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VARIATION OF FORMANT FREQUENCIES OF MONOPHTHONGS IN BUSINESS DISCOURSE

Базуючись на даних проведеного акустичного експерименту в статті розглянуто варіативність частоти формант монофтонгів сучасної англійської мови в діловому діалогічному дискурсі. На матеріалі британського телевізійного шоу «Dragons' Den» у дослідженні проаналізовано показники першої та другої формант голосних для трьох інформантів чоловічої статі. У зв'язку з цим представлені підходи сучасних дослідників до визначення артикуляторних особливостей першої і другої форманти.

Ключові слова: *акустичний експеримент, частота, перша форманта, друга форманта, монофтонг, діловий дискурс, інформант, артикуляторні особливості.*

Базируясь на данных проведенного акустического эксперимента в статье рассмотрено вариативность частоты формант монофтонгов современного английского языка в деловом дискурсе. На материале британского телевизионного шоу «Dragons' Den» в исследовании проанализировано показатели первой и второй формант гласных для трех информантов мужского пола. В этой связи представлены подходы современных исследователей к определению артикуляторных особенностей первой и второй формант.

Ключевые слова: *акустический эксперимент, частота, первая форманта, вторая форманта, монофтонг, деловой дискурс, информант, артикуляторные особенности.*

Based on the data of the acoustic experiment this article investigates the variation of formant frequencies of monophthongs in business discourse. The research has been carried out using the materials from the British television show «Dragons' Den» and the study analyzes the data of the first and second formants of vowels for three male talkers. In this regard, the study presents the approaches of the modern researchers to the determination of articulatory features of the first and second formants.

Key words: *acoustic experiment, frequency, first formant, second formant, monophthong, business discourse, talker, articulatory features.*

Variation is one of the most important notions in modern linguistics. An integral feature of language is the inherent variability that is the fundamental characteristic of a language system [5, p. 287]. It is the mode of existence and operation of any speech unit, and one of the main sources in the continuous process of language transformation. The capacity for variation is a universal feature of language manifested both in its structural organization and in the way a language fulfils its function.

Linguists have been paying more attention to the study of variability and in this regard, the study of any partial aspect of variability in individual linguistic levels (grammatical, lexical, and phonetic) is relevant. The research of variation of formant frequencies of monophthongs is important not only to the phonetic level of

language, but also for the development of a general theory of variation in linguistic units.

It is normal for any modern literary language to comprise not only a degree of constancy in the use of different language devices, but also contain a set of options that most fully reveal themselves in the way the language functions [7, p. 5]. Language as a functional system in all its levels is differentiated by a high level of variation of linguistic units regardless of their complexity. The ability to deviate from the norm as an organic feature of natural language makes it functionally flexible and modifiable [3, p. 26].

The dialectic interaction of variability and constancy in the time continuum on the one hand reflects, the changing nature of language as a system, and on the other hand represents the preservation and continuity of language in its basic function of communication. Just as the constancy of the systemic units of speech ensures their preservation in a state of communicative availability, variability is a major source of language development [2, p. 11].

The objective of the present paper is to reveal variation of formant frequencies of monophthongs in business discourse, thus, we will focus on the acoustical and physical characteristics of vowels.

The research has been carried out using the materials from the British television show «Dragons' Den». From this we will illustrate examples of the variation of vowels in business discourse. The subjects of the experiment were adult male businessmen conducting negotiations.

Although the basic feature of business discourse is its clear standing order and obeisance to the rules and restrictions [1, p. 38], one should not forget that business discourse is one of the varieties of dialogue speech. In light of this we draw attention to the fact that another characteristic of business discourse is its dynamic expression. Due to the rapid rate of speech there is stratification within a partners' speech, and the implementation of phonetic and prosodic elements of speech variability.

For speech to be understood, the listener must be able to correctly identify the intended phonemes of the speaker's utterance, which depends largely on the speaker's ability to articulate the phonemes

accurately [4, p. 342]. Both vowels and consonants have specific acoustical and physical properties that, when spoken, enable the listener to identify the target sounds correctly [6, p. 18].

The identification of vowels is largely based on the size and shape of the oral cavity. As the articulators move and the shape of the oral cavity changes, the formants also change [6, p. 16]. A formant is a natural resonance of the vocal tract as it refers to a physical property of the tract.

The measurement and comparison of formants is one of the elements of an acoustic analysis. The formant frequencies are important in the identification of vowels [4, p. 342]. R. J. Baken describes a formant as «a single frequency at which vocal tract transmission is more efficient than at nearby frequencies [4, p. 354]». Formants can be defined as peaks in the energy spectrum of vocalic sounds which correspond to the resonant frequencies of the vocal tract. Formant frequencies, however, can only be found when the vocal tract is transmitting acoustic energy.

Vowels are characterised by three articulatory features that define their acoustical characteristics: tongue advancement, tongue height, and lip rounding.

Tongue advancement is the location of the constriction (front to back) in the vocal tract. It is formed by the tongue and the hard roof. Tongue advancement is directly related to the second formant frequency (F2). Front vowels (/i:/, /e/, /æ/ and /I/) are articulated with the tongue in the anterior oral cavity. They have higher second formant frequencies. Back vowels (/@:/, /2/, /O:/, /u:/, and /4/,), where the tongue is in the posterior oral cavity, have a lower F2. Consequently vowel frontness is directly related to the second formant.

Tongue height refers to the degree of constriction of the tongue to the hard roof. Higher tongue positions correspond to a lower first formant, and vice versa. Thus, tongue height is inversely related to the first formant frequency (F1) [6, p. 34].

Lip rounding tends to lower both F1 and F2 [4, p. 356].

The third formant (F3) is considered to remain relatively constant for individuals. In phonetic analysis, formants are normally represented by their centre frequency. It corresponds to the local frequency where the energy level is the highest.

Formants can be measured and visualised in several ways. The most common method of visualising formants is through the construction of spectrograms. Spectrograms are computer generated plots which show speech energy across frequency over time. They represent higher energy with greater levels of darkness. In computer generated spectrograms the formants become visible as dark bars.

As mentioned above formants are the resonances of the vocal tract. This is precisely what is extracted from the speech signal during analysis. The primary equipment used in this experiment was Praat version 4.2.12, a computer program for speech analysis and synthesis. The program acoustically analyzes sounds for the user, depicting them in waveforms, spectrograms, etc.

Once all of the formant measurements were obtained for one analysis parameter and one speaker, the raw formant values were transferred to Microsoft Excel spreadsheet. It enabled us to insert and operate the data. Then the data was systematized and the information was organised into a figure.

Considering the fact that no two realisations of the same word are ever identical, the formant values of vowels in two instances of the same word will also never be identical. This is because each time a word is articulated there is a slight difference in the movement, position and timing of the articulators involved. This causes a relatively small amount of variation between tokens. However, a greater amount of variation can exist between the formants of the same vowel which occurs in different words. Therefore, sounds that surround vowels during individual word production or in connected speech would have an impact on the acoustical characteristics of the vowel. As vowels are often neighboured by consonant phonemes, the physical and acoustical characteristics of the consonant would directly affect the vowel. For example, the formants of the vowel /æ/ in the word ‘cat’ will be different from those in the word *ban*. Vowels neighboured by other vowel phonemes would be affected similarly. This is due to the coarticulatory effects introduced by the influence of the preceding and following segments on the movement, location and timing of the articulators [6, p 74].

Vowels, however, are rarely produced in isolation. They are normally produced within an isolated word, or in connected speech. Nevertheless, vowels produced in isolation have typical formant frequency patterns. However, the formant frequency pattern differs within every individual talker. These results, shown in Figures 1 and 2, indicate that formant frequencies at the two sample points typically differ by rough 1% of average formant frequency.

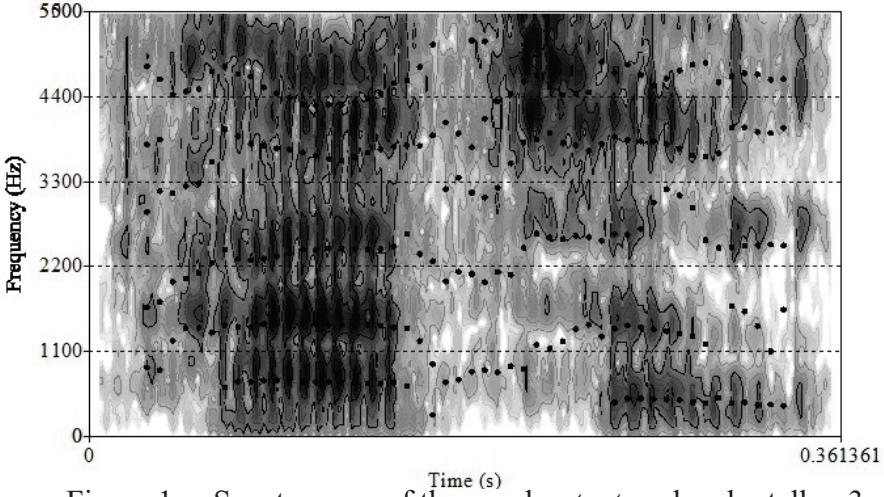

Figure 1. – Spectrogram of the word *patent* spoken by talker 3

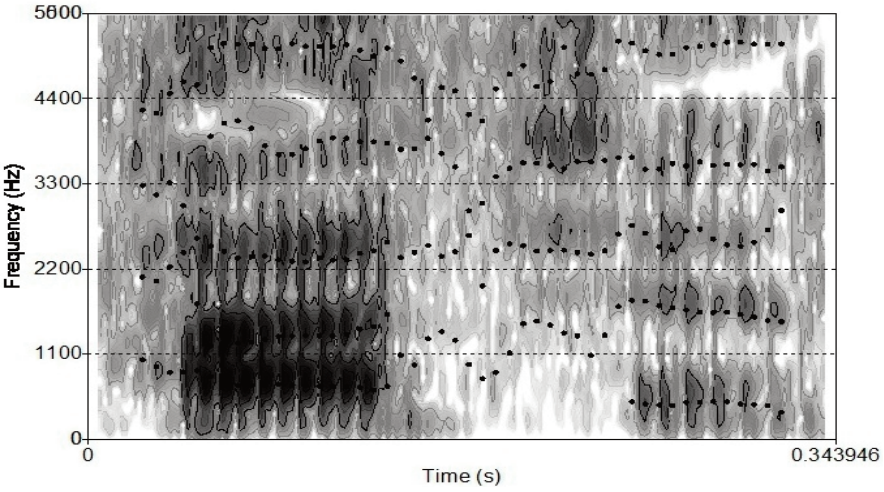

Figure 2. – Spectrogram of the word *patent* spoken by talker 1

In our experiment ten vowel phonemes were selected for analysis. The phonemes were isolated from the words in «Dragons' Den». The spectrum and the spectrogram of the sample were then displayed in Praat. We judged each vowel perceptually and visually. It was selected for analysis by dragging the cursor from the beginning to the end of the vowel sound. The first and the second formants were then automatically calculated in Praat for each of the ten phonemes.

Based on unique set of formant frequencies for the talkers under consideration it is possible to determine a concrete vowel spoken by different talkers. If we construct a graph that plots the second formant versus the first, we find that a particular vowel sound tends to lie within a certain region of the plane. Therefore, if we determine the first two formants, we can construct decision regions to estimate which vowel was spoken. The first two average formants for monophthongs are plotted in Table 1.

Phoneme	**Talker 1**		**Talker 2**		**Talker 3**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
/i:/	367	2187	343	1920	280	2250
/ɪ/	531	1952	403	2015	490	1944
/e/	582	1648	495	1817	521	1643
/æ/	616	1697	775	1603	635	1445
/ɑ:/	709	1350	770	1443	755	1452
/ɒ/	632	1194	620	1243	600	1216
/ɔ:/	366	994	501	1405	570	840
/ʊ/	470	1207	394	1611	525	2085
/u:/	391	1809	541	1420	352	1854
/ʌ/	558	1482	568	1425	607	1446
/ɜ:/	680	1520	671	1654	588	1332
/ə/	548	1617	496	1658	465	1695

Table 1. Average formant frequencies (in Hz) for English vowels by three adult male talkers

The averages exposed in the table are based on measurements from individual tokens that were well recognized in the listening study, and will be discussed in the following research.

The original intent of this study was to collect a database of acoustic measurements for utterances, but with additional measures of spectral change it could be used to study the role of dynamic properties in vowel recognition.

In this regard there are some prospects for further research of formant frequencies of monophthongs, namely to investigate the development and functioning of vowels in various styles, such as: scientific-professional style, publicistic style, literary colloquial style and familiar colloquial style in Modern English.

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