

ARTICULATORY DYNAMIC ORGANIZATION OF WORD  
PRODUCTION ACCORDING TO CINEMA X-RAY  
PHOTOGRAPHY DATA (METHODS OF INVESTIGATION  
AND RESULTS OF APPLICATION)

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The definition of the dynamic articulatory organization of words according to the cinema X-ray photography data is based on the comparative analysis of regularly resumed micromovements (impulses), superglottal (tongue) and glottal (the pre-laryngeal part of the pharynx) ones, in speech organs. The analysis resulted in the definition of modal articulatory indications of the syllable and the word as well as in the consonantal and the vocalic types of articulatory activity determined by them.

It has been proved that the nature of the word entirety can be defined on the segmental level: syllables as segments of CVCV word types unite due to interconnection of modal indications. This makes up the structural nature of the word.

In home linguistics word has been studied both as an entirety and as an intersystematic unit for the last decade.

The entirety of word is understood as the entirety of a syntagmatic unit; the analysis of phonemes and establishment of regularity in their distribution and combination are considered to depend on the entirety of the word and its inherent morphological and syntactical characteristics. Investigations in a number of languages carried out by L.G.Zubkova resulted in a series of universal and typological regularities /1/. Phonemic structure of the word is acknowledged as one of its universal properties. It has been proved that distribution of phonemes, first of all of consonants, and the concrete specificity of their positions, regarded in the unity with their phonetic and morphological properties, is of typological nature.

Finding out regularities of the organization of word entirety in the speech process is one of scantily explored problems of linguistics and psycholinguistics, as well as of general and experimental phonetics. Detection of dynamic characteristic properties of all phenome-

na in a linguistic system is an indispensable condition in defining the entirety of language. In the process of speech activity, and first of all of its production and perception, language exists as a social as well as a dynamic phenomenon, as an individual speech experience of any person speaking a living language, the experience which is to be investigated. /10/

A method of cinema X-ray photography worked out in the Laboratory of Experimental Phonetics in Kiev Shevchenko State University serves to investigate the perceptive and articulatory sound manifestation of the word in its dynamics, and not in statics. /4, 5, 7/

The experimental material presented by cinema X-ray photography enables us to investigate the last link of speech production - the direct process of syllable formation and uniting syllables into words as entireties. The object of research made by means of the cinema X-ray pictures is in fact transient: it reflects results of the production of the syllable as a most complicated component of speech activity, and at the same time, characteristics of sound segments (traditionally called articulatory characteristics) manifest themselves dynamically in it.

A linear succession of cinema X-ray frames obtained at the rate of 48-50 frames per second, was transformed into comparative schemes, which made it possible to observe at the interval of every 20 msec the changes occurring in the superglottal part of the speech apparatus.

The detection of dynamic articulatory tendencies working in the organized entirety of Russian CV syllables in disyllabic words was the main objective of the cinema X-ray photographs presented here.

Methods of processing of the experimental material as well as segmentation of the articulatory continuum were carried out in accordance with the modes described by the author. /6, 7, 8/

The definitions of the notions "articulatory dynamics", "consonantal and vocalic activity types", "modal and qua-

litative indications" used in this paper are based on the analysis of the micromovements occurring regularly in the superglottal and glottal speech organs, but being differently performed in the articulations of consonants and vowels. Conventional abbreviations TI and PLI mean superglottal and glottal activity accordingly. The superglottal activity manifests itself by impulsive muscular contractions of the tongue (in the form of clasping and unclasping movements). The glottal activity is realized by impulsive downward and upward movements in the pre-larynx zone of the pharynx (PLI). The superglottal activity is different with consonants and vowels: with consonants it is intermittent and frequently resumed, which results in the development and the establishment of a certain form of the tongue (the consonant activity type); with vowels it is respectively continuous and leads to the muscular contraction of the whole tongue, and consequently to the increase of the superglottal resonator (the vocalic activity type). The glottal activity (PLI) is realized uninterruptedly from the beginning of the segment (the syllable, the word) and up to its completion. /6, 9/

The rate of downward and upward movements in the pre-laryngeal part of the pharynx (PLI) is lower with consonants and higher with vowels. The rate of movements (contractions) of the tongue (TI) at the beginning of a CV-syllable is higher during the consonant and lower during the vowel articulation.

The correlation of such parameters of the tongue (TI) and the pre-laryngeal impulses (PLI) as the rate of development, duration, amplitude, synchronization - nonsynchronization of matching have been basic ones for the definition of a new notion - that of modal articulatory indications of syllables and words. It's according to these indications that the consonantal and the vocalic types of articulatory activity are discerned. /7/

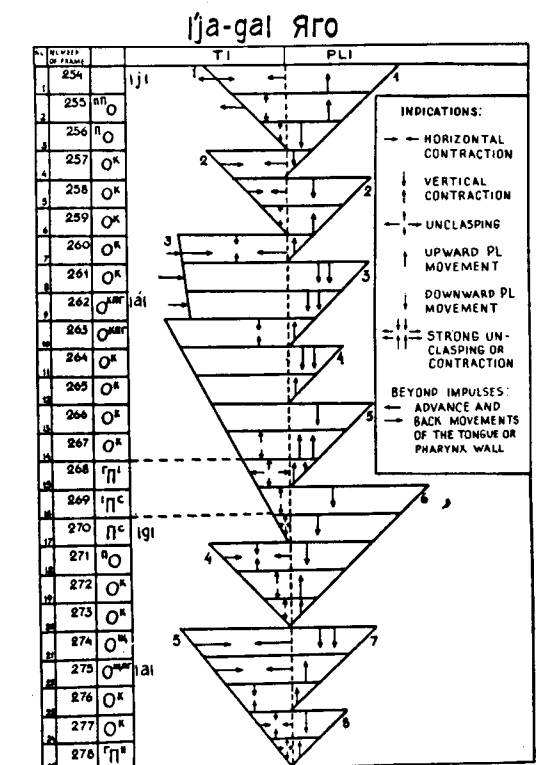
The superglottal activity (TI) is responsible mainly for qualitative, and the glottal activity (PLI) for modal vocalic indications of the syllable and the word as entireties. The notion of articulatory dynamics implies first of all modes of development of articulatory efforts, modal indications. /6, 9/

The articulatory dynamics of words of the CVCV and CVCV types was analysed and described by comparing the modes the consonantal and the vocalic activities are realized. The results of the analysis are illustrated with the words /jaga/ and /j'iga/.

According to the obtained data, the CVCV model is characterized 1) by articulatory tension within the first syllable,

which manifests itself both in the contrastive dynamics of its components and in the greater duration of the syllable peak (the vowel); 2) by relative separateness of the dynamics of the 1st and the 2d syllables, which is evident from the contrast of interruptedness - uninterruptedness of the TI cycles and from the rate difference of PLI at the syllable boundary.

Though vocalic activity comes to its maximum at the end of the first syllable, the articulation sonority grows towards the end of the word: from interruptedness to greater uninterruptedness of TI, from the greater to the lower uninterruptedness of PLI. The continuity of articulatory dynamics in the word of the CVCV type manifests itself in two ways and can be represented 1) by the TI line in which the growing rate of renewing TI is followed by deceleration and becomes minimal at the end of the first syllable, while in the second syllable the transition from the higher rate to the lower rate of renewing TI is shortened; 2) by the PLI line where the higher rate (interruptedness) in the first syllable is followed by the lower rate and then, in the second syllable, the renewed impulses grow more frequent. Both lines correlate in rate indications. A mutual compensation of the two growing amplification types seems to take place. This makes the articulatory dynamics of the word uninterrupted and entire (Fig.1)



Consequently, the CVCV word type is one of the existing organizations of the uninterrupted integrity of the word. The peak of sonority is next to the second syllable. This syllable completes the growth of amplification developed within the word, making up its high-rated shortened final phase. The end of the first syllable, the moment of its peak is accompanied by the growth of amplitude of PLI and their greater uninterruptedness, which matches the uninterruptedness of TI. There is every reason to regard these facts as manifestation of the growing tension, as indications incarnating the unity of syllables as well as stress in the word of the CVCV type. Maximum of activity, both superglottal (tongue activity) and glottal, which is prosodic by nature, are indispensable to the realization of stress.

In the CVCV word type the unity of syllables is attained due to a special correlation of the development of TI and PLI.

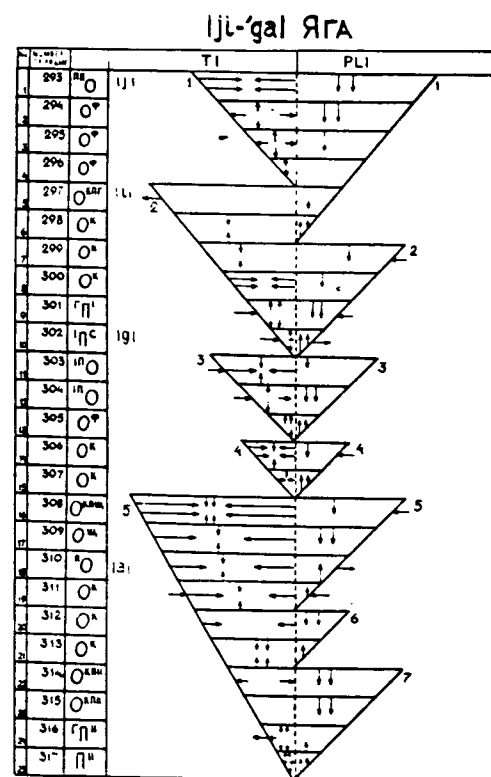
The integrity, the unity of the components in the first syllable manifests itself in that a lower rate and duration of TI matches with a greater duration and lower rate of the development of PLI in the initial part of the syllable, changing further into some other correlation in which the greater uninterruptedness (duration) of TI matches the greater interruptedness (brevity) of PLI. Such development favours the initial part of the syllable to become a vocalic threshold of the word peak, owing to a synchronic development of TI and PLI, their rate increasing.

The correlation of the first and the second syllables in the CVCV word type is of a peculiar type.

The organization model of articulatory dynamics in the CVCV word type resembles the impulse developing according to the scheme of rising sonority: a harmonious vocalic beginning, when the first syllable conditions the development of a strong consonantal-vocalic peak completed by the final vocalic segment of the word - the vowel.

The amplification of the peak, i.e. the prominence of the stressed syllable in the CVCV word type is attained 1) due to a contrastive, mutually compensating relation of syllables according to their modal indications: the connection of the growing tension of the tongue (TI) and the pre-larynx (PLI) in the first syllable leads to a more rapid development of the intersyllabic transition. It also promotes the development of modal indications in the second syllable, which seem to compensate the absence of contrasts and the relative equivalence of TI and PLI in the first syllable (Fig.2); 2) owing to a synchronic development of TI and PLI at the head of the second syl-

lable and to the growing rate of development of these impulses connected with synchronization; 3) due to further non-synchronous yet contrastive development of TI and PLI, as compared with the final syllabic segment; a maximum of vocalic intensification of TI is observed, which means a continuous and the most durative in the word process. Thus the vocalic component of the syllable increases as well as the vocalic completion of the word; 4) owing to the growing number of amplifications of PLI (three PLI's correlate with a single TI which unites the end of the consonant and the vowel).



The growth of amplification and duration of the components in the second syllable is caused by different reasons: the consonant grows longer owing to synchronous actions of the superglottal and glottal amplifications and their speeding-up before they unite with the vowel; duration and sonority of the vowel increase in consequence of lengthening the impulse of the tongue activity (the phase of the tongue contraction becomes relatively uninterrupted) and a simultaneously growing frequency of the pre-laryngeal impulsion.

In the word of the CVCV type the unstressed syllable differs by a relative uninterruptedness of TI and PLI. Something like their mutual "seizure" takes place: the beginning of PLI matches with the end of TI. The beginning of the syllable is notable for a greater

rate of TI and a lower rate of PLI; their end is distinguished by the reverse correlation. Here the consonant shares with the vowel the function of syllable formation to a greater extent than the consonant of the second syllable. Consequently, the beginning of the word is realized as growth of vocalic activity. Further, continuity changes into interruptedness, that is into a synchronous inclusion of TI and PLI going at a higher rate. The second segment of the word, which involves the beginning of the consonant and the moment of its joining the vowel, makes up the beginning of the peak of the word organization. The final word segment is represented by a vowel, which dynamics differs by the combination of maximum continuity of TI (the maximum lengthening of the contraction phase of the last TI in the word) and a simultaneous maximum interruptedness (frequency) of the PLI in the word. This results in the amplification of the vowel, that is of the end of the second syllable, and accordingly in the amplification of vocalic characteristic and in the sonority of the word end. Within the word of the CVCV type, as well as in the syllable, acts a dynamic model, i.e. an impulse made up by the following scheme of matching superglottal (tongue) and glottal (prelaryngeal) amplification (Fig.2).

Thus pre-laryngeal amplifications play the leading part in making up the integrity of the word: its common ascending line (the first stage of development) going from higher to lower interruptedness, that is from lower to higher frequency of occurrence, unites the initial syllable and the consonant of the second syllable. Their following resumption adjoins the vowel to the consonant of the second syllable, making it more durative and sonorous. The sonority of the consonant in the second syllable depends on the first ascending line of the development of PLI. Thus voicing of consonants in the Russian speech is an indication stipulated by the organization of word as entirety.

The second stage of the resumed amplifications of PLI is marked by a lower rate and a greater amplitude of impulses. This stage serves to complete the prominence of the end of the word.

All said above enables us to maintain that the articulatory organization of the word as an entirety (the CVCV and CVCV models) can be defined (at the segmental level) as a phenomenon realized in the correlation of modal indications of syllables; within syllables it is realized in the correlation of consonantal and vocalic activity. The unity of syllable components as well as syllables depends on modal indications.

The analysis which has been carried

out gives reason to maintain that the described models (schemes) of word articulation are originated and produced as entreties. These entreties have their own maxima, and the shapes of their development before and after the maxima are not identical. The segments of each model are mutually conditioned. Thus isomorphic character of both models manifests itself. There is every reason to speak, on the one hand, about isomorphism of the articulatory formation of syllables within words, and, on the other hand, about the organization of words.

The segment that embodies the articulatory maximum is most likely the defining segment in each model. The models CVCV and CVCV differ in the way of their modal organization and position of that segment.

Changes in the rate of glottal and superglottal impulsion and ways of their matching are the crucial mechanism of realization of the segmental organization of the word, the dynamic and articulatory structure of the word, as a unit of speech production.

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