READING ALOUD IN A LANGUAGE WITH TRANSPARENT ORTHOGRAPHY: CHARACTERISTICS OF ADULTS WITH DYSLEXIA

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Abstract: *Dyslexia is a lifelong condition whose manifestations change with age (Davies et al., 2017). Although dyslexia may present differently in adulthood than in early childhood, the associated difficulties persist, particularly in reading accuracy, reading rate, and comprehension. These difficulties are particularly pronounced when reading pseudowords, unfamiliar words, or complex texts, and they are often accompanied by a persistent lack of self-correction (Pedersen et al., 2016; Provazza et al., 2019; Re et al., 2011; Reis et al., 2020). However, little is known about the characteristics of dyslexia in adulthood, particularly in languages with transparent orthographies (Reis et al., 2020). The aim of this study was to investigate the characteristics of adults with dyslexia in reference to reading aloud in Croatian, a language with transparent orthography. The study included 14 participants: 7 people with dyslexia (PwD) and 7 typical readers (TR, control group). The results indicate that PwD showed poorer performance than TR when reading pseudowords, real words, and texts, since they make more types and number of errors and are less inclined to correct these errors. However, the most persistent and striking feature of dyslexia in adulthood continues to be slow reading. This is consistent with the results of several studies based on transparent languages (e.g., Re et al., 2011; Reis et al., 2020, Suárez-Coalla & Cuetos, 2015). In the group of PwD, substitutions, omissions, and additions of graphemes and morphemes were most frequent, followed by substitutions of whole words. The error patterns of most participants indicate so-called phonological dyslexia.*

Keywords: *adults with dyslexia, reading aloud, reading errors, Croatian language, transparent orthography, dyslexia subtypes*

INTRODUCTION

Reading in adults with dyslexia: characteristics and challenges

Dyslexia is an alternative term for a specific learning disorder characterised by persistent difficulties with reading accuracy, reading fluency, and reading comprehension, despite the individual having at least average intellectual ability and access to regular educational opportunities (American Psychiatric Association [APA], 2013). Although dyslexia is often identified in childhood, it is a lifelong condition whose manifestations evolve with age (Davies et al., 2017). These changes require careful adaptation of definitions and diagnostic criteria when assessing adolescents and adults with dyslexia (Roitsch & Watson, 2019). While younger children with dyslexia typically exhibit many decoding errors, older individuals often develop compensatory strategies that mask some of these difficulties. In adults, subtle reading errors and increased cognitive effort are observed, rather than frequent, overt decoding errors (Re et al., 2011; Reis et al., 2020). Although dyslexia in adults can manifest in different ways compared to early childhood, challenges can still exist in terms of reading accuracy, especially in terms of reading rate and comprehension, particularly when reading unfamiliar words, pseudowords, or texts (Provazza et al., 2019; Re et al., 2011; Vizzi et al., 2025). Some authors argue that these difficulties are particularly apparent with long and

linguistically complex texts (Bazen et al., 2020; Carioti et al., 2021; Fletcher et al., 2007; Hulme & Snowling, 2016; Lenček, 2012; Warmington et al., 2013), as well as in the presence of time constraints (Gelbar et al., 2016; Re et al., 2011; Snowling, 2013). Accordingly, text reading remains a consistent and reliable measure for assessing the reading skills of people with dyslexia (PwD) throughout their lifespan, at least in terms of reading rate, which is consistently somewhat slower than in typical readers (TR). Others argue that when reading texts, as opposed to reading lists of pseudowords or real words, the individual can rely on the context. Hence, over time, it becomes increasingly challenging to identify PwD by solely observing the process of reading texts (see, e.g., Stanovich, 2000). Therefore, in research on reading in older PwD, a range of materials is typically used, including lists of pseudowords, lists of real words, and text. Pseudoword reading primarily assesses phonological decoding, while real word reading also involves visual familiarity and lexical processing (Kuvač Kraljević et al., 2022; Rathvon, 2004). It is recommended to assess pseudoword reading before real word reading to avoid semantisation effects that could influence decoding (Lenček, 2012). When reading texts, two approaches are commonly distinguished. Technique-focused reading emphasises accurate pronunciation and fluency, and does not assess comprehension, cognitive resources are primarily devoted to decoding. In contrast, comprehension-oriented reading prioritises understanding, analysing, and integrating the content, often benefiting from silent reading, which allows control over pace and revisiting complex sections (Fumagalli et al., 2019). Because these tasks differ, it is important to clearly inform participants about the reading goal in such research studies. Difficulties in comprehension can negatively affect fluency (Álvarez-Cañizo et al., 2015), highlighting the bi-directional relationship between fluency and comprehension. Specifying whether only technique or comprehension is expected helps participants allocate cognitive resources appropriately.

Nevertheless, regardless of task type there is insufficient data on reading in adults with dyslexia (Vizzi et al., 2025), especially on the types of errors they make and how often they recognise and correct them. Previous research suggests that adults with dyslexia make word substitutions based on semantic (e.g., *view* instead of 'scene') or phonological similarity (e.g., *here* instead of 'hear'), or even omissions, substitutions, and additions of graphemes or morphemes, and metatheses (De Rom & Reybroeck, 2024; Elbro et al., 1994; Lenček et al., 2012; Reis et al., 2020). Metathesis occurs when the position of graphemes in a word is swapped, when the graphemes in question are not next to each other. In other words, this type of error involves the transposition of non-contiguous graphemes or phonemes within a word. It leads to the misreading of the word, as the order of the graphemes is changed, but the error still results in a sequence that could resemble the original form of the word (e.g., reading the name of Croatia's capital city as *Zabreg,* instead of 'Zagreb'). In addition, it is known that people with reading difficulties often process pseudowords by giving them meaning, most of the time relying on their phonological or orthographic similarity to known words or to the context, which is known as semantisation of pseudowords (e.g., de Carvalho Rodrigues et al., 2023; Ramljak, 2021). This phenomenon occurs because PwD rely more on semantic processing than on phonological decoding in reading, which stems from their phonological deficit (van Rijthoven et al., 2018). Moreover, due to difficulties in phonological processing, syllabic reading can persist in adulthood. It is the act of correctly syllabifying a word, but being unable to combine these syllables into a complete word (blend them, i.e., synthetise them), which is ultimately the goal and definition of reading (Adams, 1994; Perfetti, 2007; Stanovich, 1986). Furthermore, PwD have a less active error-detection mechanism during reading than their typical peers (Horowitz-Kraus, 2016). Self-correction is another important aspect of skilled reading that reflects the reader's ability to recognise and correct errors in real-time (Clay, 1969). Research on children has long shown that proficient readers self-correct more frequently and more effectively than less proficient readers (Mudre & McCormick, 1989; Whaley & Kibby, 1981). However, studies on adults are still limited.

Pedersen et al. (2016) found that adults with dyslexia produced more reading errors than their peers without dyslexia. While both groups attempted to self-correct their errors, PwD were only able to successfully correct 13% of their errors, compared to 20% in the control group. In addition, studies show that adults with dyslexia correct fewer meaning-altering errors, which can further impair comprehension (Clay, 1969; Nes Ferrara, 2005). These research findings on self-correction suggest a weaker link between phonological processing and semantic integration (Lindamood & Lindamood, 1992), that is, a weaker integration and fine-tuning of the two reading routes - phonological (i.e., sublexical) and lexical - according to the dual-route model of reading (Coltheart et al., 2001; Coltheart, 2005; 2006).

The differences in reading characteristics between adults with and without dyslexia, as well as between children with dyslexia and adults with dyslexia (Singleton, 2005), highlight the need to identify continuous, age-appropriate diagnostic indicators of dyslexia. The next sections examine these indicators, how orthographic transparency shapes adult reading profiles, and why these considerations are particularly relevant for Croatian.

Effects of orthographic transparency on reading in adults with dyslexia

While research on adults with dyslexia is limited, there is even less evidence on the characteristics of this disorder in transparent orthographies (Reis et al., 2020; Vizzi et al., 2025). Most research on dyslexia relates to the English language and cultural context. Many European orthographies, including Croatian, are more regular and transparent. Research indicates that dyslexia manifests differently depending on orthographic depth (e.g., Arfé et al., 2020; Bigozzi et al., 2015; Caravolas, 2005; Daniels & Share, 2017; Landerl et al., 1997; Soriano & Miranda, 2010; Verhoeven & Keuning, 2017; Wimmer & Shurz, 2010; Ziegler et al., 2003). It is therefore reasonable to assume that orthographic transparency could also influence developmental changes in reading and writing abilities in individuals with difficulties in these domains, i.e. changes in how dyslexia manifests in adulthood compared to childhood. Orthographic transparency is not a binary category, but rather a continuum in which orthographies are more or less transparent (Babayiğit, 2022). On this continuum, English and Croatian would be at two ends of the continuum: Croatian has an orthography that is among the closest to a 1:1 correspondence between graphemes and phonemes, with minimal exceptions, such as phoneme place or voicing assimilation and the use of digraphs (e.g., /lj/, //nj/, /dž/), representing single phonemes (Lenček & Anđel, 2011). According to the orthographic depth hypothesis, shallow (transparent) systems tend to preserve accuracy and shift group differences toward rate and effort, whereas deep (opaque or non-transparent) systems amplify accuracy and irregular-word difficulties (e.g., Ziegler & Goswami, 2005). Therefore, findings about reading, particularly in populations with language difficulties or disorders such as dyslexia, cannot simply be adopted or translated from research on the English language and cultural context. Instead, it is necessary to investigate the specific features of dyslexia in highly transparent languages such as Croatian. Research shows that PwD have pronounced difficulties with reading accuracy, reading rate, and reading comprehension in opaque orthographies such as English, French, and Danish (e.g., Carioti et al., 2021; Kirby, 2018). In these orthographies, inconsistent grapheme-phoneme correspondences lead to more pronounced reading difficulties, which reflect the underlying phonological difficulties of PwD even more strongly (Carioti et al., 2021; Reis et al., 2020). In contrast, decoding in transparent orthographies such as Spanish, Italian, or Polish may improve with age in PwD. Still, slow reading rates with increased cognitive effort remains one of the most pronounced and lifelong dyslexia characteristics, especially when reading longer pseudowords or low frequency words (Re et al., 2011; Reis et al., 2020; Suárez-Coalla & Cuetos, 2015;). Even learning to read in transparent orthographies with more consistent letter-sound relationships does not entirely eliminate reading errors (Kuvač Kraljević et al., 2024; Lenček & Anđel, 2011; Lenček et al., 2012; Suárez-Coalla & Cuetos, 2015). Yet adults with dyslexia do make fewer decoding errors compared

to their early childhood. Therefore, in adulthood, self-correction may be less pronounced for simple words in transparent orthographies, but can be present when reading longer or less frequent words (Suárez-Coalla & Cuetos, 2015).

These findings emphasise the importance of measuring both reading accuracy and reading rate in adult readers, even in languages where decoding is expected to improve significantly with age in individuals with dyslexia. A meta-analysis of 178 studies by Reis et al. (2020) confirmed that adults with dyslexia performed worse than control groups on various reading tasks, including word reading, pseudoword decoding, text reading and spelling, regardless of orthographic depth. The most significant differences occurred in tasks that required rapid decoding, such as reading longer pseudowords and low frequency words. They also showed that, in order to fully understand the universal and language-specific characteristics of dyslexia in adults, it is essential to investigate how dyslexia manifests in different languages and orthographies.

For example, as previously mentioned, the dual-route model describes two partially independent, but interactive routes involved in reading: a sublexical (indirect) route used for regular words and pseudowords, as well as a lexical (direct) route, which recognises high-frequency and/or familiar words through whole-word retrieval (i.e., by activating stored orthographic representations) and is also used for irregular words where grapheme-to-phoneme conversion (i.e., applying rules) is insufficient and an alternative strategy is required. When applying the dual-route model to explain dyslexia, it is assumed that the phonological (sublexical) route is impaired in phonological dyslexia, the lexical route is impaired in surface dyslexia, and both the phonological route and, partially, the lexical route is impaired in deep dyslexia. It should be noted that differences in orthographic transparency influence how these routes are used. For example, Ardila and Cuetos (2016) explained, that in transparent orthographies such as Spanish, skilled readers increasingly rely on the lexical route over time, especially for high-frequency words. Due to the language's transparency, features of deep dyslexia are rare, whereas phonological or surface dyslexia is more likely. Despite Spanish having a completely transparent orthography, readers still use a system that may include both routes working together, as seen in opaque orthographies, yet the lexical route is used less than in English because the sublexical route is less demanding of resources and can be used very efficiently by skilled readers. However, it is expected that individuals with reading disorders, such as phonological dyslexia, may rely more on the lexical route as a compensatory strategy even in transparent orthographies, because their reading is not yet fully automatised. However, this reliance does not always result in accurate reading. Verhoeven and Keuning (2017) also concluded that in Dutch, a language with semi-transparent orthography, PwD show a phonological deficit and persistent problems with phonological recoding of orthographic representations. Therefore, due to difficulties in phonological processing, we would expect classic decoding errors in dyslexia, even in transparent languages, but we would also expect errors in the use of the lexical route, since its overuse as a compensatory strategy can lead to errors when it is applied inappropriately for the given stimulus (e.g., word that needs to be decoded because of its characteristics). On the other hand, in transparent languages, surface dyslexia can still occur. The transparency of the orthography facilitates decoding, so the sublexical route generally functions well. The errors are therefore not a result of overreliance on the lexical route or poor dynamic coordination between the two routes, but rather reflect a difficulty in reading via the direct lexical route, that is, in accessing the orthographic mental lexicon. As a result, individuals with dyslexia misread words that cannot be accurately processed through simple letter-to-sound conversion, such as words with unusual stress patterns or other exceptions, i.e., irregular words (Zoccolotti et al., 1999). In Croatian, irregular words are generally absent, but this can apply to loanwords that retain features of the original orthography, such as chef [*šef*], or to homographs like *kupìti* (to buy something with money, perfective verb) versus *kúpiti* (to gather something from the floor, imperfective verb). It is also possible that the characteristics and profile of dyslexia

change with development, since the dynamics and balance of reliance on these two pathways actually shift as reading evolves (Ardila & Cuetos, 2016). Finally, in transparent orthographies, as decoding accuracy for familiar and regular items approaches ceiling, group differences between PwD and TR shift towards reading rate and cognitive effort, especially for long and low-frequency items, words with dense consonant clusters or diacritics, as well as reading under time pressure. However, from the perspective of the dual-route model, although a language is highly transparent and thus facilitates sublexical processing during reading, if it is morphologically complex, an additional layer of segmentation and recombination is required (e.g., prefixes, suffixes, inflections, compounding). This places additional demands on decoding. Thus, transparency is not the only language feature that influences reading as explained by this model and the reading routes in general, since morphological parsing requires precise letter-position information (Grainger & Ziegler, 2011).

Perspective and data from Croatian

The Croatian language has a very transparent orthography. This enables children to achieve basic decoding accuracy earlier than their peers in opaque languages (Kelić et al., 2021; Kuvač Kraljević et al., 2024). However, decoding success alone does not imply reading proficiency, and many features of dyslexia in Croatian, especially in adults, are not yet fully known and explained.

Some specific reading errors have been described in Croatian, mainly in children with language disorders such as dyslexia (Lenček, 1994; Kolundžić, 2009; Lenček et al., 2007; Vancaš, 1999). Common errors include the substitutions of p/b/d, s/z, and m/n, as well as the addition of additional graphemes, especially vowels, into the consonant cluster to support oneself in reading. The omission of graphemes has also been reported in some cases (Lenček &Ivšac, 2007; Vitas, 2003). Reading pseudowords containing graphemes specific to the Croatian alphabet (/č/, /ć/, /dž/, /đ/, /lj/, /nj/, /š/, /ž/) poses an additional challenge for decoding. Although both typically developing children and those with dyslexia mainly produce similar types of errors, the number of those errors is significantly higher in children with dyslexia. Moreover, children with dyslexia sometimes make rare types of errors that do not occur in children without reading difficulties (Lenček, 1994; Lenček & Ivšac, 2007). Although these studies primarily document reading errors in childhood, evidence suggests that many difficulties persist in adulthood, emphasising the need to investigate how these early patterns develop or change. However, there are only a few studies addressing the manifestation of dyslexia in adulthood in the Croatian language (Lenček, 2012; Olujić Tomazin et al., 2023; Perkušić Čović et al., 2024). Some of these studies have focused on writing (Lenček, 2012; Olujić Tomazin et al., 2023), while others have examined reading (Lenček, 2012; Perkušić Čović et al., 2024). However, only Lenček (2012) investigated reading at all levels, from words and pseudowords to text. In a study involving 21 university students with dyslexia and 21 control participants, Lenček (2012) compared the reading and writing skills of PwD and TR. Among other things, the accuracy and rate of decoding lists of (pseudo)words, as well as the rate of silent reading and reading comprehension, were measured. PwD showed significantly poorer performance than TR in all tasks, especially in reading rate and reading comprehension. Error analysis of word decoding showed that vowels were frequently inserted in pseudowords within consonant clusters, along with the typical substitution of p/b/d. In Croatian, self-correction patterns during reading in adults with dyslexia continue to be unexplored at the text level. Data on reading texts in Croatian could provide deeper insights into language-specific error types and self-correction during reading in adults with dyslexia.

Aim and hypotheses

Guided by cross-linguistic findings on dyslexia in adults (Reis et al., 2020; Suárez-Coalla & Cuetos, 2015), this study investigates whether Croatian-speaking adults with dyslexia differ from TR in the following aspects of reading aloud: reading accuracy, reading rate, and self-correction of reading errors. Although many adults develop compensatory strategies, research consistently shows

that slower reading persists even in languages with transparent orthographies (Reis et al., 2020). Clay (1969) and Lindamood and Lindamood (1991) predicted that adults with dyslexia self-correct less efficiently due to persistent difficulties in error detection and phonological monitoring. Assessment of these components can provide a profile of adult reading performance and help explain how dyslexia affects reading process and error management (Brysbaert, 2019; Pedersen et al., 2016). Therefore, the aim of this study was to examine the characteristics exhibited by adults with dyslexia when reading aloud in Croatian, a language with a transparent orthography. The purpose is to identify the characteristics and difficulties present in these individuals and how their reading differs from that of TR, in order to better understand their needs and provide appropriate systematic intervention in education and employment.

Based on the literature review and the research aim, the following research questions were formulated:

RQ1: Are there differences in reading aloud accuracy between PwD and TR?

RQ2: Are there differences in reading aloud rate between PwD and TR?

RQ3: Are there differences in the percentage of self-corrections of reading aloud errors between PwD and TR?

RQ4: What types and extents of reading errors do PwD and TR make when reading aloud?

Based on the research questions, the following hypotheses were formulated:

H1: There is a statistically significant difference in reading accuracy between PwD and TR when reading pseudoword lists, word lists, and text, with TR being more accurate than PwD.

H2: There is a statistically significant difference in reading rate between PwD and TR when reading pseudoword lists, word lists, and text, with TR reading faster than PwD.

H3: There is a statistically significant difference in the amount of self-correction of reading errors between PwD and TR, with TR self-correcting their reading errors at a higher percentage.

METHOD

Participants

In this study, the sample of participants is non-probabilistic, i.e., a voluntary sample, consisting of a total of 14 participants. All participants were female. The mother tongue and first language of all participants is Croatian, which is also the primary language of their education. The group of PwD included seven fourth-year high school students from the city of Zagreb. After a team assessment conducted by a psychologist and a speech-language pathologist, the speech-language pathologists diagnosed them with dyslexia. The control group of TR included seven first-year undergraduate students of Speech-Language Pathology at the Faculty of Education and Rehabilitation Sciences (University of Zagreb). These students were selected as a control group because they met the criteria for speech, language, and voice assessment during the admissions process. This assessment includes a short interview with two examiners, a reading aloud task with a given text, and, if necessary, a specific examination of speech mechanism and articulation patterns. No preparation is required, and the assessment is designed to evaluate a range of speech, language, and voice characteristics typically acquired from early childhood through school age. A passing result indicates the absence of noticeable deviations such as hearing impairments, articulation disorders (auditorily and/or visually noticeable or structurally conditioned), atypical rhythm or speech rate, voice quality deviations, or reading difficulties. In addition, as part of the admissions process, all participants in the TR group presented a medical certificate confirming at least average cognitive, emotional, and perceptual ability. However, since they are still at the beginning of their studies and do not yet have specific knowledge in the field of speech-language pathology, they could serve as naive participants in this research study. TR and PwD were matched by gender and age. The demographic data of the participants are listed in Table 1.

Table 1. *Demographic data on participants*

Group	*n*	**Age** (year; month)	
		M	***SD***
PwD	7	18; 6	0; 6
TR	7	18; 11	0; 4

n, number of participants; PwD, people with dyslexia; TR, typical readers; *M*, mean; *SD*, standard deviation

MATERIALS

In this study, internal materials of the Teaching and Clinical Centre of the Faculty of Education and Rehabilitation Sciences of the University of Zagreb were used as measuring instruments: (1) a pseudoword list and (2) a real word list, both developed for scientific and professional purposes. The word and pseudoword lists were created as part of Lenček's (2012) research based on her many years of scientific and clinical experience with children and adults with dyslexia. The pseudoword list is based on the method of syllable concatenation (König et al., 2020). Both lists can be found in the Appendix. The (pseudo)words on both lists are made more complex through a combination of increased length (number of graphemes) and segmental complexity (the number of syllables, as well as the length and structure of consonant-vowel combinations). For a detailed overview of the characteristics of (pseudo)words, please see Table 2 and Table 3. Note that from the beginning to the end of the real word list, frequency decreases from 4.6 and tends towards 2 (on 0-5 point scale, based on psycholinguistic features available from data on Croatian - Kuvač Kraljević & Olujić, 2018)

Table 2. *Length and structure of pseudowords on the list*

Length in graphemes	Length in syllables	Syllabic structure
5	2	CC-CVC
7	2	CCV-CCVC
8	3	CV-CCV-CVC
9	4	V-CV-CV-CCVC
9	4	CV-CV-CV-CVC
11	5	CV-CV-CV-CCV-CV
11	5	CV-CV-CV-CV-CVC
10	4	CV-CV-CCV-CVC
12	5	CV-CV-CV-CV-CCVC
12	5	CV-CV-CCV-CCV-CV

Table 3. *Length and structure of words on the list*

Length in graphemes	Length in syllables	Syllabic structure
3	1	CVC
5	2	CV-CCV
5	2	CC-CVC
7	3	CV-CCV-CV
10	3	CCC-CCV-CVCC
7	3	CVC-CV-CV
12	5	CV-CV-CV-CCV-CCV
9	3	CVC-CCV-CVC
15	6	CCV-CV-CCV-CV-CV-CCV
10	5	CV-V-CV-CCV-CV
11	6	CV-V-CV-CV-CV-CV
11	4	CV-CV-CCVC-CCV
13	5	CCV-CV-CV-CCV-CCV
14	7	CV-CV-CV-CV-CV-CV-CV
20	8	CVC-CV-CCV-CV-CV-CCVC-CV-CV

The texts[1] used in the present study are those used in the previously described assessment of language, speech, and voice status conducted during the admission procedure. These texts are suitable in terms of length, linguistic complexity, and content for the chronological age and educational level of the participants in this study (Ministry of Science, Education and Youth, Republic of Croatia, 2019). The first text consists of 279 words, the second of 250 words, and the third of 164 words. The first text deals with an everyday topic (shopping and generational differences in sustainability), the second with space, and the third with an art movement from the past century. The texts are rich in graphemes from the Croatian language that are phonologically and articulatory complex (/s/, /š/, /ž/, /č/, /ć/, /l/, /r/), especially when paired into clusters (Blaži & Arapović, 2003), as well as with visually similar graphemes (m/n, b/d, s/z/š/ž), which are known to be potentially more challenging for PwD (Lenček, 2012). The texts also contain idioms and less frequent and less familiar words, for which participants are less likely to possess well-devel-

[1] Due to confidentiality restrictions and the proprietary nature of the texts used in this study (as they are employed in the official admission procedure), these materials cannot be made publicly available. Further information about their content and structure, or access to the texts for inspection, may be provided by the authors upon reasonable request.

oped orthographic representations, thus, a balance between visual recognition and decoding during reading is also required here. The average word familiarity in the first text is 3.101, while it is 2.278 in the second text, and 1.154 in the third. The average word frequency in the first text is 4.199, while it is 4.008 in the second text, and 4.097 in the third. The average word familiarity for all three texts is 2.178, and the average frequency is 4.101. The list of (pseudo) words was formatted in Arial font, size 12, with a line spacing of 1.5. The text was also formatted in Arial font, size 12, left-aligned, with wide margins and divided into paragraphs according to the recommendations of Lenček et al. (2022).

Procedure

All participants signed an informed consent form before taking part in the study. The testing was conducted individually in a quiet room, free from any distracting factors. All tasks were administered by the authors of this paper (speech-language pathologists). A sheet of paper with a list of (pseudo)words or the text that the participant was reading was placed on the table in front of her. Other papers were removed from the table during this time (e.g., the first text, while the second was being read) to avoid possible visual distractions. The first task always consisted of reading pseudowords, followed by reading real words, in order to avoid potential semantisation effects after reading words. This was followed by the text reading task. The order of the texts varied from participant to participant (guided by permutations of the possible orders of providing the three different texts) in order to avoid possible fatigue effects on reading performance for a particular text. Before reading the text, the participants were informed in advance (before the reading began) that only reading technique would be examined, not reading comprehension. All participants' readings were audio-recorded and transcribed by two final-year graduate students in speech and language pathology, with a 98% overlap in transcription.

Data analysis

Reading accuracy when reading (pseudo) words was expressed as the number of correctly read (pseudo)words on the list. The list of pseudowords consists of 10 pseudowords; therefore, the theoretical score range on the pseudoword reading task is from 0 to 10. For the real word list, the range is from 0 to 15 points, as the list contains 15 words. As the reading of texts was assessed based on three different texts, the data on reading accuracy and reading rate were averaged. For each text, the proportion of correctly read words was calculated as the ratio between the correctly read words and the total number of words in the text. Therefore, the theoretical range of possible scores is from 0 to 1. An approach that focuses on correctly read words (see, e.g., van der Kleij et al., 2019), rather than counting errors, is more justifiable, since PwD may make repeated errors on the same word. This means that the total number of misread words is not a representative measure of reading accuracy itself. Therefore, determining the number of correctly read words and then analysing errors is often a better method for gaining insight into their reading status. Reading rate was expressed as the time taken to read each list in seconds. The average reading rate for each text was calculated as the arithmetic mean of the reading time for all three texts.

Data analysis included both quantitative and qualitative components. The quantitative data analysis was performed using SPSS Statistics (version 26, IBM). The Shapiro-Wilk test showed that the distribution of results for all variables deviated significantly from normality ($p < 0.05$). The small number of participants in the groups and the overall limited sample size also led to the use of non-parametric statistical methods (Mann-Whitney *U*-test for group comparisons). The differences in percentage of self-corrections (number of self-corrections/errors number) were analysed based on the entire material, and not separately for each task (material). A separate quantitative analysis would not have been very informative, as some participants made no errors in certain tasks (e.g., TR made very few or no errors at word level when reading). In the qualitative analysis, the types and frequencies of reading errors were analysed. Errors were coded and categorised by the first and last authors of the study, showing 87%

agreement. Remaining discrepancies between the two coders were resolved through discussion, and the third author was included when necessary. All errors that occurred were analysed, regardless of whether the participants corrected them afterwards, since the corrections were addressed in a separate part of the analysis, i.e. the qualitative analysis focused on all errors that occurred during reading. Although few studies have focused on the detailed categorisation and classification of reading errors, based on insights from the relevant literature and following their approach, errors were classified into the following categories: syllabic reading, omission, substitution, or addition of a part of a word or an entire word, syntactic reversal (word-order changes), pseudoword semantisation, pseudoword creation, and metathesis (De Rom & Reybroeck, 2024; Elbro et al., 1994; Lenček, 2012; Reis et al., 2020). Guided by the approaches and insights of Gerhand et al. (2000), Hanley and Gard (1995), and Zabell and Everatt (2002), and primarily based on performance in individual tasks and types of errors in general, a cross-case review of errors is presented from the perspective of the dual-route model of reading.

RESULTS

Reading accuracy

Pseudoword list reading accuracy

The descriptive statistics show a higher average accuracy in reading pseudowords for TR compared to PwD (Table 4). In both groups, the maximum score achieved is equal to the maximum possible score, but PwD show a greater variation in their results and a much lower minimum score compared to TR. However, according to the results of the Mann-Whitney *U*-test, the difference in pseudoword reading accuracy between the two groups was not statistically significant ($U = 21.000$, $p > 0.05$).

Table 4. *Descriptive statistics on the pseudoword list reading accuracy*

Group	*n*	Pseudowords reading accuracy			
		C	***Q***	**min**	**max**
PwD	7	9	1.5	4	10
TR	7	10	0.5	8	10

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

Real word list reading accuracy

Table 5, which contains descriptive statistics on word reading accuracy, shows differences between the two groups, with the TR achieving a higher score compared to the PwD. Once again, the maximum score achieved in both groups corresponds to the maximum possible score, but PwD show a greater variation in their results and a lower minimum score compared to TR. The results of the Mann-Whitney *U*-test show a statistically significant difference with a large effect size between the groups in word reading accuracy ($U = 10.000$, $p < 0.05$, $r = 0.53$). The TR group read the words on the list more accurately (mean rank = 9.57) than the PwD group (mean rank = 5.43).

Table 5. *Descriptive statistics on the word list reading accuracy*

Group	*n*	*Words reading accuracy*			
		C	***Q***	**min**	**max**
PwD	7	13	2	11	15
TR	7	15	0.5	14	15

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

Text reading accuracy

First, the data on reading accuracy in text reading was calculated and analysed as the average across all three texts. The descriptive statistics show that the TR are more accurate in reading texts, with the average proportion of words read correctly in the texts being higher than that of PwD (Table 6). The results of the Mann-Whitney *U*-test show a statistically significant difference with a large effect size in reading accuracy across the three texts between the two groups ($U = 7.000$, $p < 0.05$, $r = 0.60$), with TR reading the

texts more accurately (mean rank = 10) than PwD (mean rank = 5).

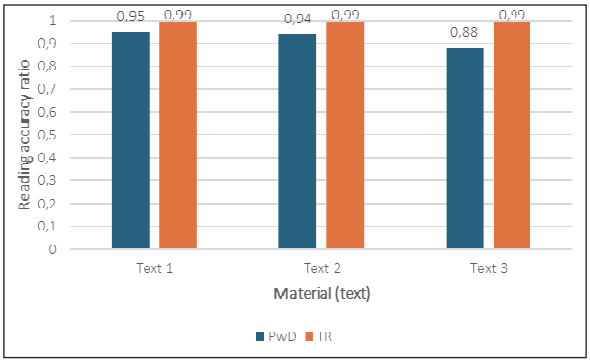
Table 6. *Descriptive statistics on text reading accuracy*

Group	*n*	Text reading accuracy			
		C	***Q***	**min**	**max**
PwD	7	0.95	0.06	0.88	0.99
TR	7	0.99	0.01	0.98	1

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

The reading accuracy data for the individual texts can be found in Figure 1. Both groups of participants achieved the highest accuracy when reading Text 1, with almost minimal accuracy differences in TR group. In contrast, Text 3 was read with the lowest accuracy.

Figure 1. *Reading accuracy across different texts*



*LEGEND: Reading accuracy ratio = number of accurately read words/total number of words in the text

Reading rate

Pseudoword list reading rate

According to the descriptive statistics, there was a difference in the average reading time of the pseudoword list between two participant groups (Table 7). The Mann-Whitney *U*-test revealed a statistically significant difference with a large effect size in pseudoword reading speed between the two groups ($U = 0.000$, $p < 0.01$, $r = 0.84$). PwD required more time to read the pseudoword list (mean rank = 11) than TR (mean rank = 4). TR read the list of pseudowords almost twice as fast as PwD.

Table 7. *Descriptive statistics on the pseudoword list reading rate*

Group	*n*	Pseudowords reading rate			
		C	***Q***	**min**	**max**
PwD	7	28 s	9 s	21 s	50 s
TR	7	16 s	2.5 s	13 s	19 s

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

Real word list reading rate

The descriptive statistics show that PwD took almost twice as long to read the real word list compared to TR (see Table 8). The Mann-Whitney *U*-test showed that these differences were statistically significant, with a large effect size ($U = 4.500$, $p < 0.05$, $r = 0.68$). TR read the real word list significantly faster (mean rank = 4.64) than the PwD (mean rank = 10.36).

Table 8. *Descriptive statistics on the real word list reading rate*

Group	*n*	Words reading rate			
		C	***Q***	**min**	**max**
PwD	7	37 s	9 s	24 s	83 s
TR	7	19 s	5 s	17 s	30 s

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

Text reading rate

First, the data on reading rate in text reading was calculated and analysed as the average across all three texts. Descriptive statistics data is available in Table 9. According to the results of the Mann-Whitney *U*-test, the average time required to read the texts differed significantly with a large effect size between the two groups of participants ($U = 0.000$, $p < 0.01$, $r = 0.84$). PwD needed more time to read text (mean rank = 11) compared to TR (mean rank = 4).

Table 9. *Descriptive statistics on text reading rate*

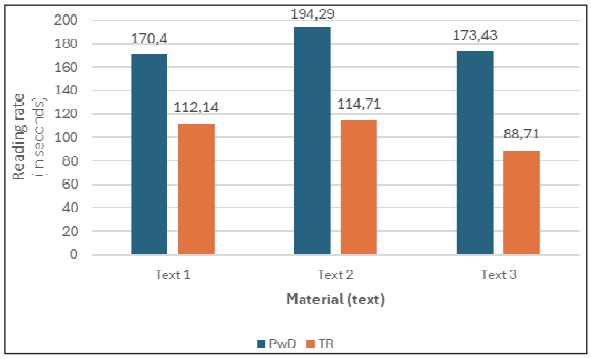
Group	*n*	Text reading rate			
		C	***Q***	**min**	**max**
PwD	7	130.33 s*	13 s	122 s	148 s*
TR	7	108 s	6.5 s	86.33 s	114 s

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum, *Note: 130.33 represents the *C* value for PwD after

excluding one outlier (a participant with a reading time of 460.67 seconds), which would otherwise inflate the *C* to 179.29 and set the maximum score.

If we examine the data separately for all three texts (Figure 2), it becomes clear that both groups needed the most time to read Text 2. PwD read Text 1 the fastest, and TR, on the other hand, read Text 3 the fastest.

Figure 2. *Reading rate across different texts*



Self-correction of reading errors

Although the descriptive statistics (Table 10) indicate a tendency for TR to self-correct more frequently than PwD, the Mann-Whitney *U*-test revealed that this difference was not statistically significant ($U = 22.000$, $p > 0.05$).

Table 10. *Descriptive statistics data on self-correction of reading errors*

Group	*n*	Self-correction of total reading errors			
		C	***Q***	**min**	**max**
PwD	7	0.31	0.15	0.20	0.92
TR	7	0.40	0.14	0.10	0.78

n, number of participants; PwD, people with dyslexia; TR, typical readers; *C*, median; *Q*, semi-interquartile range; min, minimum; max, maximum

Type and number of reading errors

Group-specific error profiles

For TR, 11 types of errors were identified. As expected, the following types of reading errors were observed: 1) omission of words, 2) omission of morphemes, 3) omission of graphemes, 4) substitution of words, 5) substitution of morphemes, 6) substitution of graphemes, 7) addition of words, 8) addition of graphemes, and 9) syntactic reversal. No instances of metathesis were observed: however, a related category, 10) transposition of graphemes, did occur. In contrast to metathesis, this category refers exclusively to the interchange of neighbouring graphemes, i.e., graphemes that lie next to each other (e.g., Croatian *Marinerove* → *Marnierove*). Additionally, a category of errors was observed among TR that extends the initially assumed pseudoword creation category, rather than representing an entirely new type of error: 11) the distortion of real words into pseudowords or non-words. This type of error arises when substitutions, omissions, or additions cannot be precisely identified due to multiple changes in the structure of the real word. For example, a participant may read *istotno* instead of cro. *istodobno* [simultaneously], or *nakol* instead of cro. *naokolo* [around]. De Rom & Reybroeck (2024) reported similar errors, although they refer to them only as pseudoword creation. However, it should be noted that not all changes made to a real word result in a form that matches the phonemic and phonological structure of Croatian, and therefore, some instances are better classified not as pseudowords, but as so-called non-words. Omissions of words included function words, such as auxiliary verbs and short conjunctions, while omissions of morphemes most frequently involved prefixes (e.g., cro. *poprilično* [quite] read as prilično) or the particle cro. *ne* [no(n)] used for negation, either as a prefix or as a medial morpheme (e.g., cro. *najnevjerodostojniji* [most unreliable] read as cro. *najvjerodostojniji* [most reliable]). It is important to highlight that, in Croatian, a morpheme may consist of multiple graphemes or a single grapheme (Barić et al., 2005). However, this type of error differs from the omission of graphemes, which involves independent graphemes that do not constitute morphemes. The situation is similar to the omission of a word consisting of a single grapheme (e.g., cro. *i* [and]), where omitting just one grapheme actually results in a new type of error (omission of a word). Substitutions of words usually occurred when the target word was replaced by a phonologically similar word with the same root (e.g., cro. *osjećaj* [feeling] instead of cro. *osjećajnost* [sensibility]), or between phonologically similar words that are also synonyms (e.g., cro. *istovremeno* instead of cro. *istodobno* [simultaneously]). Occasionally, prepositions were

also substituted (e.g., cro. *na* [on] instead of cro. *u* [in]). Other types of errors in the background, such as the substitution, addition, or omission of morpheme(s) or grapheme(s), could also lead to the substitution of the word itself, although they may occur independently without causing a change in the target word. They are, therefore, considered a separate type of error. The addition of words mostly referred to the insertion of a conjunction (such as cro. *i* [and]) or, in some rare cases, another word. Some types of errors, such as the omission or substitution of graphemes and the addition of graphemes, occurred only rarely in TR. Omissions or substitutions of graphemes typically appeared in long, less familiar, and less frequent words specific to unusual text topics. Substitutions of morphemes was hardly ever observed in TR and differed from word substitution because the lexeme itself remained unchanged while undergoing a morphological modification, such as a change of suffix. For example, reading a word in the wrong case disrupts agreement and creates a morphosyntactic error in the sentence. Additions of graphemes were also rare and occurred only with words that are extremely uncommon in the language because they were terminologically linked to a particular subject (topic) of the text that is not usual.

An overview of the types and numbers of errors made by TR according to the source material is shown in Table 11.

Table 11. *Types and number of errors made by TR when reading aloud across different tasks (starting materials)*

	Type of error	Number of errors
Pseudowords	omission of grapheme	2
	substitution of grapheme	3
	transposition of graphemes	1
Real words	omission of morpheme	2
Text	omission of word	10
	omission of morpheme	4
	omission of grapheme	9
	substitution of word	10
	substitution of morpheme	7
	substitution of grapheme	1
	addition of word	3
	addition of grapheme	2
	transposition of graphemes	2
	distortion of words into pseudo- or non-words	3
	syntactic reversal (word-order error)	6

It should be noted that, across all test materials, only two instances were observed where TR made more than one of the explained errors on the same word (so called mixed errors, De Rom & Reybroeck, 2024). In both cases, the errors involved a combination of two errors in a single word: once it was the substitution of two graphemes in a word, another time the omission of a grapheme and the transposition of graphemes. Mixed errors were not assigned to a separate category, as they could be divided into individual errors and included in existing categories (types).

All 11 error types observed in TR were also observed in PwD, but to a greater extent: some of the errors occurred up to several dozen times more frequently in the PwD group than in TR. Typical dyslexia-related errors were observed when substituting graphemes (p/b/d, n/m, s/š/z/ž). When adding graphemes, typical dyslexic insertions of vowels into complex consonant clusters were also observed. The main differences in the types of errors that overlap between the two groups include the fact that PwD make word substitutions that change the word type (e.g., noun to verb or vice versa), which was not observed in TR. In addition, PwD sometimes omitted content words, whereas TR only omitted function words. In addition to the types of errors that overlapped between the two groups of participants, several other types of errors were observed in PwD, but not in TR. Some of these errors were anticipated based on the literature review and preparation for the analysis, in-

cluding syllabic reading, addition of morphemes, and metatheses (e.g., cro. *reljefa* [terrain] is read as *refelja*). However, two additional types of errors were identified that had not been anticipated: number naming errors and other uncategorised errors. When referring to the addition of morphemes, this primarily involved the insertion of a medial morpheme, which resulted in an incorrect case form and further disrupted sentence agreement. For example, the noun cro. *sredstva* [means] (N.pl.) could be read as cro. *sredst-a-va* (G.pl.). Number naming errors are the incorrect reading (or naming) of Arabic or Roman numerals in a text (e.g., saying cro. *devet* [nine] for the number 8). Some of these digits represent the number of certain elements in the text, while others denote calendar years. Other uncategorised errors are those errors that cannot be classified within any of the defined or newly established categories. They occur when a (pseudo) word contains several different types of errors, making it difficult to determine the exact origin of the reading error. This category also includes cases where the produced form differs substantially from the target item, often resulting in a completely different meaning. For example, a participant might read cro. *navikli* [are used to] as cro. *na veliki* [on big], or cro. *itekako* [of course] as cro. *isto tako* [likewise]. In some cases, it seems that the participant segmentised part of a pseudoword, producing something that could ultimately be classified as a non-word.

An overview of the types and numbers of errors made by PwD according to the source material is shown in Table 12.

Table 12. *Types and number of errors made by PwD when reading aloud across different tasks (starting materials)*

	Type of error	Number of errors
Pseudowords	syllabic reading	2
	omission of grapheme	3
	substitution of grapheme	11
	addition of grapheme	3
	transposition of graphemes	2
	other (uncategorised)	2
Real words	syllabic reading	4
	omission of morpheme	2
	omission of grapheme	3
	substitution of word	2
	substitution of grapheme	2
	addition of morpheme	1
	addition of grapheme	8
	(phonological) metathesis	2
	distortion of words into pseudo- or non-words	1
	other (uncategorised)	1
Text	omission of word	25
	omission of morpheme	22
	omission of grapheme	28
	substitution of word	140
	substitution of morpheme	65
	substitution of grapheme	56
	addition of word	10
	addition of morpheme	6
	addition of grapheme	21
	transposition of graphemes	5
	(phonological) metathesis	2
	distortion of words into pseudo- or non-words	17
	syntactic reversal (word-order error)	3
	number naming error	3
	other (uncategorised)	7

It has been observed that many more of the mixed errors are present in PwD than in the TR group. It looks PwD make two or three different types and/or numbers of errors when reading the same exact word.

Cross-case error profile of PwD

The error analysis indicates that the most common type of dyslexia observed is phonological dyslexia, with surface dyslexia occurring occasionally.

Participant 1 made errors on both pseudoword and real word lists, with real word errors mostly on long words and pseudoword errors particularly involving b/d/p or š/s combinations. Errors included phoneme substitutions within words and morpheme addition or omission. Self-correction was relatively high, indicating awareness of errors and the ability to correct them upon re-reading. Overall, the participant showed typical signs of phonological dyslexia with lower accuracy on pseudowords, phonologically similar substitutions, but relatively good self-correction. Reliance on the lexical route sometimes led to reading by assumption, such as cro. *četri* [four] instead of cro. *četvrti* [fourth]. This pattern demonstrates that, despite Croatian being a highly transparent language, the rich morphology can limit compensatory strategies, and some words still require accurate decoding.

In Participant 2, the lexical reading route was significantly compromised, as shown by difficulties with the automatic recognition of whole words. For example, cro. *naziva*n [called] was read as cro. *nazvan* [named], and cro. *izraz* [expression] as cro. *izražajnost* [expressiveness]. These errors indicate that the participant does not consistently access stable orthographic representations, but sometimes reads words incorrectly by assumption. This phenomenon is particularly noticeable with short or morphologically simple words, which are sometimes misread as if they were longer words that appeared earlier in the text, resulting in errors such as those mentioned before (*izraz* → *izražajnost*). Pseudowords and most real words on the lists were read without phonological errors, indicating that the sublexical/phonological route was not compromised. This pattern clearly reflects surface dyslexia: the phonological route functions properly, while the lexical route is compensated for, but is still not fully efficient, thus producing typical lexical errors, and incorrect word-form substitutions with limited self-corrections.

In Participant 3, errors were primarily observed on pseudowords, while performance on known real words was relatively preserved. Self-correction was low, indicating limited awareness of errors and weak metacognitive monitoring during reading. Errors were most frequent on longer and more complex words, particularly pseudowords, confirming difficulties in the phonological route. This pattern is consistent with typical phonological dyslexia, where deficits in phonological processing restrict automatisation of reading unfamiliar or novel words, while the lexical route for familiar words remains relatively intact.

Participant 4 demonstrated very high accuracy in reading both pseudowords and real words, with only a minimal number of errors. Both the phonological and lexical routes appeared largely intact. However, the presence of even rare errors - mostly omissions, substitutions, and additions - suggests a profile of mild phonological dyslexia, in which reading is close to automatised, but occasional phonological challenges persist.

Participant 5 made errors in reading pseudowords, as well as in text passages, with frequent errors in complex or phonetically unusual words, such as cro. *wagnerijanskoga* [Wagnerian] read as cro. *Vangerove* [Wagner's], cro. *jarkocrvenom* [bright red] read as cro. *jako crvenom* [very red), and foreign or specific names such as cro. *Marinerove* [Mariner's] read as *Marinorove*. Errors related to the real word list were less frequent. Self-correction was rare or almost absent, suggesting limited recognition or correction of errors. This error pattern is consistent with phonological dyslexia.

Participant 6 demonstrated frequent errors when reading real words containing phonologically challenging clusters, such as *solisticij* in-

stead of cro. *solsticij* [solstice], *sitotiskovani* instead of cro. *sitotiskovni* [screen-printing], and *neimaiština* instead of cro. *neimaština* [poverty]. This pattern suggests that the phonological route was not sufficiently precise or automated. The lexical route may support recognition of familiar words to some extent, but it remained insufficient for correctly decoding complex or rare words. Combined with an almost complete absence of self-correction, this error profile indicates phonological dyslexia, where the main difficulty lies in decoding less familiar and phonologically complex words.

Participant 7 made errors when reading pseudowords, such as *truljuk* instead of *trljuk* and *etinkra* instead of *etinokrač*, as well as when reading some real, but less familiar words. This pattern indicates that the phonological route remains a critical locus of difficulty, even when it comes to known vocabulary and meaningful sentences, and particularly for longer and less frequently encountered words. The low frequency of self-correction further suggests that the phonological route was neither sufficiently precise nor automated, indicating phonological dyslexia.

DISCUSSION

This preliminary study aimed to investigate the characteristics of PwD in relation to reading aloud in Croatian, a language with highly transparent orthography. The study investigated whether Croatian-speaking PwD differ from TR in the following aspects of reading aloud: reading accuracy, reading rate, types of errors, and self-correction of errors. The purpose of the study was to identify the characteristics and difficulties present in PwD, as well as to examine how their reading differs from that of TR, thereby contributing to a better understanding of their needs, which is necessary for the development of objective assessments and systematic interventions in educational and occupational contexts (Sadusky et al., 2021). Given the lack of research on adults with dyslexia, as most existing knowledge is based on studies with children or adolescents in educational settings, this study serves as an initial step and a potential inspiration and motivation for further research. Since the manifestations of dyslexia vary depending on the linguistic context and language-specific features, it is crucial to investigate these characteristics in different languages. Croatian, for example, is highly transparent, morphologically rich, and in many ways distinct from English, the language that serves as the primary source of most dyslexia research, thus, potentially influencing reading patterns and conclusions.

We first assumed that there would be a statistically significant difference in reading accuracy between PwD and TR when reading pseudoword lists, real word lists, and text, with TR expected to be more accurate than PwD. The first hypothesis was thus partially confirmed, as statistically significant differences were only found when reading real words and texts. In both tasks, TR were superior to PwD, which is consistent with the results of other studies on transparent orthographies, as well as with the limited research results in Croatian. This suggests that despite the development of compensatory strategies and improvements in decoding accuracy, adults with dyslexia do not achieve high levels of reading accuracy compared to TR, even in transparent orthographies. Although errors in transparent orthographies become less frequent over time, they nevertheless persist as a feature of reading in PwD (Lenček, 2012; Re et al., 2011; Reis et al., 2020; Suárez-Coalla & Cuetos, 2015). At first glance, it may seem somewhat unexpected that there was no significant difference in reading accuracy of pseudowords, which is solely based on decoding. However, when re-examining the structure and length of the real words and pseudowords used, it becomes clear that some real words were several graphemes longer than the pseudowords. This suggests that word length may be one of the key factors influencing word-level reading in PwD. As the pseudowords were slightly shorter than the real words, PwD may have been able to achieve better results by using compensatory strategies. This phenomenon is known as the word length effect, and it has been shown to influence reading performance, even in adults with dyslexia, because they rely predominantly on serial analysis of the item (Provazza et al., 2019; Zoccolotti et

al., 1999). Therefore, it is possible that some of the real words were even more difficult for PwD to read than the pseudowords due to their length, despite the fact that it is always expected and assumed that pseudowords would present a greater difficulty for PwD. On the other hand, the word length effect seems to have a lesser impact on real words, especially if they are very common in a Croatian. The list of real words used in this study included both high and low frequency words, suggesting that the word length effect may have been smaller because some items were shorter and, more generally, because some words were already familiar to PwD, allowing them to rely on lexical processing, and not just serial phonological processing, when decoding (Provazza et al., 2019). This explanation is consistent with the finding that both groups achieved the highest accuracy when reading Text 1, which contained the most familiar and frequent words and was based on a generally known topic. In contrast, Text 3, which included a higher proportion of unfamiliar and less common words, was read with the lowest accuracy. Ultimately, although there was no statistically significant difference in the reading accuracy of pseudowords between the two groups, the descriptive statistics indicate that the TR tend to perform better than PwD.

Secondly, it was hypothesised that PwD would read more slowly than TR across all reading tasks, including pseudoword lists, word lists, and text. This was confirmed, as TR were able to read all three types of materials faster than PwD, who occasionally took up to twice as long to read the same material. This is consistent with previous findings suggesting that, in adulthood, slower reading rates are the most pronounced and consistent feature of PwD when it comes to reading in languages with transparent orthographies (Lenček, 2012; Re et al., 2011; Suárez-Coalla & Cuetos, 2015), making time constraints in reading tasks a potential disadvantage for PwD (Gelbar et al., 2016; Re et al., 2011; Snowling, 2013). This aligns with the double deficit observed in children with dyslexia (Wolf & Bowers, 1999), although their cognitive profile may change over time due to development, education, and additional support. Children with dyslexia may show deficits in both phonological processing and rapid naming, which has a negative impact on reading accuracy and rate. In transparent orthographies, however, this dual deficit tends to decrease with increasing reading experience and speech therapy, as the grapheme-phoneme connections are strong and clear. Phonological awareness and phonological processing develop over time, leading to improved reading accuracy later in life. In contrast, rapid naming remains impaired and it is still a cognitive predictor of reading in adulthood, contributing to slower reading performance (Dębska et al., 2021; Landerl et al., 2013; Wimmer & Schurz, 2010). Finally, when examining the reading rate for each text separately, it is evident that both groups read Text 2 at the slowest rate. However, they differed in which text they read the fastest. At the discourse level, PwD appear to be influenced not only by text length, but also by linguistic complexity, which can slow reading, even for shorter texts (Bazen et al., 2020; Carioti et al., 2021; Hulme & Snowling, 2016; Lenček, 2012; Warmington et al., 2013). PwD read Text 1 the fastest, despite it being the longest, probably because it was linguistically simpler and thematically closer to everyday life, thus facilitating lexical processing. In contrast, TR read Text 3 the fastest, which was the shortest, suggesting that text length may be the primary factor affecting reading rate for readers without decoding difficulties, provided that the text is appropriately complex for their educational background.

Thirdly, it was hypothesised that there would be a statistically significant difference in the amount of self-correction of reading errors between PwD and TR, with TR expected to self-correct their reading errors at a higher rate. However, no statistically significant differences were found between the two groups. Thus, the third hypothesis was rejected. It is possible that TR do not self-correct more often than one would expect because they make errors that have no effect on the meaning of the sentence, so they are less likely to notice these small reading errors. In contrast, the problem with PwD is that their errors and lack of self-correction often interfere with comprehension, as the changes resulting from these errors distort or complete-

ly change the meaning of the sentence (Pedersen et al., 2016). Although the present study does not focus on comprehension, participants probably still rely on context while reading the text.

Finally, the types and extents of reading errors made by PwD and TR when reading aloud were examined. Although it is often assumed that experienced adult readers make almost no errors when reading, our results contradict that. In addition, it is a misconception that every reading error, or even several errors of different types, indicates a disorder. However, the quantitative analysis results already indicate a greater variability in the reading performance of PwD compared to TR. The error analysis shows not only quantitative, but also qualitative differences between the two groups. PwD make a greater number of reading errors, which includes certain types of errors that were not observed in TR, which is consistent with previous studies (e.g., Elbro et al., 1994; Lenček, 1994; Lenček, 2012; Lenček & Ivšac, 2007; Reis et al., 2020; Singleton, 2005). Singleton (2005) even explains that adults with dyslexia make different types of errors than TR, but these errors also differ from those made by children with dyslexia, suggesting developmental changes in error patterns. In general, at the levels of (pseudo) words and text, PwD made the highest number of substitution and omission errors. The results of the present study showed that, at the word and pseudoword levels, substitutions and omissions of graphemes were the most frequent errors, followed by syllabic reading and additions of graphemes, while other error types, such as transpositions or uncategorised errors, occurred rarely. At the text level, substitution errors, primarily the substitution of entire words, remained the most common, followed by omissions of graphemes, morphemes, and words, whereas additions, transpositions, distortions into pseudowords or non-words, syntactic reversals, number naming errors, and other uncategorised errors were less frequent. Although expected, no semantisation of pseudowords was observed. This outcome may be explained by the possibility that the pseudowords were too simple for the participants' age, educational status, and reading level, which could also account for the absence of a significant difference between the two participant groups on this task. Tied to that, although statistically significant differences in accuracy persist at lower levels (e.g., word reading), it appears that, in highly transparent languages such as Croatian, PwD make fewer errors at lower units (individual items such as a single word or pseudoword). Higher levels, such as the discourse level, remain challenging. Reading rate, as mentioned several times, continues to be their weakest area, yet PwD still make errors when presented with unfamiliar or demanding material. The most frequent text-level errors were substitutions of words, likely due to so-called reading by assumption or guessing errors (e.g., De Rom & Reybroeck, 2024), which typically occur when PwD overuse context to compensate for their difficulties. These errors may also result from partial or insufficient sublexical reading, where a person decodes only the first grapheme(s) and then guesses the rest of the word. It appears that PwD rely more on the lexical route to compensate for their phonological deficits, potentially using their advanced visual-spatial abilities (Rajabpour Azizi et al., 2021), which support visual/orthographic processing during word reading (Miller-Shaul, 2005). In other words, PwD compensate for their non-automatised reading by relying heavily on one reading route, in this case, the lexical route, rather than dynamically integrating both sublexical and lexical routes for successful reading. Although orthographic transparency generally implies a lower occurrence of "clasical" dyslexic errors, such as substitutions, additions, and omissions at sub-word levels, these types of errors nevertheless persist in adults with dyslexia who participated in our study. This may be due to the rich morphological structure of the Croatian language and the fact that even reliance on visual familiarity does not eliminate the possibility of such errors, given the substantial variation in words, depending on their declension and conjugation. Related to this, it is evident that detailed analyses and classifications of reading errors are challenging because they depend heavily on the structural and semantic features of a language and its writing system. The same type of error may be

categorised differently across languages, and certain errors may appear in some languages, but not in others. For instance, in English, a reader might pronounce 'red' as *read*, whereas such "pronunciation" errors would not occur in a highly transparent language such as Croatian. Furthermore, for some types of errors, there would likely be disagreement among different authors, even within the same linguistic context. For instance, when discussing the addition of morphemes, it can be assumed that added morphemes, such as suffixes (e.g., *ime* [name] N.sg. read as *imena* G.pl.), could be considered substitutions of morphemes. This is because the outcome of the reading error involves a null morpheme being replaced by a specific morpheme (suffix). In morphological theory, however, the null morpheme is often treated as a theoretical construct, a tool for analysing morphological structures and explaining grammatical relations, rather than as a real linguistic element or morpheme in the classical sense (Aronoff & Fudeman, 2011; Bauer, 2003; Haspelmath & Sims, 2010; Matthews, 1991). Matthews (1991) further explained that null morphemes are not universally accepted across all morphological theories. Therefore, in the present study, this type of error was treated as an addition, rather than a substitution of a morpheme, yet it cannot be guaranteed that all researchers would have the same perspective. Overall, these considerations highlight the complexity of categorising reading errors, since their classification can depend on both language-specific characteristics and theoretical perspectives, underscoring the need for clear, well-defined, and explicit criteria, which are often lacking in many studies, thus representing a methodological limitation that hinders replication and cross-linguistic comparisons.

In the error analysis, based on the profiles of individual participants in the present study, it is evident that the most common type of dyslexia is phonological dyslexia, with surface dyslexia occurring occasionally, while deep dyslexia in relation to Croatian, a highly transparent language, seems absent. This pattern is consistent with the claims of Ardila and Cuetos (2016) for Spanish. These findings also demonstrate overlap between dyslexia subtypes and previous research (e.g., Gerhand et al., 2000; Hanley & Gard, 1995; Zabell & Everatt, 2002). However, those studies were primarily guided by criteria such as nonword reading and irregular word reading, whereas it is important to consider cross-linguistic differences in the manifestation of dyslexia. For example, in Croatian, a highly transparent language, irregular words are largely absent, which affects how dyslexia subtypes are expressed.

Limitations

The limitations of this study must be taken into account when interpreting the results. These include the small number of participants who were all female, the lack of additional measurements (e.g., IQ and cognitive abilities), and the heterogeneity of PwD. In addition, although the participants in the control group had not yet entered the field of speech-language pathology, the fact that they had chosen this field of study suggests that they were likely to have better language skills compared to their other typical peers. Furthermore, there is a slight educational difference between the groups. However, it is important to note that PwD were tested at the end of their final year of high school, whereas TR were assessed during the first week of their undergraduate studies. Therefore, they were separated only by the summer period without formal instruction. While it is possible that TR had a slight linguistic or cognitive advantage due to age and educational level, this is unlikely to have substantially influenced the results, as the difference reflects a short transition period, rather than a meaningful educational disparity. Additionally, the psycholinguistic properties of the materials that could influence reading outcomes were not measured thoroughly or in detail. For example, we lack detailed information on pseudowords; therefore, future studies should address this aspect in detail. Moreover, this study focused exclusively on reading aloud and not on silent reading, and although they are similar processes, they are not identical (van den Boer et al., 2022). Furthermore, the study focused on reading technique based on a single type of discourse, without investigating reading comprehension. However, reading fluen-

cy and reading comprehension are based on different background skills and knowledge (Brèthes et al., 2022). In relation to that, some authors who conducted error classification, such as Hanley and Gridley (1995) or Zabell and Everatt (2002), had more comprehensive data on reading skills when categorising errors, or at least included additional tasks assessing phonological processing or lexical retrieval, which was not the case in the present study. Consequently, the classifications presented here may be more susceptible to subjective interpretation. Finally, other data, such as information on speech and language therapy attendance, which might have influenced the development of compensatory or alternative strategies, and thus led to changes in the difficulty profile and dyslexia type, were not collected.

CONCLUSION

Despite its limitations, this study offers valuable insights into the features of reading aloud in adults with and without dyslexia. The results highlight the characteristics of reading in typical adults and those with language-based disorders such as dyslexia. While some of these characteristics align with findings from international studies, others differ due to specific features of the Croatian language and writing system. For example, the structure of the language and the transparency of its orthography influence the degree of reliance on, and the processing load of, the sublexical and lexical reading routes, and consequently affect the subtypes of dyslexia. In Croatian, features of phonological dyslexia are most commonly observed, while deep dyslexia does not occur. However, these are preliminary findings based on a small convenience sample with multiple limitations and should therefore be interpreted with caution. Although the small sample size prevents generalisations, this is one of the first attempts at an in-depth error and profile analysis of adults with dyslexia in Croatian, a topic which is rarely examined in transparent languages. It represents an initial step towards identifying common features of this population within specific languages and opens the possibility for cross-linguistic comparisons in future research. In the Croatian clinical and educational context, there is currently a lack of standardised and normed assessment materials and protocols for diagnosing dyslexia, especially in adulthood, with professionals still largely relying on subjective evaluations. It is therefore essential to investigate the characteristics of this disorder across different life stages. Understanding how TR and PwD differ throughout development can contribute to more accurate and sensitive assessment methods. Future research would particularly benefit from longitudinal studies that could provide insight into changes in how PwD read aloud as they mature and progress through education.

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APPENDIX

Pseudowords list (Lenček, 2012)

trljuk
zrepson
šefretok
etinokrač
peljikorad
ramekazrali
daberinjopok
badopnazar
žapaganasvid
Namesvudrabe

Real words list (Lenček, 2012)

pod
bodri
mrljav
dobrota
strpljivost
lampion
sitotiskovni
solsticij
brodogradilište
neimaština
zaobilaženje
nenamjenski
mnemotehnički
zabetoniravanje
najnevjerodostojniji