Temporal Structuring of Acoustic Segments in Speech Communication

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Abstract: The present research is aimed at revealing certain tendencies characteristic of temporal patterning in speech segment sequences of spoken texts. In other words, the temporal syntagmatic structure of each spoken utterance is considered here to be the function of linguistic context. It is possible to study the temporal structuring of spoken language as the function of segmental and suprasegmental contexts which was beyond the scope of the present paper.

INTRODUCTION

Recent experimental research has shown that temporal organization of speech is a complex phenomenon. Many scholars have repeatedly stated that the study of any physical process is impossible without the study of its development along the time axis (in a time-frame). In this connection the temporal parameter may be considered as the elementary and, at the same time, the fundamental feature of speech signal.

An attempt to elaborate the principles of the segmentation of spoken utterance was undertaken which was considered to be part of a more general problem of discovering interrelation between discrete deep language units and speech wave segments. Such interrelation created positive prerequisites for elaborating the principles of segmentation speech continuum into syllables. It was discovered that different languages are characterized by different types of temporal organization of syllables. Attempts were made to prove that temporal structuring of words in speech flow is programmed as a single whole and that there is temporal correlation among all the segments constituting ones.

METHOD AND RESULTS

The main task of this research consisted in determination and comparative description of speech segments correlated in duration within spoken utterances. The research was carried out on material for English, German, Swedish, Dutch and Danish languages. The number of linguistic units of ad-hoc experimental corpus, this selection and number of subjects-native speakers varied depending on the concrete tasks in each stage of research (n=10-25).

In the first stage our experimental corpus included phrases and texts which were read in a sound-proof studio by native speakers of each language. Duration values (in ms) for each segment analysed were taken by means of special computer programs. Temporal correlation coefficient $\rho$ was determined in each case by question. The $H$-hypothesis of the independence of relation was tested by means of double t-criterion with $p=5\%$. Research included three study stages of temporal correlation between segments of linguistic units.

The aim of the first stage consisted in discovering the temporal correlation between two adjacent speech segments in each word in the phrase according to the following C-V and V-C patterns. The next stage of research was to determine the type of temporal correlation in each phrase according to the CV-CCV and CVC-CV patterns. The last stage was aimed at discovering the temporal correlation between vowels in each phrase according to the rhythmic pattern V-V.

The tested hypothesis H on the independence of temporal correlation between C-V and V-C segments within the analysed phrases showed that identical tendency was observed for all languages. For example, English was characterized by the negative type of temporal correlation between vowel and following consonant in the word structure irrespective of its position in a phrase of spoken text. In case of German, the same negative type of temporal correlation was revealed for sequence V-C, but it was mainly observed in the final position of a phrase.

A positive type of temporal correlation between CVC-and CV segments within a word is characteristic of all languages analysed here. No correlation was observed between other types of sound CV and CCV combinations within the same words in phrases. The comparison of duration values for vowels in the V-V patterns revealed a positive type of temporal correlation between them. The data obtained suggest that the duration of constituents in a speech utterance may be realised with different degrees of regularity and hierarchic of its nature.
Taking into consideration the hierarchic character of temporal correlation between segments of speech utterance, it appears reasonable to analyse the temporal structuring of speech sequence according to the following conventional scheme: singling out for research the temporal relations a) within a syllable for subsound and sound levels - microcorrelations; b) for syllabic level within a phonetic word - mesocorrelations; and c) for vowel segments levels as the main carriers of suprasegmental information within a phrase - macrocorrelations.

It may be concluded that the composition of a speech utterance does not merely amount to a simple sum of duration values for constituents of utterance, but complex structure comprising some relatively autonomous units, the temporal organization of which is predetermined by their own segmental and suprasegmental properties, as well as by corresponding rhythmic properties of the whole structure in general.

In conclusion, it may be maintained that the variability of the temporal organization of speech utterance is brought about by the interaction of the following factors: a) physiological as predetermined by constitution of human speech organs; b) physio-linguistic, as predetermined by laws of coarticulation in accordance with features of pronunciation basis of a given language; and c) linguistic, as predetermined by a program of communication act as a whole. Naturally, such differentiation is purely conventional.