EFFECT OF VOWEL MODIFICATION ON THE PHONEMIC ACCURACY OF VOWELS AND PALATALIZATION OF CONSONANTS IN RUSSIAN VOCALIZED SPEECH

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ABSTRACT

The study analyses the effect of vowel modification, i.e. certain "colouring" of the vocal sound, on the phonemic accuracy of vowels and quantifies the formant changes it causes for Russian vowels. It is suggested that vowel modification may have an impact on palatalization of consonants. The results of detailed experimental research show that this hypothesis can be confirmed with a certain degree of confidence. However, the conclusion is that the situation is not straightforward and study of extensive additional material is required to help form a more grounded opinion.

INTRODUCTION

Vowel modification is generally agreed to be a key feature of professional operatic singing. It helps achieve an even quality of vocal sound throughout the singing registers, a certain intensity of sound and is a means of producing sounds with a certain colour. Words commonly used as synonyms of vowel modification are "covering" or "darkening". We believe, however, that vowel modification is not confined to covering, i.e. making sounds more closed. Very often in singing a vowel modification towards more open sound can be perceived.

Phonemic accuracy is pronunciation of a sound in such a way that it can be identified by listeners as a realization of the intended phoneme. Lack of phonemic accuracy is sometimes called "vowel migration" towards a different phoneme and in extreme cases can lead to vowel alteration. See [1].

The consonant system of the Russian language is characterized by a correlation of palatalized / non-palatalized consonants (otherwise known as soft and hard respectively). *Palatalization* is an auxiliary articulation in the production of consonants and is accomplished by raising the middle of the tongue towards the roof of the palate. Acoustically, palatalization is chiefly manifested within transition sectors between sounds by an [i]-like element. (See [2].) Vowels following palatalized consonants are more "closed".

An analysis of Russian speech in singing carried out by the author has identified a considerable number of changes in the quality of vowels, which can be described as vowel alteration, and cases of loss of palatalization in "consonant+vowel" syllables. We noticed that these phenomena coincide with vowel modification.

The purpose of this study was to investigate the relation between vowel modification and phonemic accuracy of vowels, to quantify the changes in migrating (altered) vowels and to analyse the effect of vowel modification on the palatalization of consonants.

DESCRIPTION OF THE STUDY

For the subject of the study we chose recordings of the singing of two celebrated Russian opera artists, bass Fyodor Shalyapin and mezzo-soprano

Yelena Obraztsova. The reasons for selecting these singers' phonations were the internationally recognised excellence of their performance and their (possibly only known locally) particular attention to the role of words in singing. It was also considered beneficial to select a male and a female singer in order to be able to cover a wider range of issues. We used recordings of Russian and West European songs and arias performed by Shalyapin as well as his recital of the Nadson's poem *Грёзы* (Dreams) selected from a collection of 12 recordings reissued by Melodia Records in 1980 and a recording *Yelena Obraztsova. Russian Songs and Romances* copyrighted Melodia 1982.

Although we are aware of the influence that recording techniques can have on sound, we believe the accuracy of conveying phonetic parameters to be sufficient for the purposes of this study.

For the identification of cases of lack of phonemic accuracy of vowels (first auditors' session) from the above described material, 90 samples were selected for auditors' and spectrographic analysis. Most of the samples were open syllables:

- 54 of them had the structure "consonant + vowel";
- 30 had the structure "a group of consonants + vowel";
- 6 were "consonant + vowel + consonant" syllables.

The stimuli included syllables where vowel alteration was expected and those containing accurately conceived vowels, or "pure" vowels presented in random order.

For the consonant palatalization study (second auditors' session) the samples had the structure "vowel + consonant / group of consonants + vowel".

All samples were presented to 3 groups of auditors with 4 people in each. All were native Russian speakers, 10 of them also spoke fluent English, 5 had a degree in linguistics, and almost none had any advanced training in music or singing.

In the first session, auditors were asked to write down in ordinary Russian letters what they heard. In the second the assignment was to circle the appropriate word on answer sheets.

The results can be summarized as follows.

Alterations of vowels were perceived in situations of vowel modification of both types ("more open" and "more closed"). Identification of alteration was considered valid when more than 60% of the auditors registered a similar alteration. "Closing" of vowels occurred throughout the singers' ranges and was used for the purposes of bridging registers and achieving the desired intensity and colour. "More open" vowels were used for giving the sounds a brighter colour. The musical and aesthetic sides of these phenomena are beyond the scope of this article.

Phonetically, alterations towards "more closed" sounds identified by the auditors can be grouped as follows.
(The phonetic symbols of Russian sounds we use are the same as those used by G Fant [3]):

[o] > [ou] or [u]

Shalyapin - [mnoi] > [mnoui] in the word combination *со мной* (with me);
- [fs'o] > [fs'ou] in the word *всё* (all);

Obraztsova - [t'ot'] > [t'out] in *цветёт* (blooms);
- [to] > [tou] in что (what).

['e] > ['i] / [e] > [i]
these alterations were found only in Obraztsova's singing:
- [l'e] > [l'i] in *прелестный* (charming);
- [sv'e] > [sv'i] in *светит* (shines);

- [ǯe] > [ǯi] in *же* (a Russian particle).

Alterations *[a] > [o]* were more rare. One of the examples is:

Shalyapin - [pa] > [po] in *покой* (quiet).

Production of vowels of "brighter", "more open" colour lead to the following alterations:

[o] > [a]

Shalyapin - [d'om] > [d'oam] in *идём* (we go);
- [mr'om] > [mr·oam] in *умрём* (we will die).

[u] > [o]

Obraztsova - [muz] > [moz] in *муж* (husband).

['o] > ['e]

Shalyapin - [jom] > [joem] in *поём* (we sing).

[e] > [a]

Obraztsova - [s'e] > [s'ea] in *сердцем* (heart).

As can be noticed from the above examples, alterations differ in their consistency. In some of them a vowel is simply replaced by another vowel, in other cases the quality changes within the duration of one vowel, thus constituting diphthongs.

The diagram below summarizes vowel alteration patterns:

"more closed"	*"more open"*
[a] > [o]	[o] > [a]
[o] > [u]	[u] > [o]
['e] > ['i]	['o] > ['e]
[e] > [i]	[e] > [a]

The second auditors' session showed that the loss of consonants' palatalization is more typical of Shalyapin's singing. Some examples are:

[r'e] > [re] in *ревность* (jealousy);
[v'e] > [ve] in *поверь* (believe).

Some of the auditors perceived in such cases as *серп* (sickle) a partial loss of palatalization, which in Russian linguistic tradition is called "semi-softness" and is indicated by the sign [·]: *[s'e] > [s·e]*

It was noticed that loss of palatalization of consonants occurred in a position before more open (but not altered) vowels.

Subsequently a spectrographic analysis of all the samples was undertaken, including syllables containing "pure" vowels, altered vowels, consonants retaining their palatalization and the "new hard" consonants.

The experiments were performed at the Research Centre of the Moscow State Conservatoire. The sound signals were analyzed with a Russian developed software package "Signal Viewer".

A brief overview of the results follows.

Production of more closed front vowels causes raising of the second formant (F2):
from 1500-1950 Hz for *['e]* to 1800-1950 Hz for *['i]*.

When front vowels are given more open colour, the second formant lowers: from 1500-1700 Hz for ['e] to 1350 Hz for ['a].

Additional lip rounding and covering, as in case of alteration of back vowels *[o] > [u]* results in lowering of the second formant: F2 = 650-800 Hz (F2 for a typical Russian [o] lies within the range of 800-1000 Hz), whereas lip spreading and increasing the degree of mouth opening has the opposite effect on the spectra of back vowels:
[o] > [a] - F2 = 1050 Hz
(as compared with F2 for [o] mentioned above).

The spectrograms of syllables, in which the auditors perceived loss of, or insufficient, palatalization, have shown that the [i]-transitions are present (with the exception of the syllable *[stre]* in Shalyapin's recital of the poem). However, these spectra are characterized by two other features that are of interest:

(a) the relative duration of transition to the whole vowel in sung syllables is much shorter than that in spoken ones (40msec / 570msec and 40msec / 280msec respectively);
(b) the vowels in the selected syllables are more open than the vowels that are found in speech after "soft" consonants.

It is possible to conclude from the above that the perceived loss of palatalization is caused by the interaction of the shorter than in speech relative duration of transitions and more open quality of the vowel caused by modification.

However, this cannot be considered the final solution. The lack of a transition sector that was registered in the spectrum of the *[stre]* syllable from Shalyapin's speech makes it possible that he simply had problems pronouncing a palatalized [r'] sound (70% of cases of loss of palatalization are with sound [r']). This difficulty can be attributed to the influence of a local dialect. Indeed, there are Russian dialects in which [r] sounds can only be hard. Such dialects are spoken near the borders of Byelarus and in some Siberian areas but Shalyapin appears to have had no exposure to those dialects. On the other hand, the remaining 30% of sounds that lost their softness should not be ignored. Moreover, loss of palatalization by soft consonants in pronunciation of opera singers has been described in the 1950s by A Reformatsky [4] who attributed it to singers' affected manners. Phonations of the examples he used cannot be obtained at present, which makes it difficult to argue with his conclusions. It appears that only a considerable amount of additional material will allow conclusions to be drawn with a high degree of certainty.

CONCLUSIONS

This study has confirmed that lack of phonemic accuracy of vowels in Russian vocalized speech (including their alteration) is indeed in some cases caused by vowel modification. As a result of this research exact changes of the formant structure of modified vowels have been registered. It is likely that vowel modification, together with the shorter relative duration of transition sectors of vowels in singing, create an auditory effect of loss of palatalization of preceding consonants. However, this is still largely a hypothesis and requires further investigation.

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