

RELATIONS BETWEEN SECOND LANGUAGE PROFICIENCY AND FORMANT-DEFINED VOWEL SPACE

Vesna Mildner and Damir Horga
Phonetics Department, University of Zagreb, Croatia

ABSTRACT

The aim of this study was to compare the vowel systems of Croatian and English in terms of their formant-defined vowel space, and to check for language proficiency effects in Croatian speakers of English as a foreign language. The proficiency of 20 male Croatian speakers of English was rated by 10 English language experts, and their production of 11 English vowels was acoustically analyzed for F1, F2 and duration. It was found that they group the English vowels according to Croatian vowel categories and that they place greater emphasis on duration differences between the tense [i, u] and their lax counterparts [ɪ, ʊ] than native English speakers. Proficiency effects were found only for some vowels, but not for duration.

1. INTRODUCTION

The phonetic component is one of the most difficult aspects of mastering a foreign language. It depends on a number of factors, one of which is the relationship between the sound systems of the native language (L1) and the foreign language (L2). Comparison of the two systems may give some idea about possible problem spots, but not necessarily about the cues in L2 perception and production that non-native speakers may use differently than the native ones [8].

Croatian vowel system consists of five vowels: high (close) front [i], midopen front [e], open central [a], midopen back [o] and high (close) back [u]. The duration of Croatian vowels may vary depending on accent: the ratio between vowels under short accents and those under long accents is on the average 1:1.3 in connected speech and 1:1.6 in words pronounced in isolation [1, 14, 17]. In some speech variants the vowel quality is correlated with the long-short accent distinction [14], but no quality-based phonemic contrast exists in any of the five standard vowels [12].

The relationship between standard Croatian (under both long and short accents) and English vowels with respect to their positions in the vowel triangle may be summarized as follows: Croatian [i] is positioned between English [i] and [ɪ], closer to the former; Croatian [e] is positioned between English [ɛ] and [e], corresponding very closely to the latter; Croatian [a] is positioned between English [æ] and [ɑ]; Croatian [o] is positioned between English [ɔ] and [ɒ]; and Croatian [u] is positioned between [u] and [ʊ], closer to the former.

The most common patterns of mispronunciation of English vowels by Croats are a consequence of the differences in the vowel inventories of the two languages and relationships, qualitative and duration, between them. For instance, Croatian students of English make the distinction between [i] and [ɪ], and [u] and [ʊ] primarily on duration. On the other hand, native

English speakers base their distinction of vowels [i] vs. [ɪ] and [u] vs. [ʊ] primarily on spectral quality, but also show a small but significant effect of vowel duration [5] although some older versions of phonetic transcription [9] stressed the duration differences rather than qualitative ones, by distinguishing between the tense and lax counterparts only by the presence or absence of a colon ([u] and [i] vs. [u:] and [i:]). In the generally accepted classifications of English vowels with respect to duration [ɪ, ʊ, ɛ, ʌ] are grouped together as short or lax and [i, u, e, o] as long or tense, whereas [æ, ɑ, ɔ] variably belong to one category or the other [11, 13]. The categorization is further complicated by the fact that low vowels have been found to be longer than high ones and that there is some overlap in duration between the shortest tense vowels and their longest lax counterparts [13]. The ratios between the English tense [i, u] and lax [ɪ, ʊ] reported in literature range between 1:1.2 and 1:1.4 [13, 15].

The aim of this study was to compare the vowel systems of Croatian and English in terms of their formant-defined vowel space and check for language proficiency effects in Croatian speakers of English as a foreign language. It was hypothesized that the Croatian speakers' production of English vowels would span a smaller area of the vowel space than was found for native speakers of English, and that they would place greater emphasis on duration differences between the tense [i, u] and their lax counterparts [ɪ, ʊ]. It was further expected that greater proficiency in English would be manifested as a better fit with the native English data, and increased emphasis on qualitative distinction between [i,u] and [ɪ, ʊ] at the expense of duration differences.

2. MATERIAL AND METHOD

2.1. Talkers

The talkers (N = 20) were male native speakers of Croatian and came from a variety of Croatian towns. All were university students, half of them majoring in English (3rd year of study), the other half in other humanities subjects. None of them had lived in an English-speaking country. The years of their formal study of English ranged from 2 to 13, and all have started learning English before the age of 15, which is before what is generally considered to be the end of the critical period, but after the age found by some authors to result in accent-free pronunciation [4]. Their age ranged from 20 to 24, and their F0 from 90 to 120 Hz.

2.2. Speech material

All talkers were recorded (Sony MiniDisc Player) reading a short passage in English, followed by a list of words containing 11 English vowels [i, ɪ, ε, æ, ʌ, ɑ, ɒ, ɔ, ʊ, u, ɜ]. The vowels were in the combination hVd, with the exception of three items of the list usually used in similar studies, namely *hud*, *hawed* and *hod*, that were replaced by *hut*, *caught* and *bother*, because most subjects were not familiar with the original three. The list was read off three times in differently randomized order. The talkers had the opportunity to familiarize themselves with the material before recording. The same talkers recorded three lists (same words, different randomized orders) of Croatian words containing the five Standard Croatian vowels under long [ki:p, ke:ts, ka:p, ko:s, ku:t] and short [kit, keks, kat, koʃ, kup] accents.

2.3. Judges

The panel of judges consisted of 10 university professors of English. The assessments were carried out individually, and each judge could take as much time as needed to complete the rating procedure, but could not go back once they heard the following talker.

2.4. Rating

For the purpose of English proficiency rating each Croatian's reading of the passage was re-recorded and presented to the judges twice in random order. This meant that each judge had 40 passage samples to assess. They were instructed to provide three grades for each sample of speech: one for the overall pronunciation, one for the pronunciation of sounds, and one for prosody. The 1 to 10 point scale was used, the highest score being English native-like pronunciation.

2.5. Acoustic analysis

The individual words were digitized at 11 kHz sampling frequency and analyzed on a personal computer (Pentium II) by PCquirer software for the first (F1) and second (F2) formants of the vowels and vowel duration (t). All three readings of each word were included in the analysis, thus yielding three tokens of each vowel per subject. Formant values were read off in the steady-state portion of the vowels by the tools provided by the software, and checked manually. Duration was measured between the onset and offset of periodicity, manually, by marking the segment on the computer screen and reading off the value in milliseconds. The readings were done by two trained phoneticians and auditory control was included.

3. RESULTS AND DISCUSSION

Since there were no significant differences ($p > 0.05$) between the first and second grade for any of the three assessed pronunciation features, the two grades of each judge were averaged, and used in subsequent statistical analysis as a single grade. On all three grades the judges showed high agreement among themselves: Cronbach's alpha (reliability item analysis test) was 0.94 for the first and third grade, and 0.93 for the second grade. Moreover, there was a very high correlation among all three grades: 0.95 between the grades for sounds and

prosody, and 0.98 between the grades for overall pronunciation and each of the other two.

It was therefore justified to use a single value for each talker, averaged across judges and assessment categories, as a measure of his proficiency in English pronunciation (PROFICIENCY). This value was then checked for relations to other talker variables, such as length of formal learning of English (FORMAL LEARNING), and their majoring in English (STUDENTS) or not (NON-STUDENTS). Regression analysis showed that PROFICIENCY was moderately positively correlated with FORMAL LEARNING ($r = 0.41$), with borderline significance: $F(1,18) = 3.67$; $p = 0.07$. Flege and coworkers [2, 5] found significant correlations between foreign accent and years of formal English-language instruction, and Flege *et al.* [3] found significant correlations between pronunciation proficiency and the ability to perceive vowel dissimilarity. Although they found no significant effects of exposure on degree of accent we suspect that in this study this correlation is not as highly significant as in theirs due to high (and uncontrollable) informal exposure of Croatian young adults to English language through films, music, satellite TV, video, Internet etc., which most likely blurs the effects of formal instruction. The present results would then be between the results of Flege and Fletcher [2] and Flege *et al.* [3] on the one hand, and those of Purcell and Suter [16] who found that age of learning was not a significant predictor of foreign accent for subjects who had learned English after about the age of 12 years, as was the case with the majority of subjects in this study. Analysis of variance showed that STUDENTS as a group were judged as significantly ($p < 0.00$) more proficient than NON-STUDENTS. However, when the median of the average grades was calculated (6.39) it became evident that two STUDENTS were below the median and two NON-STUDENTS were above the median value. In subsequent analysis the subjects were therefore treated as two groups depending on their average grade. Those above the median value were treated as PROFICIENT (grade range: 6.52 to 9.22; mean: 7.24), and those below it as UN-PROFICIENT (grade range: 4.88 to 6.27; mean: 5.74).

The relations between PROFICIENCY and the measured vowel variables were checked by regression analysis. The correlation between vowel duration and PROFICIENCY was low and insignificant. The correlations between the first formants and PROFICIENCY were moderate ($r = 0.68$), but insignificant; only the correlations with F1 of [ɔ] and of [ɑ] were borderline significant ($p = 0.06$). The correlations between PROFICIENCY and the second formant values were high ($r = 0.79$) but the only significant correlations were between proficiency and F2 of [i] and [ɑ] ($p < 0.05$).

In Table 1 are summarized significant differences between the PROFICIENT and UNPROFICIENT Croatian speakers of English and the so-called Received Pronunciation (RP) as measured by Henton [7]. This particular reference was chosen, because it contained data for all 11 vowels measured in this study, and because Croatian students of English are taught Received Pronunciation at all levels of formal English learning.

	[i]		[ɪ]		[ɛ]		[æ]		[ʌ]		[ɑ]		[ɒ]		[ɔ]		[ʊ]		[u]		[ɜ]		
	F1	F2																					
P					**	**	**	**					*	**	**	**	**	**	**	**	*		
U	**	**			**	**					**	**		**	**	**	**	**	**	**			

Table 1. Significant differences between F1 and F2 values in RP and proficient (P) and unproficient (U) Croatian speakers of English (* for $p < 0.05$; ** for $p < 0.01$)

As it can be seen from Table 1, there are fewer significant differences between the proficient Croatian speakers of English and RP values. However, the difference between the two groups of Croatian subjects is not as large as originally expected. The only significant differences between them are in the articulation of [i, ɔ, ɜ]. This may be due to relatively small differences in their proficiency level (as reflected in the narrow range of grades used by the judges).

The information in Table 1 analyzed together with Figure 1 gives an idea about the relationship between the vowel space of native English speakers, and proficient and unproficient Croatian speakers of English.

Moving of the pronunciation of [ʊ] and [u] further back and closer together (in the direction of Croatian [u]), as well as moving of [ɔ] toward the front (in the direction of Croatian [ɔ]) may be the consequence of the "magnet effect", according to which the L2 vowels that are different but sufficiently similar to L1 vowels are drawn toward the positions of those L1 vowels

they resemble [10]. The same effect is exhibited by [ʌ, ɑ, ɒ] that tend to be grouped around RP [ʌ, ɑ], moving in the direction of Croatian [a]. This corresponds to Flege *et al.*'s [5] data on the basis of which they concluded that adult beginners interpret L2 vowels as instances of the closest L1 vowel, and produce them accordingly. On the other hand, the merger of [æ] and [ɛ] half way between the two English vowels in Croatian speakers of English, in the position that is between Croatian [e] and [a] reflects the ability of Croatian speakers to distinguish the two English vowels from the closest Croatian ones but inability to discriminate between the two of them. This is manifested as replacing [æ] most frequently by a slightly more open variant of Croatian [e]. In other words, the difficulties that Croatian speakers of English have in auditory discrimination between [æ] and [ɛ] are reflected in their too open pronunciation of [ɛ], and too close pronunciation of [æ].

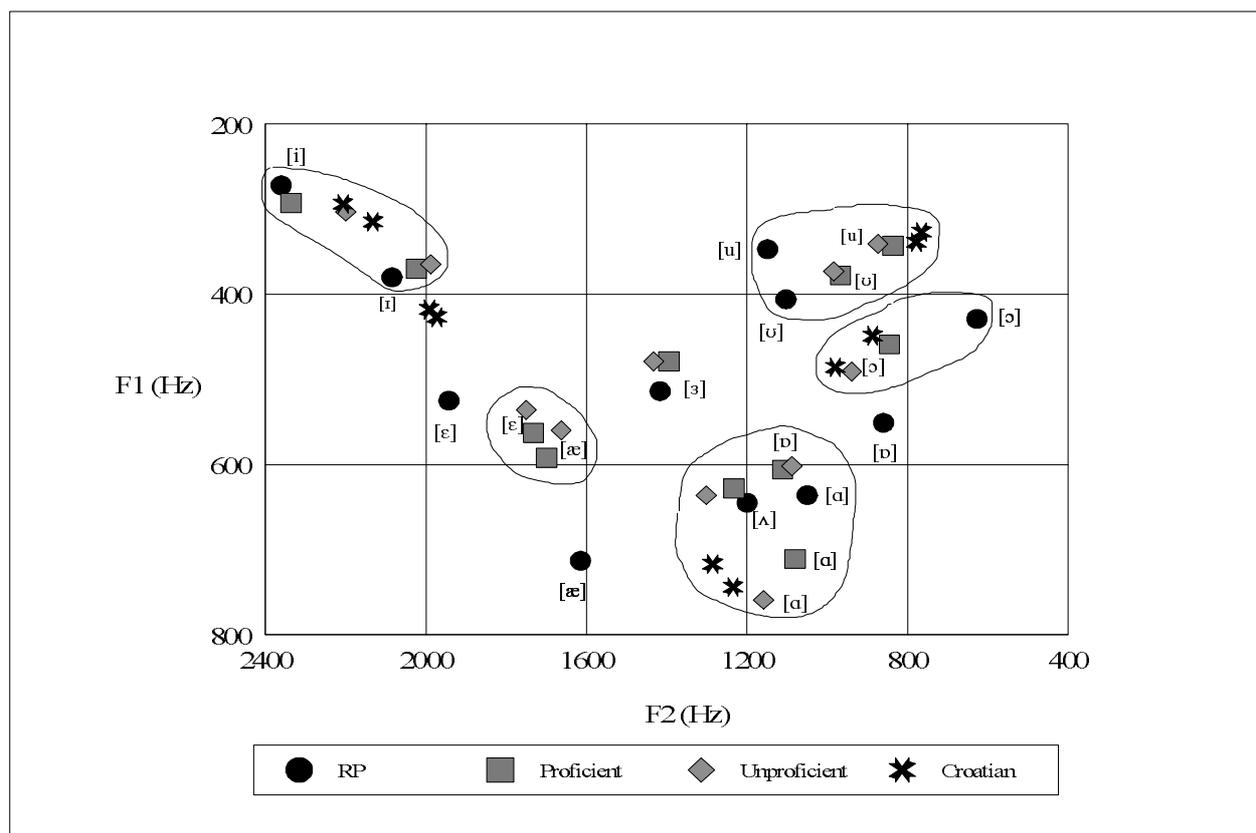


Figure 1. English vowel space of RP [7], proficient Croatian speakers of English, unproficient Croatian speakers of English, and Croatian vowel space of the same talkers.

Such behavior is opposite to the effect that crowding has on the perception of vowel dissimilarity found in some studies reported by Flege *et al.* [3]. This may be explained by the tendency of Croatian speakers to reorganize the more crowded English vowel space into fewer categories that correspond to the Croatian ones: on closer inspection of Figure 1, apart from the position of neutral [ɜ] which roughly corresponds to the Croatian syllabic [r] [1], five distinct groups of vowel realizations may be noticed. They utilize the vowel space economically albeit not as continuously as the original RP vowels. In other words, Croatian speakers of English replace the principle of sufficient contrast, underlying the organization of English vowel space, by the principle of maximal contrast, which resembles more closely their own native Croatian. A similar relationship was found between the vowel spaces of American English and Modern Greek [6].

Duration data for Croatian speakers of English are presented in Table 2. Standard deviations are given in parentheses.

Vowel	Proficient	Un-proficient	Native E.
[i]	193 (37)	186 (43)	235 (58)
[ɪ]	110 (21)	109 (10)	202 (54)
[i]:[ɪ] ratio	1.79 (0.33)	1.73 (0.52)	1.16
[u]	184 (39)	181 (47.89)	232 (66)
[ʊ]	120 (23)	114 (22.14)	199 (55)
[u]:[ʊ] ratio	1.58 (0.42)	1.67 (0.62)	1.17

Table 2. Mean vowel durations (in ms) and tense : lax ratios for Croatian speakers of English grouped according to proficiency, and native English speakers [15].

The differences in duration between tense and lax counterparts were significant for both pairs ($p < 0.00$), tense vowels being considerably longer than the lax ones. However, there were no significant differences between the two groups. Comparison with literature data for native speakers of English [15] exhibited significant ($p < 0.01$) differences in durations of all four measured vowel durations, as well as in the ratios between the tense and lax pairs ($p < 0.03$). In this study all vowels were significantly shorter than the comparable data reported by Munro [15], but all ratios were significantly greater. In other words, regardless of their proficiency, Croatian speakers of English rely heavily on duration-based distinctions between [i] and [u] on the one hand and [ɪ] and [ʊ] on the other.

4. CONCLUSION

In their production of English vowels Croatian speakers tend to reorganize the more crowded English vowel space (11 monophthongs as opposed to the Croatian 5) by mapping the principle of maximal contrast underlying the Croatian vowel system onto the vowel space of English, thus replacing the original principle of sufficient contrast. In distinguishing between the high tense:lax pairs of English vowels they use primarily duration cues, rather than differences in quality. Proficiency in English had no significant effect on either the position of most vowels in the vowel space or the trade-off

between duration and quality cues. This may be due to the fact that all the subjects were rated fairly well, regardless of the length of their formal learning of English.

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