

## Tomography for languages

*The Siberian Branch of RAS used modern digital technology and created a unique data bank of the sound systems of rare and endangered languages. Such large-scale studies, involving more than twenty languages, dialects and sub-dialects, have not been undertaken anywhere else*

There are an estimated seven thousand languages in the world today, many of which are in danger of extinction. According to UNESCO, one language dies every two weeks; if the situation does not change, the number of living languages will have decreased to one-tenth by mid-century. In Russia the situation is not less alarming. Of the 120 languages spoken by its residents dozens are on the verge of extinction, of these more than 30 being Siberian indigenous languages.

There is an impending danger to the Tubalar language since its speakers – the *Tubalars* residing in different localities of the Turochakskiy district of the Altai Republic – have not preserved their linguistic integrity. The *Chats* (Novosibirsk Oblast) and the *Kalmaks* (Kemerovo Oblast) have practically ceased to speak their languages. The Teleut, Shor, Chelkan, Kumandin, Tofa(lar) and Ket languages also seem doomed to extinction.

Work on the study and preservation of the languages of small-numbered peoples of Siberia has long been carried out at the Institute of Philology SB RAS (Novosibirsk). In 2009, the experts from the International Tomography Center SB RAS (Novosibirsk) and from the Institute of Chemical Biology and Fundamental Medicine SB RAS (Novosibirsk) joined the linguists. It took three years to create a unique data bank of the sound systems of rare and endangered languages.

In contrast to grammar, syntax and vocabulary, which could be studied from written sources, the study of live speech is possible only through the speaker of a language. For each of the 60 volunteer speakers – speakers of rare languages – there was a special research program, depending on the degree of preservation of a language. First of all, it



To identify the peculiarities of articulation, it is necessary that the speaker be placed in the scanner for several hours. There, in accordance with a specially designed program, he/she pronounces the most frequently used native words.

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included a list of words in which one or another phoneme was in the position interesting for the researchers. If the speaker was the only native speaker in the project, the list included only the vivid representatives of a phoneme.

Most of the experiments were carried out on the digital diagnostic equipment of the International Tomography Center SB RAS: a low-dose X-ray unit and a magnetic resonance imaging scanner (MRI scanner), which helped to obtain clear images of the teeth, jaws, tongue, vocal cords, and larynx. To display the dynamic work of the organs of speech, the ITC workers developed a unique program that allowed them to produce 5–10 shots per second, in

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Many indigenous languages of Siberia are in danger of extinction. The number of their speakers often amounts to just a few dozen. For example, the *Kalmaks* – representatives of the Turkic-Tatar sub-ethnic group who live in several villages of the Kemerovo Oblast – amount to fewer than 200 people, only 40 of them speaking the native language. As a rule, these are elderly people, when they pass away, the language may cease to exist. *On the right* – a representative of the Kalmaks, G. S. Aynagulova from the village of Yurty-Konstantinovy, Kemerovo Oblast, who has done a lot to preserve the native language.

*Above* – the Teleuts G. T. Tydykova and T. A. Karavaeva from the village of Bekovo, Kemerovo Oblast, in Nadelyaev Experimental Phonetic Research Laboratory, IF RAS, before the experiments

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six different projections. This made it possible to describe the position of an organ of speech when a particular sound, word, or a clause were being pronounced; in fact, it is a film about how speech sounds are produced.

The participants of the project gathered enormous phonetic material – more than 500 digital X-ray images and 7,500 MRI tomograms. It enabled the researchers to



describe the articulation of more than twenty languages, dialects and sub-dialects: the Altai, Shor, Teleut, Bashkir, Khakas, Tuvan, Yakut, Buryat, Russian languages, as well as the languages of the Siberian Tatars, Chats, Kalmaks, Telengits and other peoples.

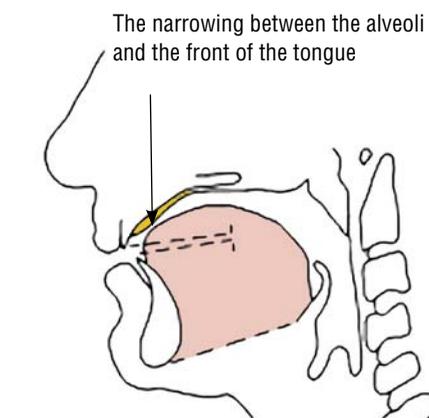
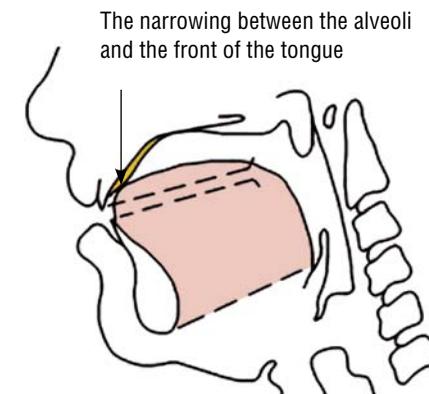
Not only did these data help the researchers to create a data bank of endangered languages, but they also led to a better understanding of their typology, cognate nature and the features of their interaction. Thus, unexpected historical-linguistic conclusions were made on the basis of the analysis of articulation peculiarities of the *Kumandins* – a small Turkic-speaking ethnic group living in the northern Altai. The Kumandin turned out to constitute the following opposition: short – long – indefinite (in length). Such a system of pronunciation may have been formed as a result of the Ugrics' and Samoyeds' having lived in this area. These peoples represented the Uralic language family, which is also characterized by the weakness of muscular tension in the organs of speech. Later, the Northern Altai was conquered by the Turks, in whose language the consonants were opposed as strong – weak – super weak. All the northern Altaians, including the Kumandins, were not able to pronounce strong consonants because of their articulation peculiarities, so they began to pronounce them like long consonants.

The study of the Khalkha-Mongols – the aborigines of Mongolia's central areas – gave equally interesting results. Their system of consonants has the same triple opposition in the degree of intensity: strong, weak, superweak, which may serve as evidence of the ancient Turkic origin of this ethnic group.

There are many examples of successful application of experimental phonetics data to the reconstruction of ethnogenetic and ethnolinguistic processes. Besides, this information is also necessary for purely practical purposes, such as the developing of alphabets for unwritten languages, or the reviving of extinct languages.

History knows examples when a dead language was restored just from written sources. Thus, in the middle of the 20th century the Hebrew language considered dead for 18 centuries was revived and adapted as the spoken and official language of Israel. This became possible due to the ancient texts which continued to be read and learnt all over Europe by fathers, grandfathers and great grandfathers of modern Jews. Another example is the

Computed tomography enables the researcher to capture the position of all organs involved in the production of speech sounds: the tongue, palate, and larynx. A specially designed program can make it possible to adjust the articulation organs



The interpretation of tomograms is carried out using the techniques developed in the Nadelyaev Experimental Phonetic Research Laboratory, IF SB RAS. The processing of experimental data results in articulation profiles, or *tomodiagrams*. Comparing them helps to identify the common and the specific in the sound system of languages belonging to the same linguistic family. Thus, the sound /s/ in the Sagay dialect of Khakas in the word form *sin* "you" (*above*) and the sound /s/ in Chat in the word form *isem* "name" (*below*) are forelingual alveolar voiceless consonants. However, the former is an ultra narrow constrictive uvularised sound, while the latter a narrow constrictive non-uvularised sound. On tomodiagrams this distinction can be seen from different positions of the tongue in relation to the alveoli (the dashed line shows the position of the jaw and teeth)

Cornish language. The last speaker of this ancient Celtic language is believed to have died in 1777; however, two centuries later H. Jenner and R. Morton Nance were able to revive the Cornish language from the available written sources. Today, according to various estimates, about 3,500 thousand people know it, and 300–400 people can speak it fluently.

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