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TITLE OF THE RESEARCH ARTICLE

Dyslexia and the Visuospatial Sketchpad: An Exploratory Study in Arabic-Speaking Fourth-Grade Students (Evidence from Algeria)

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Abstract

This study explores the relationship between the visuospatial sketchpad (VSS)—a component of working memory—and dyslexia among Arabic-speaking fourth-grade students in Algeria. Thirty students diagnosed with dyslexia participated in this exploratory research, which adopted a descriptive-correlational design and a purposive sampling approach. The study utilized a researcher-developed VSS test and a dyslexia diagnostic test adapted by Dr. Ben Sadoon Fatiha from the L'Alouette assessment.Spearman's rank-order correlation analysis was employed to investigate the associations between VSS subcomponents and reading performance indicators such as total words read, correct words, reading speed, and accuracy. Results revealed no significant correlation between the total VSS score and general reading performance ($p > .05$). However, specific VSS subcomponents demonstrated notable correlations. Visual Pattern Recognition was positively associated with total words read ($\rho = .382$, $p = .037$), correct words ($\rho = .382$, $p = .037$), and reading speed ($\rho = .382$, $p = .037$). Static Spatial Layout exhibited significant correlations with total words read ($\rho = .489$, $p = .006$), correct words ($\rho = .523$, $p = .003$), reading speed ($\rho = .523$, $p = .003$), and accuracy ($\rho = .438$, $p = .015$). Conversely, Spatial Sequence Processing showed a negative correlation with accuracy ($\rho = -.407$, $p = .026$), suggesting a potential trade-off between speed and precision. These findings highlight that certain visuospatial capacities—especially static spatial organization and visual pattern recognition—play a crucial role in supporting reading fluency and accuracy in dyslexic learners. The study recommends further investigations using larger samples to validate these relationships and to inform intervention strategies targeting visuospatial processing in dyslexic populations.

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1. Introduction

Learning disabilities (LDs) are neurodevelopmental disorders marked by persistent difficulties in acquiring academic skills such as reading, writing, or mathematics, despite adequate instruction and average intelligence (American Psychiatric Association, 2013). These difficulties, classified as Specific Learning Disorders (SLDs) in the DSM-5, often stem from deficits in essential cognitive processes like phonological awareness, visuospatial reasoning, and numerical understanding, and are not attributed to sensory impairments or socioeconomic disadvantage but rather to atypical brain development and connectivity (Norton et al., 2015). Among the subtypes of LDs defined by the Individuals with Disabilities Education Act (IDEA) including dysgraphia and dyscalculia, dyslexia is the most prevalent and extensively studied.

Dyslexia is a language-based disorder characterized by difficulties in accurate and fluent word recognition, spelling, and decoding, despite normal intelligence and adequate educational opportunities (Snowling et al., 2020). Traditionally attributed to phonological processing deficits, recent studies have highlighted the role of additional cognitive systems, suggesting a more complex and heterogeneous profile (Peterson & Pennington, 2015). This heterogeneity has led to the classification of dyslexia into subtypes such as phonological dyslexia, which affects sound-letter mapping; surface dyslexia, which impairs recognition of irregular words; and double-deficit dyslexia, which combines phonological difficulties with slow rapid automatized naming (Wolf & Bowers, 1999). Global estimates suggest that dyslexia affects 5–12% of school-aged children, with prevalence varying across languages depending on orthographic transparency (Ziegler & Goswami, 2005). For example, dyslexia is more frequent in English than in more phonetically consistent languages like Italian. In Arabic-speaking regions, including Algeria, dyslexia prevalence is estimated between 6–10% (Al Lamki, 2012), with linguistic factors such as diglossia and complex orthographic features further complicating literacy acquisition (Saiegh-Haddad & Joshi, 2014; Taha, 2013).

Core cognitive deficits associated with dyslexia include poor phonological awareness, slow naming speed, and working memory limitations. Children with dyslexia often struggle to segment or blend phonemes, resulting in decoding difficulties and reading errors (Vellutino et al., 2004). Additionally, impairments in rapid automatized naming (RAN) disrupt the automatic retrieval of verbal labels for familiar symbols, hindering reading fluency (Kirby et al., 2003). Working memory (WM) which enables temporary storage and manipulation of information—is also frequently impaired in dyslexic individuals, affecting both verbal and visuospatial domains (Swanson & Jerman, 2007). According to Baddeley's multicomponent model (2000), WM comprises the central executive, phonological loop, episodic buffer, and visuospatial sketchpad (VSSP). While most dyslexia research has focused on phonological WM, growing evidence suggests that deficits in the VSSP may also play a role, especially in languages like Arabic that demand strong visual discrimination skills due to script complexity and diacritics (Abu-Rabia & Siegel, 2002).

Several studies have reported that dyslexic children show deficits in visuospatial tasks such as mental rotation, puzzle completion, and spatial span (Poblano et al., 2000; Lipowska et al., 2011; Menghini et al., 2011), while a meta-analysis by Du & Zhang (2023) found consistent underperformance on VSSP tasks among dyslexic children compared to their peers. These findings suggest that dyslexia may involve broader working memory dysfunction beyond phonological processing. However, other studies argue that VSSP impairments are not a core feature of dyslexia. Some researchers have found that phonological deficits are more consistently linked to reading impairments, with visuospatial difficulties either absent or limited to more complex tasks (Ramus, 2003; Smith-Spark & Fisk, 2007). For example, while some dyslexic individuals struggle with spatial manipulation, they may perform adequately on basic visuospatial span tests, suggesting that task complexity influences outcomes (Chamberlain et al., 2018).

Despite increasing attention, research on the role of the visuospatial sketchpad in dyslexia remains limited and inconclusive, especially in non-English-speaking contexts. In Arabic-speaking populations, very few studies have examined the link between VSSP and dyslexia, leaving a gap in understanding how visuospatial processing may influence reading acquisition in languages with complex orthographic systems. Furthermore, the lack of standardized assessment tools and the limited number of studies examining the full spectrum of dyslexic symptoms in relation to each component of the visuospatial sketchpad constrain our ability to draw firm conclusions. This study aims to address these gaps by investigating the relationship between the visuospatial sketchpad and dyslexia among 4th-grade Arabic-speaking students, with the goal of clarifying the role of visual and spatial working memory in dyslexic reading profiles.

Study Question: Is there a significant correlation between visuospatial sketchpad and dyslexia in fourth grade students?

Hypothesis: There is a significant correlation between visuospatial sketchpad and dyslexia in fourth grade students.

General Objective: To investigate the relationship between visuospatial sketchpad (VSS) and dyslexia in 4th grade students.

2. Method

Research Design

This study used a quantitative, descriptive correlational design to explore the relationship between the visuospatial sketchpad (VSS) and dyslexia in 4th-grade students. Specifically, it examined whether visuospatial processing skills, such as pattern recognition, spatial layout, and visual attention, are significantly associated with common dyslexia indicators, including reading accuracy, speed, and error rate. Data were collected using a researcher-developed VSS test and an adapted version of the L'Alouette reading assessment, tailored for Arabic-speaking learners by Dr. Ben Sadoon Fatiha.

Participants / Sample

A purposive sampling method was used to ensure participants met the specific criteria for the study.

The participants were 4th-grade students aged 9 to 10 years from public primary schools, all formally identified with dyslexia. Inclusion criteria required normal hearing and vision, no diagnosed neurological or intellectual disabilities, and enrollment in 4th grade. Students with comorbid conditions such as ADHD, autism spectrum disorder, or uncorrected sensory impairments were excluded.

Tools / Materials

Two main instruments were used to assess visuospatial working memory and dyslexia in 4th-grade students.

Visuospatial Sketchpad Assessment Scale (VSS): Developed by the researcher, this tool evaluates visuospatial working memory in children aged 8 to 10. It is based on Logie's (2014) model, which divides the VSS into the *visual cache*, responsible for storing visual details like shapes and colorsand the *inner scribe*, which handles spatial and movement-related information.

Dyslexia Scale: To assess dyslexia, the study used the Algerian adaptation of the *l'Alouette Test*, originally adapted by Ben Saadoon Fatiha (2015) for Arabic-speaking learners. The test measures both quantitative indicators (e.g., total words read, reading speed, number of errors, accuracy) and qualitative features (e.g., unfamiliar words, phoneme-letter confusion, semantic interference).

Procedure

The study followed a two-phase process. In the pilot phase, the researcher-administered Visuospatial Sketchpad (VSS) Assessment Scale was tested with 31 fourth- and fifth-grade students to evaluate its reliability and cultural fit. Based on results, minor revisions were made to improve clarity. At the same time, students with confirmed dyslexia were identified in collaboration with school staff.

In the main phase, selected students were individually assessed using the revised VSS scale in quiet school settings to ensure consistency. Data collection, including assessments and observations, took place over five weeks between April 6 and May 8, 2025.

Data Collection

Data were collected in person at public schools in quiet, comfortable settings. The researcher individually administered all assessments to ensure consistency and accurate pacing.

During the pilot phase, data from 31 students were used to assess the VSS tool's reliability and validity. A list of previously diagnosed dyslexic students meeting the study criteria was compiled with school staff.

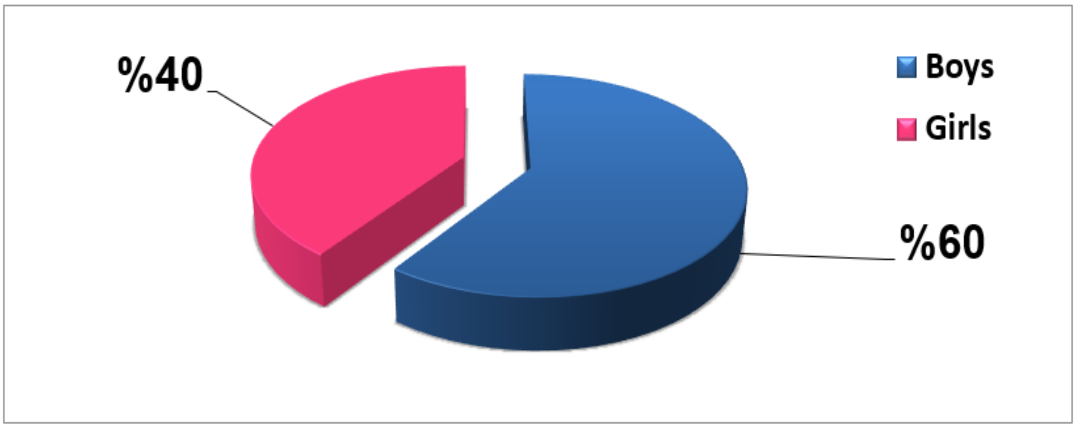
In the main phase, these students completed both the VSS and Dyslexia Scales, with the researcher documenting observations during testing. All data were securely stored, anonymized, and analyzed using SPSS, following ethical research protocols.

3. Results

Demographic Characteristics of the Study Sample

The sample included 30 students diagnosed with dyslexia, with a higher proportion of males (18 boys, 60%). Some schoolssuch as Abi Ishaq, Noah Aisha, and Sheikh Saleh Dawoudi, reported the highest number of cases (3 each), while others, like Abi Mahdi Issa, reported none, possibly due to under-identification rather than an actual absence of cases.

Figure 1 : Gender Distribution among Students with Dyslexia



Note: The figure shows that males constitute 60% of the sample compared to 40% for females, reflecting a higher prevalence of dyslexia among males.

Descriptive Statistics of Test Scores for the Study Sample

Descriptive Statistics for VSS Test Scores in the Study Sample

Descriptive statistics for the Visuospatial Sketchpad (VSS) test (N = 30) (Table 01) showed total scores ranging from 68 to 112, with a mean of 87.13 (SD = 11.72), reflecting moderate to high visuospatial abilities. The highest subtest mean was in Color and Texture Representation (M = 5.57, SD = 0.73), while Mental Rotation had the lowest (M = 3.17, SD = 1.26), indicating greater difficulty. Variability in Visual Cache and Inner Scribe scores (SD = 9.67 and 5.38) suggests notable individual differences in spatial memory processing. These findings set the stage for examining links between VSS and reading outcomes.

Table 01: Descriptive Statistics for VSS Test Scores in the Study Sample.

Component	**N**	**Min**	**Max**	**Mean**	**SD**
Visual Detail Storage	30	2.0	6.0	4.17	1.51
Visual Pattern Recognition	30	2.0	6.0	4.83	1.34
Static Spatial Layout	30	2.0	6.0	5.00	1.11
Color Texture Representation	30	4.0	6.0	5.57	0.73
Visual Cache	30	28	71	49.07	9.67
Spatial SequenceProcessing	30	2.0	6.0	4.23	1.04
Mental Rotation	30	2.0	6.0	3.17	1.26
Movement Planning	30	3.0	6.0	4.93	1.08
RehearsalRefreshing	30	2.0	6.0	4.53	1.07
Dynamic Spatial Attention	30	2.0	6.0	4.33	1.03
Inner Scribe	30	27	47	38.07	5.38

Descriptive Statistics of Dyslexia Test Quantitative Scores in the Study Sample:

Descriptive statistics for the dyslexia test (Table 02)revealed wide variability in reading skills among participants. The average number of words read was 65.67 (SD = 44.39), with correct words averaging 44.20 (SD = 35.57) and errors averaging 21.47 (SD = 14.24). The mean accuracy index was 58.05% (SD = 20.06), ranging from 21.4% to 89.5%. The speed index closely mirrored correct word count, suggesting alignment between speed and accuracy. These findings highlight diverse reading profiles within the sample, supporting further analysis of their relationship with visuospatial skills.

Table 02: Descriptive Statistics of Dyslexia Test Scores in the Study Sample.

Reading Performance Variable	**N**	**Min**	**Max**	**Mean**	**SD**
Total Words Read	30	4.0	143	65.67	44.39
Number of Errors	30	3.0	57	21.47	14.24
Correct Words Read	30	1.0	128	44.20	35.57
Accuracy Index (%)	30	21.4	89.5	58.05	20.06

Speed Index	30	1.0	128	44.20	35.57

Descriptive Statistics of Dyslexia Test Qualitative Scores in the Study Sample:

In the qualitative analysis of the dyslexia test, all 30 students (100%) showed decoding difficulties, especially with unfamiliar words, including letter reversals, substitutions, and phoneme-level errors such as omissions, additions, or confusions (e.g., ب and ث). Harakat-related issues were also widespread, with students often ignoring or misapplying vowel markings.

Two-thirds of the students (66.7%) made verbal similarity errors, misreading visually similar words or struggling to retrieve familiar ones. Notably, no semantic interference errors were observed, suggesting that deeper comprehension remained relatively intact despite surface-level decoding issues.

All students exceeded the expected reading time, and each used compensatory strategies such as finger-tracking, leaning in, guessing from context, or sounding out letters. These behaviors reflect adaptive efforts to manage reading challenges and provide insight into how dyslexia manifests in both errors and coping strategies.

Correlation Between VSS Total Score and Dyslexia test score

Spearman's correlation analysis (Table 03) showed no significant associations between total VSS scores and dyslexia indicators ($p > .05$). The strongest trenda weak positive correlation with number of errors ($\rho = .271$, $p = .147$)was not statistically significant. Other correlations, including total words read, correct words, accuracy, and speed (ρs ranging from .076 to .167), were also weak and non-significant. These results suggest no meaningful relationship between visuospatial ability and dyslexia outcomes in this sample.

Table 03: Correlation Between VSS Total score and Dyslexia score.

Variable	**ρ (Spearman's rho)**	**Sig. (p-value)**
Total Words Read	.167	.379
Number of Errors	.271	.147
Correct Words Read	.127	.504
Accuracy (%)	.076	.689
Speed	.127	.504

Correlational Analysis Between VSS Components and Dyslexia Test Results

Spearman's rank-order correlations (Table 04) revealed significant relationships between specific visuospatial sketchpad (VSS) components and reading performance in students with dyslexia. Notably, *Visual Pattern Recognition* showed significant positive correlations with total words read, correct words read, and reading speed ($\rho = .382$, $p = .037$ for all), indicating that stronger visual recognition skills may support reading fluency.

Static Spatial Layout emerged as the strongest predictor, with significant associations across multiple reading outcomes: total words read ($\rho = .489$, $p = .006$), correct words ($\rho = .523$, $p = .003$), speed ($\rho = .523$, $p = .003$), and accuracy ($\rho = .438$, $p = .015$). *Dynamic Spatial Attention* was also significantly related to total words read ($\rho = .387$, $p = .034$), correct words ($\rho = .371$, $p = .043$), and speed ($\rho = .395$, $p = .031$), suggesting that sustained spatial focus contributes to better reading outcomes.

In contrast, *Spatial Sequence Processing* was negatively correlated with accuracy (ρ = −.407, p = .026), implying that difficulties in processing spatial order may affect reading precision. *Movement Planning* showed a mixed pattern, positively correlating with both total words read (ρ = .384, p = .036) and number of errors (ρ = .416, p = .022), suggesting a trade-off between reading volume and accuracy.

Other components, including *Visual Cache*, *Color and Texture Representation*, and *Inner Scribe*, did not yield significant correlations (p > .05), though *Color and Texture Representation* showed a non-significant trend toward a positive relationship with total words read (ρ = .324, p = .080). *Rehearsal Refreshing* approached significance with speed (ρ = −.357, p = .053), suggesting potential relevance in larger samples. Overall, the findings highlight how distinct visuospatial abilities relate differently to specific aspects of reading performance.

Table 04: Correlational Analysis Between VSS Components and Dyslexia Test Results.

VSS Component	**Total Words**	**Errors**	**Correct Words**	**Accuracy**	**Speed**
Visual Cache	.114	.215	.085	.073	.085
Visual Detail Storage	.250	.217	.217	.097	.217
Visual Pattern Recognition	.382*	.265	.382*	.304	.382*
Static Spatial Layout	.489**	.310	.523**	.438*	.523**
Color& Texture Representation	.324	.303	.304	.268	.304
Inner Scribe	−.021	.123	−.085	−.159	−.089
Spatial Sequence Proc.	−.266	−.186	−.301	−.407*	.015
Mental Rotation	.200	.224	.162	.104	−.018
Movement Planning	.384*	.416*	.348	.288	.275
RehearsalRefreshing	−.288	−.168	−.294	−.179	−.357†
Dynamic Spatial Attention	.387*	.331	.371*	.221	.395*

Summary of Key Findings

This study investigated whether there is a relationship between visuospatial sketchpad abilities and dyslexia in 4th-grade students. The research focused on three objectives: first, to assess students' visuospatial skills using a researcher-developed tool; second, to measure reading performance through key dyslexia indicators such as reading speed, accuracy, and error rates; and third, to explore possible correlations between these two areas.

Findings showed that while students displayed varying levels of visuospatial skills and reading ability, the overall visuospatial sketchpad score did not significantly correlate with the overall dyslexia scores. In other words, children who performed better or worse on the visuospatial tasks did not consistently show better or worse reading outcomes. Based on this, the study concludes that there is no significant relationship between total visuospatial sketchpad ability and dyslexia in this sample of 4th-grade students.

4. Discussion

This study examined the link between the Visuospatial Sketchpad (VSS) and dyslexia in fourth-grade students, using Logie's (2014) updated working memory model. the results showed no significant correlation between VSS performance and dyslexia scores.

In fact, the results align with several studies support the lack of a clear link between visuospatial skills and dyslexia. For example, Duranovic et al. (2015) used the Paper Folding Test and found no consistent differences between dyslexic and non-dyslexic readers, suggesting that isolated visual tasks may not reflect the complexity of visuospatial processing in literacy. Similarly, Winner et al. (2001) reported no significant group differences in mental rotation, visual scanning, or memory using the Vandenberg Test and the Rey-Osterrieth Figure. Brunswick et al. (2010) and Helland & Asbjørnsen (2003) also found no spatial deficits in dyslexic groups using standard two-dimensional assessments like the WISC-R and the Aston Index.

Even studies linking spatial reasoning to math show a similar pattern. Tosto et al. (2014), using the Spatial Reasoning Test by Smith and Lord (2002), found associations with math skillsbut not reading. This supports the idea that certain visuospatial tasks may not capture literacy-related differences. Overall, when visuospatial skills are assessed in isolation or without a strong theoretical basis, findings on dyslexia remain limited. This suggests a need for more integrated, context-rich approaches to better understand the role of visuospatial processing in reading.

A key strength of this study is its comprehensive, theory-driven design. Unlike earlier work that often relied on one or two subtests, this study used a broader battery based on Logie's (2014) multicomponent model of the Visuospatial Sketchpad (VSS). This model distinguishes between the visual cache (static visual details), the inner scribe (dynamic spatial and sequential information), and the role of executive functions in managing spatial content. By including diverse componentssuch as visual storage, pattern recognition, spatial sequencing, mental rotation, and dynamic attention, the study offered a more nuanced view of visuospatial processing.

This theoretical framework was crucial in interpreting the lack of a significant correlation between total VSS scores and dyslexia. Rather than indicating an absence of connection, the null result may reflect the complexity of the VSS itself. As Logie (2014) emphasizes, the VSS consists of multiple subsystems. Collapsing these into a single score may mask meaningful relationships, as some subsystems could be relevant to reading while others are notdiluting potential effects and obscuring specific cognitive patterns linked to dyslexia.

When examined at the component level, several specific VSS functions, such as visual pattern recognition, static spatial layout, spatial sequence processing, movement planning, and dynamic spatial attentionwere significantly correlated with dyslexia scores. These align with cognitive processes central to reading. For example, spatial sequence processing supports letter order, a known difficulty in dyslexia (Goswami, 2011), while dynamic spatial attention aids in visual scanning and shifting focus across textkey challenges highlighted by visual attention theories (Vidyasagar & Pammer, 2010).

Visual pattern recognition is essential for orthographic processing, enabling readers to recognize familiar letter patterns and word forms, an area where dyslexic readers often struggle. Static spatial layout, though less commonly discussed in reading research, may influence abilities like tracking text, maintaining visual orientation, and distinguishing similar letters (Brunswick et al., 2010). Such subtle spatial difficulties can disrupt reading flow and accuracy, particularly for young or struggling readers.

Movement planning, typically linked to motor coordination, may also influence reading by supporting eye movement control and saccadic coordination, both essential for fluent reading (Stoodley et al., 2005). Disruptions in this process could contribute to the irregular, effortful reading patterns often seen in dyslexic children.

In contrast, some VSS componentssuch as visual detail storage (color, texture), mental rotation, and rehearsal/refreshing, showed no significant correlation with dyslexia. While this may seem unexpected, it reinforces the idea that not all visuospatial skills are relevant to reading. For example, visual detail storage involves surface-level features like hue or brightness, which play little role in recognizing abstract letter forms. Reading relies more on spatial orientation and symbolic recognition than on detailed visual perception. As Snowling (2006) emphasized, dyslexia is rooted in phonological and orthographic processing, not low-level visual encoding. This is supported by visual attention theories, which locate the core dysfunction in the dorsal, not ventral, visual stream (Vidyasagar & Pammer, 2010).

Mental rotation, a common benchmark in visuospatial testing, also showed no significant link to dyslexia in this study. While valuable in STEM and spatial reasoning, its relevance to reading appears limited. Mental rotation involves manipulating 3D objects in space, whereas reading is a 2D, static task with fixed letter orientations. Although early theories linked letter reversals in dyslexic children to poor mental rotation, later research suggests these reversals are a normal developmental phase, not a marker of spatial deficits (Simos et al., 2002).

Similarly, the rehearsal/refreshing componentassessing the ability to mentally sustain visual-spatial images, did not correlate with reading performance. This aligns with the idea that fluent reading relies less on visual rehearsal and more on rapid integration of phonological, orthographic, and attentional processes. Unlike the phonological loop, which supports decoding through verbal rehearsal, visual rehearsal has not shown consistent links to literacy outcomes (Smith-Spark & Fisk, 2007).

The findings of this study support the growing view that dyslexia involves selective cognitive vulnerabilities rather than a broad visuospatial deficit. Components of the Visuospatial Sketchpad (VSS) related to color perception, 3D manipulation, and non-verbal rehearsal showed no link to dyslexia, consistent with its core challenges in phonological awareness, orthographic processing, and visual attention. This highlights the limitations of relying on total VSS scores, which may obscure important subcomponent-level differences.

Within Logie's (2014) multicomponent model, the results point to a dual vulnerability. Difficulties with visual pattern recognition and static spatial layout suggest weaknesses in the visual cache, while issues with spatial sequencing, movement planning, and dynamic attention implicate the inner scribe. Together, these findings suggest that dyslexia may involve deficits in both visual storage and spatial processing, but not across the entire VSS system.

However, this study has limitations. The sample size (n = 30), similar to previous research (e.g., Duranovic et al., 2015; Von Károlyi et al., 2003), may have limited the statistical power to detect smaller or more subtle effects. It's possible that weaker associations, particularly in less central VSS components, were missed. Future research should replicate these findings with larger, more diverse samples across different languages and educational settings to determine if these component-level patterns apply more widely.

Taken together, these results speak to the value of a multicomponent, theory-guided approach to cognitive assessment in dyslexia. Traditional studies have often relied on single-task or global visuospatial measures, which may fail to capture the complexity of the systems involved. This study demonstrates that breaking the VSS into its core processes, rather than treating it as a unified construct, provides far more insight into how specific visuospatial functions relate to the reading difficulties experienced by students with dyslexia.

While this study offers meaningful insights into the link between visuospatial skills and dyslexia in primary school children, several limitations must be acknowledged. Most notably, the small sample size (N = 30) limited statistical power and generalizability. Although consistent with previous research, a larger sample would have allowed for more robust analyses and exploration of moderating variables such as gender or language background.

Practical constraints, including time and restricted school access, also shaped the sample's demographic composition, limiting the external validity of findings. The sample came from a narrow educational context, which may not reflect the broader population.

Methodologically, the study relied on paper-based assessments, which may not fully capture dynamic visuospatial processes like eye movement or attentional shifts during reading. Finally, the cross-sectional design limited the ability to track developmental changes or establish causality.

Despite these limitations, the findings point to practical implications and directions for future research. Educational professionals should consider assessing specific visuospatial components rather than relying on general spatial ability tests when supporting students with dyslexia. The study showed that subskills like spatial sequence processing, dynamic attention, and visual pattern recognition were more closely linked to reading outcomes than broader visuospatial scores. This suggests that targeted interventions, such as structured visual tracking activities or tasks that support spatially anchored phoneme-grapheme mappingcould complement traditional phonological approaches and offer more holistic support.

Future research should build on this work by increasing sample size and incorporating more ecologically valid and dynamic assessment tools, such as interactive digital tasks or eye-tracking technology. These methods could provide a more accurate reflection of how visuospatial processing supports reading in real-world classroom settings. Applying Logie's (2014) multicomponent model of working memory continues to offer a promising framework, but further studies should investigate how the visual cache and inner scribe interact with phonological and orthographic systems over time. Longitudinal designs, in particular, would allow researchers to observe how these abilities evolve with reading instruction and intervention.

In sum, while the current study is limited in scope, it contributes to a growing understanding of how specific visuospatial processes may influence reading development in children with dyslexia. By moving beyond broad diagnostic categories and exploring underlying cognitive mechanisms, both educators and researchers can work toward more precise, personalized, and effective support strategies.

Dyslexia, a neurodevelopmental disorder characterized by difficulties in reading fluency and accuracy, is often linked to deficits in working memory components, particularly the visuospatial sketchpad (VSS). The VSS plays a vital role in processing and temporarily storing visual and spatial information necessary for reading and comprehension. Understanding how visuospatial mechanisms interact with reading abilities in Arabic-speaking children is crucial, given the unique orthographic and phonological structure of the Arabic script. This study aims to explore the relationship between VSS subcomponents and reading performance in Arabic-speaking fourth-grade students with dyslexia, providing empirical evidence from Algeria to enrich the global discourse on dyslexia and cognitive processing.

2. Methodology

2.1 Research Design
The study adopted a descriptive-correlational design, allowing the identification of relationships between VSS subcomponents and reading measures without manipulation of variables.

2.2 Participants
Thirty Arabic-speaking fourth-grade students (aged 9–10 years) diagnosed with dyslexia were selected from public primary schools in Ouargla, Algeria, using a purposive sampling method.

2.3 Instruments
Visuospatial Sketchpad (VSS) Test – Developed by the researchers to assess subcomponents including Visual Pattern Recognition, Static Spatial Layout, Movement Planning, Dynamic Spatial Attention, and Spatial Sequence Processing.
Dyslexia Test – Adapted by Dr. Ben Sadoon Fatiha from the French L'Alouette reading test to evaluate total words read, correct words, reading accuracy, and speed in Arabic.

2.4 Data Collection and Analysis
Testing was conducted individually in quiet school environments. Data were analyzed using Spearman's rank-order correlation to determine associations between VSS subcomponents and reading variables. Significance levels were set at $p < .05$.

Results and Discussion

Results indicated no significant overall correlation between total VSS performance and total reading outcomes. However, strong associations were found between Static Spatial Layout and multiple reading indicators, as well as between Visual Pattern Recognition and reading speed and fluency. The implications extend to educational interventions emphasizing visuospatial skill training to enhance reading efficiency among dyslexic learners in Arabic-language contexts.

Ethical Considerations

All ethical and legal standards for research involving children were strictly followed. Informed consent was obtained from parents prior to participation. The study was approved by the institutional ethics committee of Kasdi-Merbah University, Ouargla. Participant anonymity and data confidentiality were ensured throughout the research process.

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Author Contributions

All authors contributed equally to the study's design, data collection, analysis, and manuscript preparation. Each author has read and approved the final version of the article prior to submission.

Conflict of Interest

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