The Research of Phonotactics Acquisition of Typically Developing Children and Children with Specific Language Impairment by Non-word Repetition Test

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Abstract.
The aim of this study is to investigate the phonotactics skills of TD children and children with SLI, using Non-word repetition test. The sample of the study consists of 162 children: 125 typically developing children (5 age groups) and 37 children with language impairment (mean age: 5;9).

The results of TD children and children with SLI have shown that the length of the word is an important indicator: repetition accuracy was found to decline with the increasing number of syllables in both TD and SLI groups. The results of the word complexity have demonstrated that both groups were better performing words without consonant clusters rather than with them. The accuracy of repetition of non-words was also determined by the place where the consonant clusters occurred: children with SLI made significantly more errors in repeating words with a consonant cluster in the medial position compared to those with a consonant cluster in the initial position. The overall Non-word repetition test results show that children with SLI repeat a non-word significantly less accurately than TD children (4;00–8;11).

Keywords: language acquisition, specific language impairment, non-word repetition test, short term memory, phonotactics

Introduction
Children learn their native language from the environment: they hear how their family members, other adults, or children communicate and try to imitate them. The more parents and family members communicate with the child since his/her infancy, the more quickly and easily his/her language develops.

Four interrelated components form language acquisition: phonology, semantics, grammar, and pragmatics. Phonology development depends on the child’s ability to listen to sequences of sounds, to pronounce them, and combine them into understandable words. Semantics development is related to vocabulary increase. Grammar rules are applied when the child learns more words and is able to combine them meaningfully. Pragmatics level is achieved when children can apply language to various social conditions (Navickas, Vaičiulienė, 2010, p. 186).
Language acquisition abilities and psychological development of a child are related: children who speak well express their thoughts more easily, communicate with others more freely, and get acquainted with their environment better. Under language impairment, psychological development is also slower: the child starts speaking later and acquires words and grammar tendencies more difficult; therefore, they have more difficulty in communication (Garšvienė, Juškienė, 2008).

Pronunciation flaws are one of the most noticeable language impairment features, which attract the attention of children’s language researchers. Some research is carried out in Lithuania as well; however, there is not enough exhaustive systematic research, applying the experience of foreign researchers and newer methods (see Domeikienė, 2005; Kaffemanienė, Raseckienė, 2008; Ruzaitė, Dabašinskienė, 2010). Thus, the aim of the present paper is to investigate phonotactics¹ (i.e. syllable structure, word length, and pronunciation of sounds) acquisition of typically developing children and children with specific language impairment (SLI).

A hypothesis is proposed that the general test result and the results of different features (i.e. word length and complexity) are worse for children with SLI than for typically developing children.

In order to test the hypothesis, the following objectives have been set:
1. to discuss the main features of phonotactics development from infancy to preschool age;
2. to describe the main features of specific language impairment and their possible reasons;
3. to compare the non-word repetition test results of typically developing children and children with SLI from linguistic (word length and complexity) and social aspects.

Empirical Data and Methods
Participants. The sample of the study consists of 162 children: 125 typically developing children (TD) of five age groups (4;00–4;11; 5;00–5;11; 6;00–6;11; 7;00–7;11; 8;00–8;11) and 37 children with language impairment (LI)² (see Table 1). The data were collected in kindergartens and schools in Kaunas city and region.

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¹ Phonotactics refers to the structure of sounds typical of a particular language (Girdenis, 2003).
² The children having a slight or an average LI were ascribed to this group.
Groups of Participants

<table>
<thead>
<tr>
<th>Language group</th>
<th>Age group</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD</td>
<td>4;00–4;11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>5;00–5;11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>6;00–6;11</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>7;00–7;11</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>8;00–8;11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>LI</td>
<td>mean of age: 5;9</td>
<td>11</td>
<td>26</td>
</tr>
</tbody>
</table>

**Research methods.** The non-word repetition test in Lithuanian is presented as a game using *Ms PowerPoint* (see Figure 1). The child is introduced to the main game character, the monkey, who wants to get some bananas and has to complete the tasks. The child is suggested to help the monkey and do the tasks. In each step, the child hears a recorded non-word, which s/he has to repeat. All conversation is recorded; this way, imprecise answers are not marked in the child’s presence. Children like this task because it is playful, fun, and short (it lasts only for 3–4 minutes).

![Figure 1. Visual of the Non-word repetition test](design by Kunnari, Tolonen, and Chiat, 2011)

The research data were processed in two stages. First, a quantitative analysis was carried out: SPSS 17.0 programme (*Statistical Package for the Social Sciences*) was used to process the data; then a qualitative data analysis was carried out, i.e. the most frequent mistakes of the research participants were analysed. The responses of each child were transcribed, classified (sound omission, addition, or metathesis), and discussed in greater detail.
Structure of the Lithuanian Non-word Repetition Test. The Lithuanian Non-word Repetition Test was designed with regard to the structural characteristics of Lithuanian words (word length, vowel and consonant frequency, and syllable structure) (more about Lithuanian word structure see Kazlauskienė, 2007; Kazlauskienė, Raškinis, 2008; Kazlauskienė, 2010; Girdenis, Karosienė, 2010). The test consists of 24 non-words of different structure (8 non-words have two syllables (4-6 phonemes); 8 non-words have three syllables (6-7 phonemes); 8 non-words have four syllables (7-8 phonemes). There are two non-words without consonant clusters and 6 non-words with consonant clusters in each group (see Table 2). Each non-word is associated with a Lithuanian equivalent, taking into account word length and syllable structure.

<table>
<thead>
<tr>
<th>2 syllables non-words</th>
<th>3 syllables non-words</th>
<th>3 syllables non-words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ke.mu</td>
<td>Ge.lo.ša</td>
<td>Su.le.ri.tė</td>
</tr>
<tr>
<td>Do.ja</td>
<td>Ši.ru.ta</td>
<td>Ža.de.vi.na</td>
</tr>
<tr>
<td>Ški.mo</td>
<td>Šku.li.nė</td>
<td>Sna.li.di.na</td>
</tr>
<tr>
<td>Šve.la</td>
<td>Ple.mu.ta</td>
<td>Spi.ra.tu.ša</td>
</tr>
<tr>
<td>Ga.prė</td>
<td>Ma.spu.lė</td>
<td>Ni.spa.ri.ma</td>
</tr>
<tr>
<td>Gi.tvā</td>
<td>La.smu.vi</td>
<td>Ma.gvu.no.lė</td>
</tr>
<tr>
<td>Smin.to</td>
<td>Spa.de.ki</td>
<td>Sta.li.gō.so.</td>
</tr>
<tr>
<td>Kle.štā</td>
<td>Pa.sva.pi</td>
<td>Go.sa.klu.ni</td>
</tr>
</tbody>
</table>

Note: syllables are separated by dots.

Development of Phonotactics

Language development starts with the first cry of a child when s/he reacts to the negative external and internal stimuli. The cry slowly changes and obtains various intonations. This is a pre-linguistic stage which changes to the babbling stage at about six months of age when the child stars pronouncing different sounds and their combinations. Comparative language acquisition research has revealed that until six months the children of various nationalities pronounce the same sounds: plosives (p, t, k, b, d, g), nasals (m, n), and vowels. Constantly hearing the language of adults, the children start acquiring the sounds in their environment, and when babbling at six or seven months, they more often pronounce the phonemes more typical of their native language. During the babbling period, the articulators are developed, as well as the ability to distinguish sounds; in addition, attention to language and the need to repeat sounds and, later, words, are developed. When

3 The Lithuanian non-word repetition test (Dabašinskienė, Krivickaitė, 2013) was created participating in the project COST IS0804 Language Impairment in a Multilingual society: Linguistics Patterns and the Road to Assessment (2009–2013 m.).
the baby grows, s/he produces more sound combinations. This way, the first consonant-vowel structure syllables appear, which form the first words *mama, tete, baba, bamido*, etc. if reduplicated (Garšvienė, Ivoškuvienė, 1993; Žukauskienė, 2012; Velleman, Vihman, 2007).

Thus, during the babbling stage, children learn sound repetition and sound combinations. First, children imitate themselves and later, at about seven months, they start repeating easily-articulated sounds that they often hear in their environment. The child's ability to repeat sounds and their combinations shows that speech perception is developing. When imitating, the sound has to be repeated accurately, and this is a sufficiently difficult task; as the child needs multiple cognitive-linguistic abilities: perception of sounds, phonological memory, or articulation abilities. In order for the child to start pronouncing words, first, s/he has to hear and perceive them. Being unable to imitate accurately, the child may not learn speaking on time (Garšvienė, Ivoškuvienė, 1993; Rispens, Parigger, 2010).

Having babbled and already pronounced the first words, children immediately become silent around the tenth or twelfth month. At this time, they try to stand up and make their first independent steps; therefore, all attention is directed towards physical abilities. However, most children aged 12-18 months can already say from two to 30 words. During this period, sound omission is typical; for instance, *ge* (=gerti; En. *to drink*), *noeti* (=norėti; En. *to want*), *anga* (=langas; En. *window*). Vocabulary develops especially quickly from 18 to 24 months as during this period, children learn the words that they hear in their environment very easily; there are less simplified words in their language. They can already pronounce more complicated sound combinations (e.g. two or three consonant clusters) and start speaking in sentences (Garšvienė, Ivoškuvienė, 1993; Žukauskienė, 2012).

When the third year is finishing, there are around 1200-1700 words in a child’s lexicon; even though the sentences are not grammatical, children can express almost everything. Still, consonant softening can occur (e.g. liova (=lūva; En. bed), libas (=labas, En. hello), liabai (=labai, En. very much), even well-known phonemes can be mixed, or more complicated structures may be mispronounced. During this stage, coherent language is developing very quickly, the sentences become longer and more complicated, even though they may be hardly understandable without any context (Garšvienė, Ivoškuvienė, 1993).

When the child is five or six, his/her language becomes grammatically correct, s/he can pronounce all sounds, even though physiological liping (e.g. difficulties in pronouncing *r*) may still occur. During this period, individual differences can be observed: active vocabulary of some children is substantial, and they use their resources freely, while for other children, passive vocabulary is much more
substantial; therefore, they speak less (Garšviienė, Juškiénë, 2008). Phonology development continues for a long time; thus, pre-school or school age children may have difficulty in pronouncing more complicated sounds, consonant clusters, or polysyllabic words.

Specific Language Impairment

Language impairment refers to the impairment of language development because of various reasons: the child learns the pronunciation of sounds later, the lexicon increases slowly, or the child uses ungrammatical sentences for a long time (Garšviienė, Ivoškuvienė, 1993; Leonard, 1998). In Lithuania, the term language impairment is also used. Three types of language impairment may be distinguished based on the degree of language development impairment: slight, average, and severe (Garšviienė, Ivoškuvienė, 1993). This classification of language impairment is used in logopedics and organizing corrective training.

In the world language impairment theory, the concept specific language impairment (SLI) is often used. In Lithuania, the above-mentioned concept of language impairment is used to refer to this impairment. Ruzaitė and Dabašinskiénë (2010) discuss the main symptoms of specific language impairment and compare them with the symptoms typical of language impairment. In the present article, the main symptoms of specific language impairment and its possible reasons are discussed based on the research results of foreign scholars.

Specific language impairment is diagnosed for children with the absence of brain injury, hearing loss, or mental retardation. Children with SLI show difficulties in different aspects of language acquisition: lexis, grammar, and phonology (Gathercole, 2006a, 2006b; Leonard, 1998; Joanisse, Seidenberg, 1998) (see Table 3).
### Symptoms of Lithuanian degree of language impairment and Specific language impairment

<table>
<thead>
<tr>
<th>Severe LI</th>
<th>Average LI</th>
<th>Slight LI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• no skills of narration;</td>
<td>• lack of narrative skills; children are able to give short answers about the story.</td>
<td>• Basic narration skills (the child can produce a short and not elaborate story)</td>
</tr>
<tr>
<td>• no grammatical links between words;</td>
<td>• understand some grammatical forms; more familiar with singular forms and verb tense forms; difficult to understand gender, number, and cases of adjectives;</td>
<td>• problems with pronunciation of difficult sounds and sound clusters (difficult sounds are replaced by the easier ones)</td>
</tr>
<tr>
<td>• highly limited vocabulary (child-specific vocabulary: „niam-niam“ (I want to eat), „ma“ (mom), etc.</td>
<td>• errors of word agreement; prepositions are frequently omitted</td>
<td>• pronunciation is most often incorrect; one sound can be used instead of two sounds; more difficult sounds to articulate are replaced by the easier ones</td>
</tr>
<tr>
<td>• deficits in language comprehension;</td>
<td>• problems in structuring sounds and syllables if the word is longer than 2 syllables;</td>
<td>• sometimes articulation and hearing reception are more advanced than grammatical and lexical skills; therefore, testing may reveal no phonological problems.</td>
</tr>
<tr>
<td>• no imitation of adult speech</td>
<td>• limited understanding of language; words are perceived only in a concrete situation; ability to name some objects and actions in pictures; Ability to form a sentence with a subject and a verb</td>
<td></td>
</tr>
</tbody>
</table>

### SLI symptoms

- difficult to recognize and pronounce difficult sounds and sound clusters;
- problems with tense and agreement morphemes; difficult to choose the correct morpheme and use, as well as pronounce it;
- incorrect word order in a sentence;
- restricted complexity of syntactic structures (no passive constructions or conditional sentences);
- difficult to understand and remember longer sentences;
- slower acquisition of first words and new words; small lexicon.

Table 3 shows that language impairment is described more exhaustively. Still, the comparison of the symptoms has revealed that most SLI symptoms correspond to average LI symptoms; however, some slight LI symptoms can also be noted (see Table 3). Due to a lack of more detailed research and theoretical discussions, it cannot be claimed that different terms are used to refer to the same impairment. Possibly, more arguments will appear in the future to ground one or another statement.

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The reason why language acquisition impairs is not known very well; therefore, a few hypotheses are suggested.

**Short-term memory impairment.** H. G. Taylor, D. Lean, and S. Schwartz (1989) claim that short-term memory impairment in early childhood influences language development. Short-term memory is necessary for language comprehension, grammatical analysis, or learning to speak and read; it is also responsible for learning new words as it stores the information about a new word until it is transferred to long-term memory (Leonard, 1998; Gathercole, 2006a).

Research describes the relationship between short-term memory and new lexis acquisition (for more information see Gathercole, Baddeley, 1989; Gathercole, 2006a, 2006b). The research has revealed that the lexicon of the children who had worse results in short-term memory tests (e.g. repetition of a digit span) is smaller than their peers who performed better in such tests (Baddeley, Papagno, Vallar, 1998). Other comparative research allow making a conclusion that children with SLI perform worse in short-term memory tests than their typically developing peers (Bishop, North, Donlan, 1996).

The word phonological representation is stored in the short-term memory only for a limited period of time. This means that the longer digit span, word, or sentence, the more difficult it is to memorise it (Gathercole, Baddeley, 1995). Therefore, it is more difficult to repeat longer non-words accurately. Foreign research using a non-word repetition test shows that repetition results are worse with every additional syllable (Gathercole, 2006b; Kavitskaya et al., 2011).

Short-term memory impairment accounts not only for lexis, but also for syntax and morphology development impairments (Hayiou-Thomas et al., 2004, p. 1349). If short-term memory does not store all words in a sentence, then it is impossible to analyse it grammatically and understand its meaning. J. W. Montgomery (1995, 2000) indicates that children with SLI repeat longer sentences which contain additional information significantly worse than their typically developing peers. For instance, children with SLI have more difficulty in repeating the sentence *A muddy small boy is climbing a tall tree* than the sentence *A small boy is climbing a tree*, while typically developing children repeat both sentences accurately. These results allow formulating a hypothesis that short-term memory impairment may be one of the main reasons for SLI.

**Phonological processing impairment.** Language structure forms a unified

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5 Research on language impairment uses different terms related to memory: *short term memory, working memory* (Gatercole et al., 2005), *phonology short term memory* (Archibald, Gathercole, 2006). In the present investigation, the term *short term memory* is used.

6 It is claimed that the information in the short-term memory is stored for about 30 seconds or 3-5 units. A unit can be a letter, a syllable, a number, number combination; e.g. the representations of three words and three unrelated letters are stored for the same period of time in the short-term memory (Martíšius, 2006, p. 149).
system in which sounds, lexis, and grammatical structure are closely related. Therefore, LI usually affects several components or all language system rather than one component of language structure. Phonological processing\(^7\) is closely related to all language system: semantics, morphology, and syntax (Chiat, 2001; Maillart, Parrise, 2006). Under phonological processing impairment, learning new words and acquisition of morphology and syntax rules are impaired.

In order to understand even the simplest two-word sentence, it is necessary to perceive the grammatical and semantic relationship between the words. This means that one has to know not only the meaning of words but also to hear and acquire various phonological details (Chiat, 2001). For instance, one has to note the difference between similar present and past verb forms (e.g. fly / flew). Psychoacoustic research has revealed that children with SLI demonstrate weaker skills of sound analysis as they have more difficulty distinguishing between similar sounds (e.g. ba and da or vowels a and e) than typically developing children (Bishop, McArthur, 2005).

Phonological processing is formed gradually: from the ability to hear and understand longer linguistic units (words and syllables) to shorter and abstract sound units (phonemes) (Carroll et al., 2003). It is claimed that children with SLI analyse words at syllable rather than phoneme level; therefore, they do not hear and understand the difference between similar present and past tense verb forms and do not acquire grammatical usage of tenses (e.g. walked, hopped, laughed) (Bishop, 2006, p. 546).

A comparative analysis of English, Italian, Spanish, and Catalan has revealed that phonological processing influences the acquisition of grammar, semantics, and lexis in all languages (Maillart, Parrise, 2006). This and other research suggests that under the impairment of phonological processing, language development is impaired as well (Joanisse, Seidenberg, 1998).

**Non-word Repetition Test: Theoretical Assumptions**

Much useful information about the child’s language development can be obtained doing special linguistic tasks. A non-word repetition test is the task when the respondent is asked to repeat non-words\(^8\). In order to be able to repeat the word which is heard for the first time and does not have any meaning, linguistic-cognitive abilities are necessary: phonological processing, short-term memory, articulation abilities, etc. (Rispens, Parigger, 2010). It is claimed that a non-word repetition test is a suitable tool to measure the capacity of short-term memory (Baddeley et al., 1998, p. 159). Even though non-words are created using

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\(^7\) Phonological processing refers to hearing, perceiving, and noting the differences between the phonemes in a word (i.e. the ability to understand the main grammatical features of words; e.g. tense, gender, or number forms or cases) (Chiat, 2001).

\(^8\) Non-words are a phonological sequence of sounds which corresponds to phonotactic rules of a specific language and do not have any meaning and do not have a function in a sentence.
the rules of a particular language, they do not have any similarity to real words in the language; therefore, the already obtained lexical knowledge is not used when doing the test (Radeborg et al., 2006, p. 187). Rather, the capacity of short-term memory is used, i.e. the ability to code and maintain the phonological sequence of sounds (Gathercole, 1995, p. 83).

The non-word repetition test is important in monitoring the child’s language development. At a young age, the child’s ability to repeat a new polysyllabic word that s/he hears for the first time shows his/her ability to learn new words and broaden his/her lexicon (Gathercole, 2006a). Each word that the child heard for the first time some time ago sounded unusual and strange as the words in this test do (Chiat, Roy, 2007). Longitudinal research results have demonstrated that the children who performed better in the test had a broader lexicon after a year compared to the children who performed worse (Gathercole, 1995; Baddeley et al., 1998).

The conclusions of researchers from various countries (English, Italian, Spanish, Dutch, and other languages) are the same: children with SLI repeat non-words significantly worse than typically developing children (Dollaghan, Campbell, 1998; Gahtercole, 2006a, 2006b; Girbau, Schwartz, 2008; Dispaldro et al., 2013). First comparative tests of typical and impaired language development were carried out with the same children age groups (around 7;9) (Kamhi et al., 1988). Later, two control groups were used for a comparative research, which correspond to the age and language level of children with SLI. For instance, Gathercole and Baddeley (1995) carried out a comparative non-word repetition test with three groups: 1. Children with SLI (approximate age 8;6); 2. Peers with typical language development; 3. Younger language-matched typically developing peers. The results of the research have revealed that children with SLI repeated non-words significantly worse than both control groups. The results of this and similar research suggest that non-word repetition test can be used as a diagnostic tool to identify a possible SLI (Stokes, Klee, 2009).

**Factors Influencing the Results of Non-word Repetition Test**

Comparative research using non-word test designed for different languages allows distinguishing three main factors which influence the accuracy of non-words repetition:

1. Complexity of non-words (CV vs. CCV). Non-words with consonant clusters are repeated less accurately than non-word without consonant clusters (Kavitksaya et al., 2011). To pronounce consonant clusters accurately is one of the longest language acquisition processes. First grade students have problems in pronouncing some consonant clusters. Word-medial and
word-final clusters are repeated less accurately than word-initial consonant clusters (Marshall, van der Lely, 2009, p. 50);

2. Non-words length (number of syllables in the word). Non-words repetition accuracy declines with the increasing number of syllables, i.e. 1- or 2-syllable words are repeated more accurately than 3- or 4-syllable non-words (Chiat, Roy, 2007). It is related with the ability to keep phonological information in short-term memory.

3. Age of participants: the older the age group, the more accurately both shorter (one-two syllable) and longer (three-four syllable) words and non-words are repeated (Santos et al., 2006; Park, Scarz, 2012). Elder children have a bigger lexicon and develop it more, they find out different sound clusters, and can pronounce various consonant clusters more accurately (Munson et al, 2005, p. 1034).

Application of the Lithuanian Non-word Repetition Test in the Evaluation of Phonotactics Abilities: Research Results

The results of the Lithuanian non-word repetition test allow making a preliminary conclusion, which corresponds to the research of the scholars from other countries: the children with SLI repeat non-words significantly worse than typically developing children (p = 0.000). The data provided in Figure 2 show that the children aged 4;00–8;11 repeated non-words with 70-81% accuracy, while children with SLI with 60% accuracy.

Figure 2. TD (4;00–8;11) and children with SLI correct answers of non-word repetition test
The results of children with SLI are worse than the results of the youngest typically developing respondents: the children aged 4;00–4;11 repeated non-words with 70% accuracy, while children with SLI – with 59% accuracy. The test has revealed that the results of children with SLI are different: there were very low (with 25% accuracy) and very high results (96% of the correct answers).

The data in Figure 2 demonstrate that in the group of the youngest participants, there are some outliers: the results of two participants are especially poor, while three children repeated the non-words significantly more accurately than the rest group members. Significantly poorer test results may suggest a possible SLI; however, this might also be an accidental absent-mindedness during the test. It can also be noted that the test results from the group aged 7;00–7;11 are worse than from the younger groups (5;00–5;11 ir 6;00–6;11). Such results may be influenced by the "schooling effect" (Santos et al., 2006). In the first form, children experience many new things: a new environment, friends, and a new education system; therefore, they can be slightly confused (the test was carried out during the first semester of the school year, in November), and this might influence worse test results.9

The present research has revealed that in general two-syllable words were repeated significantly more accurately than three- or four- syllable words. The group with SLI repeated two- and four- syllable words worse than other research participants: 4;00–8;11 age group repeated two-syllable words with the accuracy of 90%, three-syllable words with the accuracy of 73%, and four-syllable words with the accuracy of 66%. The group with SLI repeated two-syllable words with the accuracy of 78%, three-syllable words with the accuracy of 73%, and four-syllable words with the accuracy of 45%. Thus, the results of the Lithuanian non-word repetition test coincide with the conclusions of the comparative research carried out in other countries, i.e. the longer the word, the more difficult it is to repeat it accurately.

A more detailed analysis of the results shows that children with SLI repeated three-syllable words more accurately than the respondents from the age groups of 4;00–4;11 and 7;00–7;11 (see Figure 3). The test results have shown that the main difference between the groups is repeating two- and four-syllable words. As group samples are not large, the results might be influenced by an accidental better or/and worse test performance, absent-mindedness, etc. In order to confirm such results, larger groups should be tested.

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9 In order to confirm this hypothesis, a research with a larger number of participants should be carried out.
Another important aspect is syllable structure. The present research confirmed the conclusions of foreign researchers that it is easier to repeat the words without consonant clusters (p=0.041). For instance, such words as doja or geloža were repeated with the accuracy of 90-98%, while gaprė or škulinė with the accuracy of 59-73%. Children aged 4:00–8:11 repeated the words without consonant clusters with the accuracy of 90%, and with consonant clusters with the accuracy of 85% (p=0.003); the group with SLI repeated the words without consonant clusters with the accuracy of 71%, and with consonant clusters with the accuracy of 59% (p=0.000) (see Figure 4).

The Lithuanian research has revealed that it is easier to repeat consonant clusters in the initial position rather than in the medial position. This is because the first syllable is more prominent; in addition, the beginning of a word is important from a psycholinguistic aspect: when a person hears the first sounds, all known words starting with the same sounds are activated in the brain (Marshall, van der Lely, 2009).
The comparison of results of typically developing children and children with SLI shows that children with SLI performed significantly worse: they repeated a consonant cluster in the initial position with the accuracy of 75% and in the medial position with the accuracy of 58% (p=0,000), while the results of the children aged 4;00–8;11 are 92% and 75% (p=0,368) (see Figure 5). For typically developing children, the repetition of word initial and word medial consonant clusters did not have any significant difference. These results conform to the results obtained in other countries (see Marshall, van der Lely, 2009). Therefore, it can be maintained that one of the symptoms in identifying a SLI can be the ability to repeat consonant clusters in the word medial or final position.

Figure 5. Correct answer for initial and medial consonant clusters.

The present investigation also considered if gender has some influence on the non-word repetition test results. Slight differences can be noted: four-year olds, eight-year olds, and boys with SLI repeated non-words slightly better than girls. In the groups aged five and six, the results of girls are better. The results of seven-year-old boys and girls are the same (see Figure 6). A significant difference was identified only in the youngest group (p= 0,001).

Figure 6. Boys and girls correct answers for non-words repetition.
In the present research, not only the quantitative results, but also the qualitative features are important, as they reveal the means of simplifying pronunciation of more complicated word structure. The following ways of simplification have been identified: replacement of sounds, metathesis, consonant harmony, omission, and addition.

The most frequent way of word simplification is the replacement of complicated articulation sounds to the easier ones. It has been observed that the consonants with a similar articulation feature are used for replacement; for instance, a plosive is replaced by a plosive (e.g. *gitva* -> *gipva; gikva*). The test results of children aged 4:00–8;11 demonstrate that sounds are the most frequently replaced in three- and four-syllable words with consonant clusters. The second sound in a consonant cluster is replaced the most often; for instance, *plemuta*->*premuta; pasvapi*->*paslapī; spiratuša*->*smiratuša; maskulē*->*maškulē. Children with SLI most frequently replaced the sounds in a consonant cluster in two-syllable words: *švēla* -> *šēla; gaprē*->*gabrē; gitva* -> *gīvbā; gīkva*. Contrary to typically developing children, they replaced the first sound in a cluster the most frequently. In three- and four-syllable words, children with SLI changed the consonant in the syllable after the consonant cluster; for instance, *stalīgosa* -> *stālīsosa; stālidosā; spiratuša* -> *spajatušā; nisparīma* -> *nispalīma; gosakluni* -> *gosaklume*.

Consonant harmony is typical of the words longer than two syllables; i.e. when the features of one sound are affected by the sounds that occur in next syllables; for instance, *lasmuvi* -> *lasmumī; sulergtē*->*sugerītē; snalīdina* -> *snalīlīna. Most cases of consonant harmony have been observed in the age groups of 4;00–4;11, 5;00–5;11 and among the children with SLI. Assimilation is also typical of everyday children’s language as it occurs approximately in 32% of the words used by children.

Metathesis occurs when a sound is moved from one syllable to the other, or the sounds are interchanged. This type is not frequent, yet typical of all groups of the present research (e.g. *gitva* -> *gvtā; gaprē* -> *grape; gosakluni* -> *glosakuni; maskulē* -> *makšulē). Typically developing children transfer a sound from one syllable to the other the most frequently and form a new consonant cluster; for instance, *plemuta* -> *pelmuta, spiratuša* -> *pistaruša. Children with SLI tend to interchange consonants: *švēla* ->*šēla, magvunolē* ->*magnuvolē*.

One more frequent word simplification typical of all groups is sound omission, when children do not pronounce complex articulation sounds. Mainly consonants are omitted, especially one of the consonants in a consonant cluster; for instance, *klesa* -> *lesa; gitva* -> *gīta; gaprē* -> *gape; plemuta* ->*pemuta, lasmuvi* -> *lasuvi; magvunolē* -> *magunolē, gosakluni* -> *gosakuni, snalīdina* -> *nalīdina. The children
aged 4;00–7;11 omit a syllable, repeating three- and four-syllable words: suleritė -> sulitė; snalidina -> sladina; magvunolė -> magvulė; škuline -> škuli. Syllable omission is less frequent in the group of children aged 8;00–8;11 and children with SLI.

There were some cases when children made pronunciation more difficult by adding an additional consonant and creating one more consonant cluster; for instance, skimo -> skirmo, švela -> švelna; lasmuvi -> lasmulvi, žadevina -> žgadevina, spadeki -> spadenki. Pre-schoolers (4;00–6;11) often create a three-consonant cluster (e.g. švelna -> švelnta, gitva -> giptva), while children with SLI lengthen three- and four- syllable words by adding an additional syllable (e.g. plemuta -> plemunuta; staligosa -> stalidogosa; snalidina -> snalidinika). Addition of sounds or syllables is one of the symptoms of phonological SLI.

Test results have revealed that the children aged 4;00–4;11 and children with SLI messed up the words longer than two syllables; for instance, staligosa -> kelesosa; gosakluni -> gosastumi; magvunolė -> galmuglinė, maligulia; snalidina -> snalilii; pasvapi -> plaslapi; lasmuvi -> lasloni. These examples demonstrate that the children were not successful in memorizing and repeating the word accurately; however, they tend to maintain a rhythmical word structure, i.e. they maintain the same number of syllables in the word. In addition, some children aged 4;00–4;11 refused repeating more complex words. It can be presupposed that they did not feel self-confident and were afraid of mispronouncing the word.

Conclusions

The present research aimed at investigating phonotactics (i.e. syllable structure, word length, and pronunciation of sounds) abilities of various age groups (4;00–8;11) of typically developing children and children with SLI (mean of age 5;9) by using a non-word repetition test. The conclusions of the research have partly confirmed the initially formulated hypothesis that the general test result is significantly worse for children with SLI than for typically developing children. In addition, the influence of word structure has been identified; however, it is only partial as children with SLI repeated three-syllable words more accurately than the children aged 4;00–4;11; 6;00–6;11 and 7;00–7;11.

The results of the Lithuanian non-word repetition test have revealed the most complicated aspects of phonotactics acquisition for typically developing children and the children with SLI:

- It is difficult to repeat non-words longer than two syllables (i.e. three or four syllables) accurately. In order to perceive and repeat more complex words, more linguistic efforts and additional memory are necessary. Children with SLI (4;00–4;11) repeated four-syllable words with consonant clusters especially inaccurately.
• It is more difficult to repeat the words with more complex structure, i.e. the words with consonant clusters rather than without consonant clusters. The cluster position in a word is especially important for children with SLI. They repeated the clusters in the medial position significantly worse than in the initial position. The accuracy of repeating consonant clusters in the initial and in the medial position for children aged 4;00–8;11 was similar.

• The results of the non-word repetition test have revealed “school effect,” i.e. the results of the children aged 7;00–7;11 (first-form pupils) were worse than the children aged 5;00–5;11 and 6;00–6;11.

• Simplification of non-words is typical of all participant groups: harmony, replacement, omission, addition, metathesis.

• Mainly, the pronunciation of three- or four-syllable words, especially with consonants, is simplified; the consonants having the same articulation feature were interchanged; mainly sounds are omitted or replaced by other repeating the words with consonant clusters; the children aged 4;00–4;11 and children with SLI change the words completely when repeating them.

The interpretation of the results is limited by a comparatively small sample in the age groups; therefore, only the most general tendencies of non-word repetition can be discussed. In order to obtain more accurate results and make more grounded conclusions, larger sample research is necessary.

References


Speech and Hearing Research, 38, 463–472.


