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Assessing the Effectiveness of the Lithuanian Non-Word Repetition Test as a Screening Tool for Dyslexia

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Annotation. This paper focuses on the ability of children with dyslexia (~8;9) and TD children (~8;2) to repeat Lithuanian non-words. Research shows that dyslexic children have difficulties with phonological processing tasks, such as encoding phonological information, retaining it in VPSTM for a certain period, and retrieving it. The results of this study provide valuable insights into the phonological difficulties of dyslexic children and may contribute to the development of more effective support.

Keywords: *non-word repetition test, dyslexia, verbal phonological short-term memory, specific learning disorder, Lithuanian language.*

Introduction

Learning to read and write is an important step in early education. While some children acquire these skills without much difficulty, others face long-term challenges

caused by dyslexia. Dyslexia[1] is characterized by difficulties in learning to read, spell, and write despite adequate intellectual capacity, educational resources, and social background (Peterson & Pennington, 2012; Gedutienė, 2017). Children with dyslexia commonly make the following errors: "they often omit, alter, or add letters and syllables; they tend to swap and invert letters that look similar but are arranged differently in space; they frequently mispronounce letters; they may reverse the direction of reading and writing and alter the sequence of letters within a word; they struggle to recognize frequently occurring short words while reading; they fail to utilize textual clues during reading; and they do not consistently apply spelling rules when writing" (Gedutienė, 2018, p. 9). These difficulties become evident only after a child begins attending school. If dyslexia is not recognized and diagnosed promptly, children may face misunderstanding and criticism from teachers and parents, who might mistakenly attribute these errors to a lack of effort or intelligence (Gedutienė, 2017, p. 6). Consequently, in addition to the uncontrollable learning challenges posed by dyslexia, a child may also experience stress and frustration from not meeting educational expectations, which can negatively impact self-esteem and later vocational success. Therefore, early identification of dyslexia using reliable and valid assessment tools is crucial.

The assessment of dyslexia is multifaceted. In addition to evaluating reading and writing skills, it encompasses the assessment of other factors such as intelligence and phonological abilities. The latter is indispensable, as it has been established that the difficulties characteristic of dyslexia stem from deficits in phonological abilities (e.g., Szenkovits & Ramus, 2005; Gedutienė, 2018).

Research has shown that children with dyslexia tend to struggle with phonological awareness tasks (e.g., Snowling, 2000; Joanisse et al., 2000), rapid automatized naming (e.g., Wolf & Bowers, 1999), and have poor verbal phonological short-term memory (henceforth, VPSTM) (e.g., Szenkovits & Ramus, 2005, p. 254). One of the screening tools for assessing VPSTM is the Non-word Repetition Test (henceforth, NWR), which

[1] It is worth mentioning that in Lithuania, the term "dyslexia" is not officially used when assessing and identifying disorders and special educational needs. According to the order of the Minister of Education and Science, the Minister of Health, and the Minister of Social Security and Labour of the Republic of Lithuania "On the Approval of the Procedure for Determining Groups of Students with Special Educational Needs and Classifying Their Special Educational Needs into Levels" (No. V-1265/V-685/A1-317), the term "Specific Learning (Reading, Writing) Disorders" is used in the provided classification. These disorders manifest as lower-than-expected achievements in reading and writing compared to intellectual abilities and age-appropriate education. They are characterized by learning difficulties that do not align with general competencies and skills due to underdeveloped or impaired cognitive processes. However, their cause is not related to intellectual disabilities, sensory impairments, inadequate education, or socio-cultural conditions. In this publication, the term "dyslexia" is used synonymously with "specific learning disorder (reading and writing disorders)". The term "dyslexia" was chosen because it is increasingly used in society by education specialists, scholars (e.g., Gedutienė 2017; 2018) and parents. In addition, it is widely used worldwide and is included in the Term Bank of the Republic of Lithuania (https://terminai.vlkk.lt/paieska?search=disleksija)

requires individuals to repeat nonsense words that vary in phoneme length and complexity (Krivickaitė, 2016; Gedutienė, 2018).

Studies have shown that children with dyslexia face difficulties with NWR (Melby-Lervåg & Lervåg, 2012). One of the first studies which identified this link was carried out by Snowling (1981). The study compared typically developing children's (aged 7;7 to 10;1) and children's with dyslexia (aged 9;6 to 17;4) performance in repeating two to four syllables in length non-words and real words. It was found that children with dyslexia made more errors in repeating longer non-words than their typically developing peers. As the difference among investigated groups of children was observed in repeating only non-words, Snowling (1981) summarized that children with dyslexia struggle to process novel phonological information. A number of other previous studies also have revealed that children with dyslexia performed more poorly in NWR test than the ones without dyslexia (e.g., Messbauer & de Jong, 2003; Baird et al., 2011; Moghiminejad et al., 2013). NWR results and reading skills correlations are exposed in research on typically developing children as well. For example, Talli et al. (2023) conducted an analysis of 387 typically developing Greek-speaking children aged 7–13 years and found that NWR skills are a good predictor of reading skills and that the NWR can be successfully used as a reliable and valid measure of VPSTM.

However, as noted by Melby-Lervåg and Lervåg (2012, p. 1), there is "disagreement regarding the magnitude of the non-word repetition deficit". While some studies report significant disparities between children with dyslexia and their typically developing peers/control group, others demonstrate small differences. Moreover, there is a disagreement between the authors about how "phonological skills should be conceptualised in non-word repetition and dyslexia" (Melby-Lervåg & Lervåg, 2012, p. 2). Thus, this issue requires further discussion and exploration.

Explanations for Non-Word Repetition Deficits in Relation to Dyslexia

There are different explanations for NWR deficits in relation to dyslexia: one attributes the deficits to problems with VPSTM, while another links them to poorly defined phonological representations (see Melby-Lervåg & Lervåg, 2012).

VPSTM is responsible for preserving phonological information for a certain period of time. For example, it stores the sequence of sounds heard for the first time before phonological analysis (the perception of differences in the sounds that constitute a word) (Krivickaitė, 2016). Hachmann et al. (2014) emphasises that individuals with dyslexia face challenges in reading and writing correctly due to difficulties in remembering specific sequences of letters. Consequently, VPSTM can be assessed by asking participants to repeat sequences of numbers or words, also to repeat non-words (Gedutienė,

2018; Gathercole, 2006), which help to capture problems with the coding and retrieval of phonological information in VPSTM. In comparison to repeating sequences of familiar words, which are well established in long-term memory, NWR is considered a more accurate tool to assess VPSTM as the accuracy of repeating non-words relies solely on the individual's ability to retain the phonological segments of these words in their VPSTM, rather than on their acquired lexical knowledge (Gathercole, 2006; Daniutė & Staliūnienė, 2021). The essence of the approach is that NWR is considered an indicator of the proficiency of the phonological loop and VPSTM, and deficits in VPSTM may lead to problems with non-word repetition, learning to read, and other tasks that rely on phonological skills (see Melby-Lervåg & Lervåg, 2012). Rispens and Parigger (2010) note that one piece of evidence for the role of VPSTM in NWR comes from the observation that longer non-words are harder to repeat than shorter ones. This "length effect" is attributed to memory capacity, as longer words place greater demands on VPSTM, potentially overloading the phonological loop where non-words are temporarily maintained.

According to the phonological representations approach, VPSTM and reading are not causally linked. Instead, this view emphasizes that children with dyslexia have poorly specified phonological representations, which impede the discovery of phonetic elements in speech, constrain VPSTM tasks, and impair NWR. Difficulties in accessing these representations from long-term memory limit the ability to recall phonological information, affecting both nonword repetition and reading (see Melby-Lervåg & Lervåg, 2012).

In order to test the competing explanations about the relation between NWR and dyslexia, Melby-Lervåg & Lervåg (2012) conducted meta-analysis of research on children with dyslexia. This analysis included not only NWR but also other tests measuring VPSTM (e.g., digit span or word span) and measures of phonological awareness. The authors hypothesized the following: the VPSTM conceptualisation of the relation between NWR and dyslexia would be correct if other measures of VPSTM explained the variation in non-word repetition between samples with dyslexia. Conversely, the phonological representations conceptualization would be correct if measures of phonological awareness are controlled. The conducted metanalysis supported the latter explanation indicating that poor phonological representations contribute to the difficulties. Their study also revealed that the strongest predictor of deficient NWR performance is the presence of an oral language deficit, highlighting the comorbidity between dyslexia and specific language impairments.

With the aim of contributing to the ongoing debate, the present study raises the question of whether the Lithuanian NWR (for more details on the test, see the methodology section below and Krivickaitė and Dabašinskienė (2013), Krivickaitė (2016)) can be used as a screening tool for dyslexia. This study focuses on comparing the

Lithuanian NWR results and error types of typically developing children (henceforth, TD) and children with dyslexia (henceforth, DYS), exploring whether there are any statistically significant differences between the groups. As emphasized by Daniutė and Staliūnienė (2021, p. 54), there is still a lack of research on language-adapted, reliable, and valid instruments for assessing phonological skills in Lithuania. Therefore, research in this area could be significant not only from a theoretical perspective but also for teachers and speech therapists, as it would provide insights into the specific phonological challenges (error types) faced by children with dyslexia. Furthermore, a better understanding of phonological processing difficulties in these children can help educators develop more effective teaching strategies.

Methodology

The non-word repetition test (NWR) has been widely studied in the fields of both typical and atypical language development, including language and reading disorders (see De Bree et al., 2007; Coady & Evans, 2008; Marshall & van der Lely, 2009; Stanley, 2019; Meloni et al., 2020; Ehrhorn et al., 2021). The test of NWR involves listening to and repeating novel phonetic sequences (non-words), that are based on the rules of a specific language's phonotactic structure (Talli et al., 2023).

Non-word Repetition Test requires a child to listen to a non-word through an audio recording or live presentation by an examiner and then repeat the word that was heard. Children are required to listen, encode, temporarily store, retrieve, and reproduce the non-word, all within the same task (Stanley, 2019).

The Lithuanian NWR test (Krivickaitė & Dabašinskienė, 2013; Krivickaitė, 2016) was developed while participating in the COST project "IS0804 Language Impairment in a Multilingual Society: Linguistics Patterns and the Road to Assessment" (2009–2013)[2]. This test was created to reflect the structural characteristics of Lithuanian words, including vowel and consonant frequency, syllable structure, and word length (Krivickaitė, 2016). The test consists of 24 non-words with varying structures: 8 non-words contain two syllables (4–6 phonemes); 8 non-words contain three syllables (6–7 phonemes); and 8 non-words contain four syllables (7–8 phonemes) (Krivickaitė, 2016). Each group includes two non-words without consonant clusters (henceforth, CC) and six non-words with CC (for more about the test see Krivickaitė, 2016). The examples of non-words are demonstrated in Table 1 below.

[2] https://www.bi-sli.org/cost-action-is0804

Table 1

Examples of Words From the Lithuanian Non-Word Repetition Test

Two-syllable non-words	Three-syllable non-words	Four-syllable non-words
k e m u CV.CV	g e l ɔ ʃ ɑ CV.CV.CV	s u l e r ɪ t e: CV.CV.CV.CV
s k ɪ m o CCV.CV	ʃ k u l ɪ n e: CCV.CV.CV	s n ɑ l ɪ d ɪ n ɑ CC.CV.CV.CV
g ɑ: p r e: CV.CCV	m ɑ: s p u le: CV.CCV.CV	n ɪ s p ɑ r ɪ m ɑ CV.CCV.CV.CV
g ɪ t v ɑ CV.CCV	l ɑ s m u v ɪ CV.CCV.CV	m ɑ g v u n ɔ l e: CV.CCV.CV.CV
k l e s t ɑ CCV.CCV	p ɑ: s v ʌ p ɪ CV.CCV.CV	g ɔ s ɑ k l u: n ɪ CV.CV.CCV.CV

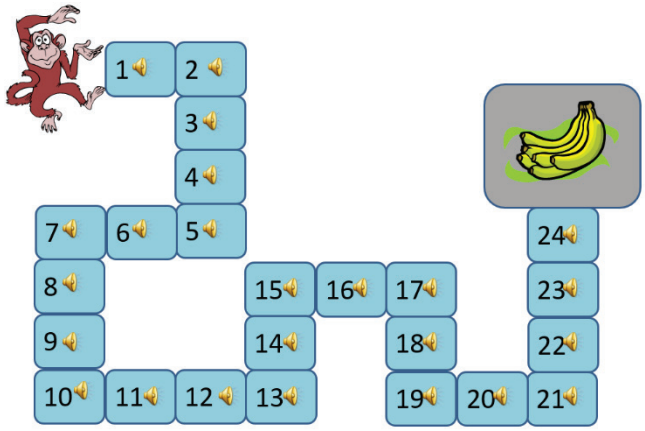
Procedure

The whole testing process was given to the children in the form of a game. Each participant was familiarized with a hungry monkey that wanted a banana. Participants were asked to help the monkey complete the task. At each step, a child heard a pre-recorded non-word and had to repeat it exactly as they heard it (Krivickaitė, 2016).

The animated version of the test was developed by S. Kunnary (2011). Permission to use this animated version for the Lithuanian language test was granted by the author.

Figure 1

Visual of the Non-Word Repetition Test (designed by Kunnari, 2011)



All multisyllabic non-word items were digitally recorded by a 40-year-old female native speaker of Lithuanian.

Each child was tested individually in a quiet room. All recorded utterances were transcribed and analysed for consonant phoneme errors. Errors were categorized into the following types: omissions, additions, substitutions, and metathesis.

The study consists of 39 typically developing monolingual Lithuanian-speaking children (mean age 8;2, henceforth, TD group) and 32 children diagnosed with specific learning disorders (reading and writing)[3] (mean age 8;9, henceforth, DYS group, see Table 2). The data were collected from primary schools in the city of Kaunas, Lithuania. The children who participated in the study had their specific learning disorders (reading and writing) officially diagnosed by specialists at the Psychological Pedagogical Service. In addition, a number of children visited the Dyslexia Centre (in Vilnius, Lithuania), where the diagnosis was confirmed.

The parents/guardians of the participants were informed about the study. Their written consent was obtained for a child to complete the NWR and for the anonymized results to be used for scientific purposes.

Table 2
Participants of the Research

Group	N
TD	39 (mean age 8;2)
DYS	32 (mean age 8;9)

Scoring

Each child's response was coded as either correct or incorrect. The coding process had two stages: analysis of the whole item and analysis of the syllable structure.

Analysis of the whole item. Each 2-, 3-, and 4-syllable word was scored as correct only if it was repeated exactly as presented. Any addition, omission, or substitution was scored as an incorrect answer.

Analysis of Syllable Structure

- Only pronunciation of the CC. Each 2-, 3-, and 4-syllable word was scored as correct if the CC was repeated accurately. Any omission (e.g., *kɪmo* instead of *skɪmo*), substitution (e.g., *ga:ple:* instead of *ga:pre:*), or other inaccurate pronunciation was scored as an incorrect answer (Krivickaitė-Leišienė & Dabašinskienė, 2023).

[3] As already mentioned in the introduction section, in this study, we use the term "dyslexia" synonymously with the term "specific learning disorder (reading and writing)".

- CC position in the non-word. Each 2-, 3-, and 4-syllable word was scored as correct if the CC in the initial or medial position was pronounced accurately. Any omission (*salıdına* (= *snalıdına*)), substitution (*pa:slʌpı* (= *pasvʌpı*), addition (*mangvunɔle* (= *magvunɔle:*) or other inaccurate pronunciation of the CC was scored as an incorrect answer (Krivickaitė-Leišienė & Dabašinskienė, 2023).

The data were coded manually by the authors of the study; data analysed using the SPSS (*Statistical Package for the Social Sciences*) programme. For statistical comparison of significant differences, the Independent Sample T-test, Repeated Measures ANOVA and One way ANOVA were used, and a standard 0.05 level of statistical significance was chosen.

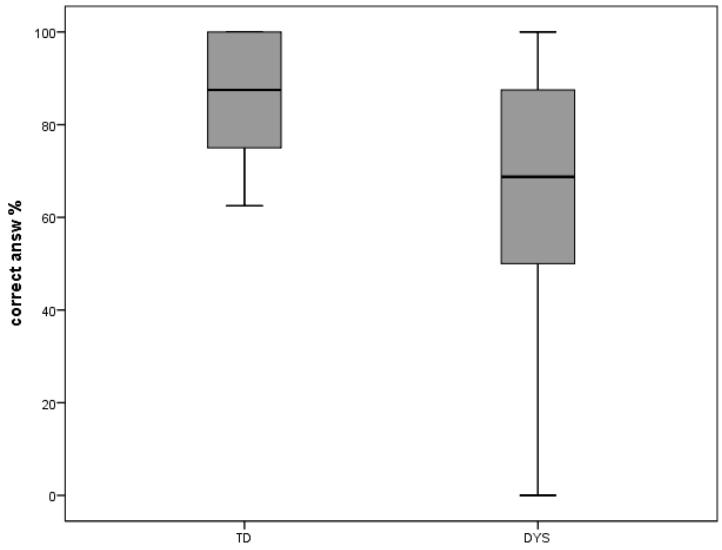
Results

The analysis of the whole-item

The analysis shows that DYS group repeated non-words significantly less accurately than the TD group ($t(211) = 8.862$, $p < .001$). The TD group repeated non-words with an accuracy of 87%, while the DYS group repeated non-words with an accuracy of 66%.

The TD group repeated non-words accurately within the 62% to 100% range, while children with DYS repeated non-words within the 0% to 100% range (see Figure 2).

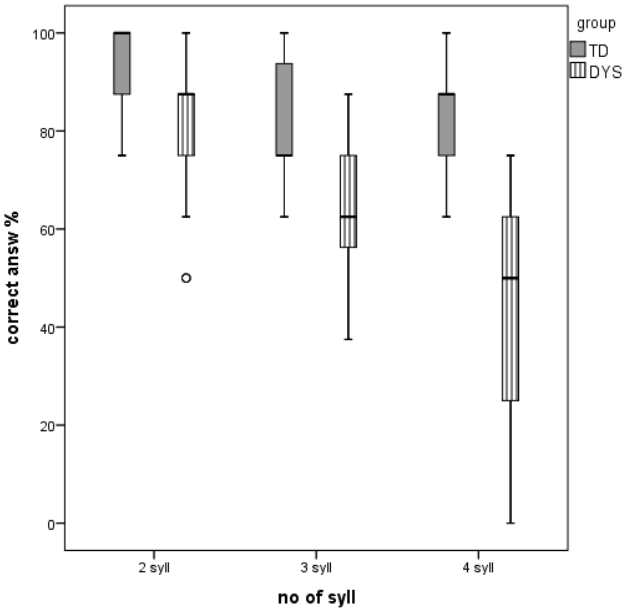
Figure 2
The Distribution of Correct Responses in the TD and DYS Groups



One more important factor is the length of the word. Figure 3 shows the repetition scores of both the TD and DYS groups for 2-, 3-, and 4-syllable non-words. The pattern is clear: the longer the word, the more difficult it is to pronounce correctly for both groups ANOVA revealed a statistically significant difference ($F (1, 69) = 84.756$, $p < .001$) between the TD and DYS groups for the pronunciation of 2-, 3-, and 4-syllable words (see Figure 3).

Figure 3

The Production of 2-, 3-, and 4-Syllable n=Non-Words in the TD and DYS Groups



The analysis revealed differences between the TD and DYS groups in the ability to repeat non-words. For 2-syllable non-words, the TD group achieved 93% accuracy, while the DYS group achieved 83% accuracy ($F (1, 69) = 14.339$, $p < .001$). For 3-syllable non-words, the TD group had an accuracy of 84%, compared to 66% for the DYS group ($F (1, 69) = 29.162$, $p < .001$). For 4-syllable non-words, the TD group repeated them with 83% accuracy, whereas the DYS group had an accuracy of 47% ($F (1,69) = 83.646$, $p < .001$).

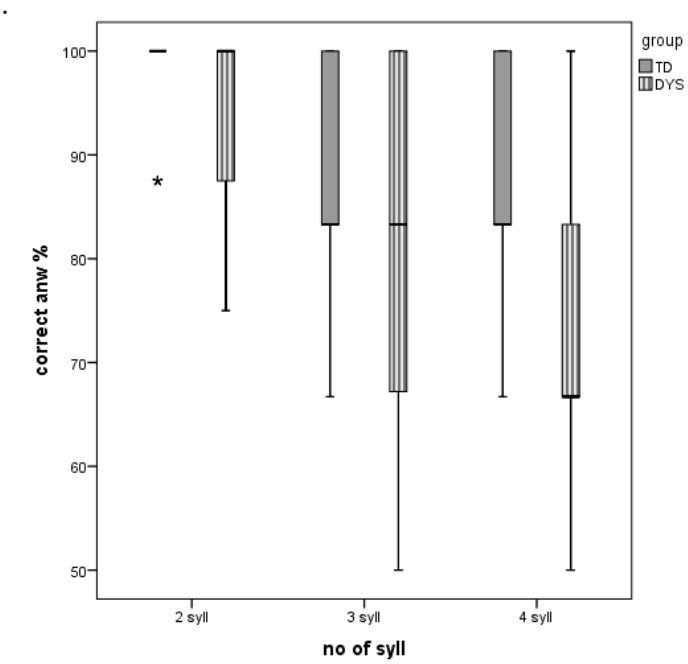
Syllable structure analysis

Repeating consonant clusters in the non-words. The data suggest that CC were repeated significantly better by the TD group than by the DYS group ($t(171) = 3.858$, $p < .001$). The TD group achieved 90% accuracy with CC in non-words, whereas the DYS group achieved 81% accuracy.

The analysis of accurate pronunciation of CC in 2-, 3-, and 4-syllable non-words reveals notable differences between the TD and DYS groups. For instance, in 2-syllable non-words, the TD group achieved 98% accuracy in repeating CC, compared to 93% accuracy in the DYS group. However, this difference is not statistically significant ($F(1, 69) = 1.673$, $p = .200$). The box plot illustrates the differences between groups repeating CC in 2-syllable non-words (see Figure 4). Specifically, CC in 2-syllable non-words pronounced by the TD group were produced correctly in nearly all cases, with few exceptions. In contrast, the accuracy range for the DYS group is broader, varying from a low of 75% to a high of 100% (Figure 4).

Figure 4

Consonant Cluster Production for 2-, 3-, and 4-Syllable Non-Words in TD and DYS Groups



The TD group repeated CC in 3-syllable non-words with 86% accuracy, while the DYS group achieved 83% accuracy. The difference, however, is small and not statistically significant ($F(1, 69) = 2.478$, $p = .1202$). The box plot shows some variability: the range of accurately pronounced CC in 3-syllable non-words for the TD group varies from 66% to 100%. In contrast, the DYS group exhibits a broader range, with accuracy levels spanning from 50% to 100% (see Figure 4).

CC in 4-syllable non-words were repeated with an accuracy of 89% by the TD group and 75% by the DYS group, showing statistically significant differences

(F (1, 69) = 23.463, p < .001). The box plot illustrates that the range of accurately pronounced CC in 4-syllable non-words for the TD group varies from 66% to 100%. In contrast, the accuracy range for the DYS group is broader, spanning from 50% to 100% (see Figure 4).

Initial position vs. medial position of the cluster in the non-words. Both groups repeated CC more accurately in the initial position than in the medial position. The analysis demonstrates that the DYS group pronounced CC in the initial position significantly worse than the TD group, with accuracy rates of 86% and 97%, respectively (F (1,70) = 5004.775, p < .001). In the medial position, the DYS group also demonstrated poorer performance, achieving 75% accuracy compared to the TD group's 86% (F (1, 69) = 2761.532, p < .001).

Initial position. Further analysis revealed that CC in 2-syllable non-words were pronounced similarly by both groups: the TD group with 99% accuracy and the DYS group with 95% accuracy. No significant difference was observed between the groups (F (1, 69) = 2.565, p = .114).

Statistically significant variations were observed in the repetition of CC in 3-syllable non-words: the TD group outperformed the DYS group, with accuracy rates of 93% and 76%, respectively (F (1, 69) = 14.311, p < .001).

Further significant differences were found in the repetition of CC in 4-syllable non-words, where the TD group outperformed the DYS group, achieving accuracy rates of 100% and 85%, respectively (F (1, 69) = 19.535, p < .001).

Medial position. The analysis of word length showed that CC in 2-syllable non-words were pronounced significantly better by the TD group (F(1,69) = 11.293, p < .001). The TD group achieved an accuracy rate of 96%, while the DYS group had an accuracy rate of 84%.

The DYS group repeated CC in 3-syllable non-words slightly better than the TD group (82% versus 80%). However, the difference was not statistically significant (F(1, 69) = 0.293, p = .590).

CC in 4-syllable non-words were pronounced significantly better by the TD group compared to the DYS group (F (1, 69) = 12.878, p < .001). The TD group achieved an accuracy rate of 80%, while the DYS group achieved 57%.

Simplification of Non-words: A Brief Analysis

Children may have difficulty pronouncing words with complex syllabic structures, so they use word simplification strategies, such as omitting one CC member or replacing a sound with one that is easier to pronounce. Other strategies, such as consonant assimilation, metathesis, or sound addition, were also found in both the TD and DYS groups.

Ommision. In most instances, one consonant from the cluster was omitted in both groups. Specifically, children tended to omit the more sonorous consonant within a cluster; for example, "kɪmo" instead of "**s**kɪmo", "ʃelɑ" instead of "ʃ**v**elɑ", and "mɑgunəle:" instead of "mɑg**v**unəle:". These findings align with the Sonority Model, which posits that children are more likely to omit the more sonorous consonant in a cluster (see Krivickaitė, 2016; Krivickaitė-Leišienė, 2023).

The main difference found between the TD and DYS groups when repeating non-words is that the DYS group tends to omit a syllable in words longer than three syllables. For example, "nɪspɑrɪ" instead of "nɪspɑrɪ**mɑ**", "snɑlɪnɑ" instead of "snɑlɪ**d**ɪnɑ" and "sulɪte:" instead of "sul**e**rɪte:". These omissions occur in various positions within the words.

Addition. The research showed that the TD group added a sound in one specific word – instead of "pɑ:svʌpɪ" they pronounced it as "pɑ:slʌp**t**ɪ". This corresponds to the Lithuanian word "paslaptis" (meaning 'secret'), which may have influenced their pronunciation.

The DYS group frequently appended a plosive sound, typically 'k', to the end of words. For example: "spɑ:dəkɪ**k**" instead of "spɑ:dəkɪ", "pɑ:svʌpɪ**k**" instead of "pɑ:svʌpɪ", and "ʃvɑlɑ**k**" instead of "ʃvelɑ". In Lithuanian, the suffix 'k' often denotes the imperative form. Additionally, the DYS group also added the 's' sound at the end of words. For instance: "snɑlɪdɪnɑ**s**" instead of "snɑlɪdɪnɑ" and "pɑ:slʌpɪ**s**" instead of "pɑ:svʌpɪ". In Lithuanian, this suffix generally signifies the masculine nominative singular form. Moreover, the endings of the -as and -is paradigms are among the most productive in Lithuanian.

Substitution. The DYS group exhibited the highest number of substitutions, replacing both consonants and vowels, whereas the TD group substituted only consonants.

Vowel substitutions were observed in the DYS group. The vowels 'e' and 'i' were replaced with the diphthong 'ie' in the middle of words, for example: "k**ɪe**mu" instead of "kemu" "sk**ɪe**mo" instead of "skɪmo", and "pl**ɪe**mutɑ" or "pr**ɪe**mutɑ" instead of "plemutɑ". The vowels 'ė' and 'i' were also replaced with the diphthong 'ie' at the end of words, for example: "surarɪtɪe:" instead of "sulerɪte:", "lɑsmuv**ɪe**" instead of "lɑsmuvɪ" and "gɔsɑklu:n**ɪe**" instead of "gɔsɑklu:nɪ".

It was found that the TD group substituted voiceless plosive consonants with voiced ones in CV and CCV syllable structures, for example: "**g**emu" instead of "**k**emu", "spɑ:də**g**ɪ" instead of "spɑ:də**k**ɪ", "pɑ:svʌ**b**ɪ" instead of "pɑ:svʌ**p**ɪ", "gɑ:**b**re:" instead of "gɑ:**p**re:", and "**b**lemutɑ" instead of "**p**lemutɑ". This pattern was not observed in the DYS group.

In both groups, consonants were substituted depending on the airflow, with plosives being replaced by other plosives and liquids by other liquids, in syllables with various structures. For example: "mɑ:s**t**ule:" or "mɑ:s**k**ule:" instead of "mɑ:s**p**ule:"; "mɑ:spu**j**e:" instead of "mɑ:spu**l**e:".

Metathesis. The DYS group exhibited a high frequency of metathesis, with examples including "žɑ**ve**d**d**ɪnɑ" instead of "žadevɪnɑ", "mɑg**n**u**v**ɔle:" instead of "mɑg**v**unɔle:", "snɑlɪ**n**ɪ**d**ɑ" instead of "snɑlɪdɪnɑ", and "su**r**e**l**ɪte:" instead of "sulerɪte:". In contrast, the TD group demonstrated metathesis in specific words, such as "su**r**e**l**ɪte:" instead of "sulerɪte:" and "mɑg**n**u**v**ɔle:" instead of "mɑg**v**unɔle:".

In summary, both TD and dyslexic children simplified the pronunciation of words with complex syllabic structures using strategies such as omission, addition, substitution, and metathesis in the Lithuanian Non-word Repetition Test. It was noticed that the DYS group had a greater tendency to omit syllables in multisyllabic words or add extra sounds at the end of non-words. This wasn't typical of the TD group. Metathesis and substitution were also more common in the DYS group.

Discussion and Conclusions

When trying to pronounce words with complex syllabic structures, children unknowingly use word-simplification strategies, such as omitting sounds with more complex articulations or replacing them with sounds that have easier articulation. Such inaccuracies or substitutions in pronunciation are a natural part of language development, reflecting the underlying cognitive processes at play as children learn new words (Dodd et al., 2003; Santos et al., 2006). These pronunciation strategies of sound simplification, also referred to as natural language development processes (see Brooks & Kempe, 2014), are analysed in this study within the framework of Naturalness Theory (Dressler, 1999; 2005; Dressler et al., 2001; Donegan & Stampe, 2009; Dziubalska-Kołaczyk, 2007; 2014; Marecka & Dziubalska-Kołaczyk, 2014). According to this theory, natural forms in a language are those that are cognitively simple, easy to pronounce, and perceive, which leads to their frequent usage. Unmarked forms are considered natural linguistic elements (i.e., less marked = more natural), and they tend to occur more often and be acquired earlier. During language acquisition, children naturally make more mistakes with marked forms – those that are less natural – by replacing them with more frequent, natural, or easier-to-pronounce alternatives (Dressler, 1999; Dressler et al., 2001; Marecka & Dziubalska-Kołaczyk, 2014; Dziubalska-Kołaczyk, 2015).

Comparative studies of languages reveal that the acquisition of CC aligns with the phonotactic rules of a given language: children tend to acquire aspects that are more common in their linguistic environment more quickly. Clusters that frequently occur in words are practiced more often and, as a result, are pronounced accurately at an earlier stage (Marecka & Dziubalska-Kołaczyk, 2014). Our data demonstrated that when children substituted one of the CC elements, the cluster was changed to one that is more typical of Lithuanian words or easier to pronounce. For example, the cluster *sp* was often replaced by *sk,* for example: "m ɑ: s**k**ule:" instead of "mɑ:spule:", or "nɪs**k**ɑrɪmɑ"

instead of "n ɪ s p ɑ r ɪ m ɑ". The cluster *sk* is more frequent in Lithuanian words than *sp* (Kazlauskienė, 2007). In addition, the cluster *sk* also appears between morphemes; for instance, in the word *skrisk* ("fly"), it marks the imperative. Therefore, children might recognize it more easily. Our study shows that simplification strategies observed in NWR are applied by both investigated groups, TD and DYS. However, differences between the groups can be identified by examining the types of simplification strategies in more detail; specifically, certain types of simplifications were observed more frequently in the DYS group. In our study, the DYS group was distinguished by not only replacing consonants but also vowels in substitutions, more frequently omitting syllables in polysyllabic words, appending extra sounds to the ends of words, and, in general, applying simplification strategies such as substitutions and metathesis more frequently. Thus, we presume that the mentioned simplification strategies in NWR could be considered when assessing dyslexia. Moreover, regarding CC, one aspect that can help distinguish children with dyslexia is the NWR results concerning the position of CC within the non-word. In the Lithuanian non-words, some CC appeared in the initial position, while others were in the medial position. Our study's results align with research in other languages, showing that CC in the medial position are repeated less accurately than those in the initial position (Marshall, van der Lely, 2009; Williams et al., 2013; Cilibrasi et al., 2018). Children in the DYS group pronounced CC significantly less accurately than those in the TD group. The increased difficulty in repeating non-words with medial CC is influenced by phonological complexity, articulatory demands, memory constraints, and lexical factors. These elements interact to make medial clusters more challenging to process and reproduce accurately, especially for children with dyslexia.

The research indicates that accuracy in non-words repetition declines as syllable count increases; specifically, 1- and 2-syllable non-words are repeated more accurately than 3- or 4-syllable non-words (Chiat & Roy, 2007; Graf Estes et al., 2007; Stanley, 2019).This decline is attributed to the capacity for retaining phonological information in verbal phonological short-term memory (VPSTM) (Talli et al., 2023). The results of this and previous studies have shown that children with dyslexia made more omission errors than their TD peers (see Stanley, 2019), and the DYS group more frequently omitted entire syllables in 4-syllable Lithuanian non-words. This confirms that children with dyslexia have difficulties with temporarily storing the resulting phonological representation in VPSTM, which consists of a sequence of familiar phonemes arranged in an unfamiliar order, and finally retrieving this representation from VPSTM to produce an articulatory response (Schraeyen et al., 2019). In addition, our research showed that, as non-word length increases, performance declines in both groups. The largest difference in accuracy is observed between 2-syllable and 3- or 4-syllable non-words in the TD group, whereas in the DYS group, performance declines with each increase in syllable length. For example, in the TD group, 2-syllable non-words were repeated

with 93% accuracy, whereas 3- and 4-syllable non-words were repeated with 83-84% accuracy. In the DYS group, 2-syllable non-words were repeated with 83% accuracy, 3-syllable non-words with 66%, and 4-syllable non-words with 47% accuracy. These challenges stem from issues with VPSTM, which affect the ability to consistently reproduce sequences of information. The consistent reproduction of information units aids in creating representations of new written words in VPSTM, thereby strengthening the connections between the orthographic (written) and phonological (spoken) forms of words (Daniutė & Staliūnienė, 2021).

The study revealed statistically significant differences in the Non-word Repetition Test results between the DYS and TD groups, highlighting patterns characteristic of dyslexic children. Thus, we presume that the Lithuanian Non-word Repetition Test used in the study can be used as one of the screening tools to help predict dyslexia. It is important to mention that while many tendencies and difficulties faced by the DYS group can be observed, the interpretation of this study's results is limited by the relatively small sample size in both groups. Therefore, only general tendencies regarding the ability of children with dyslexia and those with typical language development to repeat non-words can be discussed. To refine the results of this study and draw more generalized conclusions, further research with a larger sample size would be necessary.

To summarize, the research results may be useful and relevant in designing practical speech development tasks for children with dyslexia. By paying attention to the specific sounds, sound clusters, and word structures that children struggle to pronounce, teachers, speech therapists, and parents can offer more focused support. For instance, the findings indicate that children with dyslexia struggle with verbal phonological short-term memory and have difficulty producing words longer than three syllables. This suggests that specialists should work on strengthening their verbal short-term memory to improve multisyllabic word pronunciation while also expanding both their active and passive vocabulary. In addition, it was noted that children with dyslexia have difficulty pronouncing CC, particularly those in the middle of words and in longer words. Teachers as well as speech and language therapists can support this by creating extra practical exercises for children. It is important to respect a child's educational needs. Parents, teachers, and other specialists must be educated to recognize the signs and characteristics of Specific Learning Disabilities and be able to intervene when necessary (Thomas & Uthaman, 2019).

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Lietuviškas išgalvotų žodžių pakartojimo testas kaip priemonė disleksijos rizikai įvertinti

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Santrauka

Straipsnyje analizuojamas vaikų, kuriems nustatyti specifiniai mokymosi (skaitymo, rašymo) sutrikimai (straipsnyje vartojamas terminas *disleksija*) (N = 32, vidutinis amžius – 8; 9 m.), ir tipinės kalbos raidos vaikų (N = 39, vidutinis amžius – 8; 2 m.) gebėjimas pakartoti lietuviškus išgalvotus žodžius. Tyrimai rodo, kad disleksiją turintiems vaikams sudėtinga atlikti fonologinio apdorojimo užduotis, t. y. užkoduoti fonologinę informaciją, ją tam tikrą laiką išlaikyti trumpalaikėje atmintyje ir atkurti (ištarti). Šio lyginamojo tyrimo rezultatai leido išskirti, su kokiais fonologiniais sunkumais susiduria disleksiją turintys vaikai. Nustatyta, kad jiems sudėtinga tiksliai ištarti trijų ir keturių skiemenų žodžius: neišlaikoma žodžio skiemeninė struktūra, t. y. praleidžiamas vienas iš priebalsių samplaikos dėmenų (ypač žodžio viduryje); neišlaikomas ilgesnių nei trijų skiemenų žodžių ilgis, t. y. praleidžiamas skiemuo (tai beveik nepasitaikė tipinės kalbos raidos vaikų atsakymuose); reikšmingai dažniau nei tipinės kalbos raidos vaikų atsakymuose keičiami balsiai ir priebalsiai žodžiuose; žodžių gale pridedami papildomi priebalsiai; trijų ir keturių skiemenų žodžiuose būdingas garsų sukeitimas vietomis. Šio tyrimo rezultatai suteikia vertingos informacijos apie disleksiją turinčių vaikų fonologinius sunkumus ir gali prisidėti prie efektyvesnių intervencijų kūrimo.

Esminiai žodžiai: *išgalvotų žodžių pakartojimo testas, specifiniai mokymosi sutrikimai, disleksija, fonologinė trumpalaikė atmintis, lietuvių kalba.*

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