

The Influence of the Segment Context on the Realisation of Rising F0 Patterns in Russian.

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ABSTRACT

In the experiments reported we have tried to explore the influence of the segmental environment of the accented vowel on the realization of the rising pitch contours in Russian. A number of mono- and two-syllable words with different types of syllables were selected for the purpose. The stressed and unstressed syllable codas and onsets consisted of one consonant belonging to different phonetic classes. They included voiceless, non-sonorant voiced and sonorant consonants:

1. a final stressed syllable of the V+C (voiceless) type;
2. a final stressed syllable of the V+C (sonorant) type
3. post-stressed syllables of the C (voiceless) +V type;
4. post-stressed syllables of the C (sonorant) +V type;
5. a stressed syllables with sonorant onsets and codas.

Evidence from our experiments on modelling F0 for synthesis shows that there are differences in F0 alignment due to different segmental content. The results of the perceptual evaluation of the rising contours synthesized with regard to the phonetic make-up of the accented and unaccented syllables may help to improve the quality of the synthesized speech.

1. INTRODUCTION

The standard inventory of rising pitch contours used in Russian traditionally includes two main patterns which are realized depending on the rhythmic organization of the word – the number of syllables and the place of stress in the accented word either as a continuous rise (in monosyllabic words) or as a steep rise, followed by a fall on the post-stressed syllable(s) in polysyllabic words [1].

The F0 peak is usually associated with the stressed vowel of the tonic syllable – the fact often mentioned in the phonetic literature [2]. This is true, however, for some contours in certain phonetic contexts. There are cases when there is no strict

correspondence between a pitch peak and a stressed vowel, or a syllable, for some accents have their F0 peaks outside the stressed syllable [3].

In our experiment rising pitch contours included in the standard inventory were synthesized with monosyllabic and two-syllable words, containing stressed vowels in different consonantal environment. Thus the length of the tonal part of the segmental string varied, depending on the phonetic class of the consonant in the syllable onset and coda.

The alignment of the F0 peak was investigated for tonal parts of the syllable containing only a vowel, a non-sonorant voiced consonant and a vowel, a vowel and a sonorant or a vowel in the stressed and unstressed syllables with sonorant onsets. The degree of the F0 excursion in the resynthesized signals was modified. The duration of segments was averaged from a corpus of material recorded from a professional (male) speaker. His mean F0 was 80 Hz.

2. REALIZATION OF THE THEORETICAL MODEL.

2.1. Final stressed syllables of the V+C (voiceless) type.

A theoretical model was based on the laboratory studies of the realization of F0 in different types of rising pitch patterns and on the visual analysis of the F0 course. For the realization of the theoretical model the stressed vowel responsible for the rising contour was divided into three equal parts: the pitch peak the maximum F0 excursion was reached on the second half of the vowel (+80% of the mean F0); in the final part it dropped by 30% (Figure 1).

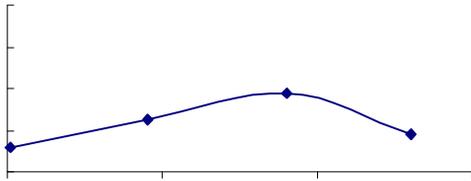


Fig.1 Modelled F0 course in the accented vowel of a question reflecting the theoretical model.

The perceptual evaluation of the synthesized stimuli revealed that with the F0 peak placed on the second third of the vowel segment the contour was perceived as falling, and the utterance was defined as a persuading statement, or an exclamation, that is belonging to a different category.

2.2. Final stressed syllables of the V+ a sonorant type

Guided by the data given in the experimental phonetic literature we tried to apply the theoretical model to syllables with a sonorant coda, having a longer tonal string. The results of the listening experiments showed that the perceptual evaluation of the stimuli was similar to the previous set of experiments with syllables containing noisy consonants.

This was true for all the syllable types of monosyllabic words described above.

2.3. Optimization of the theoretical model .

2.3.1. Modification of the F0 course in syllables with a voiceless onset and coda. By moving the F0 maximum within the boundaries of the accented vowel only we arrived at the following results.

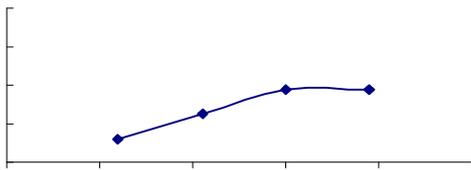


Figure 2. Modelled F0 course for a non-final countour.

With the F0 maximum (+80% or 100% of the mean F0) at the end of the accented vowel the tone

was perceived as a gradual rise, corresponding to one of the non-final rising contours (Figure 2).

With an earlier F0 maximum (+80% or +100% of the mean F0) reached at the end of the second third of the accented vowel and sustained till the end of it, the tone was perceived as mildly questioning, doubtful. This was true for all syllables with noisy consonants, where the stressed vowel is the only tonal segment responsible for the realization of the contour.

In the next set of the experiments we shifted the beginning of the rising F0 movement to the vowel onset (+40% of the mean F0), thus modelling an earlier F0 rise. The F0 peak reached at the end of the accented vowel constituted +150 or +160% of the mean F0. We also modelled a steeper rise of the F0 within the accented vowel when the F0 peak is reached by the end of the second part of the vowel (Figure 3). Both variants were found acceptable and were perceived as questions.

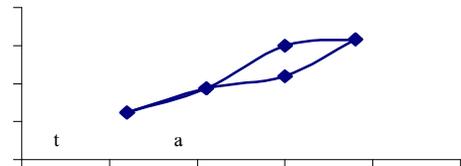


Figure 3. Modelled F0 course for questions: a voiceless syllable onset and coda.

2.3.2. Modification of the F0 course in syllables with a sonorant coda.

By moving the F0 peak to the end of the accented vowel we did not yield better perceptual results if we disregarded the syllable final sonorant. With this type of syllables for a contour to be perceived as questioning, the F0 maximum should be sustained till the end of the sonorant. The experiments showed that the variants of the model described for voiceless codas can be successfully applied to this type of syllables as well (Figure 4). It should be noted that the mean duration of open vowels and sonorants was reduced by 30%, which resulted in a more natural realization of the contour.

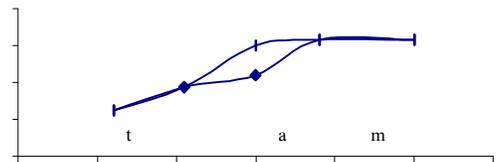


Figure 4. Modelled F0 course for questions: monosyllabic words with a sonorant coda.

3. MODELLING F0 COURSE FOR TWO-SYLLABLE WORDS.

Synthesizing rising pitch contours with two-syllable words proved to be no easy task. For our model we chose one of the most typical Russian questioning contours, in which the rise of the F0 reached on the accented vowel of the first syllable is followed by a steep fall on the following post-stressed syllable(s).

For two-syllable words with voiceless syllable codas we applied either variant of the model, that was approved in the perceptual experiments with mono-syllabic words.

For syllables with voiceless onsets the requirements mentioned for monosyllabic words should be met: an early beginning of the F0 rise from the vowel start (+40% of the mean F0), the F0 peak reached in the second part of the vowel (+150% of the mean F0) should be sustained till the end of the tonal segment. In the falling part of the contour, the drop to the mean F0 should be realized within the following post-stressed vowel, starting from the F0 level of the initial accented vowel (Figure 5).

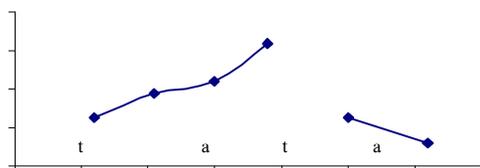


Figure 5. Modelled F0 course for two-syllable word questions: a voiceless syllable onset.

Experiments show that the model described for monosyllabic words with a syllable-final sonorant can not be mechanically transferred to modelling questions in two-syllable words where this sonorant becomes syllable-initial. The use of the model where the F0 maximum reached on the tonal part of the word is followed by abrupt fall to the mean F0 on the final vowel, results in a perceived exclamation (Figure 6). The most frequent labels reported by the listeners were «surprise, incredulity».

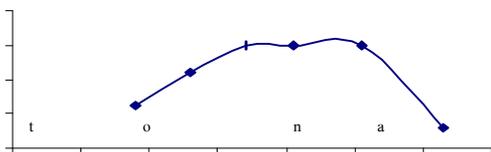


Figure 6. Modelled F0 course for a post-stressed sonorant initial syllable perceived as an exclamation.

For modelling a neutral question an early and steep rise of the F0 with the F0 maximum (+150%), reached by the end of the second part of the vowel should be followed by a drop to the mean F0 in the unstressed syllable. As it is seen from the Figure 7, the F0 drop within the sonorant reaches the starting F0 level of the stressed vowel (+40% of the mean F0) and continues through the final unstressed vowel to the F0 mean level.

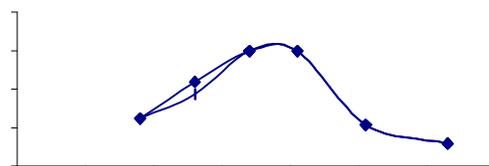


Figure 7. Modelled F0 course for a post-stressed sonorant initial syllable perceived as a question.

The most difficult situation in modelling the «rise-fall» configuration in two-syllable words was found for an all sonorant string in the accented and post-stressed syllables. From a great number of variants of testing the F0 peak location and the timing of falling F0 in the unstressed syllable the most acceptable variant proved to be the following.

The rising F0 movement starting from the sonorant onset (and not from the stressed vowel) (+40% of the mean F0) reaches its maximum (+150% of the mean F0) by the end of the second part of the stressed vowel and is sustained till the end of it. The falling part of the F0 is realized within the sonorant immediately following the accented vowel (the end F0 level is equal to the word-initial starting F0 level). The F0 reaches its calculated minimum at the end of the unstressed vowel (Figure 8).

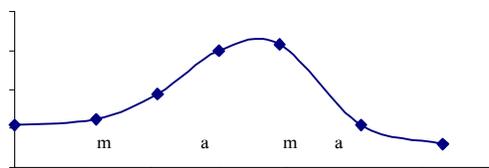


Figure 8. Modelled F0 course for an all-sonorant two-syllable word perceived as a question.

4. CONCLUSION

In our experiment we have tried to explore the influence of different phonetic classes of consonants (voiceless, non-sonorant voiced, sonorants) at the syllable onsets and codas on the F0 alignment in the realization of rising contours in Russian. We discovered that the starting and end-F0 points depend on the segmental composition of the relevant syllables. Both the place of the F0 peak and the degree of the F0 excursion influence the perception of the contour. In accented syllables with the vowel as the only tonal segment the F0 peak should be sustained till the end of the vowel. Left-shifting of the beginning of the rise results in a more natural contour. A slight lowering of the F0 (10%) at the end of the vowel does not effect the perception of the contour as rising. In syllables of monosyllabic words with a longer sonorant string, the F0 maximum reached on the stressed vowel should continue through all sonorant consonants following it. A slight lowering of the F0 (no more than 20%) at the end of the sonant is possible, without effecting the perception of the contour. Better results are achieved if the on-set of the F0 rise is shifted leftwards to the beginning of a voiced segment. It does not effect the contour type, but adds to the naturalness of the perceived contour. It is evident from the experiments performed that the information about segmental composition of syllables should be incorporated in modelling of F0 for different intonation contours.

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