



Comparison of Processing Speed and Working Memory in Students with Dyscalculia, Dyslexia, and Typical Development

Sara Oladi¹, Majid Ebrahmipour^{2*}

¹ Master's student, Department of Exceptional Child Psychology, SR.C., Islamic Azad University, Tehran, Iran

² Assistant Professor, Department of Psychology and Education of Exceptional Children, SR.C., Islamic Azad University, Tehran, Iran

* Corresponding author email address: M.Ebrahmipour95@iau.ac.ir

Article Info

Article type:

Original Research

How to cite this article:

Oladi, S., & Ebrahmipour, M. (2026). Comparison of Processing Speed and Working Memory in Students with Dyscalculia, Dyslexia, and Typical Development. *Health Nexus*, 4(1), 1-10. <https://doi.org/10.61838/kman.hn.5113>



© 2026 the authors. Published by KMAN Publication Inc. (KMANPUB), Ontario, Canada. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

ABSTRACT

Cognitive abilities such as working memory and processing speed play a significant role in students' learning processes and academic performance. Deficits in these abilities are often associated with learning disorders such as dyslexia and mathematics learning disorder (dyscalculia). The present study aimed to compare working memory and processing speed among elementary school students with dyscalculia, dyslexia, and typically developing peers in Tehran. This study employed an ex post facto (causal-comparative) design. The sample consisted of 75 male and female students from Grades 1 to 5 of elementary school during the 2021–2022 academic year in Tehran. Participants were divided into three groups: students with dyscalculia, students with dyslexia, and typically developing students. The groups were matched in terms of age, gender, grade level, and intelligence quotient (IQ). Working memory and processing speed were assessed using subtests of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV), standardized by Abedi and colleagues. Data analysis was conducted using one-way analysis of variance (ANOVA). The results of the ANOVA indicated a significant difference among the three groups in both working memory and processing speed ($p < .001$, $df = 2$). Specifically, students with dyscalculia and dyslexia demonstrated weaker performance compared to typically developing students; however, no significant difference was observed between the dyscalculia and dyslexia groups. The findings suggest that deficits in working memory and processing speed represent common characteristics among students with learning disorders. Therefore, designing and implementing educational and rehabilitation programs that focus on strengthening these cognitive abilities may contribute to improving the academic performance of these students.

Keywords: *Dyscalculia, Dyslexia, Working Memory, Processing Speed, Learning Disorders.*

1. Introduction

Learning is a complex developmental process that relies on the coordinated functioning of multiple cognitive, neuropsychological, and behavioral systems. Among these systems, cognitive abilities such as working memory, processing speed, attention regulation, and executive functioning play fundamental roles in enabling children to acquire academic skills efficiently. Difficulties in these cognitive domains may lead to persistent academic underachievement and are frequently observed in children diagnosed with specific learning disorders (SLDs). In recent decades, growing attention has been directed toward understanding the cognitive mechanisms underlying learning disorders, particularly dyslexia and dyscalculia, as these conditions represent two of the most prevalent neurodevelopmental challenges encountered in educational settings (1, 2).

Specific learning disorders are characterized by persistent difficulties in reading, writing, or mathematics despite adequate intelligence, educational opportunity, and sensory functioning. Epidemiological investigations indicate that a substantial proportion of school-aged children experience academic learning difficulties that significantly interfere with educational progress and psychosocial adjustment (1). Recent prevalence studies further emphasize that children at risk of SLD demonstrate identifiable cognitive risk factors long before formal diagnosis, highlighting the importance of early cognitive assessment and intervention (2). These findings underscore the need to examine fundamental cognitive processes that differentiate students with learning disorders from typically developing peers.

Among cognitive factors implicated in SLD, working memory has received extensive empirical support as a core mechanism underlying academic learning. Working memory refers to the capacity to temporarily store and manipulate information necessary for complex cognitive activities such as reading comprehension, mathematical reasoning, and problem solving. Research consistently demonstrates that children with reading and mathematics difficulties show impairments across multiple components of working memory, including phonological storage, visuospatial processing, and central executive control (3). These deficits reduce the efficiency with which children integrate new information, maintain task goals, and perform

sequential cognitive operations required in classroom learning.

Evidence suggests that working memory limitations are not restricted to a single academic domain but may represent a shared cognitive vulnerability across different learning disorders. Studies comparing children with dyslexia and dyscalculia have shown that reduced working memory capacity negatively affects text comprehension, arithmetic processing, and academic fluency (4). Similarly, research on arithmetic learning difficulties indicates that deficits in working memory interfere with numerical representation, calculation procedures, and problem-solving accuracy (5). These findings support theoretical models proposing that working memory acts as a domain-general cognitive resource essential for both literacy and numeracy development.

In addition to working memory, processing speed has emerged as another critical cognitive variable associated with academic performance. Processing speed refers to the efficiency with which individuals perceive, interpret, and respond to information. Slow processing speed may hinder learning by limiting the amount of information that can be processed within instructional time constraints, thereby affecting reading fluency, written output, and mathematical computation. Transdiagnostic research demonstrates that processing speed deficits are observable across various developmental disorders and may serve as a key diagnostic marker in pediatric neuropsychological assessment (6). Children with learning disorders frequently require longer time to encode stimuli, retrieve information, and execute responses, leading to cumulative academic difficulties.

The relationship between processing speed and executive functioning has also been highlighted in developmental studies examining attention-deficit/hyperactivity disorder (ADHD) and learning problems. Processing speed interacts closely with attentional control and executive regulation, and impairments in these functions may jointly contribute to academic underperformance (7). This interaction is particularly relevant because learning disorders rarely occur in isolation; instead, they often coexist with attentional, behavioral, or emotional difficulties, creating complex cognitive profiles that challenge educational intervention efforts.

A growing body of research emphasizes the heterogeneity of cognitive profiles among children with SLD. Cognitive assessment studies demonstrate that students with learning disabilities do not form a uniform group; rather, they display diverse patterns of strengths and weaknesses across cognitive domains (8). Some children exhibit pronounced working memory deficits, while others demonstrate slower processing speed or executive dysfunction. Understanding these cognitive profiles is essential for developing targeted educational interventions tailored to individual learning needs.

The comorbidity between learning disorders and behavioral or emotional difficulties further complicates the clinical picture. Investigations into SLD phenotypes reveal that cognitive deficits frequently coexist with emotional dysregulation, anxiety, or behavioral impairments, suggesting shared developmental pathways (9). Similarly, reviews of intervention research highlight strong associations between learning difficulties and behavioral problems, emphasizing the importance of integrated cognitive and psychosocial assessment frameworks (10). These findings indicate that cognitive weaknesses such as impaired working memory and slow processing speed may contribute not only to academic failure but also to broader adjustment challenges.

Language processing, auditory processing, attention, and memory systems have also been identified as interacting mechanisms underlying reading disorders. Studies examining children with word-reading difficulties show high rates of comorbidity between auditory processing deficits, attentional limitations, and memory impairments (11). Earlier clinical investigations similarly demonstrated that children with reading disabilities exhibit weaknesses in both working memory and long-term memory systems, reinforcing the centrality of memory processes in literacy acquisition (12). These converging findings highlight the need for multidimensional cognitive assessment when studying learning disorders.

Executive functioning research further supports the role of working memory as a foundational mechanism underlying academic difficulties. Investigations into ADHD-related reading problems reveal that working memory deficits significantly predict reading impairment, suggesting shared cognitive mechanisms across

neurodevelopmental conditions (13). Likewise, studies examining cognitive style and working memory among adolescents with SLD confirm that limitations in executive processes constrain academic adaptability and learning efficiency (14). Together, these studies suggest that working memory dysfunction may represent a transdiagnostic cognitive risk factor influencing multiple developmental outcomes.

Reading disorders such as dyslexia are strongly associated with deficits in phonological processing, decoding efficiency, and cognitive integration skills. Research examining developmental dyslexia demonstrates significant relationships between cognitive deficits and component reading skills across age groups (15). Children with dyslexia often struggle to coordinate attention, memory, and processing speed simultaneously, leading to reduced reading fluency and comprehension. These challenges may persist into adolescence if early cognitive weaknesses remain unaddressed.

Similarly, children with mathematics learning disorder (dyscalculia) exhibit impairments in numerical cognition, visuospatial working memory, and executive monitoring. Comparative studies indicate that both dyslexia and dyscalculia involve overlapping cognitive deficits, supporting the hypothesis of shared underlying neurocognitive mechanisms rather than entirely separate disorders (3, 4). This overlap explains why many students present with mixed learning difficulties affecting multiple academic domains.

The role of cognitive and behavioral weaknesses has also been explored in children presenting with co-occurring reading disorder and attention difficulties. Research demonstrates that deficits in executive control, attention regulation, and processing efficiency collectively contribute to academic challenges, emphasizing the importance of comprehensive cognitive evaluation (16). Such findings align with contemporary neurodevelopmental perspectives that conceptualize learning disorders as multidimensional conditions influenced by interacting cognitive systems.

Recent intervention research increasingly focuses on cognitive-based remediation programs targeting working memory, executive function, and processing speed. Evidence suggests that interventions addressing both learning disabilities and co-occurring disorders yield

improved academic outcomes compared with traditional instructional approaches alone (17). Systematic reviews further indicate that effective intervention requires identification of underlying cognitive deficits rather than reliance solely on academic performance measures (18). These developments reinforce the importance of empirical research examining cognitive differences among students with various learning profiles.

Despite substantial progress in understanding learning disorders, several gaps remain. Many previous studies have examined dyslexia or dyscalculia independently, whereas fewer investigations directly compare cognitive performance across multiple learning disorder groups and typically developing students within the same methodological framework. Comparative analyses are essential for clarifying whether working memory and processing speed deficits represent disorder-specific characteristics or shared cognitive vulnerabilities. Moreover, cultural and educational contexts may influence cognitive performance patterns, necessitating research conducted in diverse populations and educational systems.

Given the central role of cognitive processes in academic achievement, examining working memory and processing speed among students with dyslexia and dyscalculia provides valuable insight into the mechanisms underlying learning difficulties. Such investigations can contribute to improved diagnostic accuracy, early identification of at-risk students, and development of evidence-based educational and rehabilitation programs tailored to cognitive needs.

Therefore, the present study aimed to compare working memory and processing speed among elementary school students with dyscalculia, dyslexia, and typically developing peers.

2. Methods and Materials

2.1. Study Design and Participants

Since the present study aimed to examine differences in processing speed, working memory, and motor skills among elementary school students with specific learning difficulties in mathematics and reading compared with typically developing students, and because the differences and characteristics of the groups were inherent and not subject to experimental manipulation—with the researcher having no

role in creating these characteristics—an ex post facto (causal-comparative) research design was employed to investigate performance differences.

The statistical population consisted of three groups. The first and second groups included all male and female students with specific learning difficulties who were receiving supplementary specialized instruction in Learning Disabilities (LD) schools (Centers for Special Learning Problems and Educational Rehabilitation) during the 2021–2022 academic year. Based on teachers' evaluations, students' academic records, and formal assessments conducted by certified educational specialists, these students were diagnosed with either mathematics learning disability (dyscalculia) or reading disorder (dyslexia). The third group consisted of all typically developing elementary school students in Tehran who were enrolled during the 2021–2022 academic year.

The population size of learning disability schools in Tehran included all students attending three specialized schools or centers, totaling approximately 320 to 350 students. After selecting eligible participants from this population, students in the typically developing group were matched with the clinical groups.

Accordingly, the study sample consisted of 90 elementary school students from Grades 1 through 5, divided equally into three groups, each including 30 participants: 15 male and 15 female students with mathematics disorder (dyscalculia), 15 male and 15 female students with reading disorder (dyslexia), and 15 male and 15 female students enrolled in regular schools. Participants were selected using multistage random cluster sampling to ensure equivalence among the three groups in terms of gender, age, and grade level.

In this study, group performance was evaluated based on selected subscales of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV). The independent variables included reading disorder (dyslexia) and mathematics disorder (dyscalculia), while the dependent variables consisted of indices of working memory and processing speed. Working memory and processing speed were assessed using the Digit Span, Letter–Number Sequencing, Symbol Search, Coding, Cancellation, and Arithmetic subtests of the WISC-IV. In addition,

participants' motor skills were assessed using the Oseretsky Motor Skills Test.

2.2. Instruments

Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV): The Wechsler Intelligence Scale for Children (WISC-IV) is one of the most valid and widely recognized instruments for assessing children's intelligence within the age range of 6 to 16 years, originally developed by David Wechsler (Wechsler, 2003). The test includes four primary index scores, among which working memory and processing speed are central components. In the present study, working memory was assessed using the Digit Span and Letter–Number Sequencing subtests, while processing speed was measured using the Symbol Search, Coding, Cancellation, and Arithmetic subtests to evaluate these cognitive indices across different student groups. The test was administered individually, and raw scores were converted into standardized scores for statistical analysis.

Oseretsky Motor Skills Test: The Oseretsky Test is a well-established instrument for evaluating children's motor skills, assessing both fine and gross motor abilities (Oseretsky, 1967). The test consists of a series of motor tasks designed to measure children's motor performance across multiple dimensions. In this study, the test was used to evaluate participants' motor skills. Administration was conducted individually in a quiet and appropriate environment to ensure accurate assessment of each student's motor functioning.

2.3. Procedure

Following the acquisition of necessary permissions from relevant authorities and coordination with schools and educational centers, the study was conducted during the 2021–2022 academic year. Initially, the study population—including students with learning disorders in mathematics and reading as well as typically developing students—was identified. After verifying inclusion criteria and applying sampling standards, a sample of 90 participants was selected, consisting of three groups of 30 students each (15 boys and 15 girls per group). Participants were selected using

multistage random cluster sampling and were matched across groups based on gender, age, and grade level. All assessments were administered in a quiet, distraction-free environment. First, the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) was administered individually to each student. The working memory subtests (Digit Span and Letter–Number Sequencing) and processing speed subtests (Symbol Search, Coding, Cancellation, and Arithmetic) were conducted carefully in accordance with standardized testing procedures. After completion of the intelligence assessment, the Oseretsky Motor Skills Test was administered individually to each student under standardized testing conditions. All assessments were conducted by trained and experienced examiners specialized in psychological evaluation to ensure accuracy and reliability of results. Raw scores were converted into standardized scores and subsequently used for statistical analyses. All stages of the study were conducted in accordance with ethical research principles, ensuring confidentiality of participant information.

2.4. Data Analysis

Statistical analyses were performed using SPSS software, Version 26. One-way analysis of variance (ANOVA) was used to examine differences in mean processing speed and working memory scores among the three groups. When significant differences were detected, Tukey's post hoc test was applied. Effect size was calculated and reported using eta squared (η^2). The level of statistical significance was set at .05.

3. Findings and Results

To examine differences in the mean processing speed scores (one of the subscales of the Wechsler Intelligence Scale) among three groups of students—typically developing, students with dyscalculia, and students with dyslexia—a one-way between-groups analysis of variance (ANOVA) was conducted. Descriptive statistical indices related to processing speed scores in each group were calculated, and the results are presented in Table 1.

Table 1

Descriptive Statistics of Processing Speed Scores Across the Three Study Groups

Group	N	Mean	Standard Deviation	Standard Error
Typical	30	133.30	22.99	4.20
Dyscalculia	21	113.14	25.95	5.66
Dyslexia	24	95.88	34.05	6.95

As shown, the mean processing speed scores differed across the three groups, and this difference was also illustrated graphically in the corresponding figure.

To test the hypothesis regarding statistically significant differences among group means, a one-way ANOVA was performed, and the results are presented in Table 2.

Table 2

One-Way ANOVA Results for Processing Speed Across Groups

Source of Variation	Sum of Squares	df	Mean Square	F	Significance (p)
Between Groups	18,862.82	2	9,431.41	12.24	.000*
Within Groups	55,479.55	72	770.55		
Total	74,342.37	74			

The results indicated a significant difference in mean processing speed scores among typically developing students, students with dyscalculia, and students with dyslexia, $F(2, 72) = 12.24, p < .001$. The effect size (η^2) was

.25, which, according to Cohen (1998), represents a medium to large effect.

Descriptive statistical indices related to working memory scores were also calculated for the three groups and are presented in Table 3.

Table 3

Descriptive Statistics of Working Memory Scores Across the Three Study Groups

Group	N	Mean	Standard Deviation	Standard Error
Typical	30	50.53	12.26	2.24
Dyscalculia	21	31.33	9.24	2.02
Dyslexia	24	24.88	9.51	1.94

The mean working memory scores also differed across the three groups, as illustrated in the corresponding graphical representation.

To examine the statistical significance of these differences, a one-way ANOVA was conducted, and the results are presented in Table 4.

Table 4

One-Way ANOVA Results for Working Memory Across Groups

Source of Variation	Sum of Squares	df	Mean Square	F	Significance (p)
Between Groups	9,697.03	2	4,848.51	42.86	.000*
Within Groups	8,144.76	72	113.12		
Total	17,841.79	74			

The ANOVA results demonstrated that mean working memory scores differed significantly among the three

groups, $F(2, 72) = 42.86, p < .001$. The effect size (η^2) was .54, indicating a large effect according to Cohen (1998).

Based on these findings, it can be concluded that significant differences exist among typically developing students, students with dyscalculia, and students with dyslexia in both processing speed and working memory scores. The observed differences in both indices were associated with medium to large effect sizes, highlighting the importance of these cognitive variables in distinguishing and identifying these groups.

4. Discussion

The present study aimed to compare working memory and processing speed among elementary school students with dyscalculia, dyslexia, and typically developing peers. The findings demonstrated significant differences among the three groups in both cognitive domains. Specifically, students with dyscalculia and dyslexia showed substantially lower performance in working memory and processing speed compared with typically developing students, whereas no statistically significant difference was observed between the two learning disorder groups. These results provide strong empirical support for the assumption that deficits in core cognitive processes represent shared characteristics across specific learning disorders rather than isolated deficits limited to a single academic domain.

The observed differences in processing speed indicate that children with learning disorders experience reduced efficiency in perceiving, encoding, and responding to information. Processing speed is widely recognized as a foundational cognitive mechanism influencing reading fluency, mathematical calculation, and classroom task completion. The present findings align with transdiagnostic evidence demonstrating that slowed processing speed is associated with a wide range of developmental difficulties and may function as a general cognitive vulnerability across diagnostic categories (6). Students with dyslexia and dyscalculia may therefore struggle not only with specific academic skills but also with the rapid information processing required for everyday classroom learning.

These results are also consistent with developmental research highlighting the interaction between processing speed, attention regulation, and executive functioning. Studies examining middle childhood development have shown that slower processing speed is strongly related to executive function limitations and attentional inefficiencies,

both of which contribute to academic underperformance (7). The weaker processing speed performance observed in the learning disorder groups may therefore reflect broader executive system inefficiencies rather than isolated academic deficits. Such cognitive constraints can reduce learning opportunities over time, leading to cumulative academic gaps.

Importantly, the absence of significant differences between students with dyslexia and dyscalculia in processing speed supports theoretical models proposing overlapping neurocognitive mechanisms underlying learning disorders. Previous comparative investigations have reported similar cognitive profiles across reading and mathematics difficulties, suggesting that shared deficits in cognitive efficiency may explain high rates of comorbidity between learning disorders (3). The current findings reinforce the view that dyslexia and dyscalculia should not be conceptualized as entirely independent disorders but rather as conditions sharing underlying cognitive risk factors.

The results related to working memory revealed even larger group differences, with typically developing students outperforming both clinical groups. Working memory plays a central role in learning because it enables children to maintain task-relevant information while performing cognitive operations such as decoding words, solving arithmetic problems, and integrating new knowledge with prior learning. Consistent with the present findings, research has demonstrated that children with reading and mathematics difficulties show impairments across multiple working memory components, including phonological and executive subsystems (3). These impairments limit the ability to manipulate information in real time, resulting in slower learning acquisition.

Evidence from studies on dyslexia indicates that working memory capacity significantly predicts text comprehension performance. Children with dyslexia often struggle to maintain phonological information long enough to integrate linguistic meaning, thereby affecting reading comprehension and academic performance (4). Similarly, research on arithmetic learning difficulties shows that deficits in working memory interfere with numerical processing and procedural calculation skills (5). The similarity of deficits across both learning disorder groups in

the present study further supports the hypothesis of a shared cognitive foundation underlying reading and mathematics impairments.

The magnitude of the effect size observed for working memory differences highlights its importance as a diagnostic and intervention target. Working memory deficits have repeatedly been identified as central mechanisms explaining academic learning problems, particularly when combined with executive functioning limitations. Investigations into ADHD-related reading difficulties have demonstrated that working memory dysfunction can directly contribute to reading impairment even when attention symptoms are controlled (13). This evidence suggests that interventions addressing working memory may produce benefits across multiple academic domains.

The current findings also align with clinical research examining memory functioning in children with learning disorders. Neuropsychological investigations have shown that children with reading disabilities exhibit weaknesses in both short-term and working memory systems, which interfere with the efficient storage and retrieval of academic information (12). Similarly, studies exploring cognitive style among adolescents with specific learning disabilities have emphasized that limited working memory capacity constrains problem-solving strategies and adaptive learning behaviors (14). The present results extend these findings to younger elementary students, indicating that cognitive deficits are already evident during early schooling.

Another important implication concerns the heterogeneity of cognitive profiles among children with learning disorders. Although both dyslexia and dyscalculia groups demonstrated impairments, variability within groups suggests that learning disorders involve complex cognitive patterns rather than uniform deficits. Cognitive profiling research has confirmed that children with learning disabilities display diverse patterns of strengths and weaknesses across cognitive domains (8). Understanding these individual differences is crucial for designing personalized educational interventions rather than applying generalized remediation approaches.

The association between learning difficulties and broader behavioral or emotional challenges provides additional context for interpreting the findings. Research examining SLD phenotypes indicates that cognitive impairments

frequently coexist with emotional and behavioral difficulties, suggesting interconnected developmental pathways (9). Likewise, reviews of intervention studies emphasize that learning problems often overlap with behavioral challenges, requiring integrated intervention models that address both cognitive and psychosocial factors (10). Reduced working memory and processing speed may contribute to frustration, reduced academic self-efficacy, and behavioral disengagement observed among students with learning disorders.

Comorbidity patterns further support this interpretation. Studies investigating children with word-reading difficulties have demonstrated concurrent impairments in auditory processing, attention, and memory systems (11). These overlapping deficits help explain why learning disorders rarely appear in isolation and why students frequently present with complex educational needs. Similarly, research on reading disorder combined with attentional difficulties highlights shared weaknesses in executive control and cognitive regulation (16). The current findings therefore fit within a broader neurodevelopmental framework emphasizing interconnected cognitive systems.

From an educational perspective, the results reinforce the importance of early identification and intervention. Prevalence studies indicate that many children at risk of SLD can be identified through cognitive markers before academic failure becomes pronounced (2). Observational research also shows that academic learning difficulties are widespread and require systematic screening procedures within educational systems (1). Assessing working memory and processing speed may therefore provide valuable tools for early detection and prevention strategies.

The implications of these findings are also consistent with contemporary intervention research emphasizing cognitive-based remediation approaches. Recent studies suggest that interventions targeting cognitive deficits alongside academic instruction produce stronger outcomes for children with learning disorders, particularly when co-occurring difficulties are addressed simultaneously (17). Systematic reviews further highlight the importance of understanding language, cognitive, and emotional factors together when designing effective intervention programs (18). Strengthening working memory and processing speed may

thus represent a promising pathway for improving academic functioning.

5. Conclusion

Finally, developmental research on dyslexia confirms that cognitive deficits influence reading performance across age groups, supporting the stability of underlying cognitive vulnerabilities over time (15). The present findings contribute to this literature by demonstrating that such deficits are clearly observable during elementary school years, reinforcing the importance of early cognitive assessment as part of educational practice.

Despite its contributions, the present study has several limitations that should be acknowledged. First, the sample size was relatively limited and drawn from a specific geographical area, which may restrict the generalizability of the findings to broader populations. Second, the study employed a causal-comparative design, preventing conclusions regarding causal relationships between cognitive deficits and learning disorders. Third, only selected cognitive variables were examined, whereas additional factors such as attention, language ability, executive functioning, and socio-emotional characteristics may also influence academic performance. Moreover, the reliance on standardized testing environments may not fully capture students' real classroom functioning. Future investigations should therefore consider more diverse samples and multidimensional assessment approaches.

Future studies should employ longitudinal designs to examine developmental trajectories of working memory and processing speed across different educational stages. Investigating how cognitive deficits evolve over time may clarify whether early interventions can alter academic outcomes. Researchers are encouraged to include neuropsychological, emotional, and environmental variables simultaneously to construct comprehensive explanatory models of learning disorders. Comparative cross-cultural studies would also be valuable in determining whether cognitive profiles differ across educational systems. Additionally, examining intervention effectiveness targeting cognitive processes could provide stronger evidence for translating research findings into educational practice.

Educational practitioners and school psychologists should incorporate cognitive assessments focusing on

working memory and processing speed into routine screening procedures for students experiencing academic difficulties. Teachers may benefit from instructional strategies that reduce cognitive load, provide structured learning supports, and allow additional processing time for students with learning disorders. Rehabilitation programs should emphasize cognitive training alongside academic remediation to enhance learning efficiency. Collaboration between educators, psychologists, and families is essential to create supportive learning environments that address both cognitive and emotional needs of students with learning disorders.

Authors' Contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interpretation of the results, and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Declaration

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

Transparency Statement

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

Acknowledgments

We hereby express our gratitude to all who helped during the project.

Declaration of Interest

The authors report no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics Considerations

The study placed a high emphasis on ethical considerations. Informed consent obtained from all

participants, ensuring they are fully aware of the nature of the study and their role in it. Confidentiality strictly maintained, with data anonymized to protect individual privacy. The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki.

References

1. Al-Qadri AH, Zhao W, Li M, Al-Khresheh MH, Boudouaia A. The prevalence of the academic learning difficulties: An observation tool. *Heliyon*. 2021;7(10):e08164. [PMID: 34729428] [PMCID: PMC8545695] [DOI]
2. Bozatlı L, Aykutlu HC, Sivrikaya Giray A, Ataş T, Özkan Ç, Güneydaş Yıldırım B, et al. Children at Risk of Specific Learning Disorder: A Study on Prevalence and Risk Factors. *Children (Basel, Switzerland)*. 2024;11(7):759. [PMID: 39062209] [PMCID: PMC11274916] [DOI]
3. Chen R, Georgiou GK, Peng P, Li Y, Li B, Wang J, et al. What Components of Working Memory Are Impaired in Children with Reading and/or Mathematics Difficulties? *Children (Basel, Switzerland)*. 2023;10(10):1719. [PMID: 37892380] [PMCID: PMC10605512] [DOI]
4. López-Resca P, Moraleda-Sepúlveda E. Working memory capacity and text comprehension performance in children with dyslexia and dyscalculia: a pilot study. *Frontiers in Psychology*. 2023;14:1191304. [PMID: 37529304] [PMCID: PMC10389090] [DOI]
5. McLean JF, Hitch GJ. Working memory impairments in children with specific arithmetic learning difficulties. *Journal of experimental child psychology*. 2019;74(3):240-60. [PMID: 10527556] [DOI]
6. Kramer E, Koo B, Restrepo A. Diagnostic associations of processing speed in a transdiagnostic, pediatric sample. *Scientific Reports*. 2020;10:10114. [PMID: 32572148] [PMCID: v] [DOI]
7. Sabhlok A, Malanchini M, Engelhardt LE, Madole J, Tucker-Drob EM, Harden KP. The relationship between executive function, processing speed, and attention-deficit hyperactivity disorder in middle childhood. *Developmental science*. 2022;25(2):e13168. [PMID: 34403545] [PMCID: PMC8847244] [DOI]
8. Cirik M, Sak U, Arslan D, Karaduman E, Opendin E. ASIS cognitive profiles of children with learning disabilities. *Anales de Psicología/Annals of Psychology*. 2023;39(1):72-80.
9. Cristofani P, Di Lieto MC, Casalini C, Pecini C, Baroncini M, Pessina O, et al. Specific Learning Disabilities and Emotional-Behavioral Difficulties: Phenotypes and Role of the Cognitive Profile. *Journal of clinical medicine*. 2023;12(5):1882. [PMID: 36902669] [PMCID: PMC10003319] [DOI]
10. Gabriel T, Börnert-Ringleb M. The intersection of learning difficulties and behavior problems - a scoping review of intervention research. *Front Educ*. 2023;8:1268904. [DOI]
11. Gokula R, Sharma M, Cupples L, Valderrama JT. Comorbidity of auditory processing, attention, and memory in children with word reading difficulties. *Frontiers in psychology*. 2019;10:2383. [PMID: 31695659] [PMCID: PMC6817942] [DOI]
12. Kibby MY, Cohen MJ. Memory functioning in children with reading disabilities and/or attention deficit/hyperactivity disorder: a clinical investigation of their working memory and long-term memory functioning. *Child neuropsychology*. 2008;14(6):525-46. [PMID: 18608219] [PMCID: PMC2656576] [DOI]
13. Kofler MJ, Spiegel JA, Soto EF, Irwin LN, Wells EL, Austin KE. Do Working Memory Deficits Underlie Reading Problems in Attention-Deficit/Hyperactivity Disorder (ADHD)? *Journal of abnormal child psychology*. 2019;47(3):433-46. [PMID: 29923160] [PMCID: PMC6301149] [DOI]
14. Daniel M, John R, Rajkumar E, George AJ, Abraham J. Cognitive style and working memory among adolescents with specific learning disability. *Journal of education and health promotion*. 2022;11:196. [PMID: 36003254] [PMCID: PMC9393926] [DOI]
15. Park H, Lombardino LJ. Relationships among cognitive deficits and component skills of reading in younger and older students with developmental dyslexia. *Research in Developmental Disabilities*. 2013;34(9):2946-58. [PMID: 23816630] [DOI]
16. Turker S, Seither-Preisler A, Reiterer SM, Schneider P. Cognitive and behavioural weaknesses in children with reading disorder and AD (H) D. *Scientific Reports*. 2019;9(1):15185. [PMID: 31645633] [PMCID: PMC6811534] [DOI]
17. Espinas DR, Vaughn S, Fuchs LS. Interventions for children and adolescents with specific learning disability and co-occurring disorders. *Pediatric Research*. 2025:1-9. [PMID: 40681698] [PMCID: PMC12875878] [DOI]
18. Donolato E, Cardillo R, Mammarella IC, Melby-Lervåg M. Research Review: Language and specific learning disorders in children and their co-occurrence with internalizing and externalizing problems: a systematic review and meta-analysis. *Journal of Child Psychology and Psychiatry*. 2022;63(5):507-18. [PMID: 34747025] [DOI]