On the temporal component of intonational phrasing

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Abstract

In this paper we describe an experiment which was set up to investigate the phenomenon of final lengthening in Russian, to measure the degree of pre-boundary lengthening and find out factors which influence its degree in Russian.

1. Introduction

The fact that word duration depends on its position within the phrase has been known for a long time. The tendency for words to lengthen in the vicinity of phrase boundaries has been reported by many researchers (see, for instance, [1], [2], [3], [4], [5]). It has been found that the syllable duration before a pause may increase by 60-200 msec. This effect, known as prepausal (also: pre-boundary, final) lengthening, has been well studied for a number of languages. Comparable data were found for English, French and Swedish. According to Klatt, final lengthening in English takes place in the end of the phrase or intonation unit even if there is no physical pause in the acoustic signal. In such a case, it is the lengthening of the final syllable that helps the listener perceive the phrase or intonation unit boundary. “The syllable or syllables are longer in the end of the sentence than in any other place within the sentence. A word in isolation is as long as a word in the end of the sentence and two times longer than in the beginning of the sentence” [6: 1211]. Although the issue has been studied by many researchers, mainly for the purposes of the development of a temporal model for speech synthesis, it is not yet clear which segment is being lengthened, whether it is just the last vowel or the last stressed vowel, the stressed syllable only or the post-stress part of the word as well. The data reported by the researchers vary [7], [8], [9].

2. Experiment design

In our experiment, test words were extracted from sixty sentences recorded from five native Russian speakers. Duration of words placed in different positions within the sentence, — initial and final — was measured directly on the oscillogram of the digitized signal. The correlation between the duration of these words and their components and the position within the phrase was analyzed. The results obtained in this experiment were compared with other data available on the Russian material (recordings made for the INTAS project 915: Spontaneous Speech of Typologically Unrelated Languages (Russian, Finnish and Dutch): Comparison of Phonetic Properties). Duration of words pronounced by the same speaker in various positions in the utterances of the spontaneously produced and read texts was measured. Factors which influence word duration — the position within the phrase or speech style — were analyzed. Results of the experiment (with phrases where the same words appear in different positions within the sentence) are as follows:

1. Final lengthening is also found in the Russian language. The statistical analysis showed that the word duration is significantly dependent on the position within the sentence for all words uttered by all speakers. The words can be divided into two groups:
   a) isolated and sentence or phrase - final (Group 1);
   b) and those in the beginning or in the middle of the phrase (Group 2). See, for example, Fig. 1.

![Fig. 1. The duration of the word “podruszhka” depending on the position in the phrase: isol - isolated, finals - sentence final, final/ph - phrase final, begin - beginning of the phrase, middle - middle of the phrase (speaker Sh.)](image)

A similar picture can be observed for the data registered for the whole material analyzed. See for example, Fig. 2 which shows the duration of the word “babushkat” in different positions in the phrase compared to its duration in isolated pronunciation.
3. Lengthening in the phrase final position

In the phrase final position in Russian words are on average 30% longer than the same words in the beginning of a phrase. Phrase-final lengthening has been shown repeatedly, our results are in agreement with the average data reported for the English language material. It should be noted, though, that different degrees of phrase-final lengthening are observed in Russian three- and two-syllable words. For instance, Babushkat is lengthened only by 20%, while Pasha is lengthened by 35%.

4. Lengthening of the focused words

The pre-boundary lengthening of the focused word is to a certain degree influenced by the type of intonation contour. The words under phrasal stress in general questions and non-final phrases (realized with a rising tone) were somewhat shorter than the words in final phrases (where falling or level tone was realized) (see histograms on Fig. 3). This difference averages at 10%. It is interesting to note that Cooper and Danley [5] reported similar results: the phrase position effect was stronger in the phrase final position of an utterance than on a non-final phrase.

5. Lengthening in read and spontaneous speech

The analysis of the duration data on test words realized in spontaneous and read material shows similar tendencies, (see fig. 4): in non-final units focused words are lengthened to a smaller degree, compared to the same words in final intonation units.

This means that these tendencies are not style specific.

6. Segmental duration at prosodic boundaries

There has been some discussion on the problem which part of the word or syllable is lengthened, or whether the word's relation to stress has some effect on the degree of the pre-boundary lengthening. Our results show that the correlation between the length of all final and stressed syllables and the word duration is statistically significant. The correlation coefficient is the highest when the last syllable is stressed (for Pasha, Babushkat) – it is 0.96 and 0.99 respectively. The change of the word duration almost entirely depends on the change in the duration of this syllable (see Fig. 5, 6). The correlation coefficient for the relationship between the pre-stressed syllable duration and word duration is either smaller, or statistically insignificant.

In stressed or final syllables the maximum correlation is between the word duration and the vowel length. This means that the largest share of the preboundary lengthening is borne by the vowels. The consonants, however, are also lengthened as the word is lengthened. (see Tables 1, 2).
7. Conclusion

The conclusions for the present are as follows:

The preliminary results show that the most significant factors influencing the degree of pre-boundary lengthening in the Russian language are (from a greater to a smaller degree):

1) the position within the phrase (beginning or end);
2) focusing: the presence of phrasal or logical stress on the word;
3) the type of the intonation unit (final or non-final);
4) the type of the intonation contour realized on the focussed word.

In sentence or phrase final position, the whole word is lengthened in all types of phrases. It is important, however, that the type of phrase (final or non-final), or rather the melodic pattern realized on the focused word, influences the degree of such lengthening. In all types of phrases included in our research, the word lengthening occurs mostly due to the vowel lengthening of the focussed words as well as lengthening of the final post-stressed syllables.

Klatt found that segments in phrase final syllables within compound sentences were lengthened. According to his data, in this position, the vowels are 30% longer (the average vowel length before all phrase boundaries in the analyzed material. [6]. This means that in Klatt's data such factors as phrase type and melodic contour realized in the intonational center of the phrase were ignored. It is possible that for the English language such differences are minute and can be neglected. For Russian, however, in questions and non-final phrases, on one hand, particularly those where the rising tone is realized (of IC 3 type), and in statements and final phrases, on the other, the temporal pattern is different. The word duration at the end of statements is longer than that in questions and non-final phrases. Research confirms that the boundaries of non-final phrases are marked primarily by the melodic changes, as the degree of pre-boundary lengthening is very small and very often there are no acoustic pauses observed [10], [11]. Our results differ from Klatt’s in this respect. Klatt noted that there is prepausal lengthening at the end of a sentence or a phrase if there is no physical pause in the acoustic signal. [6: 1211].

Our study has revealed that out of all prosodic boundary markers, only one, the melody, may very well serve this function. At the same time, the results that we have obtained are in agreement with the data reported for other languages as far as the location of final lengthening and even the degree of the vowel lengthening are concerned.

References