

Phrase-Final Lengthening in Russian: Pre-boundary or Pre-pausal?

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Abstract. It has been shown for many languages that words are lengthened in phrase-final position. However, it is not quite clear whether this lengthening is caused more by the presence of a boundary or by the presence of a pause. The present paper aims to answer this question by analysing the duration of stressed and post-stressed vowels in words occurring at the beginning/middle vs. end of intonational phrase, and with vs. without a following pause. In addition, the present study attempts to explain how lengthening is distributed among the the final word's segments, especially in cases when the boundary is not marked by a pause.

Keywords: phrase-final lengthening, pre-boundary lengthening, pre-pausal lengthening, segment duration.

1 Introduction

In papers on the subject several terms are used to describe the phenomenon of segmental lengthening at the end of prosodic units. The most common are phrase-final lengthening, pre-boundary (pre-juncture) lengthening and pre-pausal lengthening. While the former two can be considered synonyms, the latter differs in the way that it excludes the situations when the boundary is not marked by a pause. Most authors do not distinguish between these two types of lengthening. However, it is clear that the lengthening effect is higher in the presence of a pause [1] [7].

Previous studies for Russian [2] [3] also show that segmental duration values are low for words in intonational-phrase-final position with no pause following, as opposed to those with a pause.

Another study [6] for Russian shows that in non-final phrases (i.e. intonational phrases, but not utterances) the degree of final lengthening is very small and there is often no pause, since the boundary is marked primarily by changes in melody.

There are, therefore, at least two questions to be asked:

1. Is *pre-pausal* lengthening caused only by the presence of a pause or also by the phrase-final position?
2. Are final segments lengthened at the end of an intonational phrase if the boundary is *not* marked by a pause?

Therefore, the present paper does not deal with utterance-final lengthening: the prosodic units analysed here are intonational phrases (IP).

It has been shown that in Russian final lengthening affects not only the final rhyme, but also the stressed vowel [2] [6] if the final syllable is unstressed. The results presented in [4] showed that final unstressed vowels are lengthened more in open syllables than if followed by a consonant. These are the reasons why in the present study we are analysing three types of vowels:

- stressed vowels in IP-final accentual phrases ending in -cVcv or cVcvc (as /o/ in /'vdomʲi/ ("at home") or /a/ in /dvʲi'nat͡siʲ/ ("twelve"));
- post-stressed vowels in IP-final accentual phrases ending in -cVcv (as /i/ in /'vdomʲi/ ("at home"));
- post-stressed vowels in IP-final accentual phrases ending in -cVcvc (as /i/ in /dvʲi'naʲt͡siʲ/ ("twelve")).

The CV-patterns ("c" stands for "consonant", "v" for "unstressed vowel", and "V" for "stressed vowel") are chosen based on frequency data.

2 Experiment Design

2.1 Material

The present study is based on the Corpus of Professionally Read Speech (CORPRES) [5] for Russian. The corpus is manually segmented and contains phonetic and prosodic annotation, which enables to measure segmental characteristics in different prosodic contexts. For the present analysis 4 of the 8 speakers, 2 male (A and M) and 2 female (C and K), were chosen since they had recorded more material than others (4–5 hours for each speaker).

2.2 Method

To answer the questions formulated in the Introduction, it is reasonable to analyse segmental duration values in words occurring in four positions.

1. IP-initail/medial with a pause (e. g. /**ga'tova** [pause] pʲi'tʲi na'pomaʲç:/ ("is ready [pause] to help"));
2. IP-final with a pause (e. g. /u'darʲil jɪ'vo nʲi'tʲi 'raza [pause]/ ("kicked him not three times [pause] [, but ... times]"));
3. IP-initail/medial with no pause (e. g. /'stobi' nʲebɪla 'putanʲitsi/ "to avoid confusion");
4. IP-final with no pause (e. g. /nʲet nʲitʲci'vo **ta'kova**/ "there is nothing like that [which...]").

If the duration values are greater for position 2 compared to position 1, then pre-pausal lengthening is caused not only by the presence of a pause, but also by the position of the word within the intonational phrase. This comparison will give us an answer to question 1 formulated in the Introduction.

If the duration values for position 4 are greater than those for position 3, then pre-boundary lengthening can be observed even when the boundary is not marked by a pause. This comparison will give us an answer to question 2.

Additionally, by comparing data for positions 1 and 3, we will find out whether segments are lengthened in non-phrase-final words followed by a pause. A comparison of duration values for positions 2 and 4 can confirm or reject the statement that the degree of final lengthening is greater when the boundary is marked by a pause.

To eliminate the influence of pitch movement type on vowel duration, we are observing only words *not* bearing nuclear stress.

In order to calculate the duration values for the stressed and post-stressed vowels in words (accentual phrases) ending in -cVcvc and -cVcv (see Introduction), a Python script was written which processed the annotation files of the corpus.

Despite the large size of the corpus, it appeared impossible to analyse different types of vowels separately, since the restrictions on the CV-pattern and the position of the word within the IP reduced the sample sizes drastically. In order to be able to compare duration values for different types of vowels it was reasonable to calculate *normalized* duration values. Here the formula given in [7, formula (4)] was used, which allowed us to compensate for the average duration of the segment, its standard deviation, and tempo:

$$\tilde{d}(i) = \frac{d(i) - \alpha\mu_p}{\alpha\sigma_p}$$

where $\tilde{d}(i)$ is the normalized duration of segment i , $d(i)$ is its absolute duration, α is the tempo coefficient, and μ_p and σ_p are the mean and standard deviation of the duration of the corresponding phone p .

The tempo coefficient (α) was calculated using formula provided in [7, formula (6)]:

$$\alpha = \frac{1}{N} \sum_{i=1}^N \frac{d_i}{\mu_{p_i}}$$

where d_i is the duration of segment i , and μ_{p_i} is the mean duration of the corresponding phone.

To estimate the influence of word position and presence of a pause on vowel duration, statistical analysis was carried out using R. For normally distributed data Welch's t-test was used; for non-normally distributed data (according to Shapiro-Wilks test) Wilcoxon-Mann-Whitney test was used instead.

3 Results

3.1 Stressed Vowels in Penultimate Syllables

The mean and median values for normalized duration of stressed vowels in words ending in -cVcv and -cVcvc are given in Table 1 and Table 2 respectively.

Statistical analysis has shown that the duration values of stressed vowels in penultimate syllables are higher in phrase-final words followed by a pause compared to phrase-initial/medial words also followed by a pause. The difference is statistically significant for all 4 speakers for pattern -cVcvc, and for 3 of 4 speakers for pattern -cVcv (for the remaining speaker the sample size is too small).

Table 1. Mean and median normalized duration values and sample sizes (N) for stressed vowels in words ending in -cVcv, for 4 types of position

		IP-initial/medial				IP-final			
		speaker				speaker			
		A	C	K	M	A	C	K	M
pause	mean	-0.28	0.31	0.08	-0.97	0.17	0.34	0.55	0.29
	median	-0.39	0.32	0.28	-0.93	0.08	0.38	0.51	0.05
	N	25	4	11	9	46	30	41	30
no pause	mean	-0.51	-0.38	-0.43	-0.48	-0.27	0.19	0.05	0.07
	median	-0.56	-0.42	-0.52	-0.51	0.04	0.2	0.05	0.07
	N	1456	1727	1502	1745	15	20	34	43

A similar difference can be observed for final and initial/medial words not followed by a pause, although this difference is weaker in statistical terms: significance holds true for all 4 speakers in words ending in -cVcv, but for only 1 speaker in words ending in -cVcvc.

There seems to be no influence of a following pause on the duration of stressed vowels in phrase-initial/medial words for pattern -cVcvc. For words ending in -cVcv there are statistically significant differences between duration values for 3 of 4 speakers, but the direction of the difference is not consistent between the speakers.

Finally, there seems to be a tendency for more IP-final lengthening in the presence of a pause: the difference is statistically significant for 1 of 4 speakers for pattern -cVcv, and for 2 of 4 speakers for pattern -cVcvc.

Table 2. Mean and median normalized duration values and sample sizes (N) for stressed vowels in words ending in -cVcvc, for 4 types of position

		IP-initial/medial				IP-final			
		speaker				speaker			
		A	C	K	M	A	C	K	M
pause	mean	-0.46	-0.51	-0.62	-0.88	0.27	0.08	0.36	0.27
	median	-0.4	-0.53	-0.8	-0.79	0.18	0.25	0.32	0.36
	N	16	6	11	10	21	15	18	14
no pause	mean	-0.58	-0.49	-0.64	-0.54	-0.55	-0.16	-0.18	-0.25
	median	-0.61	-0.49	-0.62	-0.52	-0.58	-0.21	-0.24	-0.24
	N	705	869	724	794	6	8	17	21

4 Post-stressed Vowels in Final Open Syllables

Table 3 provides mean and median values for normalized duration of unstressed vowels in words ending in -cVcv. Since these vowels immediately precede the boundary, we expected them to show most differences between boundary types.

Surprisingly, in words followed by a pause the duration values are *lower* in phrase-final than in phrase-initial/medial position; statistical significance is observed for 2 of 4

Table 3. Mean and median normalized duration values and sample sizes (N) for post-stressed vowels in words ending in -cVcv, for 4 types of position

		IP-initial/medial				IP-final			
		speaker				speaker			
		A	C	K	M	A	C	K	M
pause	mean	1.24	1.74	0.23	2.11	0.35	0.99	0.12	0.34
	median	0.97	1.84	-0.23	1.7	0.14	1.01	0.16	0.07
	N	25	4	11	9	46	30	41	30
no pause	mean	-0.1	-0.15	-0.06	-0.02	0.36	-0.15	0	0.11
	median	-0.16	-0.22	-0.09	0.1	0.11	-0.27	-0.03	-0.07
	N	1456	1727	1502	1745	15	20	34	43

speakers. An auditory analysis of the data showed that all speakers but speaker K sometimes make prolongations of word-final vowels before a pause, with normalized duration values above 3. However, excluding these cases from the analysis does not change the whole picture, showing statistical significance for the same two speakers (A and M).

Another interesting result is as follows: statistically, in the absence of a pause there is no difference in the duration of absolute final post-stressed vowels between phrase-initial/medial and phrase-final words. That is, absolute final vowels are *not* lengthened phrase-finally if there is no following pause.

For words in IP-initial/medial position the presence of a following pause shows more lengthening of absolute-final unstressed vowels; the difference is statistically significant for 3 of 4 speakers.

The influence of pause on phrase-final lengthening is not confirmed by statistical analysis, showing a significant difference for only 1 of 4 speakers.

5 Post-stressed Vowels in Final Closed Syllables

Table 4 provides mean and median values for normalized duration of unstressed vowels in words ending in -cVcvc.

Table 4. Mean and median normalized duration values and sample sizes (N) for post-stressed vowels in words ending in -cVcvc, for 4 types of position

		IP-initial/medial				IP-final			
		speaker				speaker			
		A	C	K	M	A	C	K	M
pause	mean	-0.09	-0.14	0.14	-0.08	-0.16	-0.05	-0.32	-0.39
	median	0.02	-0.16	0.18	-0.33	-0.2	-0.1	-0.26	-0.72
	N	16	6	11	10	21	15	18	14
no pause	mean	-0.37	-0.31	-0.13	-0.28	-0.37	-0.36	-0.2	-0.16
	median	-0.4	-0.33	-0.35	-0.36	-0.38	-0.42	-0.28	-0.25
	N	705	869	724	794	6	8	17	21

Just looking at the values given in Table 4 is enough to notice that here the position of the word has no influence on vowel duration. Not surprisingly, statistical analysis confirms this claim, revealing only one statistically significant difference (for vowels in IP-initial/medial words followed vs. not followed by a pause, speaker A). Moreover, there is no difference between *any* of the positions observed in this study (e. g. positions 2 and 3 as listed in the section "Methods").

This leads to a conclusion that post-stressed vowels in ultimate closed syllables are *not lengthened* in IP-final position. As shown above, in this case the lengthening affects the stressed vowel of the word; it probably affects the final consonant as well, but this is beyond the scope of the present study.

6 Conclusions

It is now possible to answer the questions formulated in the Introduction.

1. Is *pre-pausal* lengthening caused only by the presence of a pause or also by the phrase-final position?
 - In words followed by a pause, **stressed vowels in penultimate syllables** are longer in IP-final position than in IP-initial/medial position. Therefore, here the lengthening is caused not only by the presence of a pause, but also by the position of the word within the phrase.
 - For **post-stressed vowels in final open syllables** the opposite is observed: absolute final vowels are much longer in *non*-phrase final position before a pause than in phrase-final position before a pause. Thus, before a pause phrase-final position yields less lengthening than phrase-initial/medial position.
 - **Post-stressed vowels in final closed syllables** do not show any lengthening in either of the cases. Neither the position within the phrase, nor the presence of a pause affects vowel duration.
2. Are final segments lengthened at the end of an intonational phrase if the boundary is *not* marked by a pause?
 - The answer is "yes" for **stressed vowels in penultimate syllables**.
 - The answer is "no" for **post-stressed vowels in final open and closed syllables**.

In addition, the following observations have been made:

- In words occurring in IP-final position, stressed vowels in penultimate syllables tend to be lengthened more when the boundary is marked by a pause.
- In words occurring in IP-initial/medial position, post-stressed vowels in final open syllables are lengthened more if there is a pause following.

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