The acquisition of syllable structure by Russian-speaking children with SLI

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Abstract

The purpose of this study is to address the acquisition of syllable structure by Russian-speaking children with Specific Language Impairment (SLI). We report results of a pseudo-word repetition task in which syllable number and syllable complexity are manipulated. This study employed a non-equivalent groups design in which nineteen participants were classified into an SLI impaired group (6) and a Typically Developing (TD) non-impaired group (13) based on three measures of general language competence. All subjects participated in an experiment involving repetition of 144 pseudo-words which varied in syllable structure, number, and stress (resulting in 36 unique cells per subject). The results show that SLI children perform significantly worse than TD children on this task, indicating that Russian follows the general pattern in this respect. However, the factors affecting the difficulty of the task are the same for both groups, contrary to previous claims in the literature. We also discuss such factors as onset and coda complexity and sonority.

Key words: specific language impairment (SLI), syllable structure, pseudo-word repetition task, language acquisition

Specific Language Impairment (SLI) is a developmental disorder that is defined in the following way: while nonverbal IQ is within a normal range, the performance on various standardized language tests falls below 2.0 standard deviations limit for the child's age, and there are no neurological, sensory or physical impairments that directly affect use of spoken language (Bishop 1997, Leonard 1998). SLI is a heterogeneous disorder with several different profiles possible that can be responsible for the low performance on the standardized verbal tests.[1]

While there is a general agreement that phonology is frequently impaired in children affected by SLI, the precise nature of this phonological deficit is currently a matter of debate. There are two theories that are most relevant for the study presented below. The first theory (Gathercole & Baddeley 1990, Conti-Ramsden 2003) holds that the underlying cause of SLI is impairment in phonological short-term memory as revealed by poor performance in pseudo-word repetition tasks. The second theory (van der Lely & Howard 1993, Marshall et al. 2002, 2003) argues against the directionality of causation assumed by Gathercole & Baddeley (1990), proposing that the underlying cause of SLI is a phonological deficit, which results in an impairment of phonological memory and therefore poor performance on pseudo-word repetition tasks.

An important point made by Marshall et al. (2002), Roy & Chiat (2004), van der Lely (2004), van der Lely at al. (2004) is that the limitations on phonological memory alone cannot explain the whole range of the findings on pseudo-word repetition for SLI

[1] For example, van der Lely and colleagues have identified a separate class of SLI, called G-SLI, which is characterized by "a primary, domain-specific deficit in the computational grammatical system" (van der Lely 1994, 1998, 2000, among many others).

and Typically Developing (TD) children. Such factors as stress, word-likeness, prosodic structure, and articulatory complexity have been shown to affect children's performance on the pseudo-word repetition task (see Roy & Chiat 2004 for overview). In particular, Marshall et al. (2002) propose that only the most unmarked syllable structure (Consonant-Vowel, henceforth, CV) is available to SLI children. For example, non-words such as [dɛ.pə], consisting of two unmarked CV syllables, are predicted to be easier for SLI children than [dɛmp], consisting of the same number of phones, but comprising one CVCC syllable which is more marked than a CV syllable.

The study reported in this paper tests the hypothesis of Marshall et al. (2002) regarding the role of syllable structure representation in SLI phonological impairment. We do not consider the question of the direction of causality in phonological deficit typical of SLI children resolved, and do not necessarily see our study as providing evidence which can be used to further this debate. However, the study does provide evidence against the most simplistic application of the theory that the cause of SLI is solely the impairment in phonological short-term memory measured by the number of phonemes in a word. The study shows that both phonological memory and syllable complexity play a role in determining children's ability to remember pseudo-words. We also explore whether syllable complexity crucially relies on sonority, a factor that has not been adequately considered in previous studies.

Syllable structure and markedness

The syllable plays a central role in phonological theory as a constituent that represents phonologically significant groupings of segments (Zec 2007, p. 162). The present study assumes the theory of syllable structure widely used in the current phonological literature (for summary, see Blevins 1995, Zec 2007). In the discussion of the children's performance on the pseudo-word repetition task, we refer to syllabic subconstituents, such as onset, nucleus, and coda. There is abundant evidence for subsyllabic constituency, one possible model of which is illustrated in Figure 1.

[INSERT FIGURE 1 ABOUT HERE]

As the diagram in Figure 1 shows, the syllable consists of onset and rhyme, which can be further subdivided into nucleus and coda. The nucleus is also called the syllable peak, and onset and coda are syllable margins.

The notion of sonority is important in defining syllable structure. Intuitively, sonority is related to the overall acoustic energy of segments. The most general sonority scale, where the classes of segments are listed in the order of increasing sonority, is as follows:

Stops < Fricatives < Nasals < Liquids < Glides < Vowels

It has been suggested that the sonority scale is built into phonological theory as part of universal grammar (Clements 1990, p. 291).

The segmental composition of onsets and codas exhibits striking regularities across the world's languages. These regularities have been stated in terms of the Sonority Sequencing Principle (Hooper 1976, Kiparsky 1979, Steriade 1982, Selkirk 1984, Clements 1990, Zec 1995, Blevins 1995, among others):

Sonority Sequencing Principle (SSP)

Sonority increases towards the peak of the syllable and decreases towards its margins.

The sequencing of segments in Figure 1 exemplifies the SSP: in the syllable [dɹim], the initial consonant [d] is less sonorous than the following [ɹ], that is in turn less sonorous than the syllable peak [i], and the coda [m] is less sonorous than the syllable peak, thus showing an increase in sonority toward the peak and its decrease towards the margins.

While the SSP can be taken as a tendency, it is by no means exeptionless. For instance, English, which in general obeys the SSP, has some onsets of falling sonority, such as /sp st sk/, that violate the SSP. Russian is even more lenient with respect to the SSP, allowing such onset clusters as /lb l^jd rt/, etc.

It has been noted that certain types of structures are more general, typologically more common, and acquired earlier in first language acquisition, suggesting that these structures are less marked than others. For instance, CV syllables are less marked than CCV syllables and CVC syllables, since in the first case, the syllable has a complex onset, more marked than a simple onset, and in the second case, the syllable is closed and thus more marked than an open one (see Rice 2007 for the discussion of markedness).

Recent literature has contained criticisms of the notion of markedness on the grounds that it is used in too many different meanings. Haspelmath (2006, p. 26) lists twelve possible uses of the term markedness, such as markedness as complexity (including specification for a phonological distinction, semantic markedness, formal markedness), markedness as difficulty (in phonetics, morphology, and as conceptual difficulty), markedness as abnormality (textual, situational, typological, distributional), etc.

Even though we agree in principle with Haspelmath's criticisms of the notion of markedness, we will continue using the term in the sense that has been traditionally used in the SLI literature. This corresponds to the Haspelmath's subtype of markedness as abnormality, classified as "markedness as typological implication or cross-linguistic rarity" (Halpelmath 2006, p. 26). For instance, Russian has both /bl/ and /lb/ onsets, but since crosslinguistically /bl/ onset is widely attested and /lb/ is quite rare, in the typological sense of markedness the latter is more marked than the former. The notion of markedness in this sense is crucial in the formulation of the hypothesis advanced in Marshall at al. (2002), who claim that for SLI children only an unmarked CV syllable template is available. In the current study, we test the hypothesis of Marshall at al. (2002) and offer a new analysis based on our results.

In the next section, we describe the experimental design including the methodology used in the study and go over the hypotheses that our experiment is designed to test.

Method

Participants

This study was conducted with monolingual Russian-speaking children. The experimental group subjects come from a village in Northern Russia in which the presence of language disorders is significantly higher than in general population. This work is part of a larger study of familial Disorders of Spoken and Written Language (Grigorenko at al. In progress). The probands were identified through a screening of all children of ages 4 to 11 and then matched with a group of TD children from the same sample. All participants' parents agreed that their child could participate in this and related studies conducted at the same time under guidelines approved by the Yale University Human Subjects Research Review Committee and Northern State Medical University.

Nineteen monolingual Russian-speaking children aged 4;7–10;7 took part in the experiment. The subjects were classified based on three measures of general language ability developed for use in Russian with normal and impaired populations. The first measure, called the Assessment of the Development of Russian Language (ORRIA) (Babyonyshev at al., unpublished), was developed in conjunction with data collection on a larger sample from which a subsample was drawn. Participants electively enrolled over about four months time when invited by a specialized team of test administrators visiting their school or other community setting. Minor modifications were made to some subsections of the instrument over the study term. In order to reduce any impact of this potential threat to internal validity, residualized standard scores were generated with a regression equation that included dummy-coded indicators of version in the model, resulting in only a modest adjustment. Two additional measures of language ability were calculated for all subjects: Mean Length of Utterance (MLU) and Syntactic Complexity (SC). SC is the percentage of syntactically complex sentences the child uses, such as relative clauses, embedded clauses, passive structures, etc. In order to calculate MLU and SC, narrative samples were collected by asking the children to tell a story on the basis of a picture book.[2] The scores on the MLU and SC were combined into a standard score on the same metric as the ORRIA. Then, a cutoff for impaired status was established based on the percentile associated with two standard deviations below the

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[2] MLU for a specific child was calculated on the basis of separate words, not morphemes.

mean for the TD group on *either* the ORRIA or the MLU/SC combined. Six of the subjects were classified as SLI (age range 4;7–10;7, mean age 8;0) and thirteen as TD (age range 4;10–10;6, mean age 8;5). Non-verbal IQs for SLI children were ranged 66–98, mean IQ 80 and for TD children, the IQ range was 69–130, mean IQ 90.

Study Design

This study was designed to test the hypothesis regarding the unavailability of the marked syllable structures to SLI children and to explore the importance of phonotactics in general for SLI children. To achieve this goal, we manipulated syllable complexity with respect to the number of consonants in the syllable onset and coda. In addition, we manipulated the total number of syllables in presented words and the placement of stress in these words. Taken together, these parameters allowed us to examine the effect of the general working memory load, the complexity of syllable structure, the location of stress, and the interaction of these factors. Additionally, we examined the effects of the SSP as evidenced by children omitting certain consonants in consonant clusters.

The experiment utilized a pseudo-word repetition task. In constructing pseudo-words, the following factors were manipulated:

1) The number of syllables in a word (1 vs. 2 vs. 3);
2) Stress (1^{st} syllable vs. 2^{nd} syllable vs. 3^{rd} syllable);
3) Syllable structure (CV, CCV, CVC, CVCC, CCVC, CCVCC).

The combination of the first two factors produced six conditions, as shown in Table 1 on the example of words containing only CV syllables. Factors 1-3 combined produce 36 unique cells from each research participant for analysis.

[INSERT TABLE 1 ABOUT HERE]

In addition, we also manipulated the third factor, syllable structure. Note that the syllable structure factor can be viewed as a combination of onset complexity (one-C onsets: CV, CVC, CVCC vs. two-C onsets: CCV, CCVC, CCVCC) and coda complexity (no coda: CV, CCV vs. one-C coda: CVC, CCVC vs. two-C coda: CVCC, CCVCC). It is important to note that only the stressed syllable was manipulated; all the unstressed syllables were of the basic CV form.

There were 4 tokens of pseudo-words in each condition, giving us a total of 144 (36x4) pseudo-words. The dependent variable was the number of correct repetitions of pseudo-words. An example of the relevant conditions for a one-syllable pseudo-word is given below:[3]

a. CV; 1syll; 1st syll stress	PA
b. CVC; 1 syll; 1st syll stress	PAK
c. CCV; 1 syll; 1st syll stress	PRA
d. CVCC; 1syll; 1st syll stress	PASK
e. CCVC; 1 syll; 1st syll stress	PRAK
f. CCVCC; 1 syll; 1st syll stress	PRASK

The 144 pseudo-words were presented in a pseudo-random order to the subjects, who were asked to repeat the words exactly as they were pronounced by the experimenter. Before the start of the experiment, the children were told that the words they would hear were not real, but made up, so they should not be surprised if they sound unfamiliar or strange. If a child failed to provide a response for five seconds, the

[3] Given the peculiarities of Russian syllabification, it is not always possible to determine the syllabic affiliation of consonants within clusters in intervocalic (midword) positions (see Kodzasov 1990).

experimenter repeated the word once. No other repetitions were allowed; the experimenter did not provide any corrections or other reactions, regardless of the child's performance.

The experiment was administered to the children individually, in a quiet room, by an experimenter who spoke the same dialect of Russian as the children. The experiment was recorded on a digital voice recorder (Olympus DSS Player 2002).

Specific hypotheses

As mentioned above, we manipulated a number of factors for the purposes of the current study. One of the factors was the number of syllables in the word: monosyllabic, bisyllabic, and trisyllabic words were used in the experiment. There is a general agreement in the literature that there is an impairment of phonological memory in SLI children. Therefore, if Russian follows the general pattern, we expect TD children to be significantly better than SLI children in this respect.

The second factor manipulated in our experiment was stress, placed either on the first, second, or third syllable of a pseudo-word. Given that stress in Russian is lexically determined so that there is no apparent regularity to its placement, we predict that the location of stress does not affect the children's performance on the pseudo-word repetition task. Previous studies show the effect of stress in languages where stress is more regular than in Russian (see Sahlén at al. 1999 for Swedish, Marshall et al. 2003 and van der Lely 2005 for English). We believe that there is no reason to expect that the role of stress is going to be any different for TD children than for SLI children.

The third factor manipulated in the experiment was syllable complexity. We used the following syllable templates: CV, CCV, CVC, CVCC, CCVC, CCVCC. As was mentioned earlier, Marshall at al. (2002, p. 516) advance the following hypothesis: "We propose an interpretation of the data whereby children with G-SLI have only unmarked parameter values available to them, meaning that they have just a CV template. There is no room on this template for additional consonants."

According to the model of syllable structure given in Marshall at al. (2002) (see Figure 2), only the first consonant in the syllable-initial cluster is regularly available to SLI children presumably because only this consonant is structurally associated to the onset. No hypotheses are made as to the strategy of coda simplification.

[INSERT FIGURE 2 ABOUT HERE]

In the current study we test the hypothesis with respect to onset cluster simplification as well as discuss our results with respect to coda cluster simplification. We think that it is more plausible for TD and SLI children to have similar phonotactic constraints governing syllable structure. We predict that the pattern of difficulty of cluster repetition will be similar for TD and SLI children. Whatever patterns we observe in TD children with respect to the SSP are expected to hold for SLI children as well.

Given the preceding discussion, we expect complex onsets to be harder than simple onsets and complex codas to be harder than simple codas for both groups. However, languages vary with respect to their preference of complex onsets to complex codas, and vice versa. For example, Dakota allows complex onsets but bans complex codas, and Klamath allows complex codas but bans complex onsets (Zec 2007, p. 165). On the other hand, some languages allow both complex onsets and complex codas but are analyzed as preferring one to the other (e.g., an analysis of Bulgarian as preferring complex onsets to complex codas was proposed on the basis of the site of vowel epenthesis (Barnes 1998)). The preference for complex onsets has been analyzed as an instance of onset maximization. The most general version of onset maximization principle holds that VCV sequences are cross-linguistically syllabified as V.CV rather than VC.V. An extension of the onset maximization principle is the syllabification of VCCV sequences as V.CCV rather than VC.CV, thus maximizing the number of consonants in the onset.[4] There has been a suggestion (see Kodzasov 1990) that there is a version of onset maximization in Russian. Our results help to clarify this issue.

Results

A set of factorial analyses of variance was conducted in order to assess the difference in mean levels for the levels of the factors described above, as well as their interactions, on the number of correct repetitions. The analyses were conducted using standard statistical routines for the general linear model (Proc GLM) in SAS (2003). Omnibus tests for all of the models were significant ($p < .0001$). The findings for all main effects and interaction effects are reported individually below.

First, a two-way ANOVA (2 x 3) showed a significant main effect of Stress on number of correct repetitions of pseudo-words ($F(2, 678) = 18.5$, $p < .001$), as illustrated in Figure 3.

[INSERT FIGURE 3 ABOUT HERE]

In addition, the analysis showed a main effect of Group ($F(1, 678) = 17.1$, $p < .001$), with SLI group performing at a much lower level than TD group. However, there is no significant interaction between Group and Stress ($F(2, 678) = 2.7$, ns.).

[4] In languages which obey the SSP, the onset maximizaton interacts with the sonority profile of the cluster in question.

The main effect of Stress is likely due to the fact that in order for a word to have stress on the third syllable, the word has to consist of three syllables, for the word to have stress on the second syllable, the word has to consist of at least two syllables, and for the word to have stress on the first syllable, it is enough to have one syllable. That is, Stress is inherently confounded by Syllable Number. In order to demonstrate statistically that this was in fact the case, we controlled for the effect of Syllable Number on Stress in a supplemental ANCOVA, adjusting for Syllable Number. Once Syllable Number is adjusted for, neither the effect of Stress ($F(2, 678) = 0.3$, ns.), nor the Group by Stress interaction remains significant ($F(2, 678) = 3.3$, ns.). Based on this evidence, Stress was excluded from subsequent analyses.

Second, a three-way ANOVA (2 x 3 x 6) showed three significant main effects and two significant two-way interactions. A significant main effect of Group on number of correct repetitions of pseudo-words was shown ($F(1, 306) = 8.9$, $p < .01$), as illustrated in Figure 4.

[INSERT FIGURE 4 ABOUT HERE]

The main effect of Syllable Number is shown in Figure 5 ($F(2, 306) = 126.2$, $p < .0001$), and the main effect of Syllable Structure is in Figure 6 ($F(5, 306) = 17.4$, $p < .0001$).

[INSERT FIGURE 5 ABOUT HERE]

[INSERT FIGURE 6 ABOUT HERE]

In addition, the analysis shows a significant interaction of Group by Syllable Number ($F(2, 306) = 5.9$, $p < 0.01$) (see Figure 7).

[INSERT FIGURE 7 ABOUT HERE]

There was also a significant Syllable Number by Syllable Structure interaction ($F(10, 306) = 5.53$, $p < .0001$) (see Figure 8).

[INSERT FIGURE 8 ABOUT HERE]

However, the interaction of Group by Syllable Structure was not significant ($F(5, 341) = 0.74$, ns.). The three-way interaction of Group by Syllable Number by Syllable Structure was also not significant ($F(10, 341) = 0.45$, ns.).

Third, in a more fine-grained analysis of Syllable Complexity, this factor was further operationalized into two separate factors: Onset Complexity and Coda Complexity. Specifically, a three-way ANOVA (3 x 2 x 2) showed three significant main effects, and two interactions of theoretical interest were evaluated and were not significant. The analysis revealed main effects both of Onset Complexity ($F(1, 306) = 8.8$, $p < .01$) and Coda Complexity ($F(2, 306) = 38.6$, $p < .001$), shown in Figures 9 and 10 respectively. The main effect of Group remained significant in this model, as anticipated ($F(1,306) = 8.9$, $p < .01$).

[INSERT FIGURE 9 ABOUT HERE]

[INSERT FIGURE 10 ABOUT HERE]

The Group by Onset Complexity interaction was not significant ($F(1, 306) = 0.72$, ns.), as shown in Figure 11, and the Group by Coda Complexity interaction was also not significant ($F(2, 306) = 0.36$, ns.), as shown in Figure 12. There were no other significant interactions in the analysis.

[INSERT FIGURE 11 ABOUT HERE]

[INSERT FIGURE 12 ABOUT HERE]

Discussion

As predicted, the results show that the number of syllables in a word greatly affects the children's performance on the pseudo-word repetition task. Words of one syllable are reproduced more accurately than words of two syllables, and words of two syllables are reproduced more accurately than words of three syllables for both TD and SLI children. The interaction of syllable number by group (TD and SLI) is also significant, showing that SLI children perform worse than TD children with respect to the task that varies syllable number. This result supports the hypothesis that working memory capacity is an extremely important factor in word storage and recall in Russian, as in other languages.

The second factor that affects the accuracy of the children's performance on the task is syllable structure. It is more difficult to represent and recall a word with complex syllables. There is also a significant interaction of syllable number and syllable structure, which means that it is more difficult to repeat more complex syllables in longer words. However, the interaction of group by syllable structure is not significant demonstrating that SLI children have the same access to the full inventory of syllable templates available in Russian that TD children have. Note that this result mirrors the findings of Marshall at al. (2002), which also did not show a significant interaction of group by syllable structure (cluster number in their terms).[5]

Additionally, our results show a main effect of both onset complexity and coda complexity. For onsets, syllables with one consonant in the onset are significantly easier than syllables with two-consonantal onsets. For codas, open syllables are significantly

[5] Regardless of this result, Marshall at al. (2002) develop a theory that SLI children have an impoverished syllable template compared to TD children.

easier than syllables containing one consonant in the coda, which in turn are significantly easier than syllables with two consonants in the coda. There is no interaction of onset complexity by group and coda complexity by group, which demonstrates once again that both TD and SLI children have access to the same phonotactics constraints.

As discussed above, previous research has shown that in some languages complex onsets are preferred to complex codas, and in some other languages the opposite is true (see Zec 2007 for an overview). The fact that the results are more significant for complex codas ($p < .001$) than for complex onsets ($p < .01$) demonstrates that complex codas are more difficult than complex onsets for both groups of children, suggesting that there is at least some version of onset maximization in Russian.

We also examined the types of errors made by children when repeating pseudo-words containing onset and coda consonant clusters. We looked at the words that contained two-consonantal clusters in word-initial and word-final position. The clusters were of falling, rising, and equal sonority for both onsets and codas, as shown below.

<u>Onsets</u>

a. Rising sonority

bl

dr

b. Falling sonority

lg

rd

c. Equal sonority

bd

kt

Codas

a. Falling sonority

rk

lp

b. Rising sonority

tr

pl

c. Equal sonority

kp

kt

We chose to examine these particular combinations of consonants because they represent relatively less marked structures (onsets of rising sonority and codas of falling sonority) and more marked structures (onsets of falling sonority and codas of rising sonority). Onset and coda clusters in which there is a sonority plateau are considered to be more marked than clusters in which sonority rises towards the nucleus and less marked than clusters in which sonority rises towards the margin. The number of times each consonant in a consonant cluster was omitted is shown in Table 2.

[INSERT TABLE 2 ABOUT HERE]

While there are too few data points for a meaningful statistical analysis to be performed, the data still exhibit certain patterns that can be informatively interpreted. First, in onset clusters there are zero cases out of 35 where both consonants are deleted, as opposed to 12 cases out of 131 in coda clusters where both consonants are deleted. This is not surprising given that a universally unmarked core syllable is CV, and thus the deletion of both consonants in the onset would lead to a less preferred onsetless syllable. On the other hand, the deletion of both consonants in the coda results in a preferred CV syllable.

Note that in onset clusters of either rising or falling sonority it is always the first consonant that deletes (the prediction of Marshall at al. (2002) based on their chosen representation of syllable structure for SLI children is the opposite with respect to onsets of rising sonority). The pattern seems to be the following: the child builds a core CV syllable, choosing a consonant that is closest to the vowel. The same pattern is observed in onset clusters of equal sonority, however, it is not exceptionless (the first obstruent is deleted 9 times out of 11, and the second obstruent is deleted 2 times out of 11).

A different pattern emerges from the behavior of coda clusters. In codas of falling, rising, and equal sonority, the choice of the deleted consonant in the cluster appears to be random (in the codas of falling sonority the obstruent is deleted 22 times and the liquid is deleted 17 times out of 43, in the codas of rising sonority the obstruent is deleted 14 times and the liquid is deleted 4 times out of 25, and in the codas with sonority plateau the first obstruent is deleted 37 times and the second obstruent is deleted 25 times out of 63). A possible explanation for the pattern of errors observed is as follows: complex codas are marked and thus simplified to a simple coda. However, since the presence of coda is not required by the core syllable template, the choice of consonant does not matter.

The data suggest that the more or less marked status of onset and coda clusters with respect to the SSP does not play a role in the patterns of cluster simplification. For example, more marked onset clusters of falling sonority are simplified as often as less marked onset clusters of rising sonority. It is likely that this pattern is due to the fact that Russian does not obey the SSP.

Summary

In summary, this study has demonstrated that phonological memory and syllable structure affect children's ability to recall words. In most general terms, the results tell us that for both SLI and TD children it is always more difficult to represent and recall a longer word than a shorter word. Importantly, SLI children have been shown to have more difficulty than TD children in remembering longer words.

In addition, our results demonstrate that syllable complexity is an important factor that affects the recall of pseudo-words. We should note that the effect on processing complexity cannot be explained by limitations on working memory capacity alone because the syllable complexity is not determined by the number of phonemes in a syllable, but rather by the phonological organization of that syllable. The results also suggest that the effect of complex codas is more pronounced than the effect of complex onsets, suggesting that Russian has onset maximization.

Furthermore, our results indicate that syllable complexity becomes more detrimental in longer words, two- and especially three-syllable ones. This shows that the overall complexity of the task is determined by the combination of length and syllable complexity rather than by either of these factors alone.

The hypothesis of Marshall at al. (2002) regarding the availability of only the CV syllable for SLI children as opposed to TD children finds no support in our data. It is indeed true that the most unmarked syllable structure is easier to represent and recall than any other. However, our results demonstrate that there is no qualitative difference between this structure and all other structures. Rather, the results indicate that there is a continuum of complexity of syllable structure, with CV being the easiest and CCVCC being the hardest in our data. Moreover, this holds to the same degree for TD and SLI children. The fact that there is no interaction of group by syllable number, group by syllable complexity, group by onset complexity, and group by coda complexity conclusively demonstrates that accuracy of repetition for SLI children is affected by the same factors as for TD children.

Finally, the results reveal several suggestive patterns with respect to cluster simplification. First, children use the same strategy in simplification of onset clusters, namely, they omit the first consonant in the cluster. In the simplification of coda clusters, the omitted consonant is chosen randomly. In addition, there are cases of omission of both consonants in the coda cluster, but never in the onset cluster. The sonority hierarchy does not appear to play a crucial role with respect to cluster simplification in Russian.

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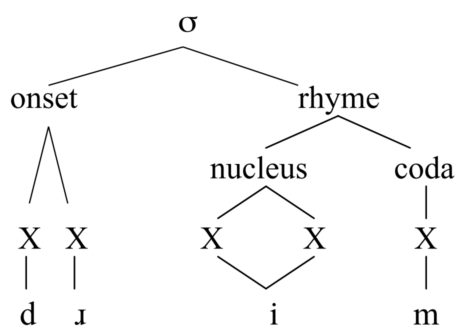
Figure Caption

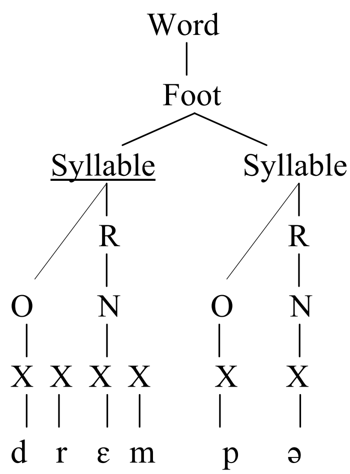
Figure 1. The syllabic structure of the English word dream

Figure 2. Representation of syllable complexity in the G-SLI child



Source: Blevins, J. (1995). The syllable in phonological theory. In J. A. Goldsmith (Ed.), The Handbook of Phonological Theory (pp. 206–244). Blackwell Publishers, p. 213.

Figure 1



Source: Marshall, C., Ebbels, S., Harris, J., and van der Lely, H. (2002). Investigating the impact of prosodic complexity on the speech of children with Specific Language Impairment. UCL Working Papers in Linguistics, 14, 43–68. p. 516.

Figure 2

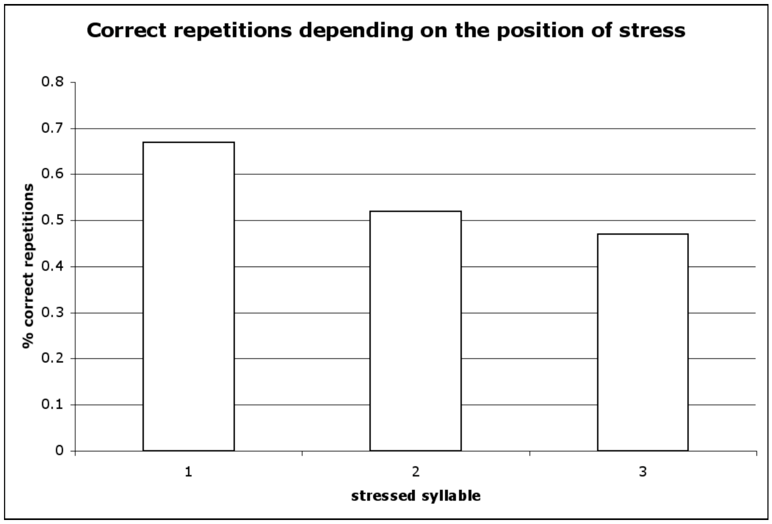

Correct repetitions depending on the position of stress
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
% correct repetitions
1
2
3
stressed syllable

Figure 3.

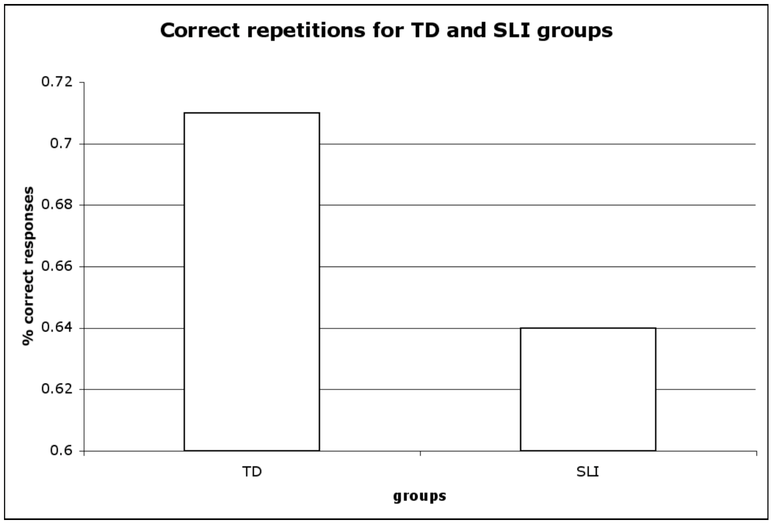

Correct repetitions for TD and SLI groups
% correct responses
0.72
0.7
0.68
0.66
0.64
0.62
0.6
TD
SLI
groups

Figure 4.

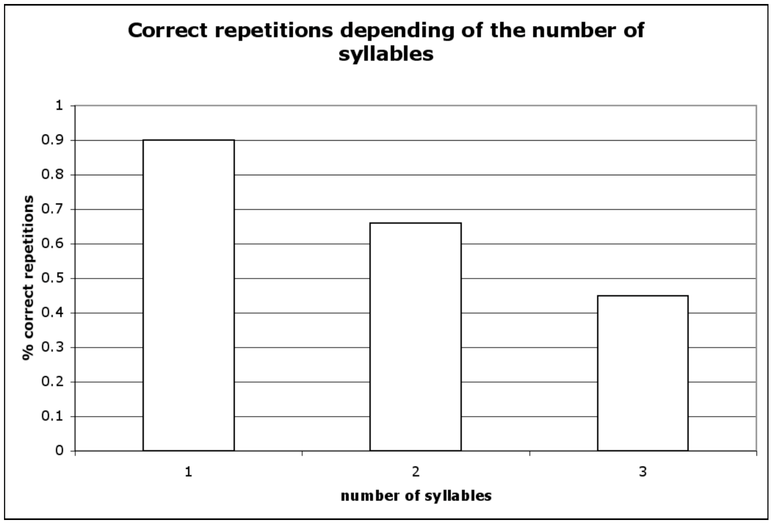

Correct repetitions depending of the number of syllables
% correct repetitions
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
number of syllables

Figure 5.

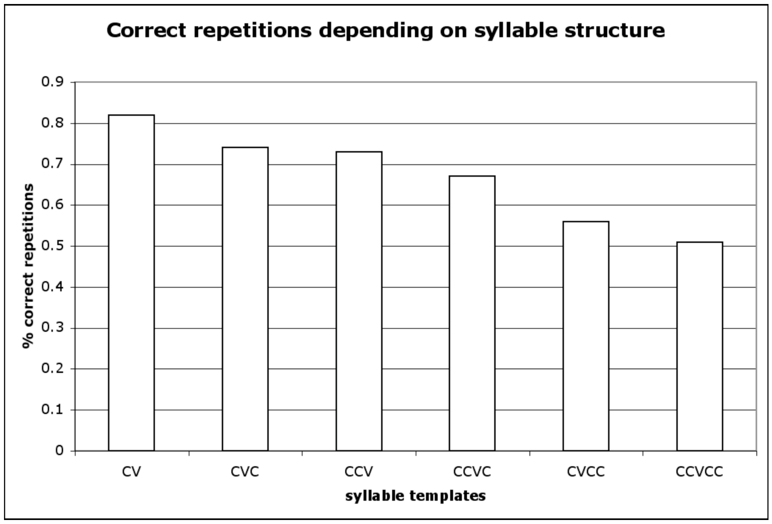

Correct repetitions depending on syllable structure
% correct repetitions
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CV
CVC
CCV
CCVC
CVCC
CCVCC
syllable templates

Figure 6.

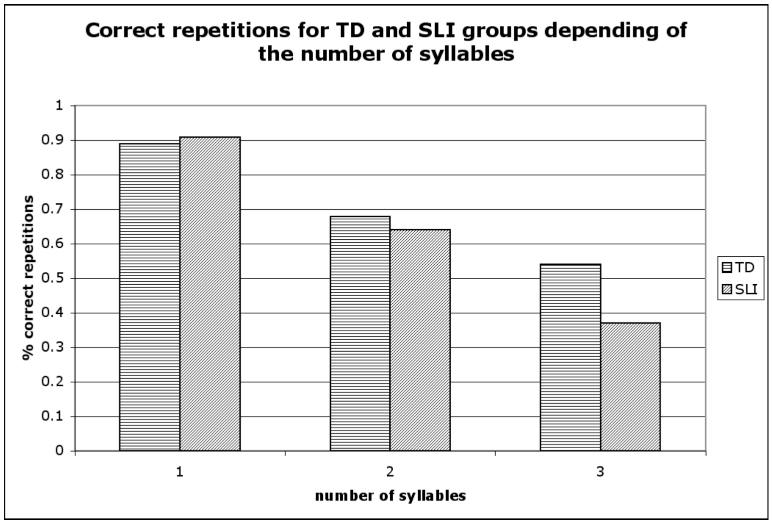

Correct repetitions for TD and SLI groups depending of the number of syllables
% correct repetitions
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
number of syllables
TD
SLI

Figure 7.

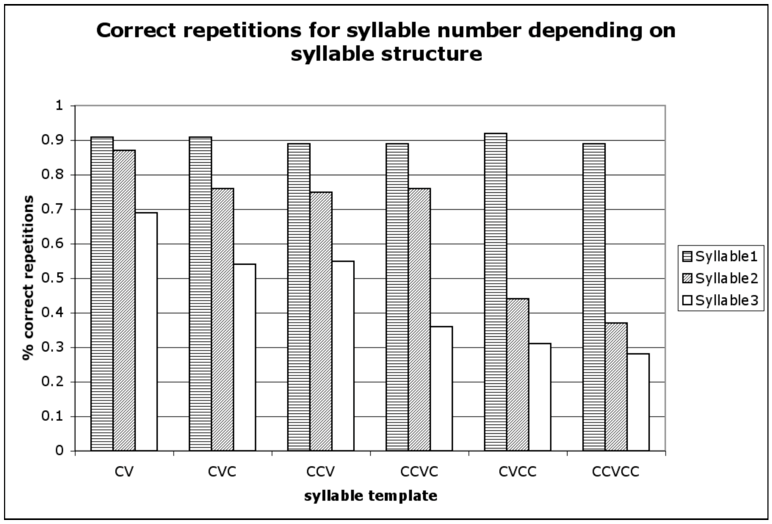

Correct repetitions for syllable number depending on syllable structure
% correct repetitions
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CV
CVC
CCV
CCVC
CVCC
CCVCC
syllable template
Syllable1
Syllable2
Syllable3

Figure 8.

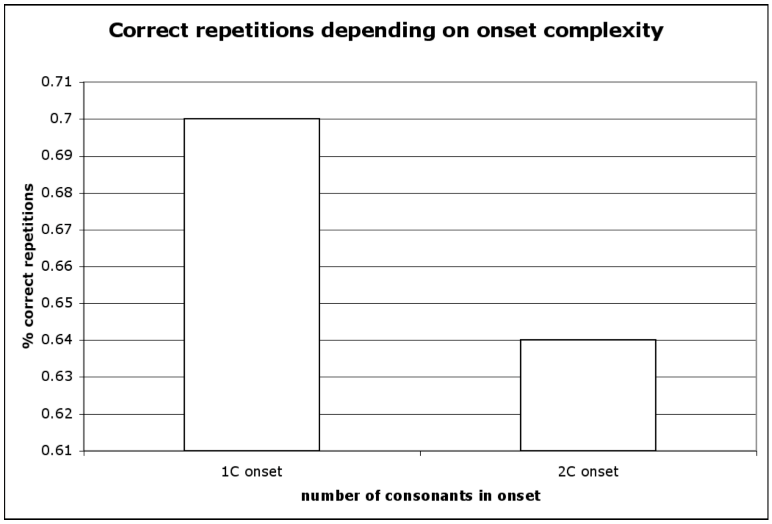

Correct repetitions depending on onset complexity
0.71
0.7
0.69
0.68
0.67
0.66
0.65
0.64
0.63
0.62
0.61
% correct repetitions
1C onset
2C onset
number of consonants in onset

Figure 9.

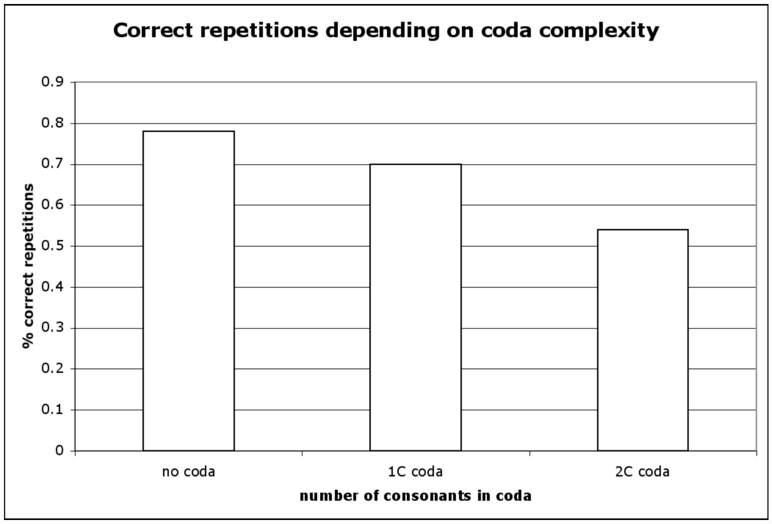

Correct repetitions depending on coda complexity
% correct repetitions
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
no coda
1C coda
2C coda
number of consonants in coda

Figure 10.

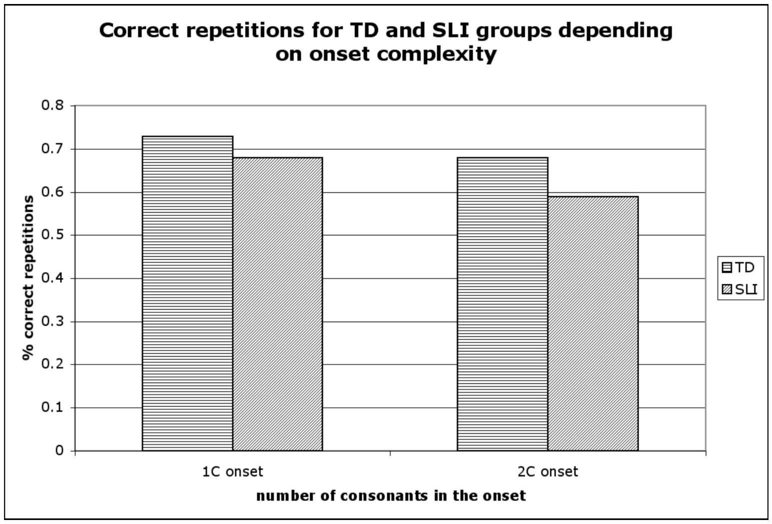

Correct repetitions for TD and SLI groups depending on onset complexity
% correct repetitions
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1C onset
2C onset
number of consonants in the onset
TD
SLI

Figure 11.

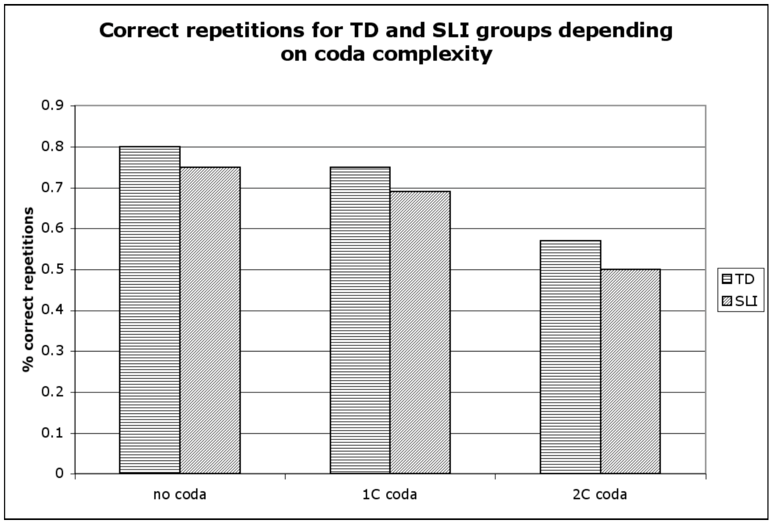

Correct repetitions for TD and SLI groups depending on coda complexity
% correct repetitions
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
no coda
1C coda
2C coda
TD
SLI

Figure 12.

Table 1.

An Example of Stress by Number of Syllables; CV Syllables Only

# of Syllables	1	2	3
1st Syllable stressed	DI	REbi	SObure
2nd Syllable stressed	---	zoRE	moZIbe
3rd Syllable stressed	---	---	fuzaBO

Note: stressed syllables are capitalized.

Table 2.

<u>The Number of Simplifications of Complex Onsets (syllable template CCV(C)(C)) and Complex Codas (syllable template (C)(C)VCC).</u>

	Onset		
	OLV	O_1O_2V	LOV
Simplified as	LV – 13 times	O_1V – 2 times	OV – 11 times
	OV – never	O_2V – 9 times	LV – never
	V – never	V – never	V – never
	Coda		
	VLO	VO_1O_2	VOL
Simplified as	O – 22 times	VO_1 – 37 times	O – 14 times
	L – 17 times	VO_2 – 25 times	L – 4 times
	V – 4 times	V – 1 time	V – 7 times

Note: O – obstruent, L – liquid, V – vowel