

The Investigation of the Siberian Peoples' Languages Sound Systems by the Advanced Instrumental Techniques

¹Irina Selyutina, ²Tatiana Ryzhikova, ¹Nikolai Urtegeshev, ¹Albina Dobrinina,
³Andrei Letyagin and ⁴Andrei Shevela

¹Nadelyayev's Laboratory of Experimental-Phonetic Researches,
Institute of Philology SB RAS, Novosibirsk, Russia

²Department of Foreign Languages, Institute of Philology SB RAS, Novosibirsk, Russia

³Institute of "International Tomography Centre" SB RAS, Novosibirsk, Russia

⁴Institute of Chemical Biology and Fundamental Medicine SB RAS,
Nikolayeva St., 8, 630090 Novosibirsk, Russia

Abstract: The complex interdisciplinary investigation being carried out by the workers of three SB RAS Institutes is in agreement with the efforts of the world scientific society aimed at preserving the minority languages as a constituent part of a biological, cultural and linguistic unity. In the research, the phoneticians of LEPR (Institute of Philology, Siberian Branch of the Russian Academy of Sciences) make use of both conventional (dental-palatography, roentgenography, acoustic analysis of speech) and modern (magnetic-resonance imaging) investigation techniques. Objective experimental-phonetic data on the endangered languages have been obtained and reported to the scientific society. A computer database of the phonetics of the indigenous ethnic groups of Siberia and the neighboring regions has been formed, somatic tuning parameters have been revealed and a typology of the articulatory-acoustic bases is being developed.

Key words: Phonetics, phonology, Siberian peoples' languages, articulatory-acoustic base, experimental-phonetic methods, dental-palatography, magnetic-resonance imaging, digital roentgenography

INTRODUCTION

The activity of the world scientific society aimed at the language diversity spreading and the endangered languages preserving is based on the recognition that the language is not only an important communication means, a culture vector, ideological and intellectual values filter but also an inseparable part of self-consciousness and self-identification of both a person and a society as a whole. At the turn of the century there appeared a number of international documents proving the global awareness of the problem connected with the minority peoples' languages preserving (The Vienna Declaration and Programme of Action adopted at the World Conference on Human Rights, 1993, Vienna, Austria; The United Nations General Assembly Resolution 52/262; the UNESCO Regulation Acts: "The Universal Declaration on Cultural Diversity", 2001; "The Convention of Intangible Cultural Heritage Preservation", 2003).

The complex interdisciplinary fundamental investigation carried out by the workers of the three SB RAS Institutes, namely, the Institute of Philology (IPhl), the Institute of Chemical Biology and Fundamental Medicine (ICBFM) and "International Tomography

Centre" (ITC) within the integration project "The Comparative Investigations of Siberian Indigenous Peoples' Articulatory Bases by the Methods of Magnetic-Resonance Imaging, Digital Roentgenography and Laryngoscopy" agrees with the world scientific society efforts aimed at the minority languages preserving as a constituent part of a biological, cultural and linguistic unity.

The necessity of retaining the linguistic diversity on the territory of the Russian Federation results from the indisputable importance of the work directed at systematic and consecutive documenting, investigating and describing the sound systems of the Siberian indigenous ethnic groups' languages and territorial dialects with a young, new or no written tradition. Such research urgency is due to the impossibility of the correct sound system study and chiefly, the ethnic Articulatory-Acoustic Base (AAB) without the bearers of the language well acquainted with the pronunciation norm. The latest expeditions of the IPhl SB RAS researchers to the places of Southern-Siberian Turkic minority peoples' living prove that a number of the languages such as Tuba-Kizhi, Chats, Kalmaks cease in fact to exist as the compact groups' communication means. To take down and to

investigate the AAB peculiarities of the endangered languages to save them for the science is the priority mission of the Siberian linguists.

MATERIALS AND METHODS

The experimental-phonetic research of the Siberian, Northern and Far-Eastern peoples' languages was initiated by a group of linguists in the late 1960s. It was Nadelyayev who founded the Laboratory of Experimental-Phonetic Researches (now it is the LEPR IPhl SB RAS) at the former Institute of History, Philology and Philosophy of the Siberian Branch of the USSR Academy of Sciences (from 1990 it is the Institute of Philology, SB RAS). For the past years different aspects of the sound systems of >40 languages, dialects and sub-dialects Turkic, Mongol, Tungus-Manchu, Samoyedic, Ob-Ugrian, Yeniseian and Paleo-Asian have been and are still being investigated in accordance with the theoretical concept and the methodological base formulated by the LEPR founder, the Turkic range of problems being developed most intensively (Selyutina, 2006). For the recent 50 years, the Siberian phoneticians have managed to work out a unified universal experimental-phonetic procedure for investigating the Siberian and Far-Eastern languages.

Any phonetic research starts from one or another language, dialect or sub-dialect phonemes discriminating. Then the set of phonemes is experimentally verified, specifically by dental-palatography refined by Nadelyaev (1984) in the late 1960s. This method is especially important and informative when investigating the consonants, e.g., a bigger contact area of the passive and active organs testify to stronger and tenser articulation (compare for example, dental-palatograms of the tense pharyngealized and non-tense non-pharyngealized sounds in the Baraba-Tartars' language (Fig. 1).

The roentgenography technique has been applied by the phoneticians since the beginning of the 20th century but it used to have considerable limitations

connected with the X-ray irradiation and its harmful effect on the human health. At the contemporary level of high-precision X-raying and electronic technologies development, the digital roentgenography seems to be rather an attractive and promising way of articulatory processes information acquisition. As early as the 1960s, the Novosibirsk phoneticians succeeded in improving the technique of sounds roentgenograms obtaining and interpreting (Nadelyaev, 1960, 1980). The chief advantage of an X-ray image is that it gives accurate information at an exact period of articulation and at the same time this is the main disadvantage of the method all the images are static, though nowadays it has become possible to record a dynamic video of a whole word-form. Moreover, the number of images made during one session is limited and recording the whole programme may take quite a long time.

The most recent way of obtaining the articulatory processes data while producing sounds proves to be the Magnetic-Resonance Imaging (MRI). Compared with X-raying, it has a considerable advantage of making, it possible to capture an unlimited number of images both static and dynamic during one session. Nevertheless, MRI has some disadvantages. Firstly, it is very expensive. Secondly, MR imaging can be carried out only stationary thus limiting the number of the potential subjects from remote and hard-to-reach places of living. Thirdly, the presence of metallic artifacts prevents the speaker from participating in an MRI experiment. Fourthly, to make a tomography recording takes much more time than in the case of X-raying, this being physically difficult for a subject, leading to articulation weakening and as a result to image distortion. However, in spite of all the disadvantages, MRI appears to be a promising method for articulation processes visualization being absolutely safe for the subject's health.

Owing to the financial support of the SB RAS Presidium the LEPR phoneticians chanced to utilize the digital X-ray machine "Sibir-N" worked out at the Institute of Nuclear Physics SB RAS and a tomographic scanner

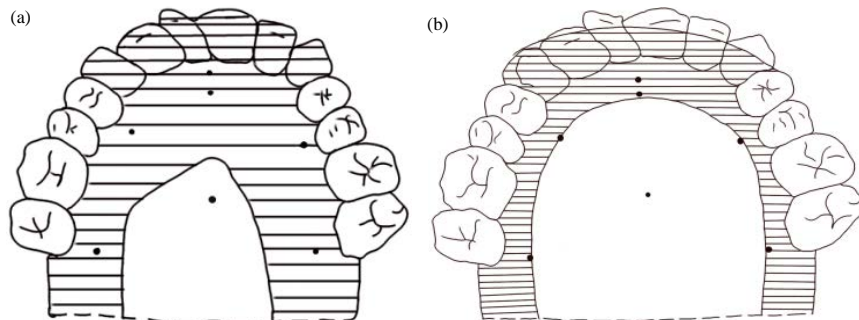


Fig. 1: a) Tense pharyngealized sound /t/ in the Baraba-Tartars' word-form ite 'his meat' and b) Non-tense non-pharyngealized sound /d/ in the Baraba-Tartars' word-form dusman 'enemy'

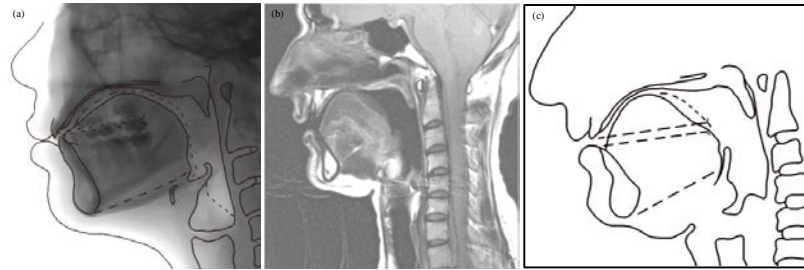


Fig. 2: a) X-ray image of the Tuba sound /Y/ in the word-form kyy ‘a melody’; b) MRI image of the Shor sound /i/ in the word-form it ‘a dog’ and c) MRI scheme of the Shor sound /i/ in the word-form it ‘a dog’

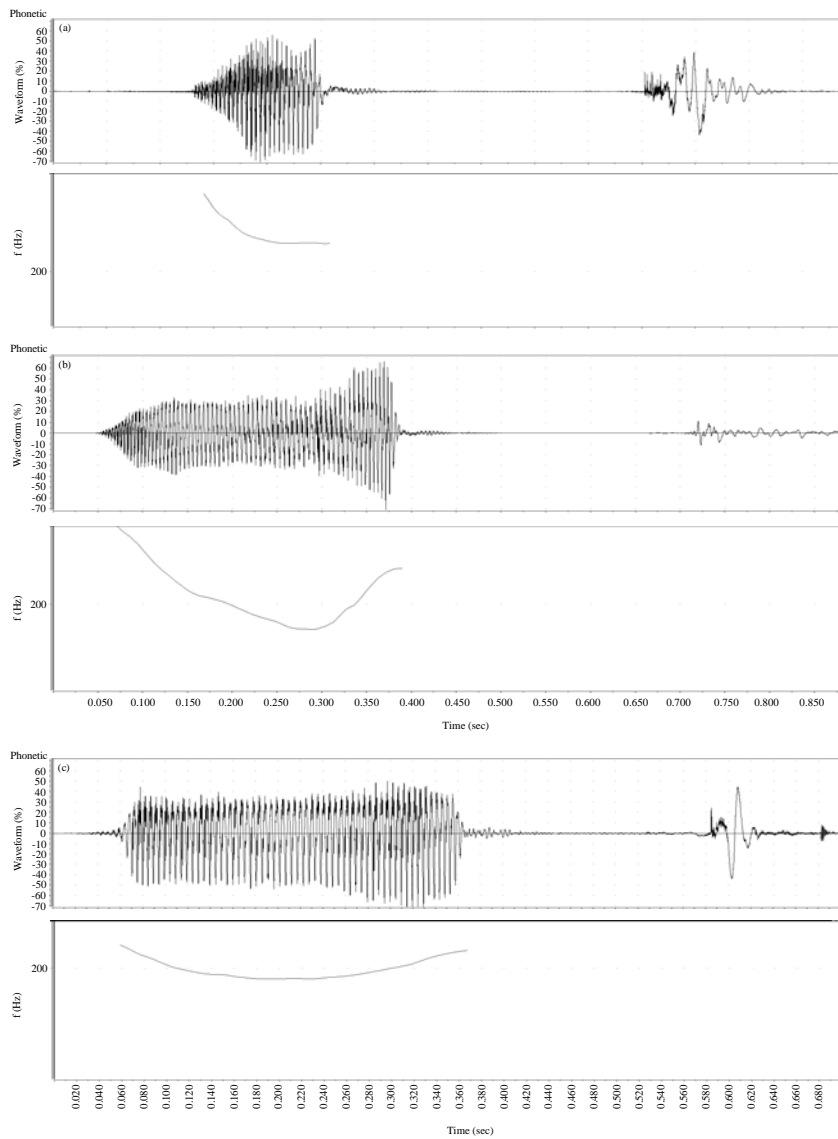


Fig. 3: a) Wave form and pitch movement in the Tuvan non-pharyngealized word-form at ‘a name’; b) waveform and pitch movement in the Tuvan pharyngealized word-form act ‘a horse’ and c) waveform and pitch movement in the Tuvan non-pharyngealized word-form aat ‘to swing’

produced by “Philips Medical Systems” for their investigation of the sound systems of the Siberian and the neighbouring region peoples’ languages. Figure 2 shows an X-ray image superposed with the roentgen scheme an MR image and its tomo scheme.

It should be emphasized that when studying the speech sounds the LEPR workers make use of the combined articulatory and acoustic methods as a tool of the methodological instrumental base; nonetheless, preference is shown to the speech physiology researching; the articulatory parameters being the basis of the majority of the most adequate scientific sounds classifications of the world languages. However, using the modern computerized programmes for the sound files analysis allows obtaining important information on some acoustic aspects of both consonants and vowels (e.g., to determine the consonantal phases of occlusiveness/fricativity, the number of voiced and voiceless components in a sound to calculate a sound length). When analyzing the vowels attention is first of all paid to the fundamental pitch motion. Thus, an analysis of the Tuvan language waveforms showed that the three-step curve of the Fundamental Pitch Frequency (FPF) acoustically correlates with the falling-rising pharyngealization: dramatic fall (35 st/sec) slow fall (9 st/sec) dramatic rise (35 st/sec). In the average, FPF descending at the first step of articulation takes two steps at the second one step at the third FPF ascending is six steps. When investigating the Tuba Vocal System, all the long vowels were found to have an additional pharyngealized voicing: this can implicitly prove the Tuvan and Tubalar substrate affinity (Sarbasheva, 2004). Figure 3 illustrates the waveforms of the Tuvan vowels.

RESULTS AND DISCUSSION

Classifications of the consonantal systems of the languages of Siberia and the North: according to the complex experimental-phonetic research carried out by the Siberian phoneticians there function four types of consonant systems in the native languages of Siberia and the Far East:

- Consonant systems based on the oppositions of articulatory tension: these systems are realized in two variants
 - The systems with a binary opposition of lenis/super-lenis consonants: they can mainly be found in the languages of the Ural region such as the Northern Samoyedic languages (Enets, Nenets, Nganasan), the Southern Samoyedic languages (Selkup) and Ob-Ugric (Khanty)

- The systems with a triple opposition of fortis/lenis/super-lenis consonants: these systems are characteristic of the Baikal-Sayan Turkic (Tuvan, Tofa, Salar and Yellow Uygur) and Mongol (Khalkha-Mongol and Kalmyk) languages
- Consonant systems with an opposition in accordance with length: such systems usually occur in the Turkic languages of the Altai-Sayan region: Altai, Bachat-Teleut, Telengit, Kumandy, Chalkan, Tuba, the Sagay dialect of the Khakas language
- Consonant systems with the opposition in accordance with voicedness/voicelessness: this type of systems generally exists in the Northern-Siberian Turkic languages such as Yakut and Dolgan and in the Tungus-Manchu ones
- Consonant systems with the opposition in accordance with glottalization/non-glottalization: these systems have been discovered most recently and function only in some Siberian Turkic languages Shor (Mras dialect) and Baraba Tatars

The results of an analysis of the actual phonetic-experimental data on the Siberian language consonantal systems allow us to assume that an interaction between the Ugric-Samoyedic substrate and the Turkic superstrate articulatory-acoustic bases has realized in the appearance of the consonant systems with an opposition in accordance with length characteristic of the Altai-Sayan languages. Some features of the ancient Turkic system with a triple opposition of fortis/lenis/super-lenis consonants have been preserved in the Tuvan and Tofa consonantisms. In the Northern and Southern dialects of Altai and in the Sagay dialect of the Khakas language, the opposition of tension had transformed into an opposition structured in accordance with length. In shor, glottalization/non-glottalization of consonants is accompanied by additional consonantal tension.

A genetic relation is to be assumed between the substrates of modern Northern Altai, Shor and Khakas. A vivid difference between the South Siberian Turkic phonological systems appear to be due to a stronger degree of Kypchakization of the Altai-Sayan group of languages and a stronger Mongol influence on Baikal-Sayan Turkic languages such as Tuvan. Emphasis is to be placed on the fact that some groups of the Mongol languages are of Turkic origin and the opposition in accordance with tension structures their consonantal systems (Nadelyaev, 1981).

The phonic-phonological systems of the Northern and Southern Altai differ mainly in their substantial features in their AABs; the phonological organization of these systems seems to have many common aspects.

The idea of the Circum-Baykal language union was put forward by Nadelyaev (1986), the languages comprising this Union have some common specific features. The peculiarities of the phonological systems of the South Siberian Turkic languages correlate with this idea. Within the Union several subunions and branches can be distinguished. The specific organization of the Altai, Shor and Khakas consonantisms allow us to include these languages into the Sayan-Altai sub-union; the existence of pharyngealized vowels in Tuvan and Tofa relates these languages to the Baikal-Sayan branch of the Union.

Electronic database formation: The somatic material on 35 languages, territorial dialects and sub-dialects of Siberia and neighbouring regions has been collected from 90 informants and systematized by the Novosibirsk phoneticians and medical men. The greatest data array has been obtained on the Turkic languages of Siberia: Altai (Ongudai and Ust-Kan sub-dialects of the Altai-Kizhi language; Telengit, Teleut, Chalkan, Tuba, Kumandy dialects), Khakass (Sagay, Kyzyl, Shor dialects, Beltir sub-dialect (Sagay dialect)), Shor (Mrass and Kondoma dialects), Baraba-Tartar, Chat Tartars' language (Novosibirsk region), language of Kalmaks, language of the Tobol-Irtysh Tartars, Yakut, Bashkir (Kubyalyak sub-dialect of the Eastern dialect, Nizhnebel'skiy-Ykskiy sub-dialect of the Northern-Western dialect, Dyomskiy and Ik-Sakmarskiy sub-dialect of the Southern dialect) as well as on Kyrgyz and Kazakh the languages genetically and typologically related with the Southern-Siberian Turkic languages. MR-tomograms, roentgenograms and laryngograms of the articulatory organs anatomy have been obtained on the Mongolian languages of Russia and Mongolia: three dialects of the Buryat language (Eastern Khorinskiy, Western Alaro-Unginskiy, Southern Mongol-Sartul'skiy), Kalmyk and Khakha-Mongolian. Moreover, the data on one of the Tungus-Manchu languages even (Tomotskiy sub-dialect of the Eastern dialect) on Ugrian-Samoyedic one Khanty and on one Slavic language Russian have been collected with the view of further studying.

All the linguistic material obtained on the languages of Russia and Mongolia has been introduced into an electronic database of the executive Institutes IPhI SB RAS, ICBFM SB RAS, ITC SB RAS.

CONCLUSION

The application of the interdisciplinary technique including both purely linguistic and objective instrumental-phonetic investigation methods conventional (roentgenography, dental-palatography,

labiography, acoustic analysis) and advanced high-technology (MRI, laryngoscopy) ones allows getting the exact idea of the sound system peculiarities of the languages belonging to the different typological groups, the idea of ethnic AAB specificities. At the present day stage, the phoneticians face a new task to further develop the procedure of complex simultaneous sound sequences fixation followed by a concurrent investigation of the acoustic and anatomo-physiological speech components. The results of speech segmentation, analysis and authentication will form the basis for correlation matrix structuring in which articulatory and acoustic parameters of speech sounds will function as variable values. The linguists have succeeded in constructing a Universal Unified Classification Model of the world speech sounds based on the organ of speech possibilities and taking into account both scientifically established sound tunings and potentially possible articulations of the unexplored languages (Sherba, 1937; Nadelyaev, 1960; Ladefoged, 2003; Urtegeshev *et al.*, 2009). The physicists worked out an acoustic theory of speech production in detail (Fant, 1960, 2004). The problem of linking the articulation phases with the corresponding acoustic effects and of establishing the correlation algorithms remains unsolved. The chief difficulty is the multi-variability of acoustic signals belonging to one and the same articulatory structure.

The integration of efforts and the creative interaction of specialists from different fields of science make it possible to obtain new data on different typology languages to make corrections in the general phonetic sounds classification to specify the history of phonetic landscape formation on the language territory of Siberia and in the neighbouring regions to reveal the main tendencies of phonological systems transformation.

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REFERENCES

- Fant, G., 1960. Acoustic Theory of Speech Production. Mouton, The Hague, Netherlands.
- Fant, G., 2004. Speech Acoustics and Phonetics. Kluwer Academic Publisher, France.
- Ladefoged, P., 2003. Phonetic Data Analysis: An Introduction to Fieldwork and Instrumental Techniques. Blackwells, Oxford, ISBN-13: 978-0631232704, Pages: 208.

- Nadelyaev, V.M., 1960. The project of the Universal Unified Phonetic Transcription (UUFT). Moscow-Leningrad, Institute of Linguistics of the Academy of Sciences of the USSR. Pages: 68.
- Nadelyaev, V.M., 1980. Articulatory classification of vowels. In: *Phonetic Studies on Siberian Languages*. Novosibirsk, Institute of History, Philology and Philosophy of the Siberian Branch of the USSR Academy of Sciences, pp: 3-91.
- Nadelyaev, V.M., 1981. Theoretical and practical significance of phonetic research on the languages of the peoples of the North. In: *The Written Languages of the Peoples of Siberia. History and Perspectives*. Novosibirsk, Institute of History, Philology and Philosophy of the Siberian Branch of the USSR Academy of Sciences, pp: 11-37.
- Nadelyaev, V.M., 1984. Palatography. Methodological notes. In: *The Phonetics of the Languages of Siberia*. Novosibirsk, Institute of History, Philology and Philosophy of the Siberian Branch of the USSR Academy of Sciences, pp: 3-38.
- Nadelyaev, V.M., 1986. Circum-baikal language union. In: *Studies on Phonetics of the Languages and Dialects of Siberia*. Novosibirsk, Publishing House Science, Siberian Branch, pp: 3-4.
- Sarbasheva, S.B., 2004. The Phonological System of Tuba-Dialect of the Altai Language (Comparative Aspect). Novosibirsk, Siberian Chronograph, Pages: 244.
- Selyutina, I.Y., 2006. Phonetic studies of the languages of Siberia: Results and prospects. In: *Language Situation and Communicative Learning Strategies*. Novosibirsk, Publishing Center of Novosibirsk State University, pp: 20-36.
- Sherba, L.V., 1937. The phonetics of the french language. *Essay French Pronunciation in Comparison with Russian*. Leningrad-Moscow, Educational Publishing House.
- Urtegeshev, N.S., I.Y. Selyutina, G.A. Esenbaeva, T.R. Ryzhikova and A.A. Dobrinina, 2009. Phonetic transcription systems UUFT and MFA: Standards of correspondence. In: *Questions of Philology, a Series of Ural-Altai Studies*, No. 1, pp: 100-115, Moscow.