Testing and Diagnosing Dyslexia in Adolescents – Focused on Phonemic Awareness

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Abstract

Aim. Phonetic deficits are one of the core language-cognitive symptoms at cognitive level aetiology of dyslexia in variety languages and orthographies. The presented study examines possibilities of diagnosis of phonological deficits in the Slovak language (similar to Czech and Polish grapheme-phoneme rules) in students at upper secondary schools. The comparison of 237 non-dyslectics and 149 dyslectics in upper secondary schools brings new stimulus for diagnostic procedures at counselling centres.

Methods. Four phonemic awareness tests for upper secondary school students (aged 15-20 years) were developed. The testing tasks included tasks on phoneme analysis/segmenting in words and non-words (10), phoneme synthesis/blending in words and non-words (10), phoneme transposition in words and non-words (8), and phoneme elision in non-words (8).

Results. Dyslectics achieved a lower average score in phonemic awareness tests than non-dyslectics. First and second year students (aged 15-17 years) achieved sim-

ilar average scores, but third and fourth year students (aged 17-20 years) achieved lower results. The t-statistic for the phonological analysis tests was 2.827 with df 56.259 and a p-value of 0.007, indicating a significant difference between the groups under study. The t-statistic for the phonological synthesis tests was -2.568 with df 284 and a p-value of 0.011, also indicating a significant difference between the groups. The t-statistics for the phonological transposition and elision tests indicate that there is no significant difference between the dyslexic and non-dyslexic group.

Conclusion. The study brought several inspirations for the tasks and tests that can be used in the diagnosis and re-diagnosis of dyslexia, specifically for adolescents.

Keywords: dyslexia, phonemic awareness, adolescent, testing, phonological deficit

Introduction

Phonemic awareness (PA) is one of the core domains for dyslexia identification at preschool (dyslexia at-risk) and primary school age. For the preschool age, phonemic awareness is important in connection with reading and writing readiness and is increasingly appearing in school readiness testing, unlike in the past, when there was more focus on the area of visual perception. In preschool age, lagging in the development of the phonological area is one of the universal predictors of dyslexia, and it can be used to identify dyslexia in at-risk children. In Slovakia, there are currently several evidence-based tests that can be used in this area, for example The Literacy Predictor Test (Mikulajova, 2012) or MABEL - Multilanguage Assessment Battery of Early Literacy (Caravolas et al, 2018). They are applied for clinical and school screening of at-risk children in preschool and younger school age. At the primary grade of elementary school, diagnosing the level of phonemic awareness is essential for an accurate and objective diagnosis of a reading disorder. However, with reading (and effective intervention), the level of phonemic awareness (PA) in dyslexic children improves, and the lower secondary grade tests of phonemic analysis and synthesis are already much less discriminating. It is questionable how effective and meaningful the testing or assessment of PA is for students of upper secondary education in languages with shallow orthography, such as Slovak, Czech, or Polish languages.

The generally accepted thesis is that in transparent orthographies the strong role of phonemic awareness is confined mainly to the first phase of acquisition of reading ability (Wimmer et al., 2000). Similar findings were found in a study in which the PA of Czech and English young pupils were examined (Caravolas et al., 2005). Authors have tested pupils in the ages of 7.5 – 11.5 from significantly different, both in linguistics and orthography, language background (Czech and English native speakers). Testing was focused on identifying the predictive value of phonologic awareness for writing, speed in writing and reading comprehension. The results had shown that phonological awareness is a significant predictor of reading speed, reading comprehension and correctness in reading and writing.

Is the phonemic deficit also present in secondary school students? If so, how does it manifest itself, how should we capture it, evaluate it at an expert level (special educational, speech therapy or psychological diagnostics)? And what types of tasks are useful for diagnostics? We will try to answer these questions in the following chapters.

Theoretical Basis

Joseph K. Torgesen at al. (1994) had exanimated that the phonemic level of representation is fundamental for ability of word decoding. Tasks of reading pronounceable non-words and phoneme manipulation are used for processing the phonemic level. There are many types of phonemic awareness tasks used in dyslexia standardised tests. According to complexity we recognise many types of tasks, e.g.:

- Phoneme isolation, initial sound identification tasks.
- Phoneme identity tasks– the student must determine what the words have in common, e.g., hand vs. house from the point of view of auditory image.
- Phoneme substitution tasks (at the beginning, in the middle of a word, at the end of words/ non-words).
- Word/ non-word phoneme analysis, oral phoneme segmenting.
- Word/ non-word phoneme synthesis, oral phoneme blending.
- Sound deletion, transposition of phoneme – spoonerism task, phoneme elision - manipulation of vowels in a word (e.g. omission of vowels: nose – ose).
- Non-words repetition.
- Memory for numbers.
- Rapid automatic naming of numbers/letters/colours/objects (RAN).

Tasks with phoneme segmenting (also known as phoneme analyses) and blending (phoneme synthesis) in words and non-words and reading non-words text or list were widely used in Czech and Slovak counselling centres as a part of the school system.

According to the Marilyn J. Adams's classification (1990, in Sodoro et al., 2002), phoneme manipulation corresponds to the fourth developmental level. The child should be able to isolate individual phonemes in words and work with them. The following types of tasks correspond to this level: phoneme elision (omitting a phoneme in a word), phoneme transposition (changing the arrangement of phonemes in a word) or adding a phoneme to a word. The first time when vowel elision and transposition tasks appeared in Central Europe was in the Czech Battery of Literacy Tests for 2nd and 5th grade pupils (Caravolas & Volin, 2005). Reaching the fifth level means gaining auditory analysis skills. This is the segmentation of words into phonemes, which the child must gradually pronounce sound by sound. This

type of task can be found in the pioneering Matejcek Auditory Analysis Test (1995) and Wepman-Matejcek Phonemic Discrimination Test (Matejcek, 1987). A Slovak version of the test was created in 1993 (Mikulajova & Rafajdusova, 1993). However, after the 6th grade, these exams are no longer useful in diagnosis, because the examinations lose their ability to discriminate, since dyslexic students have a success rate of up to 95 percent in these tests. It is therefore obvious that in languages with shallow orthography phonemic awareness loses its ability to predict reading performance in older students.

Peter F. De Jong and Aryan Van der Leij (1999) declare that the role of phonemic awareness is usually constrained to the initial phase of learning to read, especially in relatively transparent orthographies. Heinz Wimmer et al. (2000) also claim that the early phases of literacy acquisition are less affected by early phonological awareness deficits than later phases. Authors justify this by proving that later phases depend more on the build-up of spelling memory.

Methodology of Research

Background of Research

The purpose of the study is to compare performance in tests of phonemic awareness of dyslexic and non-dyslexic students of upper secondary schools (aged 15-20 years). Design of research is qualitative. Several research questions were identified:

- What are the differences in performance in phonemic awareness tests of upper secondary school students with and without dyslexia?
- What is the relationship between the level of phonemic awareness and non-word reading of upper secondary school students?
- Which tasks for the diagnosis of phonemic deficit in upper secondary school students have the best discrimination ability?
- What must be the stimulus words and non-words in the diagnostic tests for upper secondary school students to be able to distinguish dyslectics from non-dyslectics?

Sample of Research

The research sample consisted of 386 upper secondary school students in Slovakia. The PA exams were administered to a group of 386 students aged 15 to 20. The average age of the respondents was 17 years (min=14, max=20, SD=1). The research group consisted of 192 girls (49.7%) and 194 boys (50.3%) from different districts of Slovakia (43). Representation of students by years: 1st year (89), 2nd year (96), 3rd year (122) and 4th year (79). The basic set represents, on average, 190,000 upper secondary school students (excluding special secondary schools) for the monitored years. The average grade for the subject of Slovak language and literature was B/E (min=1, max=4, SD=0.8).

We monitored performance in several types of upper secondary schools. The largest group was represented by students from secondary vocational schools. The representation of students according to different types of upper secondary school is shown in the following table (Tab. 1).

Table 1
Number of students (research sample) by type of upper secondary school

Type of Upper Secondary School	*N*	*%*
Grammar School (Gymnasium), 4 years of study	98	25,4
Grammar School (Gymnasium), 8 years of study	33	8,6
Grammar School (Gymnasium), 5 years of study	23	5,9
Business School (Business Academy)	80	20,7
Secondary Vocational School, 4 years of study	133	34,5
Secondary Vocational School, 3 years of study	14	3,6
School of Music (Conservatoire)	5	1,3
Total	386	100,0

Source. Own research.

During data collection, the presence of a developmental learning disorder was also monitored. We were primarily interested in the dyslexic population, whose performance we specifically compared in order to find out whether the set of tests as a whole, but also individual tests, have discriminatory and diagnostic value. Respondents with special educational needs were not differentiated as to whether they had only one learning disability or several or in comorbidity with ADHD. Inclusive criteria for integration in the dyslexic category were the diagnosis of dyslexia in the past and the fact that the student was recognised by the school as a student with special educational needs. Less than 61.4% of the test subjects during the standardisation were non-dyslectics. 38.6% of the group consisted of dyslectics. The corpus of respondents consisted of students who were included in the research during the verification of the Slovak ČI(S)TA Diagnostic Test (Zovinec, Dufekova, 2014). Here, however, the part of dyslectics was only 13% of the entire research group. In the years 2015-2022, we expanded the research sample of dyslectics in cooperation with Slovak counselling centres. Experimental tests of phonemic awareness were administered as a complementary part of diagnostics in counselling centres.

Instruments and Procedures

In the years 2014-2022, we conducted research on a sample of 386 respondents, the aim of which was to find out the differences in phonemic awareness among dyslexic and non-dyslexic students in higher secondary education. We carried out the research in upper secondary schools all over Slovakia.

Our version of the experimental test consists of 4 sets of a mix of words and pseudowords. The creation of the test was based on preliminary rese-

arch findings (2012) and PA tests principles of Marketa Caravolas and Jan Volin (2005): phonetic analysis in words and non-words (6/4), phonetic blending in words and non-words (5/5), transposition of vowels in words and non-words (8), elision of vowels in non-words (8).

Considering the age of respondents, we selected a level of more complex manipulation of phonemes in words. Preliminary research has shown that two- and three-syllable words with open syllables are not well discriminated by older students (above 8th grade) in phonetic analysis and synthesis tasks. The success rate was over 95% (N-30) for 9th graders. Six of them were students with dyslexia. Their average success rate was 90%. Words with a low frequency of occurrence (two to five syllables) were used for phonetic analysis and synthesis. Tables 2, 3 and 4 show the experimental stimulus words used in the test.

Table 2

The partial analysis of stimulus words in tasks of phoneme segmenting and blending

Phoneme segmenting words and non-words	Structure word	Parts of speech	Phoneme blending words and non-words	Structure word	Parts of speech
hvizd	*CCVCC*	*Noun*	hudobníčky	*CVCVCCVCCV*	*Noun*
žabkin	*CVCCVC*	*Adjective*	tóly	*CVCV*	*Non-word*
vreteno	*CCVCVCV*	*Noun*	zriadením	*CCVCVCVC*	*Noun*
nekmár	*CVCCVC*	*Non-word*	mredstavy	*CCVCCCVCV*	*Non-word*
krsteň	*CCCCVC*	*Non-word*	grnkách	*CCCCVC*	*Non-word*
dodrák	*CVCCVC*	*Non-word*	kardiovaskulárny	*CVCCVCVCCVCCV*	*Adjective*
nestrašte	*CVCCCVCCV*	*Verb*	neznámejším	*CVCCVCVCCVC*	*Adjective*
prevlátené	*CCVCCVCVCV*	*Non-word*	skomší	*CCVCCV*	*Non-word*
mnohobunkový	*CCVCVCVCCVCV*	*Adjective*	čerstuš	*CVCCCVC*	*Non-word*
priestranný	*CCVCCCVCCV*	*Adjective*	neakceptovateľné	*CVVCCVCCVCVCVCCV*	*Adjective*

Source. Own research.

In the vowel transposition subtest (spoonerism task type), we designed 5 pairs of full-meaning words and 5 pairs of non-word. The student's task was to repeat a pair of words with the fact that he or she must change the first sounds in the words (e.g., *Mikuláš-Galanda: Gikuláš-Malanda*).

Table 3

Examples of mix stimulus words and non-words in the vowel transposition tasks

1.	tmavá – chodbička
2.	sledké – bočule (non-word)
3.	dlamári – posiatkov (non-word)
4.	Mikuláš – Galanda

Source. Own research.

The last task in the research trials was the vowel manipulation task. We designed the test according to Caravolas and Volin (2005) with the modification of non-words according to Slovak phonotactic rules. We created two foursomes of words that the student must repeat after the examiner, omitting first the second or third syllable in the sequence. It was always a consonant. We also conceived non-words with the omission of the first and last syllable, but preliminary research showed a 95% success rate even among severe dyslectics.

Table 4

Examples of stimulus non-words in the Phoneme Elision Tasks

The phonemic structure of non-words and the determination of the position of the omitted consonant in elision tasks CC̲VC:		The phonemic structure of non-words and the determination of the position of the omitted consonant in elision tasks CVC̲C	
1.	praň (paň)	1.	zusť (suť)
2.	hlož (mož)	2.	žomp (žop)
3.	drem (dem)	3.	herb (heb)
4.	schuč (suč)	4.	lomk (lok)

Source. Own research.

Time was not measured in the phonemic awareness tasks. Tasks are fuelled by working memory and attention. When respondent is impaired in these tasks, the diagnostician must check the level of working memory. Scoring was 2 points for a correct answer /HS-38 points/.

In Slovakia, a phonemic awareness test for the elderly (14+) has not yet been created and verified. Concurrent validity of the PA test could not be done with another standardized PA assessment instrument. To verify the validity of the experimental test, we monitored the correlations of the score in the PA test and the total score in the CISTA test (Zovinec, Dufekova, 2014) with different criteria, for the entire group together and separately for students without a diagnosis and students with dyslexia. It was shown that the experimental test was statistically significantly correlated with the grade from Slovak language and literature, at the highest level of significance in the range from r=0.348 ($p<0.001$). The second test with which we correlated the PA score was the standardized reading text "*Latys*" from the *Reading Test* by Zdenek Matejcek et al. (1992). Correlation r was 0,304 (Latys 1th minute); 0,183 (Latys 2nd minute); 0,205 (Latys Total), p - 0,000. We also verified the relationships between PA scores and scores in the Slovak translation of the Adult Dyslexia Checklist (Vinegrad, 1994). Correlation was r -.267**, p -0.000. Reliability verification was retrieved by Cronbach's alpha on a sample of N=360. Cronbach's Alpha for phoneme segmenting items is 0.473.

Table 5

Item-Total Statistics for Phoneme Segmenting Subtest (10 items)

	Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
PA1.1	8,1431	1,211	,228	.	,448
PA 1.2	8,1784	1,176	,150	.	,459
PA 1.3	8,1627	1,166	,233	.	,440
PA 1.4	8,1529	1,218	,147	.	,461
PA 1.5	8,2275	1,068	,224	.	,435
PA 1.6	8,2294	1,057	,238	.	,430
PA 1.7	8,1627	1,186	,185	.	,451
PA 1.8	8,2098	1,082	,242	.	,429
PA 1.9	8,2196	1,064	,249	.	,426
PA 1.10	8,4078	,965	,153	.	,490

Note. PA – Phoneme awareness.
Source. Own research.

Cronbach's Alpha for phoneme blending words and non-words subtest is 0,761.

Table 6

Item-Total Statistics for Phoneme Blending Subtest (10 items)

	Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
PA2.1	5,5412	5,738	,387	,167	,747
PA2.2	5,5255	6,317	,036	,166	,779
PA2.3	5,7608	5,448	,359	,180	,750
PA2.4	5,8255	5,142	,487	,272	,731
PA 2.5	5,9608	5,370	,371	,186	,749
PA 2.6	6,0373	5,250	,446	,287	,738
PA 2.7	5,7784	5,033	,558	,350	,720
PA 2.8	5,6235	5,292	,539	,360	,726
PA 2.9	5,7529	5,224	,473	,334	,734
PA 2.10	5,9000	5,025	,534	,390	,724

Note. PA – Phoneme awareness. *Source.* Own research.

Cronbach's Alpha for Vowel Transposition Subtest is 0,805.

Table 7
Item-Total Statistics for Vowel Transposition Items (8 items)

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PA3.1	5,7314	6,495	,431	,793
PA3.2	5,8765	6,254	,427	,794
PA3.3	5,7098	6,576	,417	,794
PA3.4	5,9706	6,221	,408	,796
PA3.5	6,2137	6,329	,379	,799
PA3.6	5,8020	5,935	,645	,769
PA3.7	5,8745	6,082	,509	,784
PA3.8	6,0294	6,095	,454	,791

Note. PA – Phoneme awareness.
Source. Own research.

Cronbach's Alpha for Phoneme Elision subtest is 0,425.

Table 8
Item-Total Statistics for Phoneme Elision subtest

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PA.1	6,7490	,377	,120	,419
PA4.2	6,7373	,383	,177	,396
PA4.3	6,7549	,350	,207	,381
PA4.4	6,7510	,352	,224	,373
PA4.5	6,7392	,378	,187	,392
PA4.6	6,7745	,344	,131	,426
PA4.7	6,7471	,347	,286	,347
PA4.8	6,7569	,357	,164	,402

Source. Own research.

Cronbach's Alpha for PA test is 0 ,836 (36 Items).

Table 9

Item-Total Statistics for PA test – all items

	Item-Total Statistics			
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PA1.1	28,8314	27,311	,122	,836
PA1.2	28,8667	26,996	,194	,835
PA1.3	28,8510	27,184	,142	,835
PA1.4	28,8412	27,277	,115	,836
PA1.5	28,9157	27,150	,085	,837
PA1.6	28,9176	27,270	,047	,838
PA 1.7	28,8510	27,062	,201	,835
PA 1.8	28,8980	26,638	,273	,833
PA 1.9	28,9078	26,402	,336	,832
PA1.10	29,0961	25,741	,342	,831
PA 2.1	28,9392	26,140	,368	,831
PA2.2	28,9235	26,927	,148	,836
PA2.3	29,1588	25,823	,302	,833
PA2.4	29,2235	25,109	,438	,828
PA2.5	29,3588	25,244	,405	,829
PA2.6	29,4353	25,445	,376	,830
PA2.7	29,1765	25,140	,444	,828
PA2.8	29,0216	25,451	,460	,828
PA 2.9	29,1510	25,323	,412	,829
PA 2.10	29,2980	25,078	,437	,828
PA 3.1	28,9804	26,031	,350	,831
PA 3.2	29,1255	25,183	,454	,827
PA 3.3	28,9588	26,130	,346	,831
PA 3.4	29,2196	25,248	,410	,829
PA 3.5	29,4627	25,451	,383	,830
PA 3.6	29,0510	25,054	,532	,825
PA3.7	29,1235	25,158	,460	,827
PA3.8	29,2784	25,290	,394	,830
PA 4.1	28,8431	27,315	,091	,836
PA 4.2	28,8314	27,425	,047	,836
PA 4.3	28,8490	27,130	,173	,835
PA 4.4	28,8451	27,110	,195	,835
PA 4.5	28,8333	27,373	,077	,836
PA 4.6	28,8686	26,928	,219	,834
PA 4.7	28,8412	27,085	,222	,834
PA 4.8	28,8510	27,133	,167	,835

Source. Own research.

We measured the correlation between success in the PA test and performance in reading using the contextual fluency test, reading comprehension tests. The performance in reading was measured using the Slovak standardised DS test - Dividing words test (Zovinec, Dufekova, 2014). It´s time limited contextual fluency test measures reading fluency. Cronbach's Alpha for DS test is 0 ,762 (Zovinec, Dufekova, 2014).

For the area of reading comprehension, we used two tests. PT test – Text Comprehension (Zovinec, Dufekova, 2014) based on TORC-4 test design (Brown, Wiederholt, Hammil, 2009). Students silently read five questions about short text (6) and then they read short texts. Finally, students answer the five questions by selecting the best answer from list of possibilities. Questions are structured and they asked in the subtest follow the same question type each time (main idea, story detail recall, inference, negative inference, story detail). Cronbach's Alpha for PT test is 0 ,762 (Zovinec, Dufekova, 2014).

For correlation with reading level, we also used the reading cloze test titled Slovak Reading Test with Word Completion created by the authors Caravolas et al. (2012). We used the reading cloze test in completing two words. The test is widely used in counselling centres to diagnose reading difficulties in grades 4-9. The test is time-limited and offers two types of scores. Global reading performance scores (1) include word reading accuracy, reading speed, and comprehension. The Reading Accuracy Score (2) measures reading comprehension regardless of reading time. Correlations were measured with Score 1. The authors report a concurrent correlation with the old Milan G-test at the level of r-0.742, p 0.01 (Pearson's r).

Results of Research

Table 10 shows the basic descriptive statistics. The average performance of all monitored students is 30/38 points. The minimum performance in the tests was 11 points and the maximum was 38. We record fluctuations in performance according to school year, which could be caused by the uneven representation of grades and a higher ratio of dyslectics in the sample of 4th grade of upper secondary school students. On average, the standard deviation is 5.5 points. It can be deduced that a performance lower than 19 points indicates a performance beyond the limit of normality, although we cannot unequivocally confirm it.

The table 10 shows that dyslectics achieved a lower average than non--dyslectics in tests of phonemic awareness. First-year and second-year students achieved similar average grade point performances, but third- and fourth-year students achieved lower results. The median for first grade and second-grade students was the same, but it was lower for third and fourth--graders. The mode for first-graders and second-graders was higher than for third and fourth-graders. The minimum performance was 19 points for

first-graders, 22 points for second-graders, 11 points for third-graders and 14 points for fourth-graders. The maximum performance was 38 points for first-year students, second, third and fourth-graders. The limit of normal performance for first-graders is 24.96 to 37.12 points. For second-graders, the limit of normal performance could be 26.06 to 35.58 points. For third-graders, it could be 22.48 to 35.62 points. For fourth-graders, it could be 21.34 to 33.98 points. The average scoring performance of first-year students was higher than the average scoring performance of second, third and fourth--graders. The mode and minimum performance differed between grades.

Table 10
Descriptive statistics for research sample according to year of upper secondary schooling

	1th Grade	2nd Grade	3rd Grade	4th Grade	Total
N	89	106	122	69	386
AM	31,04	31,32	29,55	27,66	29,8925
Med	32	32	31,5	28	30,875
Mod	38	31	34	26	32,25
SD	6,04	4,26	6,07	5,66	5,5075
Min	19	22	11	14	11
Max	38	38	38	38	38

Source. Own research.

Table 11 provides an overview of the differences in the performance of Slovak upper secondary school students in phonemic awareness tasks. We divided the overall performance into four areas according to the type of PA task. According to the achieved performances, we can see that the students achieved the best performances in phoneme segmenting tasks. Non--dyslectics achieved 92% success and non-dyslectics 85% success. Basically, only the last task demanding to remember 5 syllable word was the most difficult for both groups. Apparently, the phoneme blending task was more difficult, where the average success rate for non-dyslectics was 62% and for dyslectics 55%.

A difficult task was the phoneme transposition task (spoonerism tasks), in which non-dyslectics scored on average only 6.62/10 points and dyslectics 6/10 (60% success rate). The t-statistic for the phonemic analysis tests was 2.827 with a df -56.259 and a p-value of 0.007, indicating a significant difference between groups. The t-statistic for phonetic synthesis tests was -2.568 with a df of 284 and a p-value of 0.011, which also implies a significant difference between groups.

In both cases, dyslectics performed worse than non-dyslectics. The t-statistic for the vowel transposition tests was 1.533, which is lower than 1.96, indicating that the difference between dyslectics and non-dyslectics is *not*

statistically significant. In the vowel elision trials, the t-statistic was 1.720 with a p-value of 0.090, which also indicated that there was no significant difference between the groups. In general, dyslectics achieved worse results in phonological analysis and synthesis tests than non-dyslectics. The best distinction between dyslexic and non-dyslexic students is in the phonemic analysis test as it has the lowest p-value (0.007). The worst distinction between dyslexic and non-dyslexic students is in the phoneme transposition test since its p-statistic value is the highest (0.126).

Table 11

Differences in Phonemic Awareness Test performance in upper secondary school students with and without dyslexia in Slovak orthography

Type of PA task	*Sample*	*N*	*AM*	*SD*	*t*	*df*	*p*
phoneme segmenting	non-dys	237	9,20	1,05	2,827	56,259	,007
	dyslectic	149	8,51	1,65			
phoneme blending	non-dys	237	6,62	2,70	2,568	284	,011
	dyslectic	149	5,53	2,71			
phoneme transposition	non- dys	237	6,69	2,86	1,533	284	,126
	dyslectic	149	6,00	2,96			
phoneme elision	non- dys	237	7,60	0,91	1,720	64,583	,090
	dyslectic	149	7,33	1,03			

Source. Own research.

Table 12 provides an overview of the correlation of phonemic awareness exam performance with students' ability to decode text and reading comprehension. The correlation between performance in phonemic awareness tests and decoding performance (r = 0.432) indicates that there is a moderately strong positive relationship between the two variables.

In other words, the better student performs on the phonemic awareness test, the better is his or her decoding performance. The correlation between the phonemic awareness test and text comprehension (r = 0.300) indicates that there is a weak positive relationship between the two variables. The correlation between performance in the phonemic awareness test and reading in the cloze test (global reading performance area) was at the level of r = 0.272 - a weak positive relationship. The framework correlation values for different relationships are: very strong positive relationship ($r>0.7$), strong positive relationship ($0.5<r<0.7$), moderately strong positive relationship ($0.3<r<0.5$), weak positive relationship ($0.1<r<0.3$), very weak positive relationship ($r<0.1$).

Table 12

Overview of selected indicators of correlations of phonemic awareness, reading

		PA	DC	RC	Cloze Reading Test
PA	r	1			,272**
	p				,000
	n	386			146
DS	r	,432**	1		
	p	,000			
	n	386	386		
RC	r	,300**	,449**	1	
	p	,000	,000		
	n	386	386	386	

Note. DC - Decoding skills represented by DS test score - Dividing words test (Zovinec, Dufekova, 2014). RC- Reading comprehension represented PT test score – Text Comprehension (Zovinec, Dufekova, 2014). Cloze Reading Test – Score 1 in Caravolas, Mikulajova, Vencelova test (2012).

Source. Own research.

Discussion

Research findings had shown that Slovak language tasks focused on phonetic analysis and synthesis containing two- and three-syllable words with open syllables (simple word structure) do not have good discrimination ability for examining students at the end of lower secondary education.

Success rate of students in the last year of elementary school was over 95% (N-30). Of those, 6 were students with dyslexia. Their average success rate was 90%.

We designed tasks for phonological analysis and synthesis of sounds to gradually increase the length of the word and its orthographic complexity. We concluded that students have difficulty with more than a simple four--syllable non-word. It seems that the selected stimulus words represent the maximum of what a teenager and adult can read. In the analysis test, there is only one 5-syllable word (mnohobunkový - multinuclear).

In phoneme synthesis tasks, there were two longer words (cardiovascular, unacceptable). Although the word cardiovascular is long, it is predictable, and most people can identify it from the middle of the phoneme. Dyslectics cannot. It could be related to problems with working memory or word prediction. The differences between dyslectics and non-dyslectics in phonological analysis are statistically significant. This usually means a difference of 1-2 tasks and mostly the last ones. For a diagnostician, these tasks are therefore very informative.

The most difficult task for most of the tested students was the task of phonemic awareness – transposition, which is demanding for working

memory capacity. In phonemic awareness tasks, the smallest differences between the groups were found in the analysis and elision of phonemes. The average performance of students was 32/38 points. In the analysis of phonemes, the usual performance was 9 points. In synthesis and transposition, the expected performance was 7 points (70%). In the elision tasks, the most frequent performance was -7 points (87.5%). Wimmer et al. (2000) suggested that there are two main types of errors in the spoonerism task:

- The student changes the correct first syllables but disrupts the word structure – veľa-rúk (reka-vúk); e.g. Mikuláš – Galanda: Gikuláš – Malanda vs. Gikuláš – Malaranda
- The student does not change the correct first syllables of words – vela – rúk (keľa – rúk) – the other letters of the word remain unchanged.

Wimmer et al. (2000) recommend considering only bad transpositions of the first syllables as errors. He attributes the other errors to weak working memory. In our study, we scored zero for both types of errors, which did not allow us to distinguish whether it was a problem with working memory or phonemic awareness. For qualitative evaluation of errors in diagnosis, we recommend taking this methodological guidance into consideration and interpreting the error in its correct meaning. For the first type of errors indicated, we recommend testing of working verbal memory separately (there is no standardised tool in Slovakia).

It can be seen from table 4 that upper secondary dyslexic students achieved a lower average than non-dyslexic students in phonemic awareness tests. First and second-graders achieved similar average scores, but third and fourth-graders achieved lower results. Testing the differences between these groups indicates that dyslectics performed worse than non-dyslectics in tests of phonemic analysis and synthesis. The t-value of the test of phoneme transposition was -1.533, lower than 1.96, meaning that the difference between dyslectics and non-dyslectics is not statistically significant. In the subtests of phoneme elision, the t-statistic was 1.720 with a p-value of 0.090, which also suggests that there is no significant difference between the groups. We did not conduct an item analysis for each test. We evaluated the relationship between PA tests and word decoding and reading comprehension. The correlation between performance in phonemic awareness tests and decoding performance ($r = 0.432$) indicates that there is a moderately strong positive relationship between these two variables. This means that the better the performance in phonemic awareness tests is, the better is the decoding performance. The correlation between phonemic awareness tests and text comprehension ($r = 0.300$) indicates that there is a weak positive relationship between these two variables.

We found the lowest, but still good correlation with the Reading Cloze Test ($r = 0.272$; Mikulajova et al., 2012). This test measures global reading ability (decoding + comprehension). In Lucie Matejovska's (2013) research, differences were found in task processing time. The author presented 20 words for phoneme elision and 10 words for phoneme manipulation in non-words. The

average time for the neurotypical group was 86 seconds and it was 113 seconds for the dyslexic group. Respondents with dyslexia achieved significantly lower performance both in time and score. We did not measure time in our testing, but it can be assumed that it is one of the indicators which diagnosticians can observe when testing. It is, however, questionable whether such tests should be timed. This involves repeating words after the examiner, who may always have a different pace. Matejovska (2013) suggests that the quality of phonemic analysis and synthesis may be influenced by reeducation and supportive measures in education, as this is an area traditionally developed in reeducation programmes. However, our findings in a larger sample than Matejovska's (2013) did not support the hypothesis that elision of sounds is a better indicator of phonological deficit in adolescents than phonemic analysis and synthesis. The limitations of our study lie in the size of the research sample and the representativeness of the research. Time was not monitored although we repeatedly recorded increased effort and fatigue in dyslexic students during testing.

In the future, the study should focus on the comparison and analysis of stimulus words. We also did not monitor the correlation between dyslectics with poor reading performance and poor phonemic awareness with spelling and correctness of written expression. Correlations between PA phonological memory tests and RAN were not studied either. We can also assume that phonemic deficit is expressed while learning a foreign language.

Conclusions

Phonemic awareness is one of the areas which significantly improves during schooling and process of learning to read. For dyslectics, this improvement is likely to be slower and difficulties may still arise when administering specific PA tasks later in adolescent age. Recent studies have also showed that adolescents with history of dyslexia engage in phonological recoding for lexical identification comparably to their non-dyslectic classmates, but they are still more dependent on orthographic form of lexical processing (Blythe et al., 2022). It appears that in later stages of literacy, the role of phonemic awareness on reading performance is not as strong as it is in preschool and early school years.

Nonetheless, it is reasonable to map PA level in the diagnosis of upper secondary school students with dyslexia, particularly if a significantly weak performance in reading and spelling is detected by teachers or special educators. It should not be forgotten that at this age, it is necessary to map functional areas of literacy, self-directed learning and work, organisational skills as well as secondary symptoms in emotional, social, and mental areas.

In the diagnostic process, it is necessary to distinguish whether the diagnostics is done comprehensively, and the diagnosis of dyslexia is determined for the first time or if it is a re-diagnosis. Re-diagnosis is usually carried out when student is transitioning to an upper secondary school, has

problems in learning at secondary school or for the purpose of adjusting the final examination. In everyday practice, cases of dyslexia being diagnosed in students during their studies at secondary school are almost unknown. In our study, we presented findings regarding testing dyslexia in adolescent. We hopefully brought several inspirations for the tasks and tests that can be used in the diagnosis and re-diagnosis of dyslexia, specifically for this target group.

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