

Syllable structure and sonority: The case of Russian-speaking children with SLI¹

Maria Babyonyshev, Darya Kavitskaya
Yale University

1. Outline of the talk

- Topic: acquisition of syllable structure by Russian-speaking children with Specific Language Impairment (SLI)
- The notion of SLI
- The theories of the nature of the phonological deficit in SLI
- Experimental method: pseudo-word repetition task in which syllable number and syllable complexity are manipulated
- Results
 - SLI vs. Typically developing (TD)
 - Russian vs. other languages
 - Additional factors: onset and coda complexity and sonority

2. Introduction

2.1. Definition of SLI

SLI is a developmental disorder that is defined in the following way:

- Nonverbal IQ is within a normal range, the performance on various standardized language tests falls 2 standard deviations below the mean for the child's age
- 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.
--

2.2. Theories on the precise nature of the phonological deficit in SLI

- Gathercole & Baddeley 1990, Conti-Ramsden 2003: the underlying cause of SLI is impairment in phonological short-term memory as revealed by poor performance in pseudo-word repetition tasks
- Van der Lely & Howard 1993, Marshall et al. 2002, 2003: 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

A problem for the first theory *wrt* pseudo-word repetition task:

- Limitations on phonological memory alone cannot explain the whole range of the findings for SLI and TD children
- Stress, word-likeness, prosodic structure, and articulatory complexity affect children's performance (Marshall et al. 2002, Roy & Chiat 2004, van der Lely 2004, van der Lely et al. 2004)

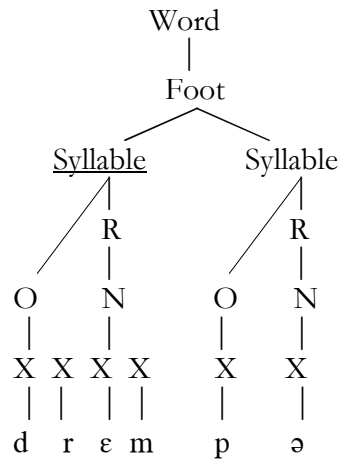
¹ Preparation of this article was supported by the Award R01 DC007665 as administered by the National Institute of Deafness and Communication Disorders (PI: Elena Grigorenko).

Marshall et al. (2002) proposal:

- Only the most unmarked syllable structure (CV) is available to SLI children

“We propose an interpretation of the data whereby children with G[rammatical]-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.” (Marshall et al. 2002: 516)

(1) The model of syllable structure (Marshall et al. 2002: 516)



- 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

2.3. The study

- tests the hypothesis of Marshall et al. (2002) regarding the role of syllable structure representation in SLI phonological impairment;
- provides 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;
- shows that both phonological memory and syllable complexity play a role in determining children’s ability to remember pseudo-words;
- explores whether syllable complexity crucially relies on sonority, a factor that has not been considered in previous studies.

A note on markedness:

- the notion of markedness criticized on the grounds that it is used in too many different meanings (e.g., Haspelmath 2006 lists twelve possible uses of the term markedness).
- We use 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, “markedness as typological implication or cross-linguistic rarity” (Halpelmath 2006: 26).
- Possible Russian onsets:
 - /bl/ [bl’in] ‘pancake’ (widely attested crosslinguistically and thus less “marked”)
 - /lb/ [lba] ‘forehead-GEN’ (quite rare and thus more “marked”)

- The notion of markedness in this sense is crucial in the formulation of the Marshall et al. (2002) hypothesis: for SLI children only an unmarked CV syllable template is available.

3. Hypotheses

- 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.
- Given that stress in Russian is lexically determined, we predict that the location of stress will 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 et al. 1999 for Swedish, Marshall et al. 2003 and van der Lely 2005 for English).
- 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.

4. Experimental Methodology

4.1. Goals

- to test the hypothesis regarding the unavailability of the marked syllable structures to SLI children
- to explore the importance of phonotactics in general for SLI children

4.2. Subjects

- nineteen monolingual Russian-speaking children aged 4;7–10;7²
- location: a village in Northern Russia where the presence of language disorders is significantly higher than in general population³
- uniqueness of the population
 - the founder effect (founded by 10 people in the 11th century AD)
 - isolation (the fall of the Novgorod republic, Old Believers)
- classification measures
 - The Assessment of the Development of Russian Language (ORRIA) (Babyonyshev et al., unpublished)
 - Mean Length of Utterance (MLU)
 - Syntactic Complexity (SC): the percentage of syntactically complex sentences (e.g. relative clauses, embedded clauses, passive structures, etc).
 - to calculate MLU and SC, narrative samples were collected by asking the children to tell a story on the basis of a picture book⁴

² 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.

³ This work is part of a larger study of familial Disorders of Spoken and Written Language (Grigorenko et al. In progress).

⁴ MLU for a specific child was calculated on the basis of separate words, not morphemes, as is traditional for highly inflected languages.

- Classification results
 - SLI – 6 subjects (age range 4;7–10;7, mean age 8;0), TD – 13 subjects (age range 4;10–10;6, mean age 8;5)
 - Non-verbal IQs for SLI children: 66–98, mean IQ 80, for TD children: 69–130, mean IQ 90.

4.3. Stimuli

- Method: pseudo-word repetition task

(2) Factors manipulated in constructing pseudo-words

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

(3) An Example of Stress by Number of Syllables; CV Syllables Only

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

(4) Relevant conditions for a one-syllable pseudo-word

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

- 144 pseudo-words presented in a pseudo-random order to the subjects
- The children asked to repeat the words exactly as they were pronounced by the experimenter
- The children were told that the words they would hear are not real
- If a child failed to respond for five seconds, the experimenter repeated the word once
- 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

4.4. Measurements

- The responses transcribed phonetically and compared to the pronunciation by the experimenter
- 5% of the data discarded (poor quality recording)

5. Results

5.1. Stress on number of correct repetitions of pseudo-words

FACTORS	DF	N	F	P
Stress	2	678	18.5	< .001
Group	1	678	17.1	< .001
Group by Stress	2	678	2.7	ns

- Stress is inherently confounded by Syllable Number

- Once Syllable Number is adjusted for, neither the effect of Stress nor the Group by Stress interaction remains significant. Based on this evidence, Stress was excluded from subsequent analyses.

5.2. Significant main effects and interactions

FACTORS	DF	N	F	P
Stress	2	678	0.3	ns
Group by Stress	2	678	3.3	ns
Group	1	306	8.9	< .01
Syllable Number	2	306	126.2	< .0001
Syllable Structure	5	306	17.4	< .0001
Group by Syllable Number	2	306	5.9	< 0.01
Syllable Number by Syllable Structure	10	306	5.53	< .0001

5.3. Syllable Complexity

FACTORS	DF	N	F	P
Onset Complexity	1	306	8.8	< .01
Coda Complexity	2	306	38.6	< .001
Group	1	306	8.9	< .01
Group by Onset Complexity	1	306	0.72	ns
Group by Coda Complexity	2	306	0.36	ns

6. Discussion

6.1. Syllable number

- The number of syllables in a word greatly affects the children's performance
- SLI children perform worse than TD children
- 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.

6.2. Syllable structure

- It is more difficult to represent and recall a word with complex syllables
- It is more difficult to repeat more complex syllables in longer words
- 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 et al. (2002), which also did not show a significant interaction of group by syllable structure (cluster number in their terms)
 - Regardless of this result, Marshall et al. (2002) develop a theory that SLI children have an impoverished syllable template compared to TD children.

6.3. Onset and coda complexity

- Syllables with one consonant in the onset are significantly easier than syllables with two-consonantal onsets
- Open syllables are significantly 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

6.4. *Complex onsets vs. complex codas*

- The results are more significant for complex codas ($p < .001$) than for complex onsets ($p < .01$): complex codas are more difficult than complex onsets for both groups of children
 - Languages vary with respect to their preference of complex onsets to complex codas and vice versa:
 - Dakota allows complex onsets but bans complex codas (Zec 2007);
 - Tundra Nenets allows complex codas but bans complex onsets (Salminen 1997)
 - Some languages allow both complex onsets and complex codas but are analyzed as preferring one to the other (see Barnes 1998 for an analysis of Bulgarian as preferring complex onsets to complex codas)
- 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.
- There has been a suggestion (see Kodzasov 1990) that there is a version of onset maximization in Russian

6.5. *Sonority*

6.5.1. Patterns

(5) Sonority of clusters examined

	Onset	Coda
Rising sonority	bl, dr	tr, pl
Falling sonority	lg, rd	rk, lp
Equal sonority:	bd, kt	kp, kt

(6) The Number of Simplifications in clusters

	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

6.5.2. Interpretations

6.5.2.1. Onset clusters

- In onset clusters of either rising or falling sonority it is always the first consonant that deletes (the result is opposite to the prediction of Marshall et al. (2002))
 - Possible interpretations
 - The child builds a core CV syllable, choosing a consonant that is closest to the vowel
 - The child chooses the first (syllabified) consonant (L in an LO cluster is extrasyllabic)
- Onset clusters of equal sonority: the same pattern, but not exceptionless

6.5.2.2. Coda clusters

- In codas of falling, rising, and equal sonority, the choice of the deleted consonant in the cluster appears to be random
- A possible explanation: 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. It is likely that this pattern is due to the fact that Russian does not obey the SSP.

7. Conclusions

- Phonological memory and syllable structure affect children's ability to recall words.
- For both SLI and TD children it is always more difficult to represent and recall a longer word than a shorter word.
- SLI children shown to have more difficulty than TD children in remembering longer words.
- 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 effect of complex codas is more pronounced than the effect of complex onsets, suggesting that Russian has onset maximization.
- 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 et al. (2002) regarding the availability of only the CV syllable for SLI children as opposed to TD children finds no support in our data.
 - Indeed, CV structure is easier to represent and recall than any other
 - However, there is no qualitative difference between CV and other structures
 - Rather, 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.

References

- Babyonyshev, M., Hart, L., Reich, J., Kuznetsova, J., Rissman, R., & Grigorenko, E. (Unpublished manuscript). The Assessment of the Development of Russian Language (ORRIA).
- Barnes, J. (1998). Bulgarian liquid metathesis and syllabification in Optimality Theory. In Z. Boskovic, S. Franks & W. Snyder (Eds.), *Formal Approaches to Slavic Linguistics: The Connecticut Meeting 1997*. Ann Arbor: Michigan Slavic Publications.
- Bishop, D. V. M. (1997). Uncommon understanding: *Development and disorders of language comprehension in children*. Psychology Press.
- Conti-Ramsden, G. (2003). Processing and linguistic markers in young children with specific language impairment (SLI). *Journal of Speech, Language, and Hearing Research*, 46, 1029–1037.
- Gathercole, S., & Baddeley, A. (1990). Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory and Language*, 29, 336–360.
- Grigorenko, E. L., Koposov, R. A., Babyonyshev, M., Hart, L. A., Pushkin, I., Reich, J., Strelina, A. (Manuscript in Progress). Cognitive and language profiles of members of a large extended pedigree with disorders of spoken and written language.
- Haspelmath, M. (2006). Against markedness (and what to replace it with). *Journal of Linguistics*, 42, 25–70.
- Kodzasov, S. V. (1990). Slog. In V. N. Iartsev (Ed.), *Lingvisticheskij Entsiklopedicheskij Slovar'*, (p. 470). Moskva: Sovetskaia Entsiklopediia.
- Leonard, L. B. (1998). *Children with specific language impairment*. Cambridge, MA: MIT Press.
- 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.
- Marshall, C., Harris, J., and van der Lely, H. (2003). The nature of phonological representations in children with Grammatical-Specific Language Impairment (G-SLI). In D. Hall, T. Markopoulos, A. Salamoura and S. Skoufaki (Eds.), *The University of Cambridge First Postgraduate Conference in Language Research*, (pp. 511–517). Cambridge: Cambridge Institute of Language Research, University of Cambridge.
- Roy, P. and Chiat, S. (2004). A prosodically controlled word and nonword repetition task for 2- to 4-year-olds: evidence from typically developing children. *Journal of Speech, Language, and Hearing Research*, 47, 223–234.
- Salminen, Tapani. 1997. *Tundra Nenets inflection*. Suomalais-Ugrilainen Seura. Helsinki.
- van der Lely, H. (2004). Evidence for and implications of a domain-specific grammatical deficit. In L. Jenkins (Ed.), *The genetics of language* (pp. 117–144). Oxford: Elsevier.
- van der Lely, H. & Howard, D. (1993). Children with Specific Language Impairment: linguistic impairment or short-term memory deficit? *Journal of Speech and Hearing Research*, 36, 1193–1207.
- van der Lely, H., Rosen, S. & Adlard, A. (2004). Grammatical language impairment and the specificity of cognitive domains: relations between auditory and language abilities. *Cognition*, 94, 167–183.
- Zec, D. (2007). *The syllable*. In P. de Lacy (Ed.), *The Cambridge Handbook of Phonology* (pp. 161–194). Cambridge University Press.

APPENDIX

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.

- ❖ A two-way ANOVA (2 x 3) showed a significant main effect of Stress on number of correct repetitions of pseudo-words ($F(2, 678) = 18.5, p < .001$).
- ❖ 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 ($F(2, 678) = 2.7, ns.$).
- ❖ A supplemental ANCOVA controlled for the effect of Syllable Number on Stress in a, 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.
- ❖ Main effect of Group on number of correct repetitions of pseudo-words ($F(1, 306) = 8.9, p < .01$) (Figure 1)
- ❖ Main effect of Syllable Number ($F(2, 306) = 126.2, p < .0001$) (Figure 2)



Figure 1.

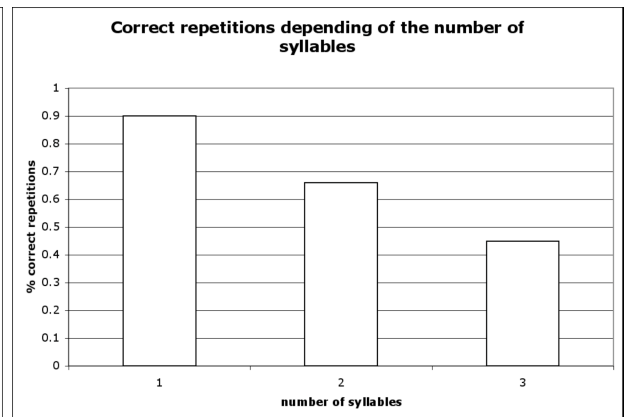


Figure 2.

- ❖ The main effect of Syllable Structure is in Figure 6 ($F(5, 306) = 17.4, p < .0001$).
- ❖ The analysis shows a significant interaction of Group by Syllable Number ($F(2, 306) = 5.9, p < 0.01$) (see Figure 7).

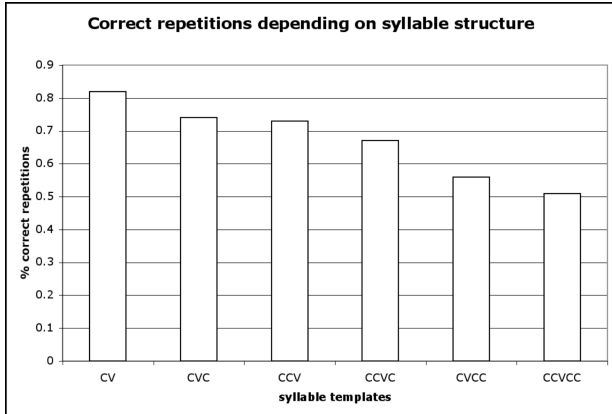


Figure 6.

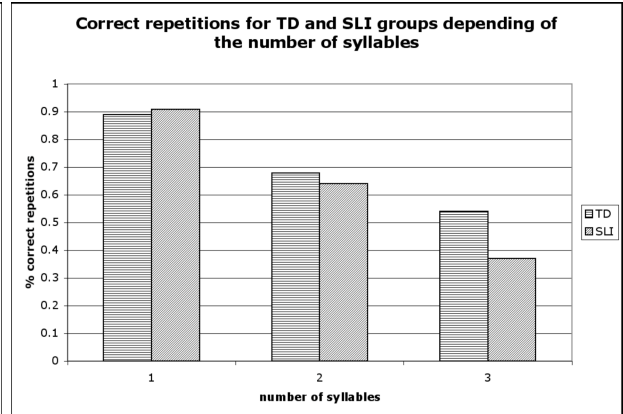


Figure 7.

- ❖ Figure 8: a significant Syllable Number by Syllable Structure interaction ($F(10, 306) = 5.53, p < .0001$)
- ❖ Figure 9: main effect of Onset Complexity ($F(1, 306) = 8.8, p < .01$)
- ❖ Figure 10: main effect of Coda Complexity ($F(2, 306) = 38.6, p < .001$)
- ❖ The main effect of Group remained significant ($F(1,306) = 8.9, p < .01$).

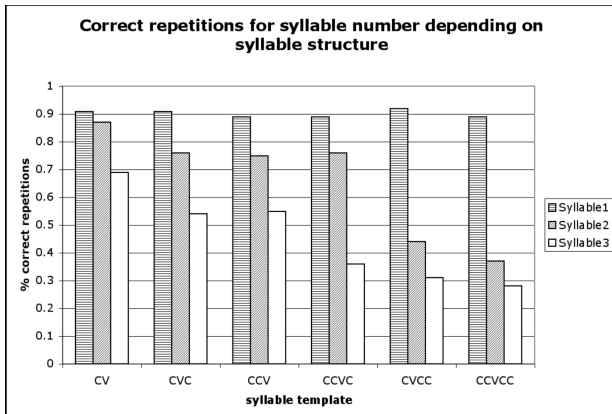


Figure 8.

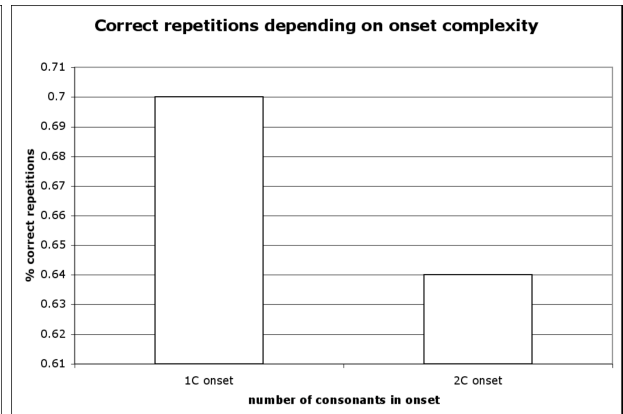


Figure 9.

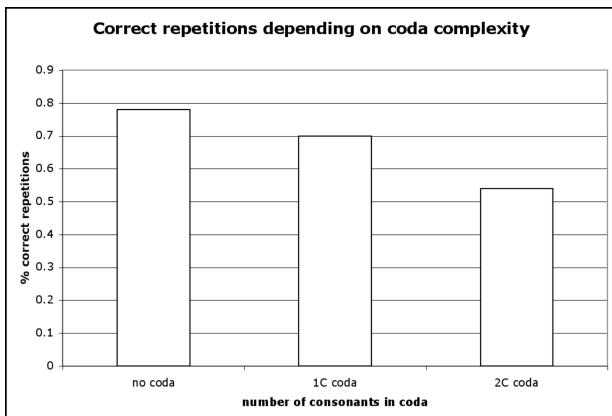


Figure 10.