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Differences in formant-defined vowel space between native speakers of English and Croatian students of English

Damir Horga
Vesna Mildner
Department of Phonetics
Faculty of Philosophy

Foreign language learning, as indeed any learning, is a transformation process from an initial state toward a new, target state. Essential components of the language student's initial state include age, cognitive, connative and motivation aspects, and command of their own native language. The maximum desired, target state is to achieve competence in the foreign language comparable to that of native speakers. In the learning process the student approaches the desired state in stages. He/she does not necessarily master all language skills equally well or equally quickly. It is assumed that at the phonetic level the desired state is reached during the early stages of language learning.
The research presented here raises the question of the extent to which university students of English master the English vowel system, in production of the ten monophtongal vowels that constitute it. The study also addressed differences between first and fourth-year students.
Two groups of subjects (10 freshmen and 10 seniors), native speakers of Croatian took part in the study. Their pronunciation of isolated words containing the ten vowels was subjected to computer analysis, determining the first two formant frequencies. The two-dimensional spaces obtained for the two groups were compared with the formant-defined vowel space of native speakers of English.

Introduction

Error analysis in foreign language speakers is a special kind of contrastive analysis in which two languages, the native and the foreign, are in contact in performative psycholinguistic reality of the learner. Samples of foreign language performance are considered from the point of view of the student's native language. In

foreign language learning the foreign language (L2) is filtered through the perceptual and articulatory structure of the student's native language (L1). This gives rise to a system of errors (Se) in the foreign language that has gained the name of interlanguage (Li). Interlanguage (Li) is the result of L1 and L2 contact and of different operators influencing the learning process, and, most frequently, found in the teaching process. The aim of teachers is to eliminate Se and bring student's L2 proficiency to the level of L1 speakers. Corder (1973) says that the description and classification of students' errors reveal those characteristics of L2 and L1 that cause difficulties in L2 learning. Thus error analysis of L2 students can be used as a means of testing the hypothesis put forward on the basis of a theoretical comparative study of two languages.

In metaphorical description of the relations between L1 and L2 the native language is viewed as a riddle through which some properties of the L2 pass and the student can perceive and learn them, while other properties cannot pass through the riddle so the student cannot perceive them and cannot learn them. This view, as far as the phonetic-phonological level is concerned, was expressed by Trubetzkoy (1949). He claimed that after the L1 phonological system is mastered, it causes the filtering out of those acoustic and perceptive characteristics that are not important in L1 from the phonological point of view. Polivanov (1969) claimed that the »sensibility level« of distinguishing the L2 sounds depends upon the phonological system of L1. That point of view is in agreement with the »gestalt theory« (the theory of form) according to which the firmly structured perceptual forms (and the phonemes of the L1 are such forms) are very difficult to destroy and do not permit a new form (the form of a L2 phoneme) to be perceived correctly. The perceptual influence of such structured forms, patterns and images in the L2 phoneme interpretation gives rise to a system of errors. The forms can be structured on the basis of a number of physical parameters. The informativeness or redundancy of those parameters varies across languages. During the L2 learning process the student's aim is to discover the informative weight (relevance) of particular physical parameters of L2 sounds.

Phonetic-phonological errors in L2 learning can be explained from the point of view of information theory. The L2 student's code is not tuned to the code of the native speakers. That is manifested as inadequate functioning of the decoding processor and results in the occurrence of semantic noise.

Finally, difficulties in L2 learning can be explained from the neurolinguistic point of view. L2 information goes through neural pathways that facilitate L1 signals but they are narrow and not tuned to the signals of a new language.

The factors influencing the L2 learning can be classified into two groups (Strange 1995, Bohn 1995). The first group is made up of those factors that are determined by the student's characteristics (student's L1, age, duration of the L2

learning process). The second group factors are determined by the L2 characteristics, that is by the new structures the student has to master.

The first factor influencing L2 pronunciation depending upon the student's characteristics is his/her L1. The experimental evidence of Trubetzkoy's and Polivanov's theoretical hypotheses came some forty years later, when Abramson and Lisker (1970) showed that the speakers of different languages (English, Thai, Spanish) put the category boundaries between voiced and voiceless plosives on the basis of VOT (voice onset time) at different points though the acoustical signal was the same. This means that the organisation of phonetic parameters into phonological categories is language-specific and creates the main difficulty in learning phonetic--phonological distinctions in a non-native language. The same kind of evidence is given by the example of Russian consonants /p/ and /b/ that are not distinguished by Chinese listeners, who classify those two sounds into the same category. Repp and Williams (1985) and Repp (1989) showed that synthetic vowel continua are imitated in non-linear, almost categorical, fashion. An enormous number of investigations in this field has been carried out during the past twenty years.

The second factor depending on one student's characteristics is the age at which the student begins to learn the L2. Lenneberg (1967) introduced the notion of critical period and stated that the reduced flexibility of neurological structures after the age of twelve results in adults' inability to learn a language so well and so naturally as children. Though Lenneberg's theory of critical period has undergone some changes it is a fact that the age of the beginning of L2 learning influences perception and pronunciation so that the relation of the phonetic skills and the student's age can be expressed: »the earlier the better«. It has been shown that children who begin learning English at the age of 5 or 6 use the same perceptual mechanisms as native speakers of English, while this is not seen with children who begin learning English after that age. Interesting results have been obtained in studies of perceptual mechanisms in very young children. It was shown that children between the second and the sixth month of age perceive the sounds of different languages based on the categorical principles of the particular language. This means that the categories of L1 are not yet established. However, these sound categories are structured by the end of the first year so that children between the sixth and twelfth month of age perceive speech sounds based on the categorical principles of their L1. In other words, the categorical functioning of speech perception is established very early. The question remains whether categorical perception is the result of the maturation process of the child or of the learning process. The second interesting fact is that the children who were in fairly intensive contact with a certain language up to the age of two, in a repeated contact with that language, after a long pause quite easily acquire its phonological structure even in adulthood. Concerning the learning of L2 phonetic structures in adults it was found that their perceptual skills have not diminished but that their listening has become selective and it is impossible for them to listen to the L2 in the way native speakers do.

The third factor depending on the student's characteristics is the duration of his/her L2 experience. Learning of the L2 perception and pronunciation requires the reorganisation of speech consciousness. This is a long-lasting process which, where adult students are concerned, has its limitations so that the students do not acquire the skill of native speakers. Some investigations show a the five-year period of continuous living in a L2 foreign country is the period in which the L2 reaches the upper limit of listening and pronunciation skills. Even after that period it is not obvious that the reorganisation of the perceptive mechanisms is established. For example, native speakers of German who have lived in the USA for a long time as the primary clue of differentiation of English vowels /ɛ/ and /æ/ use the difference in vowel duration rather than vowel spectral differences which is the primary clue for native speakers of English. Of course, an important factor influencing the process of perceptual reorganisation is the quality of the L2 input. Quite often L2 speakers can find themselves in a speech environment which does not ensure the appropriate quality of L2 input and thus does not enable them to reorganise their perceptual and pronunciation mechanisms properly.

The second large group of factors influencing L2 pronunciation is the number of categories the student has to perceive and master in the L2. Namely, not all differences in the L2 compared with L1 are on the same level of difficulty. The different level of difficulty can be caused by differences between L1 and L2, but also by characteristics of the perceptual or pronunciation category which is being learned. It has been shown that the place of articulation is more difficult to acquire than voicing distinctions, and spectral properties are more difficult than duration. It seems that there are properties which are fundamental from the physiological point of view. For example, perceiving the F2 consonantal categories is more influenced by L1 than are vowel categories. Thus it seems that vowel categories have a more universal physiological origin. It has already been mentioned that a trade off among cues is possible, so that students may use as primary cues in their L2 perception those which are redundant for native speakers. For example, Japanese learning English distinguish sounds /r/ and /l/ on the basis of the F2 values, while for native speakers of English the perceptual cue is the value of F3.

2. Purpose of the investigation

In the present investigation two questions are raised:

(a) is there a difference between the English vowel formant space of native speakers of English and of students of English whose L1 is Croatian, and

(b) is there a difference between the English vowel formant space of first–and fourth-year students at Zagreb University.

The frequency characteristics of the first two vowel formants are chosen as the measure to answer the questions raised.

3. Materials and method

3.1. The subjects

The investigation was carried out on a sample of eleven randomly chosen first-year and 10 fourth-year female students at the Department of English Language and Literature, Zagreb University. The first-year students were from 19 to 21 years of age, and the fourth-year students from 22 to 24. In both groups the subjects had begun to learn English between the ages of 6 to 14 and had thus been learning English for 4 to 9 years. They had graduated from various secondary schools and consequently followed various educational English language programs, but the two groups did not differ significantly in that respect. None of the students had a native English speaking teacher prior to enrolling at the University nor had spent more than four weeks in an English speaking country.

3.2. Vowel sample

Every student was given a list of 10 English words with 10 English vowels. The words and the corresponding vowels were: heed /i/, hid /ɪ/, head /ɛ/, had /æ/, hod /ɒ/, hawed /ɔ/, hood /ʊ/, who'd /u/, hud /ʌ/ and heard /ɜ/.

Every subject had two minutes to practice the pronunciation.

After that, every subject read the listed words in three randomised orders. The recording of subjects was made in a sound-proof room on digital CD.

3.3. Acoustic analysis

The acoustic signals were analysed by means of CSL computer program. On the spectral representation of every word the frequency values of the first and the second formant were measured in the stationary part of the vowels.

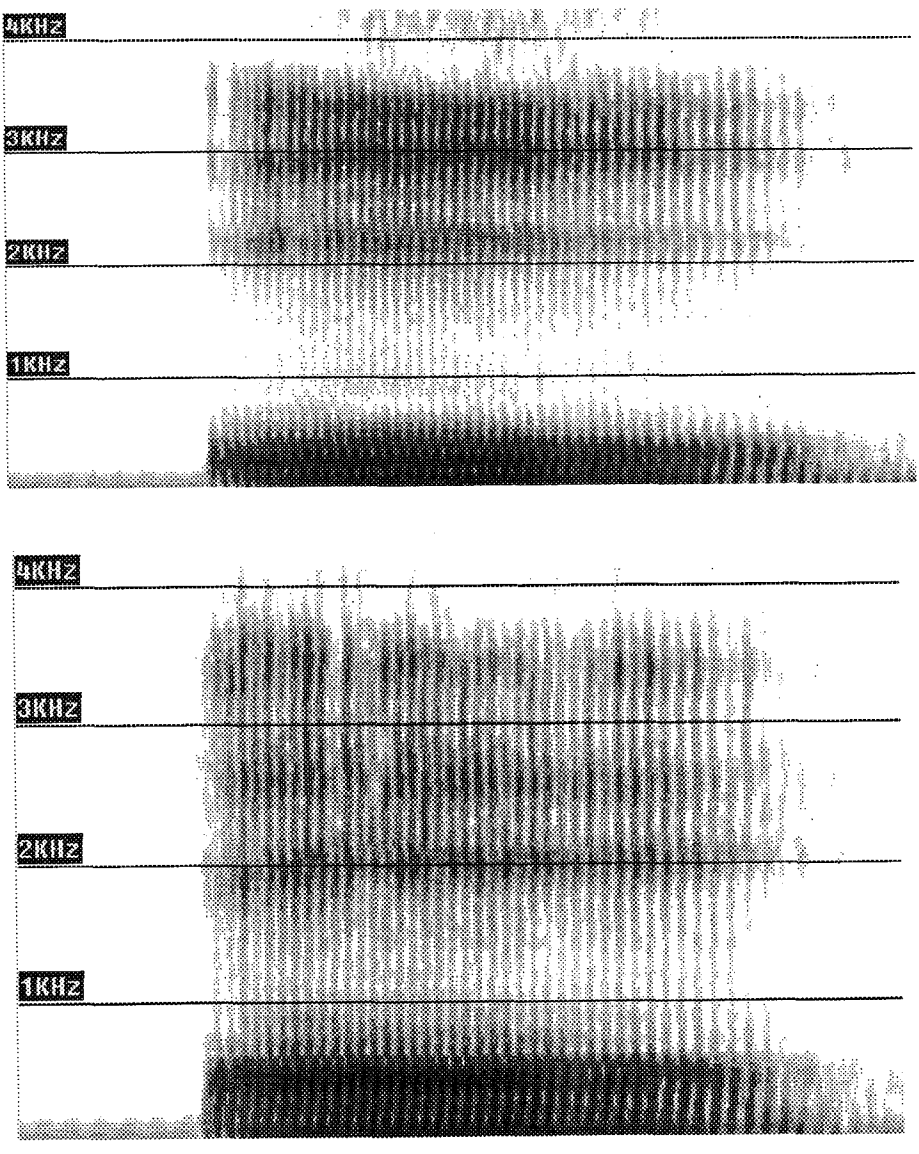

Figure 1. *The procedure of formant measuring for the vowel /i/ of subjects XX and YY.*

The formant values of the Croatian students were compared with the results of the native female speakers of English obtained by Peterson and Barney (1952).

3.4. Data analysis

The descriptive statistic parameters were calculated separately for each group of subjects (freshmen and seniors) and for Croatian students as a group. By means of ANOVA the differences between the two student groups were tested, the variables being the frequency values of F1 and the difference between F2 and F1.

4. Results and Discussion

The results of the analysis are given in Table 1 and in Figures 2 and 3.

Table 1. THE MEAN ENGLISH VOWEL FORMANT VALUES OF NATIVE ENGLISH SPEAKERS (FROM PETERSON AND BARNY 1952) (PB), CROATIAN FIRST (I) AND FOURTH YEAR (IV) STUDENTS OF ENGLISH AND FOR CROATIAN VOWELS (FROM BAKRAN 1990) (C).

	F1				F2			
	PB	I	IV	C	PB	I	IV	C
heed /i/	310	453	436	302	2790	2737	2697	2623
hid /ɪ/	430	506	497		2480	2508	2420	
head /ɛ/	610	725	795	493	2330	1922	2021	2360
had /æ/	860	800	850		2050	1852	1983	
hod /ɒ/	850	876	871	884	1220	1328	1296	1393
hawed /ɔ/	590	629	494	576	920	1193	896	980
hood /ʊ/	470	499	515		1160	1046	989	
who'd /u/	370	467	476	353	950	1022	925	758
hud /ʌ/	760	840	928		1400	1442	1466	
heard /ɜ/	500	588	586	(553)	1640	1545	1603	(1554)

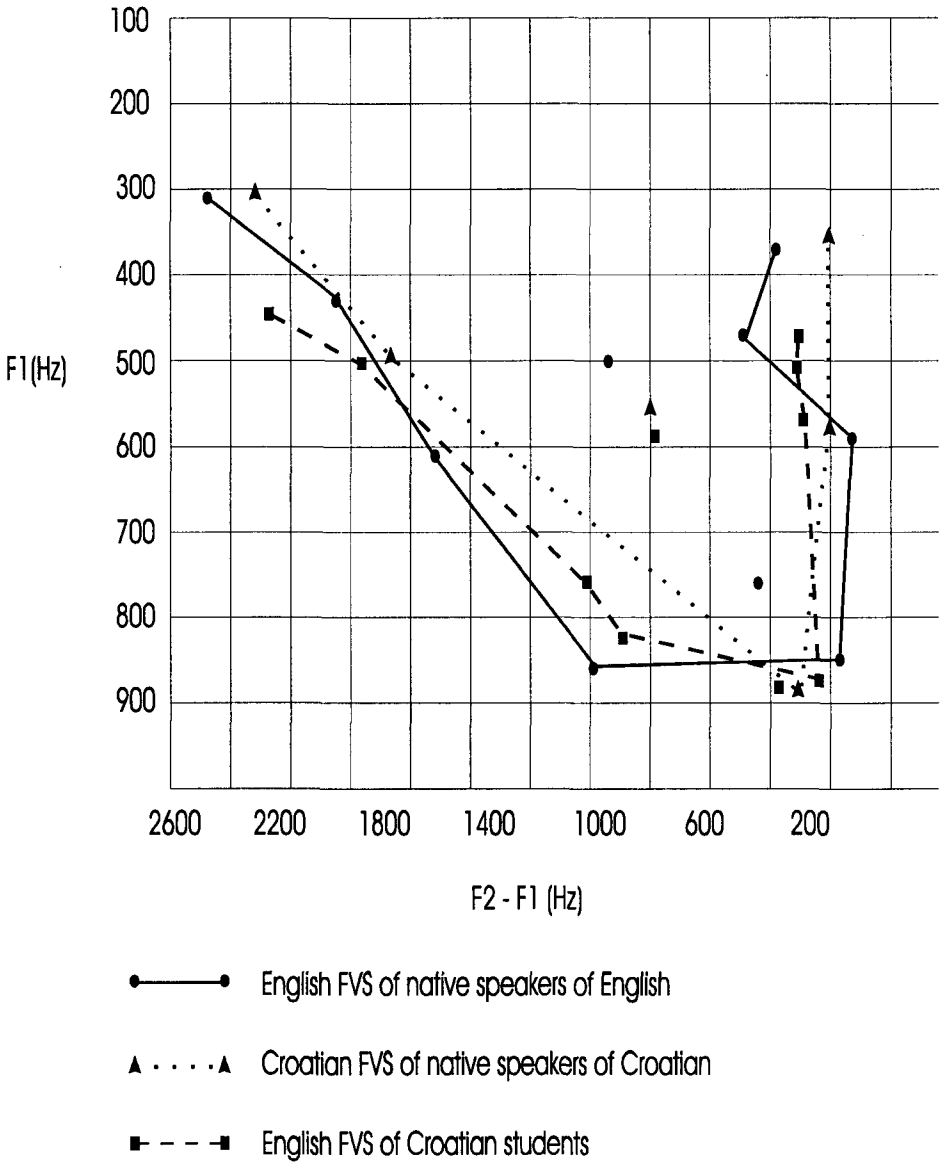

Figure 2. *English vowel-formant space for native English speakers, and for Croatian students of English and Croatian vowel-formant space for native speakers of Croatian*

The results of the analysis show that the English VFS is denser than Croatian. That is the reason why the English VFS is broadened so that the extreme frequency values of F2 are higher and the values of the F1 are lower than the extreme values of the Croatian vowels. From the articulatory point of view this means that the closed vowels in English are more closed and the open vowels more open than the corresponding Croatian vowels. In addition, in English the central part of the vowel space is filled by central vowels which do not exist in Croatian. Therefore, native speakers of Croatian when learning English have to increase their sensitivity in order to distinguish many more vowel categories than their native language requires. It is supposed that students can perceive and master some of the new vowel categories more easily if those categories are unlike the vowel categories in their L1.

The results show that in their pronunciation students of English produce the right number of vowel categories, but the distances between certain categories and their boundaries differ compared with those of native speakers of English. If the native English vowel space can be considered as balanced, the space of Croatian students can be characterised as non economical because some distances between neighbouring vowel categories are too short (/i/ - /ɪ/, /ɛ/ - /æ/, /u/ - /ʊ/), while some distances are too long (/i/ - /ɪ/, /ɛ/ - /æ/). Indeed, among the most prominent features of »foreign accent« noted in the English of Croatian students is the inability to differentiate these 3 pairs of vowels sufficiently (all 3 pairs) and/or appropriately (/i/ - /ɪ/, /u/ - /ʊ/). Croatian students of English restrict their distinction of the latter 2 pairs to durational differences rather than utilising quality distinction.

The English vowel formant space of Croatian students is denser than that of native speakers of English and its density is concentrated towards more open articulatory positions.

The analysis of variance shows that, in general, there is no significant difference in English VFS between the groups of freshmen and seniors. The difference approaches statistical significance only for the vowel /ʌ/ ($F=3.73$, $p=.069$) due to the F2-F1 values (602 Hz - freshmen, 538 Hz - seniors) because the pronunciation of the freshmen is better, i.e. closer to the pronunciation of native speakers of English (F2 - F1 - 640 Hz). The difference is statistically significant for the vowel /ɔ/ ($F=4.77$, $p=.042$) in which the pronunciation of the senior students is better, i.e. closer to the pronunciation of native speakers of English in F2 - F1 (563 Hz - freshmen, 402 – seniors) because the F2 - F1 values for the native English speakers is 330 Hz. Nevertheless, in general, the English VFS of the senior students shows a tendency to broadening and so approaching more closely the VFS of native speakers of English than the freshmen. Thus the vowel pronunciation of the senior students can be assessed as better than that of the freshmen and the improvement can be assigned to the transformational influence of the learning process at the university.

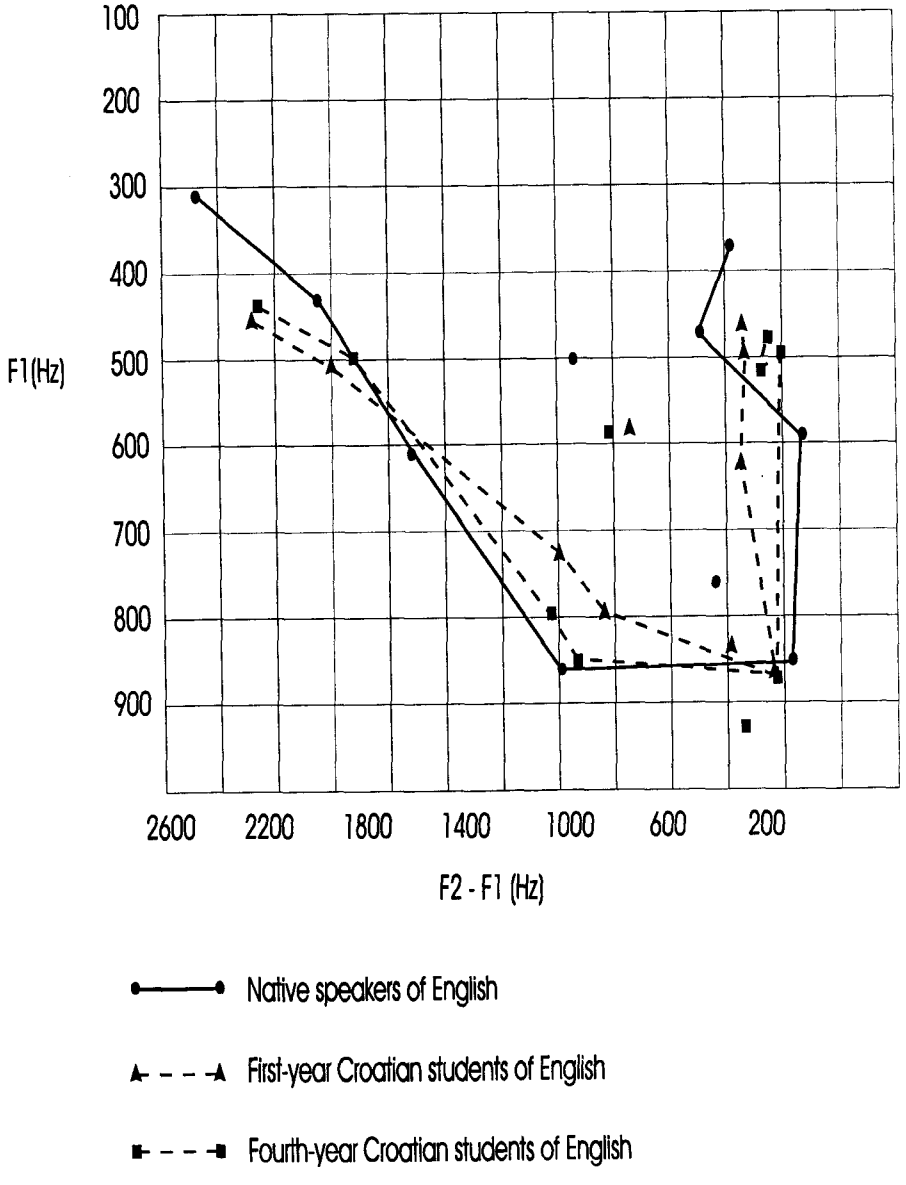

Figure 3. *English VFS of native speakers of English, of the first- and fourth-year Croatian students.*

5. Conclusion

The English vowel-formant space of Croatian students of English can be assessed as an approximative system in relation to the formant-vowel space of native speakers of English. Some general tendencies can be observed, so that the articulation of particular vowels and their interrelations are systematic.

Formant parameters of vowels constitute only one of the elements of vowel pronunciation. For this reason it is necessary to investigate the other parameters of vowel differentiation which may provide cues for their auditory identification and show whether the students approach good English pronunciation in these elements more closely. The most important of such parameters is vowel duration.

Physical parameters do not always reveal the principles of perceptive mechanisms so it would be useful to assess the effectiveness of English vowel pronunciation of Croatian students by means of perception tests.

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RAZLIKE U FORMANTSKOM PROSTORU ENGLESKIH SAMOGLASNIKA IZVORNIH GOVORNIKA I STUDENATA KOJIMA JE MATERINSKI JEZIK HRVATSKI

Učenje je stranog jezika, kao svako učenje, transformacijski proces, od nekog polazišnog stanja učenika prema nekom novom željenom stanju. Bitne su komponente polazišnog stanja dob učenika, njegove kognitivne, konativne i motivacijske osobine, te vladanje materinskim jezikoma. Kao željeno se stanje, u maksimalističkom pristupu, određuje vladanje stranim jezikom onim stupnjem vještine kao što tim jezikom vladaju izvorni govornici. U tom se procesu učenik u različitim stadijima učenja približava željenom stanju. Učenik ne mora svim razinama jezične strukture ovladati jednako vješto, niti u različitim stadijima učenja jezika, niti u konačnom ishodu. Pretpostavlja se da se dostizanje željenog stanja fonetske razine postiže u ranim stadijima učenja stranog jezika.

U ovom se istraživanju postavilo pitanje u kojem stupnju studenti engleskog jezika uspjevaju ovladati izgovorom samoglasničkog sustava engleskog jezika i postoji li razlika na početku i na kraju studija. U istraživanju su sudjelovale dvije skupine (I i IV godina studija) od po 10 studentica. Kompjutorskom su obradom na izgovoru izoliranih riječi izmjerene frekvencijske vrijednosti prvih dvaju formanata za engleske samoglasnike. Tako dobiveni dvodimenzionalni prostori ovih skupina uspoređeni su s formantnim prostorom izvornih govornika engleskog jezika. Rezultati su pokazali da je općenito formantski vokalski prostor izvornih govornika engleskog širi nego onaj koji ostvaruju studenti i s druge strane da studenti četvrte godine pokazuju tendenciju ka širenju vokalskog prostora i približavanja karakteristikama izvornog engleskog formantskog prostora.