

Complex Research on speech interference characteristics

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***Abstract.** In the research we tried and systemized the peculiarities of Russian speech by Azerbaijanians which could help to identify an unknown Azerbaijani speaker. We analyzed perceptually and acoustically interfered Russian speech with Azerbaijani accent and using a number of programme and mathematic methods made a list of characteristics typical of Azerbaijanian accent and their relative weight (significance).*

***Keywords:** Speaker identification, Russian, Azerbaijanian.*

Introduction

Experts working with forensic expertise of audio records often need to analyse an interfered speech (i.e. speech with residual dialectic or foreign occurrences) of an unknown speaker with the purpose of identifying or diagnosing the speaker on the basis of his voice and speech. To solve such tasks, the expert linguist needs a description of how the given foreign accent or dialect sounds when its speaker is speaking Russian, an audio sample for it, and a possibility to check if the deviations from the Russian standard pronunciation found in the speaker's speech constitute a system of characteristics inherent in a regional variety of the language.

In the linguistic and special expert literature there is a number of works on this topic: (see Bondarko and Verbitskaya, 1987; Erofeyeva, 1997; Galyashina and Khurtilov, 1991; Galyashina and Goloshchapova, 2004 for more detail). There are also specialized software packages (“Территория” Territory, “Интерференция” Interference, “Регион” Region, “Этнос” Ethnic Group). The base for all research in this area certainly consists of, first, the comparison of language systems and, secondly, studies of the peculiarities of their interaction.

But the available data are still insufficient for a proper analysis of the interfered Russian speech. First of all, there are no works describing a system of characteristics of an interfered speech enabling the expert to match it up with this or that accent or type of accent.

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In this research, we attempted to systematize deviations from the Russian standard pronunciation in Russian spoken by the Azerbaijani and establish the set of deviations which would enable us to say, more or less confidently, that the characteristics of an unknown speaker's accent correspond to a system of characteristics of the Azerbaijani speech. We have analysed interfered Russian speech with Azerbaijani accent, performed perceptual and acoustical analysis of deviations from the Russian norm, and, by means of software (STATISTICA 6.0, Microsoft Excel, MS Visual Fox Pro 9.0) and mathematical methods (standard deviation, average dilatation, correlation analysis etc.), have established a set of characteristics which are peculiar for the Azerbaijani accent (as a single set), and the relative significance of each of them. On the basis of the obtained selection of Azerbaijani speakers we have obtained a stable function of the characteristics inherent in this particular accent. Thereafter, we created a program for analysis of interfered speech (for the purpose of determining if an unidentified accent can be Azerbaijan). This function is stable only if the characteristics have been identified correctly.

Theoretical basis and terminology

Interfered speech is a subject of a separate linguistic research. An interfered Russian speech is a Russian speech containing characteristics of a dialect or a foreign accent. As the term itself suggests, this type of speech emerges as a result of contamination of standard speech and spheres of speech which directly influence it in the course of their interaction. One of the main criteria of interfered speech as a separate sociolinguistic phenomenon is that it is marked and recognizable, more or less, from the point of view of the ordinary linguistic consciousness of a speaker of the standard language.

Interfered speech is a rather intricately organized complex phenomenon involving different levels of language one way or another. It has many characteristics distinguishing it from standard speech. But deviations are most consistently manifested on the phonetical level. This is accounted for by the fact that phonetical skills are automated and cannot always be corrected. Standard pronunciation is also included in interfered speech, as the interfered characteristics can be present in a foreigner's Russian pronunciation or be absent altogether. Besides, some accent characteristics can be similar in different types of accent, which also shows the necessity for a detailed description of different types of accent with isolation of a complex of national and diagnostic features. That being said, the unit of study in this research are the interfered phonetical characteristics of Russian, and the unit of description is the set of identification characteristics of a given accent in the Russian speech.

Phonetical accent requires a complex analysis combining the methods of articulatory, acoustic, and perceptual phonetics. Our research is based on data obtained in the course of perceptual analysis. These data were then studied using the methods of acoustic analysis (spectrographic analysis, fundamental frequency analysis). The possibilities and advantages of perceptual and acoustic analysis make them the primary methods in voice and speech expert studies.

Reference units in the study of interfered speech are *soundclass* and *rhythmic word structure*, or RWS (rhythmic pattern, an analogue to phonetical word).

A **soundclass** is a group of elements corresponding to identical perception of non-simultaneous segments of speech with some quality differences in their acoustic and articulatory properties (Galyashina and Zlatoustova, 1999). The *interfered soundclasses*

we are considering participate in the formation of an accent in the speech of a non-native speaker. An **RWS** is a whole phonetical unit of the plane of realisation ensuring that the flow of speech is divided into words. Its realization depends on the position within an utterance and the speaker's belonging to one of the types of the pronunciation standard or to a dialect. The Russian RWS has its own peculiarity: the quality of sounds is determined by the position within the word in relation to stress, and a peculiar division into prosodic core (the stressed syllable, sometimes the stressed syllable plus the first pretonic syllable) and the surrounding syllables, both pretonic and post-tonic. The correlation of their quality in the phonetical word is what creates the RWS which is typical for modern Russian. The presence of reduced sounds and voiceless vowels is aimed at preservation of the RWS in the flow of speech. For the Russian language, the RWS is defined by such indicators as the number of syllables in a phonetical word/stressed syllable (Zlatoustova, 1975, 1994). The RWS in accented speech is subject to interfering influence of another language system.

The RWS forms the syntagma's rhythmical frame. In the flow of speech the RWS and the syntagma can be subject to different changes. It has been established that the types of RWS can be significantly deformed under the influence of its place in the intonation contour. *Intonation contour*, in its turn, is defined as the structural unity of intonation means employed to connect rhythmical structures in the utterance and divide the flow of speech into separate utterances.

Research

The research has demonstrated that all types of deviations in the interfered Russian speech are connected with the skills obtained in the course of mastering the Russian language, and shall manifest themselves to a variable degree of frequency, depending on the level of proficiency in Russian. Some analogous data were got by other researchers during their studies on the Russian speech speaking by non native speakers (see, for example, Barkhudarova, 2008; Rogoznaya, 2001).

For this research we used authentic records submitted for audio expertise. We deliberately decided not to limit ourselves with an experiment (both experimentally devised recordings and authentic real-life segments have been used). We reasoned that in this case, the research would benefit from employing the method of modelling not on the basis of preset rules, but on observed types of deviations (see Vinarskaya and Zlatoustova, 1977: 103) for a similar choice of method of modelling).

For our analysis we have chosen 50 speakers whose speech shows Azerbaijani accent. On the phonetical level, their accent manifests itself differently: from very slight to very strong. 49 of them are ethnic Azerbaijani and native speakers of the Azerbaijani language; one speaker is an Azerbaijani-born native speaker of Russian. 38 speakers are male, and 12 are female. Their age ranges from 21 to 60, their education, from secondary to higher, and they are people of different professions: some of them are engaged in technical sciences, some in humanities, and some in natural sciences, some of them are sportsmen, and some have no special education. All participants speak Russian, almost all of them are native speakers of Azerbaijani. They were born and used to live and/or live in the territory of Azerbaijan, in different cities and regions of the country: Baku, Sumgayit, Gyandzha, Agdam, Nakhchivan, Lankaran, Salyan, Tovuz, Khachmaz, Fizuli, Astara, Ordubad, Yardymli, Shemakha. Some of them moved around within the territory

of Azerbaijan, lived in Russia or Ukraine for a short time due to different circumstances, or moved to Russia. Total duration of the used spoken material from the fifty speakers was more than fifteen hours. Besides, we used control records of native speakers of the Turkish and Russian standard language reading a text and talking. For experiments with expert listeners, we also used records with Germans, Georgians, and Armenians speaking Russian, and authentic expert records with imitation of the so-called accent of people from the republics of the Caucasus.

Results

As a result of multistage research and pilot running of the program, we compiled a list of forty phonetical features, both segmental and suprasegmental, characteristic for the Azerbaijani accent in the Russian speech. In the course of the research we have studied the regularity, frequency, and strength of their occurrence in the speakers' speech, and determined their distinguishing ability. We have also developed a system of relative appraisal of accent manifestation by points.

Table 1 shows the experimentally established list of interfered characteristics of the Russian speech with the Azerbaijani accent.

Group	Characteristic
Consonantism	Pronunciation of a deeper or more uvular consonant [χ] instead of [x]
	<i>Pronunciation of a laryngeal [h] instead of the Russian velar [x]</i>
	Pronunciation of palatalized or not velarized enough sibilants instead of [ʂ] and [ʐ]

Table 1. Interfered Characteristics of Russian Speech with Azerbaijani Accent.

The system of characteristics inherent for the interaction of the Russian and Azerbaijani languages is shown in bold; separate features of interaction between Russian and dialect varieties of the Azerbaijani language are shown in italics; and features of the accent inherent to speakers of typologically different languages are shown in plain text.

We have conducted a mathematical research of the described characteristics of the Azerbaijani accent in the interfered Russian speech (all mathematical calculations and software development described have been performed under the control and with personal participation of mathematician Yu.V. Zaytseva, leading expert of Autonomous Non-Commercial Organisation Laboratory for Applied Linguistics).

The selected characteristics were evaluated by their 'weight' for the formation of a linguistic profile of the Azerbaijani accent and classified by their strength and frequency, as well as by their belonging to the Azerbaijani accent, or its regional variant, or to the characteristics of the accent which manifests itself in the Russian speech spoken by native speakers of different languages. With due consideration of these parameters, we have derived a function of the set characteristics. The value of the function informs the researcher of the degree of certainty with which he can consider the given interfered speech to be containing the characteristics of the Azerbaijani accent. The function and list of characteristics have been included in a program enabling to register the selected characteristics in the speakers' speech and obtain their sum in order to diagnose the Azerbaijani accent. Apart from the indicated list of characteristics inherent to the Azerbaijani interfered speech, the program contains a player and a sample base. By pressing

a key near the field containing the list of characteristics, you can listen to sound samples of the interfered characteristics of the accent. A field for entering a commentary to a characteristic has also been added in order to specify its content in more detail where needed. For the view of the program’s working window, see Figure 1:

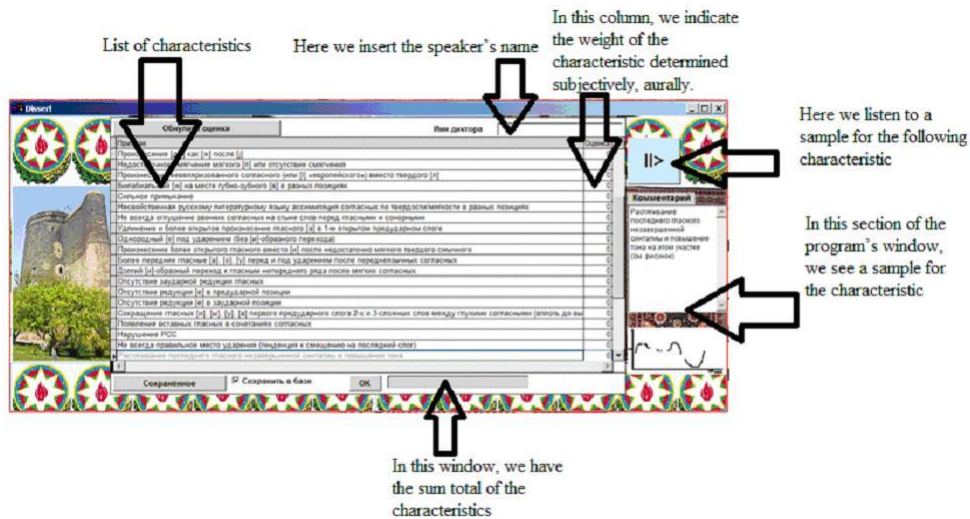


Figure 1. Interface of the Program for Research of the Russian Interfered Speech with an Unknown Accent (for Establishing the Presence or Absence of Characteristics of the Azerbaijani Accent).

Upon listening to a record, the expert can compare them to the samples from the base and evaluate them using a 5-point rating scale (the function shall be calculated using only the selected/non-selected characteristics). The values obtained as a result of calculating the function from the characteristics using the derived algorithm inform the expert of the degree of certainty with which he can consider the accent in question to be Azerbaijani (for this purpose, threshold values have been set – see Table 2).

0-5	More likely not Azerbaijani Accent
5-25	Accent Blending
25-30	May be Azerbaijani Accent
30-61,0702	Most Probably Azerbaijani Accent
61,0702	Almost Confidently Azerbaijani Accent
$<Q \leq 3481$	

Table 2. Values of sum and their interpretation.

Approbation of the program showed that in most cases the selected complex of characteristics allows to correctly identify the characteristics of the Azerbaijani accent in the Russian interfered speech. But the key factor during a real research is the expert’s readiness for diagnostic tasks of this kind. Field testing showed that experts’ error in identification of these characteristics is sometimes dramatically big. For example, some listeners who had a great teaching experience in teaching Russian for non-Russian speakers could correctly define the whole set of marked characteristics of Azerbaijani accent in Russian

interfered speech and distinguish this accent from German, Georgian, Turkish and imitated accents (more than 6 approbation tasks of 8 were solved right). Other listeners, who did not have enough experience of listening to interfered speech could mix up marked accent features, incorrectly treat their significance and confuse foreign accents (less than 4 tasks of 8 were right solved).

We tried to minimize the error artificially by employing different mathematical algorithms. Firstly, the 'reliability' of the characteristics depended on their frequency in the appropriate positions per a unit of time (in fact, an allowance for the duration of the record has been introduced for sake of 'reliability' of some characteristics). In actual practice, the record can be just too short for the probability of appearance of some characteristics to reach one. Secondly, we introduced duplicated or strongly correlated characteristics, and, if the expert's evaluations of these characteristics were significantly different, the 'level of credibility' for the answers as a whole was lowered. Thirdly, we lessened the weight of the characteristics the experts made most errors with.

Nonetheless, because of the GIGO principle, it is mathematically impossible to fully exclude the error caused by the experts' errors.

Conclusion

The given list of interfered characteristics shall be useful for identification researches aimed at facilitating singling out and formulating the accent peculiarities the expert heard.

Thus, we may conclude that the characteristics identified in the interfered Russian speech with a given accent can only be considered as part of a complex. Individual features can be similar in different accents or types of accents (dialects). Obtaining reliable results of identification of a complex of national diagnostic characteristics requires a comparison with the characteristics of an accent of contrasting languages, both with a similar and a dissimilar phonetical layout. The scheme for studying interfered speech developed in this research enables us to study the peculiarities of interaction of Russian and any other language (with due consideration of its regional diversification). Apart from its scientific and theoretical significance, this information has great practical value, because this is connected with the main task of forensic expertise of an audio record: identification of a person on the basis of their speech.

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