ADHD	5–10	NFT + Yoga	NFT: 24 (8 weeks), 60 min; Combined: 24 (8 weeks), 60 min	ADHD Symptoms	↑ Beta, ↓ Theta
56	(Masoudi et al., 2019)	Isfahan	Clinic	EPP	8 (6/2)	ADHD	12–13	NFT (Dynamic/Static Difficulty)	10 sessions	Attention	Dynamic vs. Static difficulty adjustment
57	(Fathian et al., 2024)	Tehran	Clinic	QEPP	40 (10/10/10/10)	ADHD	8–12	NFT + Sensory-Motor Games	–	Working Memory	–
58	(Hajehforoush et al., 2018)	Isfahan	Clinic	QEPP	36	ADHD	6–13	NFT + Barkly's Parent Training	NFT: 30 (10 weeks), 30 min; PT: 9 sessions, 60 min	Auditory Attention, Comprehension	–
59	(Asbaqi et al., 2016)	Tehran	Clinic	QEPP	20 (10/10)	ADHD	7–10	NFT + Cognitive Rehabilitation	NFT: 30 (10 weeks), 30 min; Combined: 30 (10 weeks), 45 min	Attention, Impulsivity	↑ SMR & Beta, ↓ Theta
60	(Farahmand et al., 2019)	Mashhad	Clinic	QEPP	45 (15/15/15)	ADHD	–	NFT + Ritalin	NFT: 45 sessions, 45 min; Combined: 15 weeks	Academic Achievement, ADHD Symptoms	–
61	(Zandkarimi et al., 2022)	Karaj	Clinic	SCS (ABAB)	5	SLD (Dyscalculi	14–1	NFT + tDCS	16 sessions (8 weeks), 50 min	Cognitive Abilities, Academic	Alpha/Theta enhancement, B3 suppression

						a)	6			Achievement	
62	(Naeimian et al., 2020)	Karaj	Clinic	QEPP	30 (15/15)	SLD	–	NFT + Cognitive Rehabilitation	CR: 10 sessions; NFT: 10, 30 min	Dyscalculia, Dyslexia, Dysgraphia	Theta/Beta protocol
63	(Golmohammadi et al., 2018)	Gorgan	Clinic	QE	24 (6/6/6/6)	ASD	8 – 12	NFT + SPARK	NFT: 16 (8 weeks), 45 min; Combined: 16 (8 weeks), 45 min	Salivary Cortisol Level	–

* QEPP: Quasi-experimental study with pretest-posttest design – QE: Quasi-experimental study – EPP: Experimental study with pretest-posttest design – SCS: Single-Case study staircase with multiple baselines – QE: Quasi-experimental study

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