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VÝZKUMNÁ STUDIE

The Test of Silent Word Reading as a Diagnostic Tool for The Identification of Dyslexia in Pupils of School Age

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Abstract: The paper introduces a new Slovak diagnostic tool, the Test of Silent Word Reading, designed to assess the fluency of silent reading at word level. This brief test takes only 3 minutes, making it suitable for individual and group administration. It comprises two distinct forms, A and B, facilitating repeated testing for monitoring reading progress. Building on a pilot survey conducted among primary education pupils, the test demonstrated acceptable reliability and strong concurrent validity. The study's objective was to investigate whether pupils diagnosed with dyslexia perform worse on the Test of Silent Word Reading than their non-dyslexic counterparts and whether this test could be utilized for diagnostic purposes in the future. Analyzing a sample of 23 pupils diagnosed with dyslexia and 23 control pupils without dyslexia from grades 2 to 5 in primary schools, the study confirmed that dyslexic pupils performed significantly worse in both versions of the test (A and B), as evidenced by the observed scores, raw scores, errors, and percentage correct. However, there were no statistically significant differences between the two groups in terms of correction parameters. The observed differences exhibited a moderately strong effect size. The study's findings suggest that the Test of Silent Word Reading holds promise for future diagnostic applications in identifying dyslexia among school-age children in clinical and educational settings.

Key words: Test of Silent Word Reading, silent reading fluency, dyslexia diagnosis, school age

Abstrakt: Príspevok predstavuje nový slovenský diagnostický nástroj Test tichého čítania slov, ktorý je zameraný na hodnotenie plynulosti tichého čítania na úrovni slov. Ide o krátky, rýchly, 3-minútový test, ktorý je možno administrovať individuálnou aj skupinovou formou. Test má dve rôzne formy, A a B, ktoré môžu slúžiť na opakovanú administráciu a identifikáciu pokroku v čítaní. Na základe predchádzajúceho pilotného prieskumu na súbore žiakov primárneho vzdelávania bola preukázaná jeho akceptovateľná reliabilita a solídna súbežná validita. Cieľom výskumu bolo overiť, či žiaci s diagnostikovanou dyslexiou podávajú v Teste tichého čítania slov

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slabšie výkony ako žiaci bez dyslexie a či predstavený test by mohol v budúcnosti slúžiť aj na diagnostické účely. Na výskumnom súbore 23 žiakov s diagnostikovanou dyslexiou a 23 kontrolných žiakov bez dyslexie 2. – 5. ročníka základných škôl sa potvrdilo, že žiaci s dyslexiou dosahujú štatisticky významne horšie výkony v oboch verziách testu, A aj B, v sledovaných skóre – hrubé skóre, chyby a percento správnosti, avšak v parametri opravy neexistujú medzi týmito skupinami štatisticky významné rozdiely. Preukázané rozdiely majú z hľadiska hodnotenia veľkosti efektu stredne silný efekt. Výsledky výskumu naznačujú, že Test tichého čítania slov môže v budúcnosti slúžiť na diagnostické účely pri stanovovaní diagnózy dyslexia u detí v školskom veku v klinickej i školskej praxi.

Kľúčové slová: Test tichého čítania slov, plynulosť tichého čítania, diagnostika dyslexie, školský vek

Introduction

Reading plays a crucial role in today's society, serving as a fundamental indicator of literacy and a necessary component of social activities such as communication, education, and engagement with social media. This intricate process of deriving meaning from abstract written symbols stands as the primary means of accessing information in our modern age (Handler & Fierson, 2011). Accurate and fluent reading comprehension is indispensable for daily life, cognition, education, and workplace functionality (Krieber et al., 2016).

Difficulties in reading pose a significant challenge for individuals, manifesting in poor comprehension of text, limited vocabulary, and a negative attitude towards reading (Lyon, Shaywitz & Shaywitz, 2003). Moreover, reading difficulties can have broader repercussions, such as hindering educational attainment and influencing career choices (Morris & Turnbull, 2007).

Dyslexia as a subtype of developmental learning disorders

Developmental learning disorders are globally acknowledged as a diverse range of disorders affecting academic abilities and are included in all major diagnostic classifications, such as the Diagnostic and Statistical Manual of Mental Disorders and the International Classification of Diseases (Grigorenko et al., 2020).

In the latest, 11th revision of the International Classification of Diseases (WHO, 2019), dyslexia is classified under Developmental learning disorders (code 6A03) and more specifically defined as a Developmental learning disorder with impairment in reading (code 6A03.0). It

is characterized by significant and persistent difficulties in acquiring academic reading-related skills, such as word reading accuracy, reading fluency, and reading comprehension. The individual's reading performance falls significantly below the expected level for their chronological age and level of intellect, resulting in substantial impairment in academic or occupational functioning. A developmental learning disorder with impairment in reading is not attributed to disorders of intellectual development, sensory impairment, neurological disorders, lack of access to education, lack of proficiency in the language of academic instruction, or psychosocial disadvantage.

The European Dyslexia Association (EDA, 2020) reports that dyslexia affects approximately 9–12% of the population, with a severe form observed in 2–4% of school-age children. In Slovakia, 3.2% of children were integrated into primary schools in 2019 (Slovak Centre of Scientific and Technical Information, 2020). However, it's important to note that this figure encompasses all developmental learning disorders and not only dyslexia. This suggests a significant underdiagnosis of dyslexia, or probably captures only the most severe disorders, which means that at least 6% of children are not identified and consequently do not receive appropriate support.

Dyslexia is a developmental learning disorder with a neurobiological origin (Lou et al., 2019), manifests in varying degrees of severity (Shaywitz & Shaywitz, 2005), and persists into adulthood (Vellutino et al., 2004).

Depending on its manifestations, dyslexia can significantly influence the life decisions of individuals, as they may opt to avoid studies and career paths that require extensive reading. In addition to being a considerable barrier to academic success, dyslexia has been shown to have a detrimental impact on employment and career progression (Morris & Turnbull, 2007).

Schulte-Körne (2010), drawing on various research studies on the psychological well-being of children and adolescents with dyslexia, concludes that 40 to 60% of individuals in this group experience psychological issues, including anxiety and depression. This percentage is notably higher than the general prevalence of mental disorders, which, according to data from the German Child and Adolescent Mental Health Survey, ranges between 5 and 18%, depending on the diagnostic criteria. Children with dyslexia, even in elementary school, often encounter negative thoughts, depression, a melancholic mood, and anxiety related to school. They frequently feel excluded, unaccepted, and rejected by teachers. The rate of negative thoughts and suicide attempts is three times higher in adolescents with dyslexia, the occurrence of depression is twice as common, and anxiety disorders are up to three times more frequent.

To mitigate the significant psychosocial implications of dyslexia, it is crucial to promptly identify students experiencing reading difficulties and offer them appropriate compensatory strategies or sufficient support for the enhancement of their reading skills. Reliable diagnostic tools are essential for the early identification of these children, enabling the identification of dyslexia reliably, both within educational settings and counselling services.

Oral versus silent reading

Reading can occur in two ways: as oral reading, where students read aloud with appropriate phrasing, or silently, where the text is processed automatically without oral output (Wissinger et al., 2023). Currently, research has shown that oral and silent reading are different constructs, not only on a behavioural level (Robinson, 2019) but also on a neurobiological level. In neurotypical children, both reading modes are processed in distinct neuroanatomical regions (Xia et al., 2018).

While oral and silent reading share the same fundamental processes and strategies, reading aloud entails more ongoing processes than reading silently. The primary distinction between these two reading modes lies in verbalization (Krieber et al., 2017); in other words, when reading aloud, speech production must be coordinated with ongoing language perception, including the pronunciation of words, intonation, etc. (Kim, Petcher & Vortius, 2019). Because oral reading necessitates the production of understandable speech, it is considerably slower compared to silent reading (Laubrock & Kliegl, 2015). Silent reading is less demanding than oral reading due to the additional demands caused by oculomotor movements synchronized with articulatory processes in silent reading (Krieber et al., 2017).

Silent reading typically emerges in development after oral reading (Laubrock & Kliegl, 2015). In elementary school, during reading instruction, the emphasis swiftly shifts from decoding aloud to silent reading. As students advance and gain proficiency in oral reading, they tend to gravitate towards silent reading, where they also display enhanced speed (Krieber et al., 2017). Within the first three years of formal education, children may not clearly prefer either reading mode (Smyrnakis et al., 2021), but after this period, silent reading becomes the favoured approach (van den Boer, van Bergen & de Jong, 2014), and for adept readers, the primary method (Rayner, 1998). Research confirms that oral reading is slower than silent reading, not only among children but also adolescents (van den Boer, Bazen, & de Bree, 2022). Typical readers read 4–9%

faster when reading silently compared to reading aloud (van den Boer et al., 2014; van den Boer et al., 2022).

Reading fluency is a multifaceted construct that exhibits bidirectional relationships with other language abilities (Berninger et al., 2010). An essential aspect of functional reading is fluency. Fluency in oral reading can be delineated by three primary components: automaticity of word recognition (i.e., speed), decoding accuracy, and appropriate utilization of prosodic features of speech during reading (Kuhn & Stahl, 2003). Norton and Wolf (2012) conceptualize "fluency" in a more complex way than merely the pace and precision of oral reading, recognizing that much of our reading occurs silently. They define it as the "fluency of understanding" of the text, indicating a manner of reading in which all perceptual, linguistic, and cognitive processes operate precisely and automatically, allowing ample time and cognitive resources for comprehension and deeper reflection. Conversely, van den Boer et al. (2022) construe fluency in a narrower sense, focusing on word recognition, particularly the number of syllables a reader can accurately identify within a given time frame. They characterize reading fluency as the metric of reading that most effectively distinguishes between proficient and struggling readers.

The findings of the study conducted by Psyridou et al. (2023) confirm that silent reading fluency can bolster reading comprehension in typical readers during the early years of formal education. Conversely, proficient reading comprehension can also enhance silent reading fluency in later grades. In a study by Prior et al. (2011), which involved 173 children in grades 1 through 7, a comparison between oral and silent reading in relation to reading comprehension was made. The results indicated that oral reading is the optimal approach for comprehending text from 1st to 5th grades. By 6th grade, neither reading mode demonstrated superiority over the other in terms of comprehension. Nevertheless, silent reading has been shown to enhance reading comprehension starting in the 7th grade.

The minimum number of words read aloud for successful comprehension by English pupils in the 2nd grade of elementary school is 63 words per minute (Burns et al., 2011). This figure corresponds to the socially acceptable rate of reading, which ranges from 60 to 70 words per minute (Matějček, 1974). In contrast, Slovak pupils already meet this criterion at the beginning of the second grade (October/November), with their average speed reaching 63 words per minute, which increases to 79 words per minute by the end of the school year (Zubáková & Mikulajová, 2021).

The relationship between speed and comprehension is more pronounced

among typical readers than among struggling readers. Fourth-grade English speakers who could accurately read between 120–140 words per minute, equivalent to the pace of conversational speech, exhibited superior comprehension. Conversely, an increase in reading speed had an adverse effect on reading comprehension. Although some typical students reached speeds of nearly 200 words per minute, such rapidity did not necessarily correlate with improved comprehension. It appears that proficient readers require a higher speed (at least 70 words/min.) to achieve average comprehension levels, whereas children with dyslexia typically exhibit much lower speeds (at least 40 words/min.) (O'Connor, 2018).

The average silent reading speed for adults is 12.5 syllables per second, nearly twice the pace of reading aloud. Silent reading speed tends to increase from adolescence through the completion of university studies, while the rate of reading aloud remains relatively constant. As a result, silent reading fluency typically improves until early adulthood, establishing it as the quickest and most efficient mode of reading (Ciuffo et al., 2017).

Although the linguistic-cognitive precursors of oral reading are relatively well-documented across different language typologies (e.g., Caravolas et al., 2012), there is still insufficient scientific investigation into whether this also applies to silent reading. The results of a longitudinal study by Bar-Kochva (2013) of Hebrew-speaking children, spanning from preschool age to the end of the second year of elementary school, indicate that the language-cognitive skills fundamental to learning to read aloud are also essential for the development of silent reading. In another study by van den Boer et al. (2014) involving Dutch fourth graders, they examined key abilities for both oral and silent reading, discovering that rapid automatic naming is more predictive of reading aloud, whereas visual attention span is more closely associated with silent reading.

Silent Reading Fluency and Its Diagnostic Significance

There is now evidence indicating that children and adolescents with dyslexia read more slowly in both reading modes than their peers without reading difficulties (van den Boer et al., 2022). Impairments in reading fluency can be regarded as persistent behavioural markers of dyslexia into adulthood (Christodoulou et al., 2014).

For many years, conclusions drawn from English research, characterized by its outlier orthography, have demonstrated limited validity for other language typologies (Share, 2008). Orthographic transparency has been shown to significantly influence the manifestation of dyslexia, with dyslexic symptoms

being less pronounced in languages with transparent orthographies (Reis et al., 2020).

The most recent meta-analysis (Carioti et al., 2021) indicates that in non-transparent languages, individuals with dyslexia experience impaired reading accuracy, whereas fluency (in terms of reading speed) can be regarded as language-non-specific or universal. The developmental pathways of reading vary across languages and are significantly influenced by orthographic depth. While typical and dyslexic school-age readers exhibit higher levels of reading accuracy in transparent languages, this language-specific effect of dyslexia diminishes in adulthood. It has been established that lexical reading (i.e., reading words) poses greater challenges in non-transparent languages, whereas non-lexical decoding (i.e., reading pseudowords) appears to be language non-specific. Consequently, reading speed (referred to as the automaticity deficit) can be considered a more consistent marker of dyslexia than reading accuracy, irrespective of age, as achieving a ceiling level in accuracy becomes easier in adulthood. Many individuals with dyslexia can attain a reasonable level of proficiency in reading during adulthood, although mild but persistent decoding difficulties persist, such as slow reading and reading with considerable effort (Gagliano et al., 2015).

Students diagnosed with dyslexia encounter challenges with reading fluency, which can impede their reading comprehension (Robinson, Meisinger & Joyner, 2019). An American longitudinal study (Robinson, 2019) investigated the relationships between oral and silent reading fluency and comprehension in 2nd, 3rd, 4th, and 5th graders diagnosed with dyslexia. The children underwent a battery of tests during two testing periods within a year, conducted at the beginning and end of the school year. Read-aloud accuracy was identified as the most significant component of fluency affecting text-level reading comprehension in both reading modes. The study's findings suggest that oral reading promotes the development of silent reading, although this relationship is not reciprocal. Silent reading fluency does not affect oral reading comprehension performance, while proficient oral reading enhances comprehension in both reading aloud and silent reading. Thus, it can be inferred that oral reading fluency, rather than silent reading fluency, significantly contributes to reading comprehension.

Van den Boer et al. (2022) compared both reading modes in children and adolescents with and without dyslexia. They found that while reading fluency was similar in both modes in typically developing children, silent reading was faster in adolescents. However, in children and adolescents with dyslexia, the deficit in silent reading was comparable to or even greater than the deficit in oral reading,

highlighting the importance of assessing both modes of reading.

Silent reading fluency is inherently less observable, rendering its assessment more challenging and less reliable compared to oral reading fluency (Ciuffo et al., 2017). Nonetheless, when evaluating reading skills, it is crucial to assess both modalities. One compelling reason for this approach is that dyslexia diagnosis often relies on deficient performance in oral reading fluency, while support strategies apply mainly to the area of silent reading. Therefore, it is imperative to incorporate both modes of reading into the diagnostic process, not only to evaluate them but also to concentrate on enhancing both aspects as part of the intervention (van den Boer et al., 2022).

Currently, eye movement tracking technology is regarded as the most objective means of assessing silent reading, enabling precise data collection regarding an individual's reading habits. However, this diagnostic approach is notably constrained, as it necessitates strict conditions to be met (e.g., subjects must remain motionless while reading and be supervised by trained administrators). While eye tracking offers detailed insights into eye movements during reading, it does not furnish information regarding language processing, including reading comprehension (Ciuffo et al., 2017).

Van den Boer et al. (2014) note that most research studies have focused primarily on oral reading, even though silent reading is the primary reading mode for advanced readers. Although in schools, once the reading technique is mastered, the focus shifts to independent silent reading, the same shift is not seen in practice when diagnosing dyslexia. Even though Slovak-speaking children are already accurate in reading aloud words and pseudowords by the end of the first grade (Schöffelová & Mikulajová, 2012), most diagnostic tests in school practice focus on assessing reading skills through oral reading.

There are now several standardized tests available internationally that can be used to evaluate silent reading fluency. These tests assess silent reading at various levels, including word, sentence, and text. Some of the most well-known standardized tests for evaluating silent reading among English speakers include:

Gray Silent Reading Tests – GRST (Wiederholt & Blalock, 2000) consist of several short text passages that are developmentally ordered, each followed by multiple-choice questions. The test offers norms for individuals aged 7 to 25.

Test of Silent Reading Efficiency and Comprehension – TOSREC (Wagner et al., 2010) evaluates silent reading efficiency (i.e., speed and accuracy) and comprehension at sentence level. Students are tasked with reading and verifying the truthfulness of as many sentences as possible. The test provides norms for

grades one through twelve of formal education.

Other options for assessing silent reading fluency include tests such as the Test of Silent Contextual Reading Fluency – TOSCRF (Hammill, Wiederholt & Allen, 2014) and the Test of Silent Word Reading Fluency – TOSWRF (Mather et al., 2014). The TOSCRF evaluates basic contextual reading skills (i.e., word identification, lexical and semantic skills, and comprehension) by presenting examinees with a series of short passages where words are printed in capital letters without spaces. Their task is to mark the boundaries of the words in the sentences. This test provides norms for individuals aged 7 to 24 years. In contrast, the TOSWRF measures the ability to accurately and efficiently recognize isolated words presented in a solid block of text without spaces and sorted by reading difficulty. Examinees are tasked with marking word boundaries with vertical lines within a time limit. This test offers norms for individuals aged 6 to 24 years. A meta-analysis examining the validity of the TOSCRF and TOSWRF (Wissinger et al., 2023) revealed that scores on these tests strongly correlate with students' performance on a wide range of other tests assessing reading competence.

Currently, Slovakia offers several standardized tests for assessing silent reading. The first is the Picture-Word Matching Test from the MABEL battery (Caravolas et al., 2018), which provides norms for 1st and 2nd-grade elementary school students. The second option is the Test of Word Completion (Mikulajová, Vencelová & Caravolas, 2012), which offers norms for elementary, middle, and high school students. Additionally, two subtests from the Reading Battery for Older Pupils – Čí(s)ta (Žovinec & Dufeková, 2014), namely Word division and Text comprehension, provide benchmark standards for 8th and 9th-grade middle and high school students.

To address the necessity of evaluating silent reading fluency among Slovak-speaking children at the word level, for screening, diagnosis, and monitoring progress in therapy, a new Slovak test was developed – the Test of Silent Word Reading. This test was inspired by the TOSWRF mentioned above (Mather et al., 2014). In the empirical section, we emphasize its diagnostic potential in counselling and school practice.

Defining the research problem

Currently, the assessment of reading fluency is widely regarded as one of the most reliable indicators of dyslexia, irrespective of age and language typology (Carioti et al., 2021). In the international literature, inconsistencies in the interpretation of the concept of reading fluency are apparent (cf. Kuhn & Stahl, 2003; Norton & Wolf, 2012; van den Boer et al., 2022). In our research, we conceptualize

silent reading fluency following van der Boer et al. (2002), defining it as the number of correctly identified words within a specified time frame. The Test of Silent Word Reading (TSWR) assesses silent reading fluency, measuring how quickly and accurately learners recognize lexical words. Drawing on prior research in the domain of silent reading among children with dyslexia, we hypothesize that students with dyslexia will exhibit poorer performance in silent reading fluency (van den Boer et al., 2022), in terms of accuracy indicated by the frequency of errors (Váryová, 2012), and, given the documented impairment of executive functions in dyslexia (Varvara et al., 2014), in the frequency of corrections made.

Research objective and hypotheses

This research aims to compare the performance of two groups of pupils in grades 2–5 of primary school: pupils diagnosed with dyslexia and a control group without dyslexia, using the Test of Silent Word Reading (TSWR). In the formulated hypothesis (H), we posit that statistically significant differences will exist between pupils with dyslexia and those without dyslexia in the TSWR, across both versions (A and B), and across all observed assessment parameters, namely: H1) raw scores; H2) number of errors; H3) number of corrections; and H4) percentage of correctness.

Research implementation

The research was conducted in June and September 2021. Initially, we approached the principals of selected primary schools in Bratislava and Central Slovakia to request their assistance and cooperation in conducting the study. Our first step involved identifying and testing pupils diagnosed with dyslexia. Subsequently, we identified and administered tests to a control group—comprising pupils without dyslexia—matched to the set of dyslexic children. Parents of the approached pupils provided informed consent for their child's participation in the study. Dyslexic pupils underwent screening in June 2021, while non-dyslexic pupils underwent screening in September 2021.

Research methods

Test of Silent Word Reading (Zubáková, experimental version)

The TSWR is a screening tool inspired by the English TOSWRF (Test of Silent Word Reading Fluency; Mather, N. et al., 2014). This test focuses on assessing silent reading fluency based on speed and accuracy. It consists of sequentially arranged lexical words in lines without spaces. The examinee's task is to swiftly identify the words and demarcate them with a vertical line at word boundaries within a 3-minute time limit. The TSWR can be administered to individual pupils or in group settings. Two test forms (Version A and Version B) allow for repeated

testing of the same pupils without affecting their performance due to familiarity with the test material. Each version comprises 196 words. A comprehensive description of the test's development and its linguistic underpinnings is available in a study by Zubáková and Bekečová (2022). Before the actual testing, a practice session ensures that learners understand the task. Scoring in the TSWR is straightforward, with 1 point awarded for each correctly separated word. Four types of scores are provided: 1) a raw score, which is the sum of all correctly separated words; 2) errors, indicating the number of incorrectly separated words; 3) corrections, representing items initially separated incorrectly but then corrected through a specially designated mark; and 4) percentage correct, denoting the proportion of correctly separated words out of all separated items.

Reading Test with Word Completion (Mikulajová, Vencelová & Caravolas, 2012)

This is a standardized diagnostic tool designed for pupils in grades 1 to 9 of primary school. There are two versions of this assessment tool: a simpler version tailored for younger pupils in grades 1-4 of primary school, consisting of single-word selections, and a more complex version intended for older pupils, which includes the standards for the two-word version applicable for grades 4-9 of primary school. The test evaluates reading comprehension at the sentence/short passage level within a defined time interval. The examinee's task is to read the sentences silently and identify the target word from multiple offered options by underlining it. This task engages semantic, lexical, and phonological language skills, as well as working memory. The lexical-semantic way of reading is employed. Each correctly underlined word earns the pupil one point. The reading performance score (raw score) is the sum of all correctly completed words. The reading accuracy score gauges comprehension level regardless of reading speed; it is computed by dividing the raw score by the total number of items (correctly and incorrectly completed) and multiplying by 100, yielding the percentage of correctly completed words (percentage correct). The test can be administered either in groups or individually.

Graded Word Spelling (Caravolas et al., 2018)

This test is a component of the Multilanguage Assessment Battery of Early Literacy (MABEL), a comprehensive assessment tool designed to evaluate early literacy skills and map the ability to spell increasingly complex words. The assessment encompasses various spelling rules, including graphotactic, morphological, and morphophonological principles, and also assesses knowledge of selected words. Dictated words incor-

porate different types of inconsistencies. Words within the test are arranged in ascending order of difficulty and vary in syllable length (ranging from 1 to 3 syllables) as well as syllable structure, including variations with and without consonant clusters. During administration of the test, the administrator dictates each word three times: initially as the target word, then within a short phrase, and finally as the target word again. This repetition ensures that the pupil hears the target word multiple times, facilitating comprehension and recall. The test can be administered to individuals or groups, allowing for flexibility in testing environments. Each correctly spelled word earns the test taker one point, while incorrectly spelled words receive zero points. The gross score is calculated by adding up all the correctly spelled words.

Advanced Spelling Test for Upper-Level Pupils (Vencelová, Mikulajová & Caravolas, 2012)

This spelling test is tailored for pupils in the second stage of primary school, encompassing grades 4th through 9th. The assessment comprises 50 target words, each dictated to the pupils up to three times to minimize errors resulting from misunderstanding the target words. The test aims to evaluate the spelling proficiency of older pupils, particularly focusing on their ability to accurately spell 'i' and 'y' after consonants in the root of a word, as well as after consonants in a grammatical morpheme at the end of a word. In evaluating spelling performance, a clear distinction is drawn between specific errors, referring to deviations from the correct spelling of the target graphemes, and non-specific errors, encompassing all other inaccuracies excluding the target graphemes. Each correctly spelled target grapheme in a dictated word earns the pupil one point. The raw score is derived from the total number of words in which the pupil correctly spelled the target grapheme. Furthermore, the non-specific error score indicates the total number of errors made by the pupil outside the designated target spelling phenomena. Testing can be conducted both individually and in group settings to accommodate different instructional contexts.

Participants

The research sample comprised two distinct cohorts of pupils spanning grades 2 through 5 within the primary school setting: 1) pupils devoid of dyslexia or any officially diagnosed developmental learning disorders (such as dysorthographia, dysgraphia, dyscalculia), and 2) pupils diagnosed with dyslexia at a Counselling and Prevention Centre. Initially, 35 pupils were assessed in each group during the research's preliminary phase, which took place during the months of June and September in 2021.

The investigative process commenced with the evaluation of a cohort of pupils identified as having dyslexia, followed by their pairing with non-dyslexic counterparts through a method of pairwise selection based on a corresponding grade level. A fundamental prerequisite for inclusion in the dyslexic group was the verification of a developmental learning disorder, specifically dyslexia, by a qualified professional. Conversely, pupils without dyslexia were admitted to the control group based on parental affirmation of the absence of any neurodevelopmental disorders. In addition to the administration of the TSWR (versions A and B), both cohorts underwent assessment utilizing the Reading Test with Word Completion (Mikulajová, Vencelová & Caravolas 2012). The examination comprised single-word completion tasks for pupils in grades 2 through 4 and two-word completion tasks for those in grade 5. Furthermore, spelling proficiency was evaluated through the implementation of the Graded Word Spelling assessment for pupils in grades 2 through 4 (Caravolas et al., 2018), while students in grade 5 took the Advanced Spelling Test for Upper-Level Pupils (Vencelová, Mikulajová & Caravolas, 2012).

Despite the child's designated status (diagnosis of dyslexia versus non-dyslexic pupil), we established our inclusion criteria for the 'dyslexic' and 'non-dyslexic' groups to ensure that they remained mutually exclusive. This decision was motivated by the longstanding unfavourable situation in Slovakia, where the Minimum Diagnostic Standards for Developmental Learning Disorders were not established until 2019 (National Institute for Education, 2019), resulting in considerable variation in diagnostic procedures among Counselling and Prevention Centres. We also recognized the possibility of children with poor reading or spelling performance being included in the cohort of non-dyslexic pupils due to the historical underdiagnosis of developmental learning disorder in Slovakia. For these reasons, we decided that only pupils meeting predefined criteria could be included in each group. For each pupil, we evaluated performance in reading and spelling skills using a standardized test. In establishing the criteria, we drew inspiration from the guidelines outlined by van den Boer et al. (2022) and admitted only those children to the dyslexic group who demonstrated an elevated risk (below the 10th percentile) in at least one of the administered tests. Conversely, pupils without dyslexia were required to perform above the risk threshold (above the 10th percentile) in both tests for inclusion. Pupils who did not meet the specified criteria in their respective groups were excluded from the research population.

The ultimate research sample comprised 46 pupils spanning grades 2 through 5 in primary school, specifically 23 pupils diagnosed with dyslexia and an

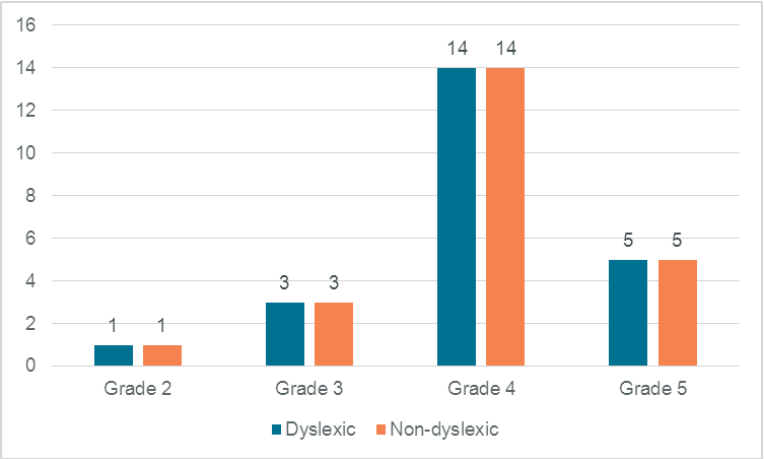


Chart 1. Distribution of Dyslexic and Non-Dyslexic Pupils Across Grade Groups

equal number of 23 pupils without dyslexia (refer to Figure 1). Regarding gender distribution, the sample consisted of 33 boys and 13 girls, with 16 boys and 7 girls in the non-dyslexic group, and 17 boys and 6 girls in the dyslexic group.

The research groups exhibited significant age differences, with an average gap of 11 months, as indicated by the Mann-Whitney U test ($U = 106.5$, $Z = -3.474$; $p = 0.001$). This discrepancy can be attributed to the following factors:

1. Varied testing times: The dyslexic pupil group, tested towards the end of the academic year, boasted an average age of 10 years and 6 months, approximately 11 months older than the non-dyslexic control group, which underwent testing at the start of the year and had an average age of 9 years and 7 months.
2. Higher prevalence of deferred school entry: The dyslexic group displayed a higher incidence of deferred school entry, with 9 pupils compared to the 6 pupils in the control group.

The decision not to test the grouped pupils at a single point in time was based on the primary focus of our research being centred on evaluating reading fluency in children with dyslexia, who are known to be particularly affected in this area. Therefore, we opted to provide pupils with dyslexia one full school year to consolidate their reading skills, ensuring that any observed performance

Table 1. Characteristics of Non-Dyslexic and Dyslexic Pupil Groups by Age

	N	Min	Max	Mean	Median	SD
Non-Dyslexic pupils	23	86	133	116,22	118	10,91
Dyslexic pupils	23	108	142	127,39	125	8,86

Note: The pupils' ages are expressed in months.

Table 2. Descriptive Statistics of Performance for the Group of Non-Dyslexic Pupils

	N	Min	Max	Mean	Median	SD	Normality
TSWR A (RS)	23	22	99	64,39	64	18,05	,29
TSWR A (E)	23	0	14	2,43	2	3,3	,00
TSWR A (C)	23	0	6	1,26	1	1,51	,00
TSWR A (%)	23	61,11	100	95,21	97,18	8,41	,00
TSWR B (RS)	23	30	108	74,17	73	18,73	,24
TSWR B (E)	23	0	20	2,83	0	4,78	,00
TSWR B (C)	23	0	6	1,83	1	1,59	,01
TSWR B (%)	23	71,43	100	95,92	100	7,21	,00
RTWC 1 (RS)	18	4	12	7,67	7,5	1,97	,91
RTWC 1 (%)	18	80	100	92,69	91,16	7,18	,00
RTWC 2 (RS)	5	17	29	21,80	22	4,76	,59
RTWC 2 (%)	5	90	95,65	92,54	92	2,43	,55
GWS (RS)	18	7	31	25,67	27,5	5,84	,00
ASTUP (RS)	5	31	46	40,4	41	5,77	,4
ASTUP (E)	5	0	4	1,8	1	1,64	,49

discrepancies were not influenced by external factors. For instance, we aimed to mitigate the potential impacts of reduced lesson allocations during the COVID-19 pandemic measures implemented from 2020 to 2021, which may have affected dyslexic pupils more acutely than their peers without reading difficulties.

Table 3. Descriptive Statistics of Performance for the Group of Dyslexic Pupils

	N	Min	Max	Mean	Median	SD	Normality
TSWR A (RS)	23	25	92	48,57	46	16,64	,1
TSWR A (E)	23	0	17	6,13	6	5,29	,04
TSWR A (C)	23	0	5	1,74	2	1,14	,01
TSWR A (%)	23	59,52	100	87,9	88,52	11,2	,01
TSWR B (RS)	23	33	105	60,48	60	17,13	,35
TSWR B (E)	23	0	13	5	4	4,22	,03
TSWR B (C)	23	0	7	2,52	2	1,95	,1
TSWR B (%)	23	80,77	100	92,37	92,96	5,74	,3
RTWC 1 (RS)	18	3	14	6,83	6	2,83	,17
RTWC 1 (%)	18	21,74	100	81,21	88,2	19,69	,00
RTWC 2 (RS)	5	4	20	14,2	16	6,02	,11
RTWC 2 (%)	5	44,4	88,89	75,39	83,33	18,73	,10
GWS (RS)	18	8	29	18,67	18,5	5,79	,67
ASTUP (RS)	5	23	37	28	27	5,39	,26
ASTUP (E)	5	2	29	18	24	12,19	,21

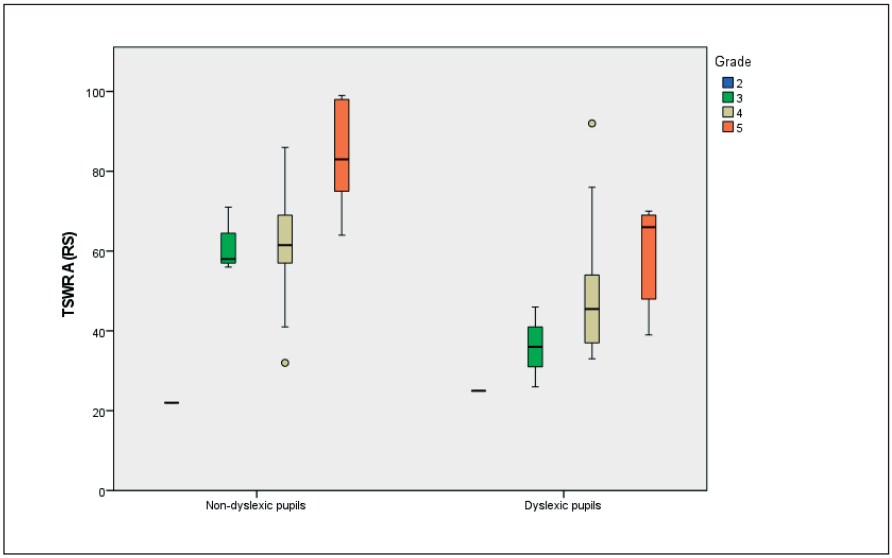
Note: TSWR A/B (RS) – raw score; TSWR A/B (E) – number of errors; TSWR A/B (C) – number of corrections; TSWR A/B (%) – percentage of correct responses; RTWC 1 (RS) – Reading Test Word Completion (raw score) – the number of words correctly completed for the single-word version administered to pupils in Grades 2 to 4; RTWC 1 (%) – Reading Test Word Completion (percentage) – percentage of reading accuracy for the single-word version administered to pupils in Grades 2 to 4; RTWC 2 (RS) – Reading Test Word Completion (raw score) – the number of words correctly completed for the two-word version administered to pupils in Grade 5; RTWC 2 (%) – Reading Test Word Completion (percentage) – percentage of reading accuracy for the two-word version administered to pupils in Grade 5; GWS (RS) – Graded Word Spelling (raw score) – number of correctly spelled words; ASTUP (RS) – Advanced Spelling Test for Upper-Level Pupils (raw score) – number of correctly spelled words; ASTUP (E) – Advanced Spelling Test for Upper-Level Pupils (number of non-specific errors); the Shapiro-Wilk test was utilized to evaluate the normality of the test data

Results

For the statistical analysis of the results, we utilized the statistical software SPSS 23. Before interpreting the results, we present tables containing descriptive statistics of the performances, including mean values, medians, standard deviations, minimum and maximum values, and the normality of distributions, for both research groups separately (Table 2 for pupils with dyslexia and Table 3 for pupils without dyslexia).

In Figures 2 and 3, the discrepancies

Figure 2. Comparison of Raw Scores Performance in TSWR A between Non-Dyslexic and Dyslexic Pupils by Grade Group

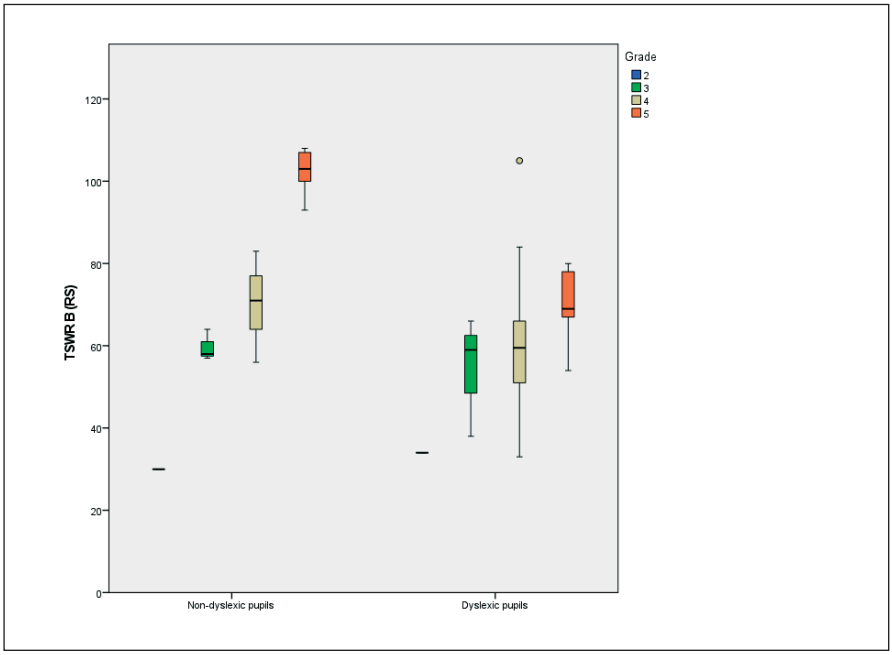


Note: The y-axis displays the raw score values, representing the number of correctly separated words.

in the raw scores of TSWR A and B between the groups of dyslexic and non-dyslexic pupils across grade levels are evident. Notably, in both groups, pupils attained higher raw scores on average in version B, which was administered second in order. Additionally, it is observable that performance gradually improves for both research groups throughout grades 2-5. As the grade level increased, pupils exhibited higher scores on the TSWR in both versions of the test.

Based on the literature reviewed, we hypothesized the presence of statistically significant differences in performance on the Test of Silent Word Reading (both A and B versions) for dyslexic and non-dyslexic pupils across all studied parameters (H1, H2, H3, H4). We employed the non-parametric Mann-Whitney U test to compare differences in the Test of Silent Word Reading (refer to Table 4). The statistical verification results confirmed the validity of the formulated hypotheses in H1, H2, and H4. Specifically, there are statistically significant differences be-

Figure 3. Comparison of Raw Scores Performance in TSWR B between Non-Dyslexic and Dyslexic Pupils by Grade Group



Note: The y-axis displays the raw score values, representing the number of correctly separated words.

tween the research groups in raw scores, error rates, and percentage correctness, all to the disadvantage of dyslexic pupils. However, our research did not confirm H3, indicating no statistically significant differences between the groups in the area of corrections. Additionally, when differences were observed, we further investigated the effect size(r) calculated using the formula $r = \frac{z}{\sqrt{n}}$. The results revealed a medium effect size between the groups across the parameters of raw scores, errors, and percentage correctness in both versions A and B.

Discussion

Our research aimed to compare the performance of two research groups, namely dyslexic and non-dyslexic pupils, in the

Table 4. Comparison of Performance on the Test of Silent Word Reading Between Dyslexic and Non-Dyslexic Pupils

	TSWR A (RS)	TSWR	TSWR A (corrections)	TSWR A (%)	TSWR B (RS)	TSWR B (errors)	TSWR B (corrections)	TSWR B (%)
Mann-Whitney U	131,000	147,000	185,500	148,000	153,000	165,000	209,000	144,500
Z	-2,935	-2,622	-1,797	-2,589	-2,451	-2,237	-1,242	-2,693
p	,003	,009	,072	,010	,014	,025	,214	,007
r	**0.43**	**0,39**		**0,38**	**0.36**	**0,33**		**0,4**

new Test of Silent Word Reading. We utilized a sample of 46 Slovak-speaking pupils from grades 2 to 5 in primary school and assessed their performance on the Test of Silent Word Reading in terms of raw scores, errors, corrections, and percentage correct. Our formulated hypothesis posited that there would be statistically significant differences in all parameters to the disadvantage of pupils with dyslexia.

The research population consisted of mainstream primary school pupils, who were matched according to their year group, with non-dyslexic pupils being tested at the beginning of the school year and dyslexic pupils at the end of the school year. Dynamic changes in literacy development occur during the early years of formal education, as confirmed by Mikulajová, Vencelová & Caravolas (2012, p. 162), who assert that grades 1 to 4 represent *"the stage of reading development from its origins to its automation"*. Given that our research primarily focused on children at the primary level of education, we opted to test dyslexic pupils only at the end of the school year to allow them time to consolidate their reading skills, for at least two reasons.

One reason was that we tested silent reading fluency, which is considered a scientifically validated neurobiological indicator (Christodoulou et al., 2014) and a behavioural marker of dyslexia (van den Boer et al., 2022), across typologically different languages (Carioti et al., 2021). Since children with dyslexia are known to exhibit lower reading fluency compared to their peers (van den Boer et al., 2022), we aimed to ensure that the validated test could effectively differentiate between them within the same grade level, even with nearly a 10-month disparity over the school year. This is particularly important if standardized tests establish norms based on assessing

a standardized sample at a single point in time for an entire grade.

The second, crucial reason was that all children were tested during the COVID-19 pandemic, a period when the pandemic's impact had not yet been scientifically examined. However, there was an increase in negative feedback from families, schools, and clinical settings, particularly in relation to the children with neurodevelopmental disorders. Hence, we scheduled the assessment of the dyslexic children at the end of the school year to provide time for academic skill consolidation and mitigate the potential effects of the COVID-19 pandemic. This pandemic, which occurred from 2020 to 2021, resulted in reduced instructional hours and in social isolation due to anti-pandemic measures, factors to which dyslexic pupils might have been more susceptible compared to their neurotypical peers with regard to literacy. This assertion is supported by an Italian study conducted by Baschenis et al. (2021), which examined the effects of the pandemic lockdown on 65 dyslexic children in grades 3 to 8 (mean age 10.64 years, SD = 1.60). The study revealed that up to 63% of dyslexic children did not achieve the expected average progress in reading skills, underscoring the vulnerability of dyslexic children as a specific at-risk group for whom school closures may carry greater consequences than the neurotypical population.

We were interested in comparing the performance of dyslexic and non-dyslexic pupils in the Test of Silent Word Reading across both versions. We found that performance improved for both research groups throughout Years 2-5, a trend consistent with findings from pilot studies conducted at both primary level (Zubáková & Bekečová, 2022) and lower secondary level (Zubáková et al., 2023). Additionally, we noted differences in performance between versions A and B for both groups, with version B consistently yielding better results. This improvement can be attributed to the learning effect, a phenomenon confirmed by previous research (Mather et al., 2014; Zubáková & Bekečová, 2022). In another investigation (Zubáková et al., 2023) focusing on the new TSWR, we verified whether versions A and B were comparable in difficulty and if the observed learning effect contributed to the enhanced performance in the second administered test. Through paired sampling of 50 pupils in grades 5 to 9 of primary school, we confirmed no statistically significant differences between versions A and B in either type of score.

When comparing the two research groups, the most notable difference between them was evident in the average raw scores in both test versions - dyslexic pupils correctly identified a lower number of words on average compared to their non-dyslexic counterparts. This outcome could be attributed to the slow and non-fluent reading

commonly observed in individuals with reading difficulties (Mikulajová, Vencelová & Caravolas, 2012), which has been confirmed in both reading modes (van den Boer et al., 2022). Another contributing factor may lie in the distinct reading strategies employed by individuals with dyslexia, as suggested by Vagge and colleagues (2015) in their research. They argued that dyslexic individuals engage in a more complex and effortful visual scanning process when reading written information compared to those without dyslexia. Additionally, Rayner et al. (2016) proposed that language processing, particularly word identification, serves as the primary driving force behind reading. According to the authors (Reichle, Pollatsek & Rayner, 2006), the speed of reading relies on the linguistic processing of the written material. Another factor that may contribute to the lower number of words identified by dyslexic students is vocabulary knowledge. This has been supported by research (Wise et al., 2007) conducted on primary school dyslexic pupils in Grades 2 and 3. The findings revealed that a good level of expressive vocabulary significantly enhances the ability to read words aloud. Since performance on the TSWR encompasses reading accuracy as well as speed, we can refer to the research of Šelingerová (2018), concerning the influence of vocabulary on pupils' performance. Based on her findings, she identified vocabulary as one of the predictors of reading fluency, alongside RAN (rapid automatized naming) ability, phonemic awareness speed (phoneme transposition), and working memory. Ouellette (2006) explains that individuals with larger vocabularies tend to be more attuned to sublexical details, which impacts reading fluency. These results align with the lexical quality hypothesis (Perfetti, 2007), which posits significant associations between lexical ability and reading comprehension.

The two research groups were also distinguished by the parameter of the number of errors. The higher error rate in the dyslexic group may stem from less developed language abilities (Adlof et al., 2017), weaker vocabulary (Adlof & Hogan, 2018), deficiencies in reading technique (van den Boer et al., 2022), deficits in executive function (Brosnan et al., 2002), as well as a consequence of possible comorbidity with ADHD, predominantly relating to attention (Boada, Willcutt & Pennington, 2012).

Within the framework of the formulated hypothesis, we hypothesized that statistically significant differences would be present in the performance of pupils with and without dyslexia in the TSWR. This was confirmed, based on the results of the Mann-Whitney U test, in all observed parameters in both versions A and B, except for the parameter of corrections. There was no statistically significant difference in the correction parameter; the research groups did not differ signi-

ficantly from each other in terms of the number of corrections made. The lack of significant differences in corrections between dyslexic and non-dyslexic pupils can be attributed to the primary difficulties in reading fluency experienced by individuals with dyslexia (e.g., Carioti et al., 2021). Despite being slow, individuals with dyslexia tend to be accurate when reading, especially in transparent languages (Mikulajová, Vencelová & Caravolas, 2012). Since the test sheet is perceptually present throughout testing, students were not shown to make a statistically higher number of corrections than the general population. Although the differences in this parameter did not prove to be significant, there were more corrections in the group of pupils with dyslexia. For instance, in Test Form A, pupils without dyslexia scored between 0 and 6 corrections (M = 1.25), while pupils with dyslexia had scores ranging from 0 to 13 (M = 1.74). A higher number of corrections in the test may indicate impairments in attention and executive functions, which are typical features of ADHD (Shiels & Hawk, 2010). Although children with dyslexia may experience difficulties in executive functions (Barbosa et al., 2019), these challenges are more likely related to deficits in phonological working memory, which is directly associated with the core deficit in dyslexia. Alternatively, it could be ADHD with a predominance in the attentional domain, a comorbidity that frequently occurs with dyslexia (DuPaul & Volpe, 2009). However, research findings suggest that an increased number of corrections in silent reading is not a typical diagnostic marker for dyslexia.

In addition to our aim of determining whether there were statistically significant differences in TSWR between the groups, we were also interested in the magnitude of the demonstrated effect. As noted by Hajdúk (2020), simply stating that a difference is statistically significant is not sufficient; it is crucial to quantify the demonstrated finding to indicate the level of evidence. The effect size in the parameters - raw scores, errors, and percentage correct - indicated an effect size (r) ranging from 0.33 to 0.43, which can be considered a moderate difference.

We also compared the results of our research with the outcomes of the TOSWRF (Mather et al., 2014), which was standardized on a cohort of 2,429 individuals aged 6 to 24 years. In the manuscript, the authors reported the mean scores of the entire normative set (M = 100 words, SD = 15), as well as the performances of different clinical subgroups with neurodevelopmental differences that were part of the normative set. Among the clinical group of developmental learning disorders, those with combined deficits (dyslexia, dysorthographia, and dyscalculia, M = 80 words, SD = 13) performed the poorest, while those with dyslexia alone performed

slightly better (M = 87 words, SD = 13). In our research set, non-dyslexic pupils separated an average of 16 more words in Version A than those with dyslexia, which aligns with the findings of the authors of the TOSWRF test, who showed a 13-point difference for those diagnosed solely with dyslexia.

The Test of Silent Word Reading is a quick, brief, and easily administered assessment that is timed. The utilization of time-limited tests in the diagnostic process is also advocated by Carioti et al. (2021). This recommendation is particularly pertinent because reading can be arduous for individuals with dyslexia and overburdening them with lengthy and challenging tasks during the diagnostic process may yield subjective results. Identifying dyslexia early is crucial, as highlighted by Denton et al. (2011), as delayed intervention can severely limit effective remediation options, especially if a child's reading skills lag behind their peers by several years. After undergoing the standardization process, the silent word reading test can serve as an essential diagnostic tool in assessing reading ability comprehensively.

Research limitations, future directions, and conclusion

The research study possesses several limitations that necessitate consideration when interpreting the findings. One limitation stems from the absence of uniform criteria for diagnosing dyslexia in Slovakia for many years. Furthermore, the lack of standardized diagnostic tools capable of comprehensively assessing all areas poses another limitation. Consequently, children officially diagnosed with dyslexia had to be excluded from the research sample based on inclusion criteria. Conversely, control pupils matched to those with dyslexia were also excluded from the research set due to poor performance in reading and/or spelling skills, despite their parents reporting no neurodevelopmental difficulties. While the Minimum Diagnostic Standards for the Diagnosis of Developmental Learning Disorders (National Institute for Education, 2019) now exist, the absence of diagnostic tools for comprehensive, objective diagnosis persists. Specifically, there is a dearth of tools for assessing language abilities during school age, tests to evaluate diagnostic markers of dyslexia, tests of reading and spelling skills beyond the word level, and reading tests that assess both modes of reading at various levels.

Another limitation of the research is that intellectual ability was not assessed when selecting participants for the groups. In the sample of dyslexic pupils, we received information from the Counselling and Prevention Centres indicating that the intellectual abilities of the selected pupils were within the average range. However, in the future, it

would be necessary to evaluate the intellectual abilities of the pupils as well.

A third limitation of the research is that in the study population of dyslexic pupils, there were also children with comorbid disorders who were not specifically identified. We believe that in the case of comorbidity with a developmental language disorder (an older term for developmental dysphasia) or ADHD, these individuals may have performed below expectations, as language abilities and attentional processes are crucial components in the reading process. Therefore, we recommend that future research explores performance on the TSWR with a larger sample of dyslexic pupils, while also identifying and controlling for comorbid disorders.

In conclusion, the present research demonstrates that the new Test of Silent Word Reading has the potential to be utilized by speech therapists, special educators, and psychologists in the future as an assessment tool for evaluating silent reading fluency during the diagnosis of developmental learning disorders, in counselling, clinical, and school settings. A comprehensive assessment of reading skills should encompass both reading modes—silent and oral—at various levels (word, sentence, and text). The new Test of Silent Word Reading fills a gap in the absence of diagnostic tools in Slovakia and is the only tool that, following the standardization process, can be employed to evaluate silent reading fluency at word level. Our objective is to gather normative data in the future not only from elementary school pupils but also from secondary and university students, thereby enabling its use as supplementary diagnostic material not only for school-age children but also for adolescent and adult populations. Considering the availability of two forms of this test, we recognize its potential in the therapeutic domain, as it allows for the assessment of reading progress in individuals due to the comparability of the two test forms. Due to its potential for short and group administration, this test could be employed in the future not only for diagnostic purposes but also for screening or research endeavors.

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