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Duration of English Vowels as Pronounced by Croatian Speakers of English

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To my grandfather

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I dedicate this paper to my beloved grandfather Vladimir – the only one of my closest family who has not lived to see me graduate.

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1. Introduction

There are many Croatian speakers of English as a foreign language. In Croatia, a foreign language as a compulsory subject in schools is learned from the age of 7 – that is, from the first grade of primary school onwards. Very often, primary schools offer the choice of two to three foreign languages, one of which is usually English. Therefore, a lot of children in Croatia learn English for the whole duration of their education. If successful, by the time one graduates from high school, one has a proficient knowledge of English, to the level at which one is able to fluently communicate in English in most everyday situations.

However, a relatively small amount of attention is given to the phonetic training of the EFL learners in Croatia. Therefore, Croatian speakers of English transfer some of the habits from their native language into their speech when talking English. Some of those habits are also obvious in terms of vowel duration, which is conditioned differently in English and in Croatian, as this study will show.[1]

The aim of this study is twofold. Firstly, it aims to show to what extent the voicing of the postvocalic consonant in monosyllabic words influences the duration of the preceding vowels in English and in Croatian, and thus, to predict to what extent Croatian speakers are likely to achieve native-like results when pronouncing English monosyllabic words in terms of the duration of their nuclei vowels.

The second aim of the study is to predict to what extent duration of English vowels changes when pronounced by Croatian speakers and by the English speakers, respectively, in the stressed first syllables of disyllabic words compared to the monosyllabic words which contain the same vowel as a nucleus, followed by the same postvocalic consonant. Furthermore the goal of this part will be to test to what extent Croatian speakers of English

[1] Cf. sections 2.1.6. and 3.1.3.

are similar to or different from the native speakers of American English in terms of those changes in vowel duration.

First step to achieving both of these two goals will be to present the earlier work on these topics.[2] Relying on this work, research questions and hypotheses will be produced.[3] Generally spoken, the hypotheses will predict firstly that Croatian speakers of English do not lengthen the vowels as effect of the voicing of the postvocalic consonant to the same extent as the American native speakers do and secondly, that the Croatian speakers will shorten the vowels of the stressed initial syllable of a disyllabic word as a function of the introduction of the second syllable more than the American native speakers.

After having set up the hypotheses, experimental work will be produced, in which nine Croatian speakers of English and nine American native speakers of English will be recorded in controlled conditions.[4] They will be provided with stimuli which will consist of English monosyllabic and disyllabic words.[5] Those words will be used as carrier words for the vowels of Standard American English. The participants will be asked to read those words out loud while they are being recorded by a microphone. Thus, an audio corpus will be built. The recordings will be analyzed in terms of vowel duration by the means of SFS/WASP – computer software for phonetic analysis. All the duration data will be systemized in terms of the earlier set hypotheses, necessary calculations will be made and the results will be tested for their statistical significance by the means of SPSS, software for statistical analysis. Finally, that data will be used in order to conclude whether or not the hypotheses of this study can be accepted as valid or not.

[2] Cf. sections 2.1. and 3.1.

[3] Cf. sections 2.2. and 3.2.

[4] Cf. section 2.3.

[5] For an extensive explanation of the criteria according to which the stimuli were chosen, as well as for the list of the carrier words, cf. sections 2.3.2. and 3.3.2.

2. Influence of the voicing of the postvocalic consonant on vowel duration

2.1. Theoretical framework

2.1.1. A note on terminology – vowel duration vs. vowel length

In order to prevent ambiguity in the following sections, a clear terminological foundation needs to be set at the very beginning. Fox (2000: 22), discusses the differences and similarities between these terms 'length', 'duration', 'quantity' and 'weight'. He indicates that the term 'length' can be left free for phonological use. The term 'weight' is, according to him, used in relation to syllable length. 'Quantity' is, in his words, used in relation to metrical values, but also more generally. Fox here refers to Allen (1973), who suggests using 'quantity' for syllabic length. Finally, when talking about the term 'duration', Fox states that "[t]he duration of a sound is measured in absolute terms, viz. in milliseconds or centiseconds, with no phonological implications." (2000: 22) In the same text, he suggests that this term is accepted and common term for referring to "'phonetic' length, i.e. the absolute physical length of a sound or syllable."

Lodge has a simpler approach to this topic. He introduces only two terms:

> […] it is preferable to distinguish between phonological length and phonetic duration. The former, which may or may not relate to duration […], has to be established in relation to the ways in which long and short partners behave in the language concerned, for example, what kind of syllable they can occur in. The latter is either based on auditory judgment of relative duration, or is measured in milliseconds. (2009: 120)

Following the suggestions made by those two authors, the term 'length' will be used in terms of phonology and 'duration' will be used for describing temporal values of produced sounds in the following text.

Another possible point of discussion is presented by Fox (2000: 22). Namely, he says that:

> ‘length’ provides us with the terms long and short, […] but there are no corresponding terms for ‘duration’ or ‘quantity’, so that we must again have recourse to ‘long’ and ‘short’, perhaps with qualifications such as ‘phonologically long’, ‘phonetically short’, and so on.

Therefore, special attention will be paid when using the terms ‘long’ and ‘short’ with respect to the context to which they are applied (i.e. phonetically or phonologically long or short), in order to prevent eventual ambiguity in further text.

2.1.2. Vowel inventory of Croatian

According to Brozović (1991: 408-9), phonologically, there are six vowels in Croatian: [a], [e], [i], [o], [u] and [ə]. Brozović sorts them as follows:

1.

	I.	II.	III.	IV.	V.
1.	i				u
2.		e	ə	o	
3.			a		

Legend:

Horizontally:

I. First front place of articulation
II. Second front place of articulation
III. Middle place of articulation
IV. First back place of articulation
V. Second back place of articulation

Vertically:

1. High position of the tongue, smallest opening
2. Middle position of the tongue, middle opening
3. Low position of the tongue, greatest opening

Brozović (1991: 409) states that no additional positions, such as the intersections of 1/2 and I/II or IV/V and 2/3, are necessary for the norm of use of standard Croatian. Additionally, (1991: 406) he considers [ə] to be only an “additional” vowel, which is used mainly as a help in pronunciation of standalone consonants (for example [bə], [cə], [čə], [ćə], [də]).

He goes on in describing the vowel system of Croatian, by saying that:

> Samoglasnički fonovi hrvatskoga književnog jezika [...] mogu biti i dugi i kratki [...]. Oni se [...] ostvaruju u izgovornom pogledu podjednako, iako su dugi vokali neprimjetno zatvoreniji, no uporabna norma hrvatske ortoepije ne tolerira osjetnijih razlika u otvorenosti ili zatvorenosti. Drugim riječima, dugi se samoglasnici razlikuju od kratkih praktički samo po relativnoj kvantiteti, koja dakle ne utječe osjetno na glasovnu kvalitetu vokalskih fonova kao što to inače biva u mnogim jezicima. [Vowel phones of standard Croatian language […] can be both long and short […]. In terms of pronunciation, they are [...] being realized approximately in the same way, although the long vowels are inappreciably more closed, but the usage norm of Croatian orthoepy does not tolerate more perceivable differences in openness or closedness. In other words, long vowels differ from the short ones practically only in their relative quantity, which does not influence phonic quality of the vowel phones noticeably as it is usually the case in many languages.] (Brozović 1991: 405)

Pletikos (2008: 12) refers to a number of authors of, as she calls them, "normative books for standard Croatian" (Babić et. al. (1991); Težak & Babić (1992); Barić et. al. (1995); Raguž (1997); Ham (2002); Klaić (1979); Anić (1991); Anić & Goldstein (1999); Šonje (2000); Babić et. al. (2007); Vukušić, Zoričić & Grasselli-Vukušić (2007)), when describing Croatian accentual system as a four-accent system, containing a long-falling, long-rising, short-falling and short-rising accent, as well as phonologically short and long postaccentual syllables. The following table shows the examples of the notation of the accents and postaccentual lengths (cf. Pletikos 2008: 12):

Table 1: Notation of the accents and postaccentual lengths in Croatian

	Notation	Example	Translation
Long-falling accent	ˆ	zlâto	gold
Long-rising accent	´	rúka	hand
Short-falling accent	̏	kȕća	house
Short-rising accent	`	žèna	woman
Short postaccentual syllable	¯	vòjnīk	soldier
Long postaccenutal syllable	˘	vìtăk	slim

Furthermore, Pletikos (2008: 12) says that minimal pairs of words which differ only on the basis of accent (Pletikos calls them 'isographic heterophones') can be found in Croatian.

There are instances of those pairs made by the opposition of each of the four accents (grâd – grȁd, râdio – rádio , kȕpiti – kúpiti, pàra – pàra, Péro – pèro); however, she adds, there are no words of the same segmental structure which could be differentiated by opposing all the four accents.

Bakran (1984: 48-49) presents the results of an experiment on duration of vowels in Croatian by Lehiste & Ivić (1963), and adds the results of some of his own measurements. He presents those results in a following way (expressed in milliseconds):

Table 2: Duration of vowels in Croatian

Measurement condition	i	e	a	o	u
Vowels under long accents in words inside of a frame sentence (Lehiste & Ivić 1963)	184	181	222	220	204
Vowels under short accents in words inside of a frame sentence (Lehiste & Ivić 1963)	123	135	139	148	127
Vowel duration under long accents in connected speech (Bakran 1984)	77	86	106	89	76
Vowel duration under short accents in connected speech (Bakran 1984)	57	67	77	74	62

Out of the table above, it is evident that the type of accent exhibits a significant influence on duration of each of the vowels, thus creating a short-long contrast for each of the vowels on a phonetic level. It is also evident that Bakran "grouped" the accents into the "long" and the "short" ones here, omitting their differences in tone (i.e. rising or falling). Following his example, this feature will not be paid attention to in this study as well, its subject matter not being the tone anyway.

Škarić (1991: 322) explains the topic of vowel duration in Croatian into greater detail by saying that:

> [u]nutarnja se prozodijska duljina (kvantiteta) slogova [u hrvatskom] ostvaruje tako što prozodijski dugi slogovi imaju dulje trajanje samoglasnika nego prozodijski kratki u istim uvjetima. Dugosilazni je naglašeni slog za 30% dulji nego kratkosilazni a dugouzlazni za prosječno 22% dulji nego kratkouzlazni. [[i]nternal prosodic length (quantity) of syllables [in Croatian] is realized in such a manner that prosodically

long syllables have longer vowel duration than the prosodically short ones in the same conditions. The long-falling stressed syllable is 30% longer than the short-falling one and the long-rising one is on average 22% longer than the short-rising one.]

In other words, the duration of a vowel in Croatian depends on a type of accent which is applied to a syllable which contains the respective vowel. Škarić supports this when listing all the phonemes of Croatian, together with their positional variants and examples of their use (1991: 352-354). Here is how he lists the vowels of Croatian (cf. Škarić 1991: 352):

Table 3: Vowels of Croatian and their positional variants

Phoneme	Positional variant	Examples	Translation
/i/	[i]	[sîn], [vìdīm]	'son', 'I see'
/e/	[e]	[šêst], [žènē]	'six', 'women'
/a/	[a]	[znâš], [dánā]	'you know', 'of the days'
/o/	[o]	[nôs], [dòbro]	'nose', 'good'
/u/	[u]	[tû], [sùtra]	'here', 'tomorrow'

It is important to notice that he lists only five vowel phonemes[6] but examples of both short and long realizations of each of them,[7] as influenced by a short or a long accent. That supports the earlier mentioned claims that each of the vowel phonemes in Croatian can have both a long and a short realization. Out of the table above, it is also evident that each of the vowel phonemes has only one positional variant, i.e. there is no difference in vowel quality between short and long realizations of the respective phonemes.

Out of the observations above, one can safely conclude that, phonemically speaking, vowel inventory of Croatian consists of five elements, namely /a/, /e/, /i/, /o/ and /u/. Each of them can be phonetically realized both as a short or a long vowel, depending on the accent which

[6] Škarić (1991) also mentions the sixth vowel, /e/, the positional variant of which is a diphthong [ie]. This is, however, irrelevant for this study, since it deals only with monophthongs, and will therefore not be examined.

[7] The examples of realizations of the phoneme /a/ are both long here (long-falling and long-rising). This should not be taken as an indication that short accent can not be applied to /a/ in spoken Croatian. Some examples of /a/ under short accents are: 'lȁv' (lion), 'mȁč' (sword), 'sàkupiti' (gather) and 'dàdilja' (nanny) (cf. Anić, 2003).

influences the syllable which contains the respective vowel. Minimal pairs of words can be built on the basis of the accent which is applied to them. This shows that the accent in Croatian has a contrastive role and, further on, that vowel duration contrast in Croatian is produced on the suprasegmental level.

2.1.3. Influence of the voicing of the postvocalic consonant on vowel duration in Croatian

Bakran (1984: 99-118) mentions word prosody and consonantal environment as relevant factors in terms of influence on vowel duration in Croatian. Apart from the type of accent, as described in the previous section, voicing of the postvocalic consonant also plays an important role in determining duration of vowels in Croatian: Vowels are longer when followed by voiced consonants than when they are followed by voiceless consonants. (Bakran 1996: 269-270). However, not every type of consonant influences the duration of the preceding vowel in the same manner. The table below shows the duration values (in milliseconds) of vowels in function of the postvocalic consonant in connected speech in Croatian (Bakran 1996: 270):

Table 4: Vowel duration in function of different postvocalic consonant in connected speech in Croatian

voiceless stops	voiced stops	nasals	voiceless fricatives	voiced fricatives
55	60	60	70	71

Bakran (1996: 270) comments on this table by noting that the influence of the voicing of the postvocalic consonant can not be proven in the case of vowels followed by voiced or voiceless fricatives. However, he claims the difference in duration of five milliseconds in the case of vowels followed by voiced or voiceless stops to be statistically significant. He also presents an experiment in which, in isolated two- and three-syllable words, duration of vowels of 124 milliseconds in front of voiceless stops and 140 milliseconds in front of voiced stops was measured, thus producing an even more prominent difference of 16

milliseconds (Bakran 1984: 115-116). In other words, a duration ratio of vowels before voiceless stops and vowels before voiced stops was 1:1,13.

2.1.4. Vowel inventory of English

Wells ([1998], 1: 120) presents the vowel system of General American English in the following way:

2.

ɪ	ʊ	i			u		
ɛ	ʌ	eɪ	ɔɪ		o	ɜ	ɔ
æ			aɪ	aʊ		ɑ	
checked		*free*					

Adding to this, Wells ([1998], 1: 120) also mentions [ə] and [ɚ], which, according to him, are "restricted to weak (unstressed) syllables. He also mentions ([1998], 1: 121) that, /ə/ and /ɜ/ can be treated as phonologically identical.

Furthermore, Wells exemplifies the lexical incidence of the previously mentioned vowels by using a "standard set of keywords" ([1998], 1: 121-122):

3.

KIT	ɪ	FLEECE	i	NEAR	ɪr
DRESS	ɛ	FACE	eɪ	SQUARE	ɛr
TRAP	æ	PALM	ɑ	START	ɑr
LOT	ɒ	THOUGHT	ɔ	NORTH	ɔr
STRUT	ʌ	GOAT	o	FORCE	or
FOOT	ʊ	GOOSE	u	CURE	ʊr
BATH	æ	PRICE	aɪ	*happ*Y	ɪ
CLOTH	ɔ	CHOICE	ɔɪ	*lett*ER	ɚ
NURSE	ɜ˞	MOUTH	aʊ	*comm*A	ə

One might notice here that Wells lists the vowel *ɒ* only when talking about the lexical incidence of the vowels in American English. He accounts for that by describing the THOUGHT-LOT merger (Wells [1990], 3: 473-475). Briefly described, he says that in some regions of the United States, the speakers do not perceive the difference between those two vowels. Both of them are, however, present in everyday speech and a great number of speakers preserve the opposition between those two vowels.

Out of the above data, a monophthong inventory[8] of General American can be presented as follows: /ɪ/, /i/, /ɛ/, /æ/, /ʌ/, /ɑ/, /ʊ/, /u/, /o/, /ɔ/ and /ɒ/.

According to Ladefoged (1975: 223), "[i]n English, variations in [duration] are completely allophonic." In other words, unlike in Croatian (cf. sections 2.1.2. and 2.1.3.), variation in duration of vowels in English is not contrastive. In English, the contrast is realized on a phonological level, between the two counterparts within tense-lax vowel pairs. One has to add here that "the qualities of the long and the short vowels [in a vowel pair in English] are often different, /i/ and /ɪ/ for instance, so length is not the only distinctive feature." (O'Connor [1984]: 197).

2.1.5. Influence of the voicing of the postvocalic consonant on vowel duration in English

Wells ([1998], 1: 120) claims that "[v]owel length (duration) is not as important in [General American] as in some other accents; all vowels vary somewhat in duration depending on their phonemic environment." According to Arnold & Hansen (1995: 100-101), the factors which influence vowel duration in English are voicing of the postvocalic consonant, rhythm, stress and intonation.

Lehiste (1970: 19), referring to a number of sources (House & Fairbanks (1953); Zimmerman & Sapon (1958); Peterson & Lehiste (1960); House (1961); Delattre (1962)) states that "in English, the voicing of a postvocalic consonant strongly affects the duration of a preceding vowel." She adds (24) that, according to a study by Peterson & Lehiste (1960),[9] "the durational ratio of vowel before voiceless consonant to vowel before voiced

[8] Since this study deals only with stressed monophthongs, the diphthongs and the reduced monophthongs are omitted here.

[9] According to Lehiste (1970: 24), Peterson & Lehiste (1960) used "minimal pairs and triplets such as *heat-heed* and *back-bag-bang*" in their study. That indicates that they conducted their study on the corpus which consisted of isolated words and not words in connected speech.

consonant […][is] 2:3."[10] According to Arnold and Hansen (1995: 100) and Chen (1970: 129), in English, vowels which are followed by voiced consonants are generally longer than the vowels which are followed by voiceless consonants.

2.1.6. Comparison of vowel systems of English and Croatian

Out of the previous sections, one can safely conclude that the voicing of the postvocalic consonant influences the duration of the stressed vowel which precedes it: the vowels which are followed by voiced consonants have greater duration values than the vowels which are followed by voiceless consonants. Bakran (1996: 270) even says that this is the case in many languages and that it can be considered a universal principle. Some features of American English and Croatian vowel systems, which were discussed in the earlier sections and which are relevant for this study are laid out in the following table:

Table 5: Comparison of vowel systems of Croatian and American English

	Croatian	English
Vowel inventory	/a/, /e/, /i/, /o/, /u/	ɪ/, /i/, /ɛ/, /æ/, /ʌ/, /ɑ/, /ʊ/, /u/, /o/, /ɔ/, /ɒ/
Processes and features on the phonological level	///	-tense-lax (long-short) opposition is built -difference in quality among the members of the same vowel pair
Processes and features on the phonetic level	-type of accent conditions the duration of a vowel – long-short opposition is built -no significant difference in quality among the members of a long-short vowel pair -voicing of the following consonant influences the duration of a vowel (vowels are longer when followed by voiced consonants)	-voicing of the following consonant influences the duration of a vowel (vowels are longer when followed by voiced consonants)
Duration ratio: vowel before voiceless consonant vs. vowel before voiced consonant (isolated words)	1:1,13 (only in the case of stops – in the case of fricatives, no difference could have been proven)	1:1,5

[10] For easier comparison of these values to the ones in the case of Croatian it is useful to normalize them: thus, this ratio can be also presented as 1:1,5

2.2. Research question and research hypothesis

2.2.1. Research question

Having presented and discussed the vowel inventories and the influence of the voicing of the postvocalic consonant in English and Croatian, a question can be set: Does the lengthening of vowels before voiced consonants occur to the same extent in the case of Croatian speakers pronouncing English words as in the case of native speakers of American English pronouncing the same words? Compared to native speakers of English, to what extent do Croatian speakers assume the lengthening process conditioned by the voicing of the postvocalic consonant when talking English?

2.2.2. Research hypothesis

The previous sections show that the voicing of the postvocalic consonant influences the duration of the preceding vowel both in Croatian and in English. The influence is the same in its manner: Vowels before voiced consonants are longer in their duration than the same vowels before voiceless consonants. However, as presented earlier in this paper, the previous research (Peterson & Lehiste (1960), Bakran (1984)) have shown that the influence of the voiced postvocalic consonant is greater in English than in Croatian, i.e. it creates a greater duration ratio.[11] In other words, the lengthening of a vowel before voiced consonant occurs to a greater extent in English than in Croatian. Also, it was shown that the voicing of postvocalic fricatives in Croatian does not have a statistically significant influence on vowel duration whereas the voicing of postvocalic stops influences the duration of the preceding vowels significantly. No specific data on this topic has been provided for English. Claims were produced that the vowels are longer when followed by voiced consonants in general, with no specific remarks on their quality.[12] Hence, one may conclude that, unlike in

[11] Cf. sections 2.1.2. and 2.1.5.

[12] Cf. section 2.1.5.

Croatian, the duration of a vowel is also affected by the voicing of a postvocalic fricative in English.

Therefore, a threefold hypothesis for the empirical part of this study will be produced: Firstly, Croatian speakers of English will not assume the lengthening of vowels before voiced stops to the same extent when talking English as the native speakers of English do. The duration ratio in the case of vowel before voiced vs. vowel before voiceless stop, which they produce when talking English will be smaller than the duration ratio of the same phonetic material produced by native speakers of English.

Secondly, the duration ratio in the case of vowel before voiced vs. vowel before voiceless fricative would be greater when produced by native speakers of English than by Croatian speakers of English.

Thirdly, the duration ratio of vowels followed by voiced vs. vowels followed by voiceless fricatives will be even smaller than the one of vowels followed by voiced vs. voiceless stops in the case of Croatian speakers of English.

These hypotheses could be presented by the following formulae:

4.

1. $\frac{(V+S(+voiced))_E}{(V+S(-voiced))_E} > \frac{(V+S(+voiced))_C}{(V+S(-voiced))_C}$
2. $\frac{(V+F(+voiced))_E}{(V+F(-voiced))_E} > \frac{(V+F(+voiced))_C}{(V+F(-voiced))_C}$
3. $\frac{(V+S(+voiced))_C}{(V+S(-voiced))_C} > \frac{(V+F(+voiced))_C}{(V+F(-voiced))_C}$

Legend:

V = vowel

S = stop

F = fricative

$(+voiced)$ = feature: voiced

$(-voiced)$ = feature: voiceless

$_E$ = the case of native speakers of English

$_C$ = the case of Croatian speakers of English

In this case, the contents of each of the brackets respectively present a duration value of a vowel in specific conditions. So, for example, $(V + S(+voiced))_E$ would mean 'duration of a vowel which is followed by a voiced stop, spoken by a native speaker of English', and $(V + F(-voiced))_C$ would mean 'duration of a vowel which is followed by a voiceless fricative, spoken by a Croatian speaker of English.'

The experiment by which the hypotheses above were tested in practice will be presented in the following sections.

2.3. Experiment

In order to prove the theoretical premises on this topic, an experiment was conducted, during which a number of Croatian and American speakers of American English were recorded while they were reading a pre-defined list of words. The experiment is described into greater detail in the following text.

2.3.1. Participants

Eighteen volunteers were found – nine Croatians and nine Americans. All the volunteers were female; hence, the recordings were named AF1-AF9 (meaning *American Female*) and CF1-CF9 (meaning *Croatian Female*). The recording process was conducted anonymously, i.e. none of the participants was asked for their name. After having read the word lists, Croatian participants were asked to fill in a questionnaire on their level of knowledge in English, their level of education and age. The data elicited by the questionnaires will be presented in the ongoing text.

Additionally, a Croatian girl who was raised in a Croatian family in the United States was recorded. Her case will be analyzed separately in order to observe how her pronunciation skills have developed in a bilingual environment.

2.3.1.1. Control group – Native speakers of American English

Control group consisted of nine native speakers of American English. All of them were born and grew up in the United States of America. They are between 22 and 58 years of age and have at least a B.A. degree.

2.3.1.2. Experimental group – Croatian speakers of American English

This group consisted of nine Croatian high school seniors (attending "Gornjogradska gimnazija", Zagreb), who have excellent marks in English. The selection among the pupils was made by their teachers of English. The ones whose pronunciation was evaluated as excellent were included in the experiment. All of the students had been learning English for at least seven years at the time of recording. None of them had been raised bilingually nor had lived in an English-speaking country for longer than a week.

Such learners of English are supposed to have a level of knowledge proficient enough for them to speak fluently. On the other hand, they have not been exposed to any extensive phonetic training and thus, they are not aware of the majority of phonetic elements of their mother tongue which they should suppress or change in order to achieve as native-like Standard American English accent as possible. Therefore, they were chosen as a valid experimental sample. According to their teachers, the students prefer American English to British English when speaking. This was confirmed by the students themselves. Therefore, a group of American speakers could be taken as a valid control group for this experiment.

2.3.2. Stimuli

Two lists of monosyllabic carrier-words were created. In the first list, each word carried a respective vowel which was a part of vowel inventory of American English, followed by voiced and then by voiceless alveolar stop. In the second list, the choice of carrier words was such that the same vowels were followed by voiced and voiceless alveolar fricatives. The choice of the carrier words is presented in the table below:

Table 6: Carrier words which were used in the first part of the experiment (influence of the voicing of the postvocalic consonant on the duration of the preceding vowel)

Vowel (GA)	[d] – [t]	[z] – [s]
i	bead – beat	tease – peace
ɪ	bid – bit	Liz – kiss
ɛ	bed – bet	says – chess
æ	bad – bat	jazz – pass
u	mood – boot	booze – goose
ʊ	could – put	wuzz – wuss
ɔ	broad – brought	cause – sauce
ʌ	Bud – butt	buzz – bus

The words were mixed up before they were presented to the interviewees, so that they would not notice any logical bonds between them. Thus, any attempts of overexaggeration of the utterances were prevented, which the participants might want to produce in order to deliberately produce noticeable difference if they saw the words pairwise.

2.3.3. Procedure

Croatian interviewees were recorded in an empty classroom of "Gornjogradska gimnazija" high school in Zagreb. American speakers were recorded either at their temporary homes in Croatia and Austria or at the places where they work. In all cases, attempts were made to achieve the most studio-like recording conditions, i.e. background noise and echo were reduced to the minimum level possible.

All the speakers were recorded by the computer software "SFS/WASP". Recorded data was saved in .wav format at a sample rate of 44100 Hz and audio sample size of 16 bit. The bit rate of the files is 705 kbps.

Croatian speakers were recorded using Apogee Mini-Me A/D Converter and Neumann KM 184 P48 microphone. American speakers were recorded using the AKG D-24 microphone.

Each participant of the experiment was recorded separately. None of them was able to hear any of the other participants read the words. First, the word list was presented to a

participant, who was instructed to silently skim read the words in order to get familiar with them. Before reading, the Croatian interviewees were encouraged to ask any possible questions on the words (e.g. what they mean), which were consequently answered. None of the participants was informed about the goal of the study before having read the word lists.

2.3.4. Measurements and the analysis of data

The recorded files were analyzed using the SFS/WASP software for phonetic analysis. Duration of each of the vowels was measured, and its duration value was entered into a table in order to get average duration values for each of the vowels and each of the speakers. This was done with the help of the Microsoft Office Excell program. The carrier words were sorted into pairs again, together with their durational values. Then, duration ratio was calculated for each speaker and each vowel, first followed by voiced and voiceless alveolar stops, and then by voiced and voiceless alveolar fricatives, as described in section 2.2.2. of this study. That resulted in nine duration ratio values per each vowel and each case (i.e. followed by stops or by fricatives, respectively) in the CF group and nine in the AF group. Consequently, overall mean results and mean results for each vowel were calculated and then compared. Additionally, the duration ratios were compared within a t-test in order to prove the statistical significance of the elicited data. The results of the calculations will be presented and discussed in the ongoing sections.

2.3.4.1. Measurement criteria

Before beginning of the measurement of the recordings, rules for the measuring procedure were determined. They include the criteria according to which the onset and the offset of the vowel should be determined during the measurement process.

Flemming (2005: 1) instructs on this matter by saying that "[w]e aim to measure vowel duration from the release of the constriction of the preceding consonant to the formation of the constriction of the following consonant."

The only situations in which those two points can be clearly determined are the cases of vowels preceded or followed by stops, where the changes in the airflow appear very abruptly. In other cases, there is often a longer transition between the sounds of a word, so that sometimes it seems as if the end of one sound and the beginning of the other overlap (e.g. a vowel followed by a fricative) or as if the one sound glides into the other (e.g. a vowel preceded by an approximant). Therefore, sometimes, it might be difficult to determine a single point in which one sound ends and the other one begins. In order to measure durations of all the vowels in a uniformed way in cases like these, rules for measuring the duration of vowels within the carrier words of this experiment were determined. They were followed consistently throughout the course of the measurement.

Wright & Nichols (2009) have compiled a set of guidelines for measurement of vowel duration. They were used as the basis for determining measurement criteria of this experiment.

Firstly, they state that

> Most researchers include the consonant release burst and any aspiration following it as part of the vowel's duration since the onset of the release burst represents the transition point from the consonant closure into the vowel. […] Fricative noise is never included as vowel duration since fricative turbulence is only generated during the consonant's closure phase. When measuring around fricatives, look for the point where the fricative turbulence ends (or changes dramatically in intensity) and where higher formant structure becomes visible in the spectrogram […]. Similarly, when excluding the following consonant's closure, look for the point where there is a marked drop in intensity together with a loss of energy in the higher formants. (Wright & Nichols 2009: 2).

Furthermore, they add that:

> In measuring the duration of vowels flanked by approximants such or approximant /l/ /ɹ/ /j/ /w/ and approximant allophones of voiced stops and voiced fricatives, you have to make a decision about where the vowel ends and the consonant begins and be consistent in your measures. The spectrogram can help you make your decision; look

for a change in intensity in the higher formants that coincide with a point where the formants (especially F2 or F3) change abruptly. (Wright & Nichols 2009: 3)

All but one of the above suggestions were sorted into a following set of rules:

1. Do not include fricative noise into vowel duration – neither in the case of fricative preceding the vowel nor in the case of fricative following the vowel.
2. Determine the closure of the consonant following the vowel at the point of a significant drop of intensity and loss of energy in higher formants.
3. In the words in which the vowel is preceded by an approximant (i.e. Liz, wuzz, wuss, broad, brought, loosen) the beginning of the vowel is determined by the abrupt change of the F2 and F3.

The only suggestion which was not followed was to include the consonant release burst or aspiration as a part of vowel duration. Instead, the rule was set:

4. Determine the point in which the vowel formants are clearly visible as the starting point for the measuring of the duration of the vowel.

The reason for this is that not every vowel was preceded by the consonant of the same quality (cf. sections 2.3.2. and 3.3.2.). Thus, if one would include the consonant release burst or the eventual aspiration in the measurement, the measurement conditions would be less controlled: Sometimes within a pair, the burst would be greater and sometimes lesser (e.g. could-put), sometimes aspiration would occur, and sometimes not (e.g. Liz-kiss). In such pairs, the duration values of the pair members would not be comparable to each other – because the burst and/or the aspiration would increase the duration of only one member of such pairs and not of the other (e.g. Liz-kiss) or the duration of one member of the pair would be increased more than the duration of the other member (e.g. could-put).

The measurement rules were followed consistently throughout the measurement process, so that the duration values were all elicited according to the same criteria, and thus, can be compared to each other. As suggested by Flemming (2005: 1), the onset and the offset

points of each of the vowels were determined by examining the waveform and the spectrogram tracks.

A few examples of the application of these rules are presented in the spectrograms below:

Figure 1: Spectogram of the word *saucy* (speaker: AF7; vowel duration: 148 ms)

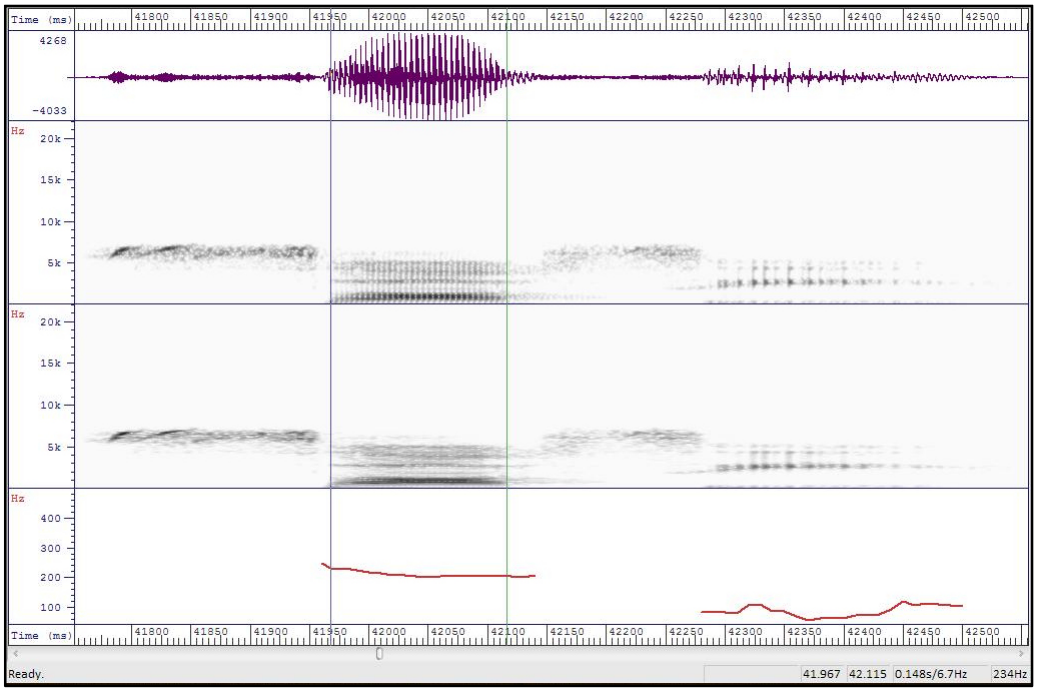


Figure 2: Spectogram of the word *chess* (speaker: AF3; vowel duration: 155 ms)

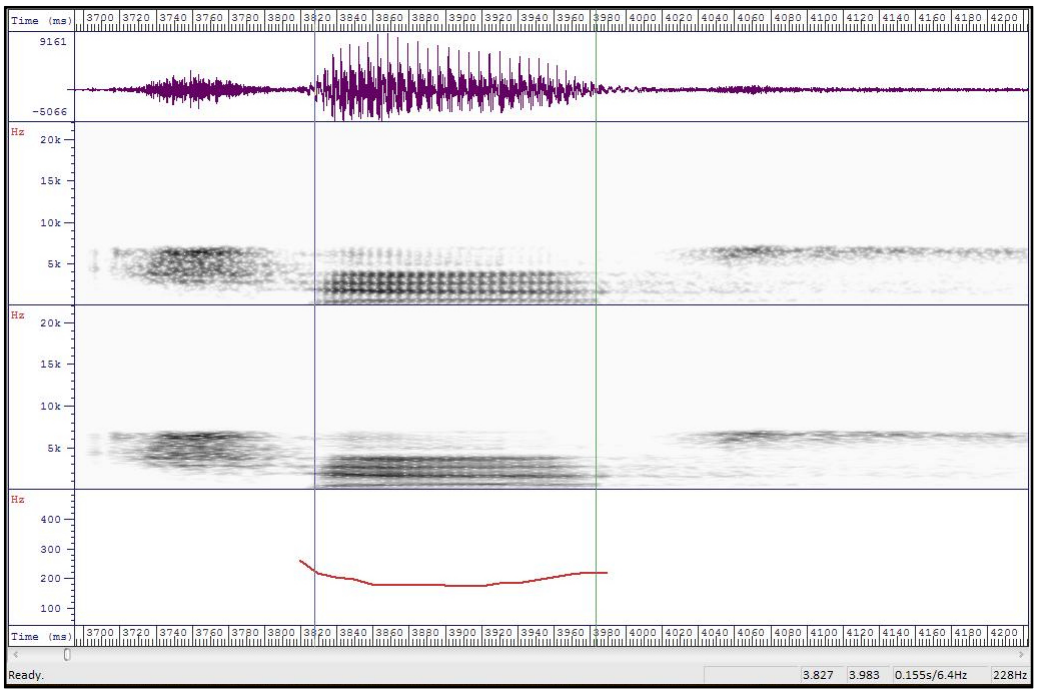


Figure 3: Spectogram of the word *brought* (speaker: AF8; vowel duration: 115 ms)

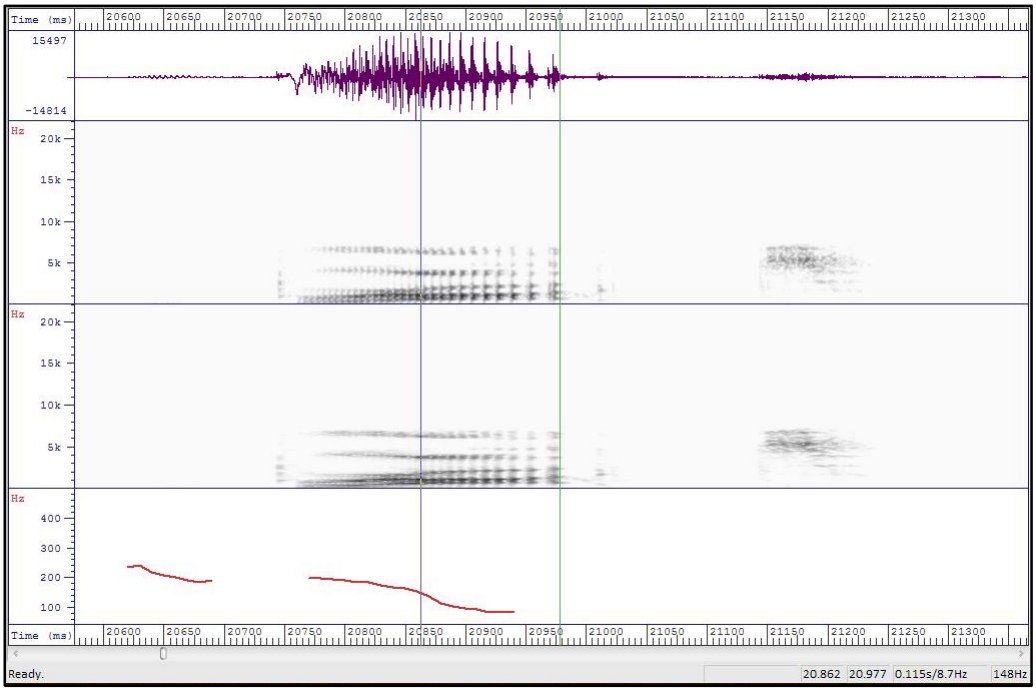
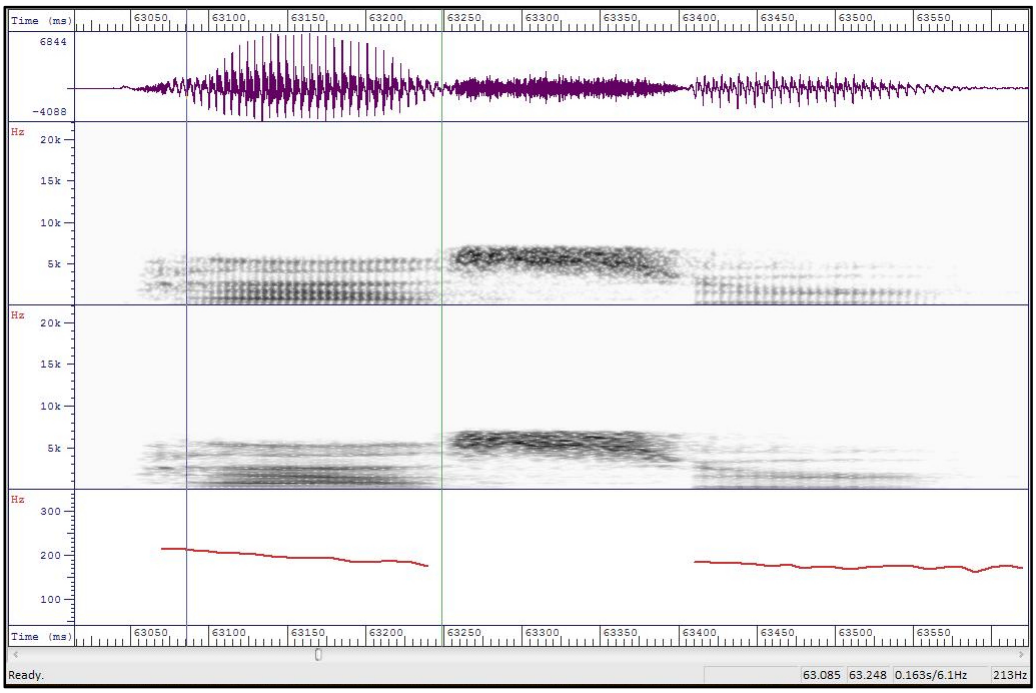


Figure 4: Spectogram of the word *passer* (speaker: AF6; vowel duration: 163 ms)



2.4. Results

As mentioned in the previous section, the results which were elicited by measuring the duration values of the recorded vowels were sorted and used for calculation so that duration ratio for each case was calculated. The duration ratios for each vowel and each case were calculated following the formula:

5.

$$\frac{\big(V + C(+voiced)\big)}{\big(V + C(-voiced)\big)}$$

Legend:
V = vowel
C = consonant
$(+voiced)$ = feature: voiced
$(-voiced)$ = feature: voiceless

Here, $\big(V + C(+voiced)\big)$ means 'duration of a vowel which is followed by a voiced consonant'. Logically, $\big(V + C(-voiced)\big)$ means 'duration of a vowel which is followed by a voiceless consonant'. Mean results of the calculations for each vowel and each case are presented in the table below:

Table 7: Duration ratios (influence of the voicing of the postvocalic consonant in monosyllabic words)

	CF	AF
/i/ + S	1,173027	1,634907
/ɪ/ + S	1,206472	1,78498
/ɛ/ + S	1,18901	1,388462
/æ/ + S	1,104773	1,490197
/u/ + S	1,252209	1,597572
/ʊ/ + S	1,337101	1,735671
/ɔ/ + S	1,241832	1,907393
/ʌ/ + S	1,216053	1,380883
/i/ + F	1,111196	1,838151
/ɪ/ + F	1,318776	1,744363
/ɛ/ + F	1,322074	1,712548
/æ/ + F	1,128051	1,413712
/u/ + F	1,18131	1,592033
/ʊ/ + F	1,050702	1,634351
/ɔ/ + F	1,1966	1,337693
/ʌ/ + F	1,283187	1,655008

The leftmost column presents each respective duration ratio case. For example, */ɪ/ + S* stands for the result of

6.

$$\frac{(/ɪ/ + S(+voiced))}{(/ɪ/ + S(-voiced))}$$

where $(/ɪ/ + S(+voiced))$ stands for 'duration of the vowel */ɪ/* which is followed by a voiced stop' and $(/ɪ/ + S(-voiced))$ means 'duration of the vowel */ɪ/* which is followed by a voiceless stop'. Following the same notation path, the example of */ɪ/ + F* presents the result of

7.

$$\frac{(/ɪ/ + F(+voiced))}{(/ɪ/ + F(-voiced))}$$

where $(/ɪ/ + F(+voiced))$ means 'duration of the vowel */ɪ/* which is followed by a voiced fricative' and $(/ɪ/ + F(-voiced))$ stands for 'duration of the vowel */ɪ/* which is followed by a voiceless stop'.

These results will be discussed in the following sections.

2.5. Discussion

The data which was elicited will be analyzed in terms of the three earlier mentioned hypotheses.[13] Each set of data will first be analyzed at the overall level (i.e. the mean values of the CF group and of the AF group respectively will be compared) and then the CF and AF results for each specific vowel will be compared. In order to prove the statistical significance of each of the comparisons, a paired samples t-test will be conducted in each case. The statistical significance will be confirmed or denied by observing and interpreting the level of statistical significance of the results (in statistics usually marked with the letter 'p', here marked with the abbreviation 'Sig.', as produced by the SPSS software). The level which will be taken as the norm for determining statistical significance will be 0,05. All the

[13] Cf. section 2.2.2.

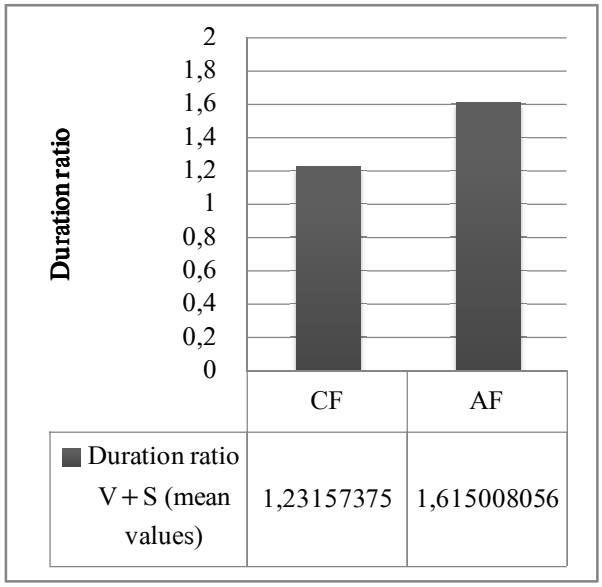
comparisons which have the Sig. value greater than 0,05 will be rejected and interpreted as statistically not significant. Logically, all the comparisons which have the Sig. value smaller than or equal to 0,05 will be accepted as statistically significant.

2.5.1. Hypothesis 1

2.5.1.1. Analysis of the overall results

The first hypothesis predicted that the American speakers would produce a greater duration ratio ———— than the Croatian speakers would do with the same phonetic material (cf. section 2.2.2.). As can be seen from the Figure 5, those predictions were right at the overall level:

Figure 5: Comparison of duration ratios (overall results – V+S)



By comparing mean duration ratio values, one can see that American speakers produced a duration ratio which is by ~0,38 greater than the one which the Croatian speakers of English produced. Overall duration ratio values were compared by means of a paired samples t-test. For this purpose, the SPSS software for statistical analysis was used. The table below presents the results of the t-test:

Table 8: Results of the paired samples t-test (overall results – V+S)

Paired Samples Test

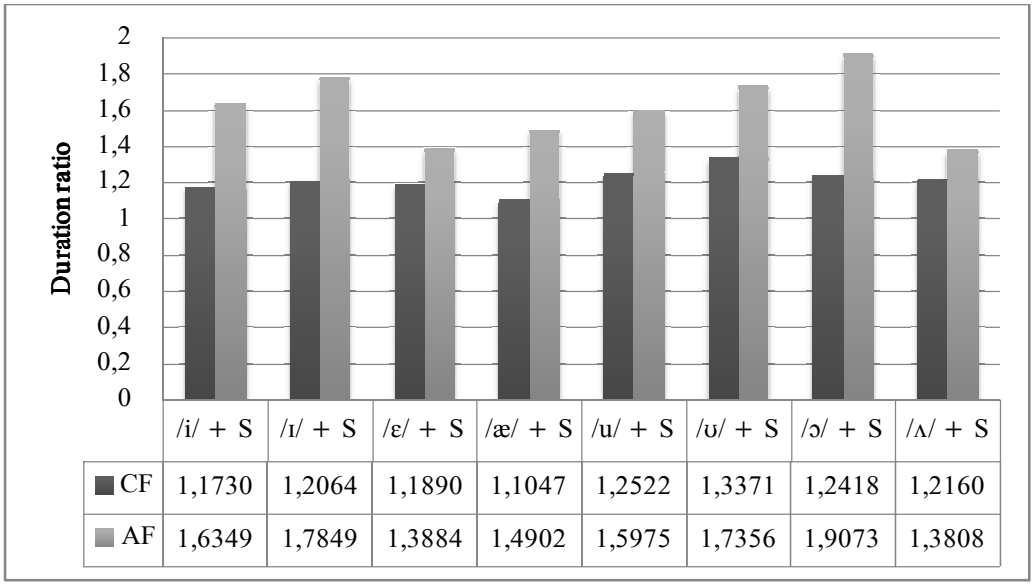
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	V+S_all_CF – V+S_all_AF	-,274357924	,531855407	,062679761	-,399337817	-,149378031	-4,377	71	,000

As presented in the table, the Sig. value of the t-test is 0,000, which indicates that the results are statistically significant. Therefore, it is safe to conclude that the first hypothesis is valid. In other words, the conclusion can be produced that the process of vowel lengthening in front of voiced stops is more prominent in the case of American native speakers of English than in the case of Croatian speakers of English.

2.5.1.2. Analysis of the results for each respective vowel

As mentioned earlier, the duration ratios for each respective vowel were also compared, in order to gain more insight on the differences in the extent to which Croatian and American speakers lengthen the vowels as a function of voicing of a postvocalic stop. Figure 6 presents the results of that comparison:

Figure 6: Comparison of duration ratios (separate cases – V+S)



	/i/ + S	/ɪ/ + S	/ɛ/ + S	/æ/ + S	/u/ + S	/ʊ/ + S	/ɔ/ + S	/ʌ/ + S
CF	1,1730	1,2064	1,1890	1,1047	1,2522	1,3371	1,2418	1,2160
AF	1,6349	1,7849	1,3884	1,4902	1,5975	1,7356	1,9073	1,3808

In each case, the duration ratios of vowels in function of the voicing of postvocalic stops were greater when produced by the native speakers of English. However, before jumping to any conclusions, a t-test was conducted here as well, so that the statistical significance of each case can be proven.

The table below shows that the results for the vowels /i/ and /ʌ/ have a Sig. value greater than 0,05, which means that they are not statistically significant. Therefore, the Hypothesis 1 can not be confirmed in the case of those two vowels. On the other hand, the t-test returned statistically significant results in all the other cases. That means that in the cases of the vowels /ɪ/, /ɛ/, /æ/, /u/, /ʊ/ and /ɔ/, the hypothesis proves to be correct and valid.

Table 9: Results of the paired samples t-test (separate cases – V+S)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	/i/+S_CF - /i/+S_AF	-,461879945	,655469858	,218489953	-,965718680	,041958789	-2,114	8	,067
Pair 2	/ɪ/+S_CF - /ɪ/+S_AF	-,578508613	,547694407	,182564802	-,999503802	-,157513424	-3,169	8	,013
Pair 3	/ɛ/+S_CF - /ɛ/+S_AF	-,199451212	,144849762	,048283254	-,310792595	-,088109828	-4,131	8	,003
Pair 4	/æ/+S_CF - /æ/+S_AF	-,385424079	,327533273	,109177758	-,637188440	-,133659718	-3,530	8	,008
Pair 5	/u/+S_CF - /u/+S_AF	-,345362887	,366076672	,122025557	-,626754327	-,063971447	-2,830	8	,022
Pair 6	/ʊ/+S_CF - /ʊ/+S_AF	-,398570024	,375950827	,125316942	-,687551411	-,109588637	-3,180	8	,013
Pair 7	/ɔ/+S_CF - /ɔ/+S_AF	-,665560449	,740910983	,246970328	-1,235075046	-,096045853	-2,695	8	,027
Pair 8	/ʌ/+S_CF - /ʌ/+S_AF	-,164830003	,356482485	,118827495	-,438846698	,109186692	-1,387	8	,203

2.5.1.3. Conclusion

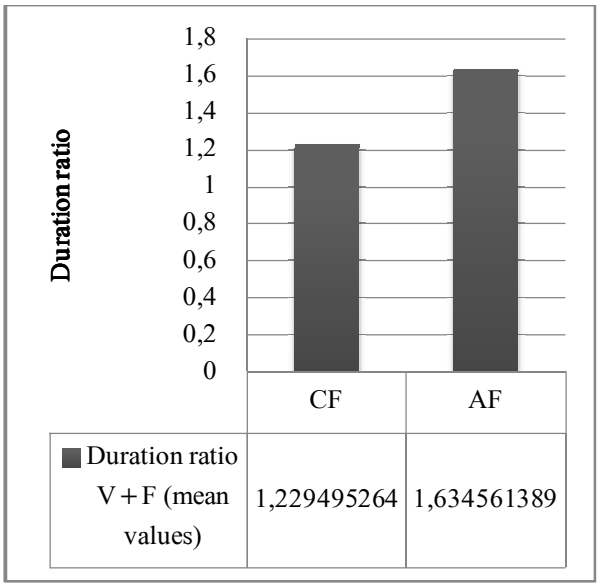
The statistically significant data show that the vowel duration ratio which was produced by the American native speakers was greater than the vowel duration ratio which was produced by the Croatian speakers of English. This goes in favor of the premises which were set by the Hypothesis 1: The duration ratio in the case of vowel before voiced vs. vowel before voiceless stop, which is produced by Croatian speakers of English is smaller than the duration ratio of the same phonetic material produced by native speakers of English (cf. section 2.2.2.). That means that Croatian speakers do not lengthen the vowels as a function of the voicing of the postvocalic consonant as prominently when talking English as the American native speakers of English do.

2.5.2. Hypothesis 2

2.5.2.1. Analysis of the overall results

This hypothesis predicted that the native speakers would produce a greater duration ratio ———— than the Croatian speakers of English. Figure 7 presents the results of the comparison of the overall results for duration of vowels in function of the voicing of the postvocalic fricative. As it is obvious, the AF group produced greater overall mean results than the CF group again:

Figure 7: Comparison of duration ratios (overall results – V+F)



The chart shows that there is a noticeable difference between the duration ratios of V + F in the case of Croatian speakers and in the case of the native speakers of American English. The difference of ~0,41 between the mean results of the CF and the AF group is even slightly greater than the difference among the mean results of the $\frac{(V+S(+voiced))}{(V+S(-voiced))}$ duration ratio (cf. section 2.5.1.1.). The Sig. value of 0,000, which was elicited by the t-test proves that these results are statistically significant:

Table 10: Results of the paired samples t-test (overall results – V+F)

Paired Samples Test

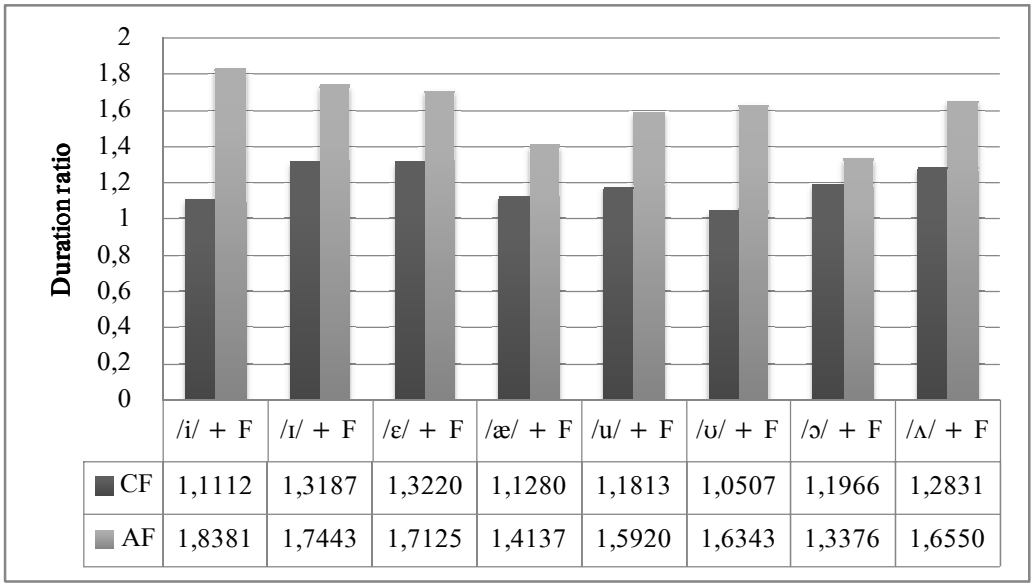
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 V+F_all_CF – V+F_all_AF	-,416995448	,430037443	,050680399	-,518049293	-,315941603	-8,228	71	,000

The results of this comparison show that the Hypothesis 2 is valid. In other words, generally spoken, the process of vowel lengthening in front of voiced fricatives is more prominent in the case of native speakers of American English than in the case of Croatian speakers of English.

2.5.2.2. Analysis of the results for each respective vowel

As it was the case with the analysis of the previous hypothesis, the duration ratios for each vowel are compared here as well. The results are presented in the Figure 8.

Figure 8: Comparison of duration ratios (separate cases – V+F)



	/i/ + F	/ɪ/ + F	/ɛ/ + F	/æ/ + F	/u/ + F	/ʊ/ + F	/ɔ/ + F	/ʌ/ + F
CF	1,1112	1,3187	1,3220	1,1280	1,1813	1,0507	1,1966	1,2831
AF	1,8381	1,7443	1,7125	1,4137	1,5920	1,6343	1,3376	1,6550

As it was in the case of V + S, duration ratio of every single vowel was greater as produced by the AF speakers than by the CF speakers. The results of the t-test have shown that all results but one (that is, /ɔ/ + F) have Sig. values lower than 0,05, and are therefore statistically significant:

Table 11: Results of the paired samples t-test (separate cases – V+F)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	/i/+F_CF - /i/+F_AF	-,726955058	,342171304	,114057101	-,989971205	-,463938911	-6,374	8	,000
Pair 2	/ɪ/+F_CF - /ɪ/+F_AF	-,425587038	,504956925	,168318975	-,813731290	-,037442786	-2,528	8	,035
Pair 3	/ɛ/+F_CF - /ɛ/+F_AF	-,390474334	,497304053	,165768018	-,772736069	-,008212600	-2,356	8	,046
Pair 4	/æ/+F_CF - /æ/+F_AF	-,285661564	,266998289	,088999430	-,490894617	-,080428511	-3,210	8	,012
Pair 5	/u/+F_CF - /u/+F_AF	-,410722897	,345758302	,115252767	-,676496254	-,144949539	-3,564	8	,007
Pair 6	/ʊ/+F_CF - /ʊ/+F_AF	-,583649620	,612937638	,204312546	-1,054795196	-,112504044	-2,857	8	,021
Pair 7	/ɔ/+F_CF - /ɔ/+F_AF	-,141092729	,283334985	,094444995	-,358883279	,076697820	-1,494	8	,174
Pair 8	/ʌ/+F_CF - /ʌ/+S _AF	-,371820347	,357078057	,119026019	-,646294839	-,097345855	-3,124	8	,014

2.5.2.3. Conclusion

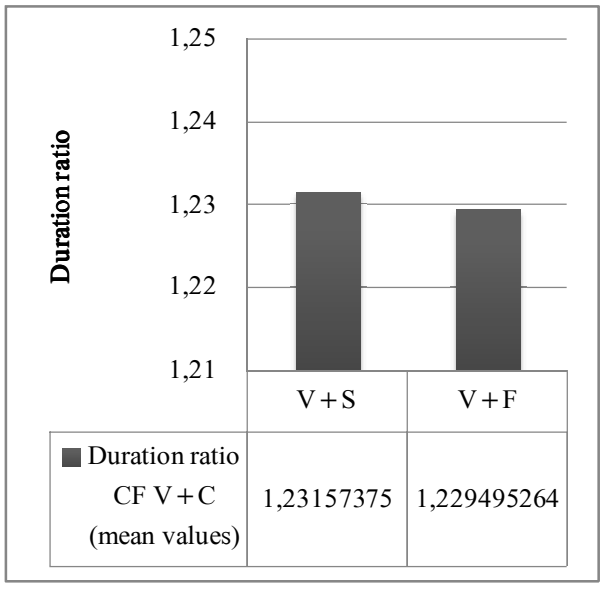
The Hypothesis 2 can not be confirmed in the case of the vowel /ɔ/. On the other hand, all the other cases, including the overall mean results have returned statistically significant data, which showed that the native speakers of American English produced greater duration ratio than the Croatian speakers of English did. Therefore, it is safe to confirm the Hypothesis 2 for general case of V + F and for the vowels /i/, /ɪ/, /ɛ/, /æ/, /u/, /ʊ/ and /ʌ/, and to claim that the native speakers of American English lengthen the vowels as function of the voicing of the postvocalic consonant to a greater extent than the Croatian speakers of English do.

2.5.3. Hypothesis 3

2.5.3.1. Analysis of the overall results

The third hypothesis predicted that the duration ratio of vowels followed by voiced vs. voiceless stops would be greater than the duration ratio of vowels followed by voiced vs. voiceless fricatives, in the case of Croatian speakers of English (cf. section 2.2.2. of this study). The measurements indeed resulted in slightly higher mean values in the case of V + S than it was the case with V + F:

Figure 9: Comparison of duration ratios (overall results – CF V+S vs. CF V+F)



However, it is questionable whether any relevance should be given to a difference of ~0,002. Also, the results of the t-test have shown a Sig. value which is greater than 0,05:

Table 12: Results of the paired samples t-test (overall results – CF V+S vs. CF V+F)

Paired Samples Test

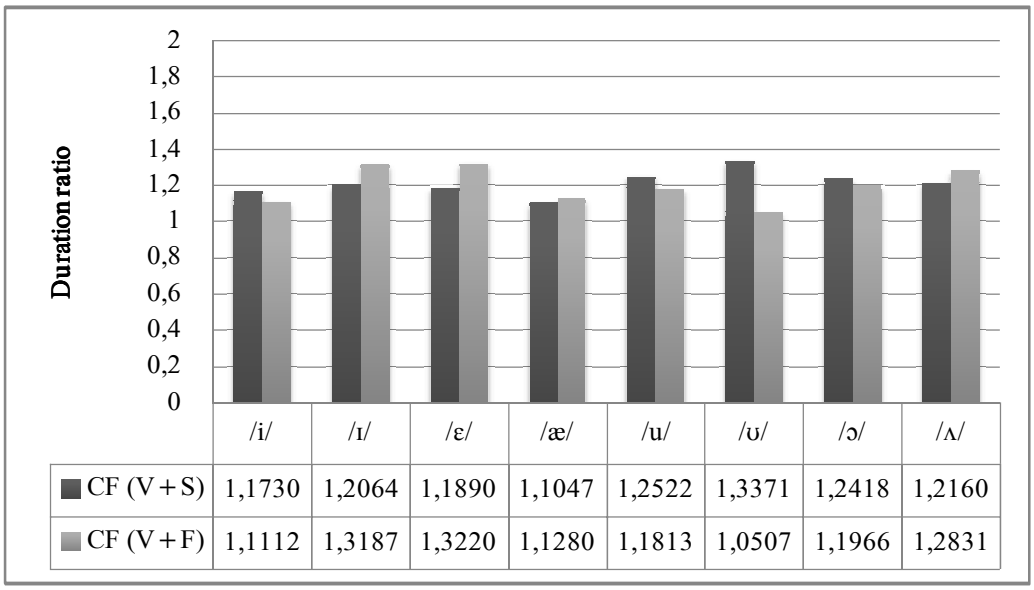
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 V+S_all_CF – V+F_all_CF	,078868054	,377211080	,044454752	-,009772204	,167508312	1,774	71	,080

That means that the difference between those two groups of vowels is statistically not significant. Therefore, the Hypothesis 3 can not be confirmed as valid.

2.5.3.2. Analysis of the results for each respective vowel

The Hypothesis 3 was also tested by comparing the duration ratios V + S and V + F for each of the vowels separately. The comparison is presented by the following chart:

Figure 10: Comparison of duration ratios (separate cases – CF V+S vs. CF V+F)



	/i/	/ɪ/	/ɛ/	/æ/	/u/	/ʊ/	/ɔ/	/ʌ/
CF (V + S)	1,1730	1,2064	1,1890	1,1047	1,2522	1,3371	1,2418	1,2160
CF (V + F)	1,1112	1,3187	1,3220	1,1280	1,1813	1,0507	1,1966	1,2831

The chart shows no unified relations between the duration ratios of the vowels in function of the voicing of the postvocalic stop or fricative, respectively. Those results have also been subjected to a t-test, which resulted in the following manner:

Table 13: Results of the paired samples t-test (separate cases – CF V+S vs. CF V+F)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	/i/+S_CF - /i/+F_CF	,061831441	,265355522	,088451841	-,142138869	,265801752	,699	8	,504
Pair 2	/ɪ/+S_CF - /ɪ/+F_CF	-,112304289	,427654697	,142551566	-,441028789	,216420211	-,788	8	,454
Pair 3	/ɛ/+S_CF - /ɛ/+F_CF	-,133063531	,360608825	,120202942	-,410252011	,144124950	-1,107	8	,300
Pair 4	/æ/+S_CF - /æ/+F_CF	-,023277870	,143884484	,047961495	-,133877275	,087321535	-,485	8	,640
Pair 5	/u/+S_CF - /u/+F_CF	,070899226	,227304885	,075768295	-,103822775	,245621228	,936	8	,377
Pair 6	/ʊ/+S_CF - /ʊ/+F_CF	,286399541	,300212618	,100070873	,055635695	,517163387	2,862	8	,021
Pair 7	/ɔ/+S_CF - /ɔ/+F_CF	,045232142	,419999165	,139999722	-,277607795	,368072079	,323	8	,755
Pair 8	/ʌ/+S_CF - /ʌ/+F_CF	-,067134135	,389245668	,129748556	-,366334841	,232066571	-,517	8	,619

The only result which is statistically significant (i.e. has a Sig. value lower than 0,05), is the one in the case of /ʊ/.

2.5.3.3. Conclusion

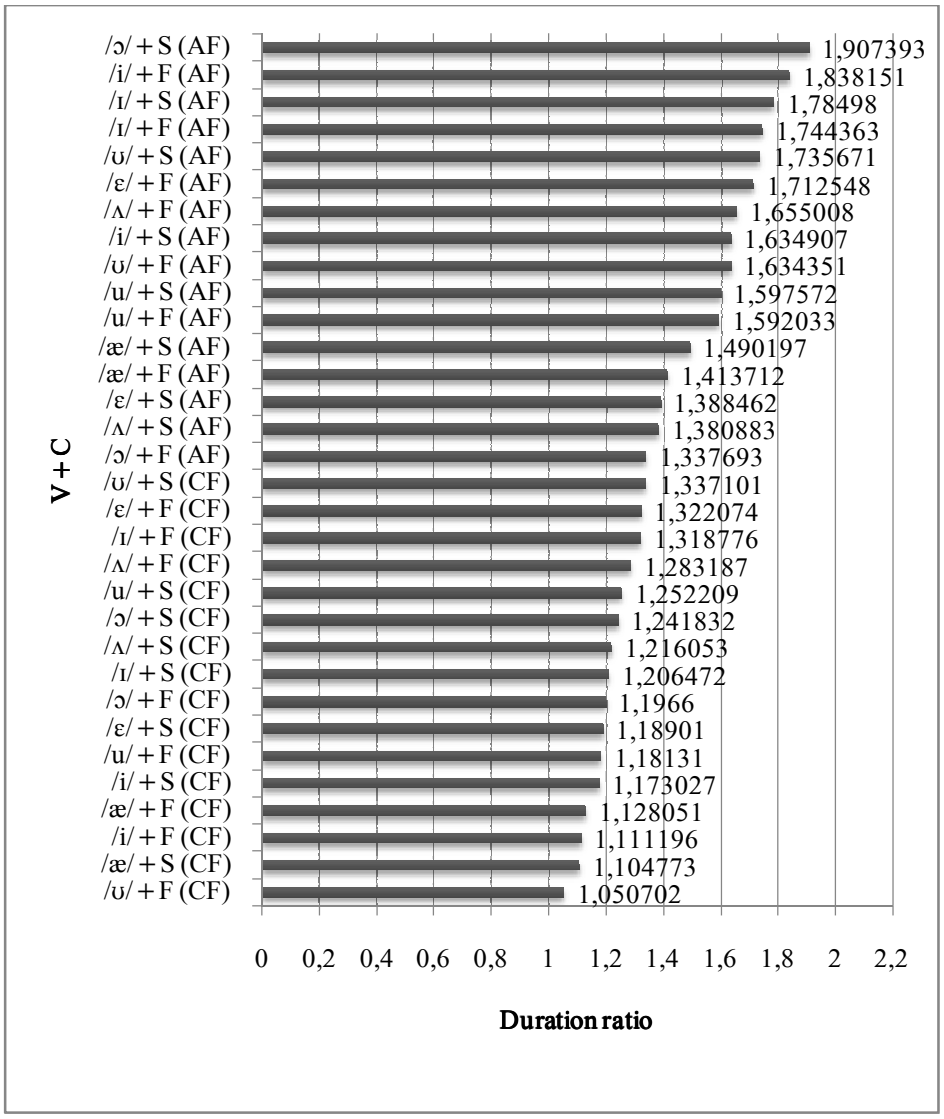
Since the Hypothesis 3 made predictions in favor of duration ratio V + S and taken in account the elicited data, there is only one piece of evidence that this hypothesis might be correct. This is not enough for this hypothesis to be confirmed. In other words, it cannot be confirmed that the duration ratio of vowels followed by voiced vs. vowels followed by voiceless fricatives is smaller than the one of vowels followed by voiced vs. voiceless stops in the case of Croatian speakers of English.

However, an interesting point appears here: As can be seen in the section 2.5.3.1, the overall duration ratios of V+S and V+F as pronounced by the Croatian speakers of English are very close to each other. This might indicate that the Croatian speakers of English in general lengthen the vowels as a function of the voicing of the postvocalic consonant to the approximately same extent, independently on the manner of articulation of the consonant which follows – in this particular case, stop or fricative.

2.6. Additional observations

In order to gain more insight into the differences and similarities within the process of lengthening of the vowel as a function of the voicing of the postvocalic consonant, some additional observations have been conducted.

Figure 11: Mean duration ratio values of vowels in function of the voicing of the postvocalic consonant



In this section, a general overview of all of the lengthening ratios will be presented, analyzed and discussed. Figure 11 presents all the mean duration ratio values of vowels in function of the voicing of the postvocalic consonant which were elicited during this research, sorted from the smallest one to the largest one.

Firstly, one can easily notice that all the duration ratios produced by the American speakers are higher than the ones produced by the Croatian speakers, with no exception. The lowest duration ratio produced by the AF group is still higher than the highest duration ratio produced by the CF group.

The duration ratio of the American group covers the range between ~1,34 and ~1,91 and the Croatian covers the range between ~1,05 and ~1,32. In other words, the smallest and the greatest average duration ratio differ by 0,57 in the case of native speakers and by 0,27 in the case of Croatian speakers of English. This additionally goes in favor of the claim that Croatian speakers are rather reluctant of lengthening the vowels before voiced consonants, compared to the American speakers.

There are 32 cases all in all: 16 on the CF side and 16 on the AF side. The top 8 duration ratios (the upper half) of each case can be presented by the following table:

Table 14: The top 8 duration ratios from each of the two respective speaker groups

Rank	AF	CF
1.	/ɔ/ + S	/ʊ/ + S
2.	/i/ + F	/ɛ/ + F
3.	/ɪ/ + S	/ɪ/ + F
4.	/ɪ/ + F	/ʌ/ + F
5.	/ʊ/ + S	/u/ + S
6.	/ɛ/ + F	/ɔ/ + S
7.	/ʌ/ + F	/ʌ/ + S
8.	/i/ + S	/ɪ/ + S

Interestingly, the majority of the duration ratios in the upper halves of each respective case are produced in the case of lax vowels – slightly more so in the case of CF speakers (6 cases) than in the AF case (5 cases).

No regularities in terms of quality of the following consonant (i.e. whether it is a case of V + S or V + F), nor in terms of the quality of the vowels themselves were found.

2.7. A single case of a bilingual speaker

Additionally, a separate case of a bilingually raised speaker was observed within this study. The results which this speaker produced were compared to the mean results of the AF group and the CF group, respectively. Taken in account that this is a case of only a single speaker, no firm evidence can be produced on the basis of these observations; however, the data elicited from this case may indicate to some phenomena which could be used as a motivation for further research.

2.7.1. Participant

The girl who was recorded had grown up in a Croatian family living in the USA (Boston and Washington). She had been living there for the first seven years of her life. After having moved to Croatia, she has been visiting the USA every summer. She perceives herself as bilingual. At the time of recording, the girl was eighteen years old.

According to Yule ([1996]: 171), "during childhood (up until puberty) there is a period when the human brain is most ready to 'receive' and learn a particular language. This period is referred to as the critical period." This is a period during which a child 'acquires' a language and does not 'learn' it. Yule ([1996]: 191) also says that "[t]hose whose L2 experience is primarily a learning one tend not to develop the proficiency of those who have had an acquiring experience." Taken in account that the participant had spent a large part of the critical period in a bilingual environment, it is safe to say that she had not learned any of

the two languages but that she had acquired both of them. Therefore, she can be considered a bilingual speaker.

In the following text, charts and tables, this speaker will be marked by the abbreviation BF (meaning *Bilingual Female*).

2.7.2. Stimuli, procedure, measurement and analysis

The same two lists of monosyllabic carrier words were used here as for the rest of the participants of the study (cf. section 2.3.2.). The participant was recorded in an empty classroom of "Gornjoradska gimnazija" high school in Zagreb. The recording was conducted by the means of Apogee Mini-Me A/D Converter, Neumann KM 184 P48 microphone and the SFS/WASP computer software. The audio data was saved in .wav format at a sample rate of 44100 Hz, audio sample size of 16 bit and at the bit rate of 705 kbps. The recording process was conducted in the same manner as in the case of the Croatian speakers of English (cf. section 2.3.3.). Also, the data was measured and analyzed in the same way as the rest of the recordings, with the difference that no mean results for each vowel were calculated – logically, since in this case there was only one speaker.

2.7.3. Results

In order to obtain the duration ratios for each of the cases, as pronounced by the BF speaker, the same formulae were used as for the rest of the participants: $\frac{(V+S(+voiced))}{(V+S(-voiced))}$ in the case of vowel lengthening as a function the voicing of the postvocalic stops and $\frac{(V+F(+voiced))}{(V+F(-voiced))}$ in the case of lengthetning of a vowel as a function o the voicing of the postvocalic fricatives. The measurements of vowel durations and the calculation of the duration ratios returned the following results:

Table 15: Duration ratios (influence of the voicing of the postvocalic consonant in monosyllabic words – bilingual speaker)

	Duration ratio (BF)
/i/+S	1,62791
/ɪ/+S	1,302521
/ɛ/+S	1,24113
/æ/+S	1,54237
/u/+S	1,41885
/ʊ/+S	1,30534
/ɔ/+S	1,12281
/ʌ/+S	0,87356
/i/+F	1,75776
/ɪ/+F	1,379845
/ɛ/+F	1,48077
/æ/+F	1,27236
/u/+F	1,36686
/ʊ/+F	1,76852
/ɔ/+F	1,16602
/ʌ/+F	1,71223

Calculations of the mean values returned an average duration ratio of 1,30431 (≈1,3) in the case of vowels followed by voiced vs. voiceless stops and an average duration ratio of 1,48805 (≈1,49) in the case of vowels followed by voiced vs. voiceless fricatives. The comparison of these data with the data from the CF and the AF groups will be presented and discussed in the following sections.

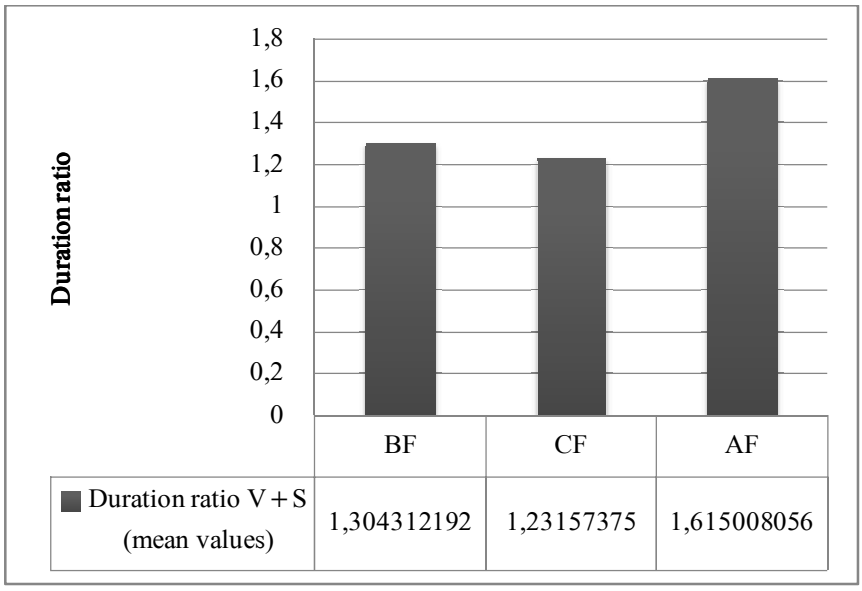
2.7.4. Discussion

2.7.4.1. Hypothesis 1

First, the results of the measurements will be presented in the context of the Hypothesis 1. This hypothesis predicted that the duration ratio $\frac{(V+S(+voiced))}{(V+S(-voiced))}$ would be greater when produced by American native speakers than by the Croatian speakers of English. An assumption can be made that the BF speaker would produce an average overall duration

ratio which would be somewhere (ideally, in the very middle) between the mean CF and AF results. The results of the measurements and calculations are compared in Figure 12:

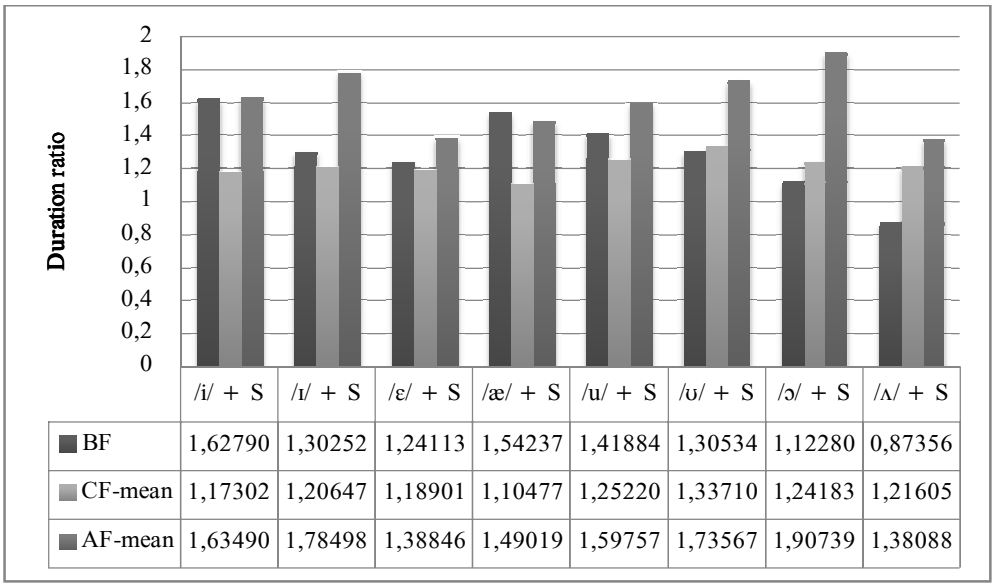
Figure 12: Comparison of duration ratios produced by the BF speaker, the CF group and the AF group, respectively (overall results – V+S)



The chart shows that the BF speaker indeed produced an average result which is between the overall CF and AF mean results; however, that result is relatively close to the mean CF result (the difference between the BF and the CF mean results is ~0,7). On the other hand, the average duration ratio of ~1,30 is higher than average V + S duration ratio for any respective vowel produced by the CF group apart from the one for the vowel /ʊ/, which is ~1,34. This fact might indicate that, although closer to the Croatian pronunciation habits, the BF speaker tends to exceed the extent to which Croats lengthen the vowels as a function of a voiced postvocalic stop and assumes the lengthening of the vowels in front of voiced stops more prominently than the Croatian speakers of English.

Mean results for each vowel as pronounced by both the CF and the AF group are compared to the results produced by the BF speaker in the following chart:

Figure 13: Comparison of duration ratios produced by the BF speaker, the CF group and the AF group, respectively (separate cases – V+S)



	/i/ + S	/ɪ/ + S	/ɛ/ + S	/æ/ + S	/u/ + S	/ʊ/ + S	/ɔ/ + S	/ʌ/ + S
BF	1,62790	1,30252	1,24113	1,54237	1,41884	1,30534	1,12280	0,87356
CF-mean	1,17302	1,20647	1,18901	1,10477	1,25220	1,33710	1,24183	1,21605
AF-mean	1,63490	1,78498	1,38846	1,49019	1,59757	1,73567	1,90739	1,38088

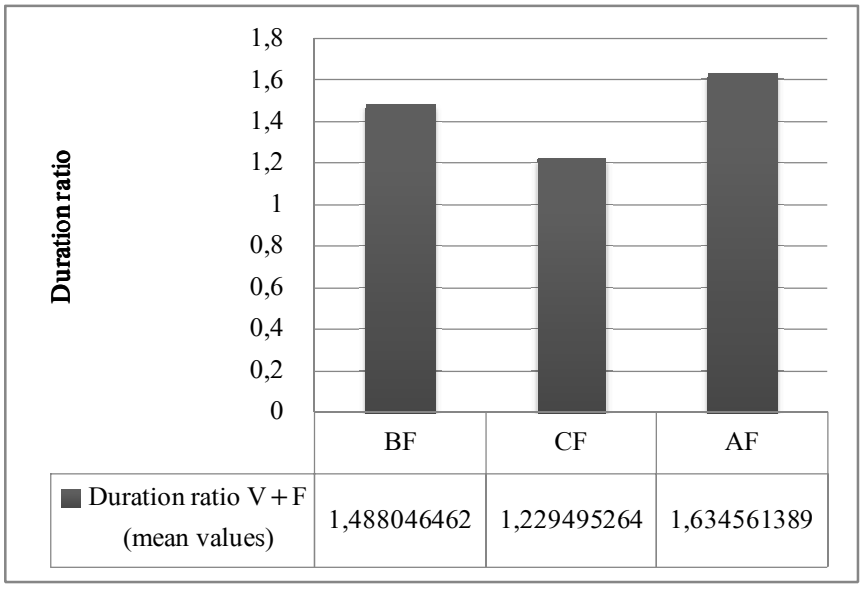
The BF participant produced the duration ratios of /i/+S and /æ/+S very similar to the AF means of those two cases. In the case of /u/+S, her duration ratio lies almost precisely in the very middle between the CF and the AF ratios. The other results tend towards the CF average: /ɪ/+S and /ɛ/+S are slightly above the CF mean values and /ʊ/+S, /ɔ/+S, and /ʌ/+S are even below the CF values. Moreover, in the case of /ʌ/+S, she produced a duration ratio of ~0,87, which means that she produced a longer instance of that vowel when followed by voiceless stop than when followed by voiced stop.

Once again, this is a case of only one speaker, so no rules and regularities can be produced out of these observations. Yet, it is interesting that the speaker, although being raised in a bilingual environment and exposed to long periods of interaction with native speakers of American English on a yearly basis, still tends to assume the "Croatian" way of pronunciation of the vowels in the function of voiced vs. voiceless postvocalic stops. This might be due to the fact that, despite the bilingualism and prolonged exposition to English, the language to which she has been exposed more in the last eleven years still was Croatian.

2.7.4.2. Hypothesis 2

Secondly, the results of the measurements of the BF speaker will be analyzed and presented in the context of the Hypothesis 2. This hypothesis predicted that the duration ratio ———— would be greater in the case of American speakers than in the case of Croatian speakers of English. Similarly to the assumption from the previous paragraph, one would assume that the BF speaker would produce an average duration ratio which would be somewhere between the mean overall CF and the mean overall AF results and which would, in ideal case, represent the very mean of the CF and AF overall means. Figure 14 presents the results of this comparison:

Figure 14: Comparison of duration ratios produced by the BF speaker, the CF group and the AF group, respectively (overall results – V+F)

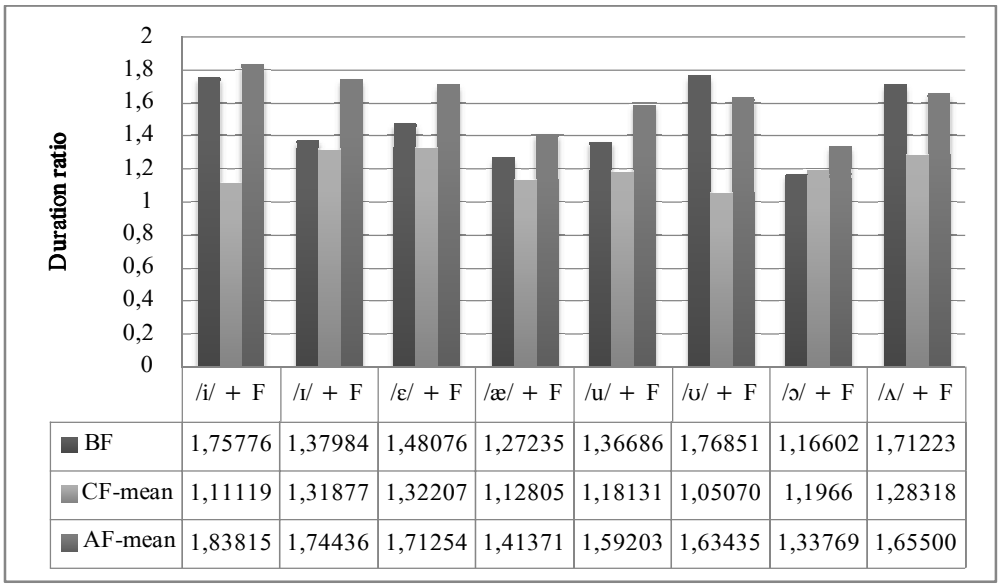


The chart shows that the BF produced overall mean duration ratio (~1,49) which indeed really is very near the arithmetical middle of the CF and the AF means (~1,43), and slightly tends towards the AF mean result. This differs greatly from the results of the comparison of BF, CF and AF in terms of V + S (cf. section 2.7.4.1.). Also, the mean duration ratio of ~1,49 in this case is notably higher than the one of ~1,30, which was produced in the V + S case. This shows that the BF speaker assumed the lengthening of the vowels in function of the voicing of the postvocalic fricative to a notably greater extent than the Croatian speakers

of English and to a lesser extent than the American native speakers, and that she tends to represents a, so to say, 'perfect average' of the ways in which Croatian and American speakers respectively lengthen the vowels as a function of the voicing of postvocalic fricatives.

The BF results for each specific vowel again vary in relation to AF and CF mean results. They are presented in the chart below:

Figure 15: Comparison of duration ratios produced by the BF speaker, the CF group and the AF group, respectively (separate cases – V+F)



	/i/ + F	/ɪ/ + F	/ɛ/ + F	/æ/ + F	/u/ + F	/ʊ/ + F	/ɔ/ + F	/ʌ/ + F
BF	1,75776	1,37984	1,48076	1,27235	1,36686	1,76851	1,16602	1,71223
CF-mean	1,11119	1,31877	1,32207	1,12805	1,18131	1,05070	1,1966	1,28318
AF-mean	1,83815	1,74436	1,71254	1,41371	1,59203	1,63435	1,33769	1,65500

The duration ratios produced by the BF speaker can be divided into three groups: the first, where the duration ratios would be close to the AF average (/i/, /ʊ/ and /ʌ/), the second, where the duration ratios are close to the CF average (/ɪ/ and /ɔ/) and the third, in which the results would be close to the average between the CF and the AF results (/ɛ/, /æ/ and /u/). The bilingualism is more evident here than in the BF case of V + S: First of all, the duration ratios are relatively evenly distributed (three tend towards the AF mean, two tend towards the CF mean and three tend towards the average between CF and AF). Secondly, here, they are all in the domains of averages, unlike e.g. the case of /ʌ/ + S, where the BF duration ratio was far below the CF average.

2.7.5. Comparison of the results

The results of the comparison of the bilingual speaker to the Croatian speakers and the native speakers of American English, which were presented in the previous two sections, can be summed up in the following way:

Table 16: Comparison of the BF speaker to the CF group and the AF group

	V+S			V+F		
Vowel	Tends towards CF	Tends towards mean	Tends towards AF	Tends towards CF	Tends towards mean	Tends towards AF
/i/			•			•
/ɪ/	•			•		
/ɛ/	•				•	
/æ/			•		•	
/u/		•			•	
/ʊ/	•					•
/ɔ/	•			•		
/ʌ/	(much lower than the CF mean)					•

Very few similarities in terms of tendency towards CF or AF mean results between V+S and V+F cases can be found here: /i/ tends to be lengthened in a way which is more similar to the AF group, /ɪ/ and /ɔ/ tend to be lengthened more similarly to the CF groups and /u/ is pronounced so that it represents mean results of CF and AF means in both cases. V+S and V+F differ in the cases of remaining vowels. Therefore, no regularities can be determined out of these observations. On the other hand, concluding from the comparison of overall results, the bilingual speaker generally lengthens vowels in function of the voicing of the postvocalic consonant more than Croatian speakers of English on average do. Also, the fact that the BF speaker lengthens some of the vowels to the approximately same extent as the American native speakers do indicates that she adopted some elements of the lengthening manner of the native speakers of American English.

A larger BF group would produce a greater corpus out of which mean results could be calculated. That would perhaps provide a possibility for establishing certain regularities which could not have been noticed in this case. Therefore, a further investigation on this topic is needed and encouraged.

3. Influence of the presence of a second syllable on duration of vowels in stressed first syllables of disyllabic words

3.1. Theoretical framework

In the following sections, attempts will be made to compare the changes in duration of vowels in stressed first syllables of English disyllabic words versus their monosyllabic counterparts, as pronounced by Croatian speakers of English on the one hand and by American native speakers on the other hand. According to Bakran,

> [u] pokušaju objašnjenja porasta tempa artikulacije u funkciji broja slogova riječi […] treba uzeti u obzir i neke druge faktore koji djeluju na trajanje segmenata. To su: dulje trajanje naglašenog sloga, duljenje posljednjeg sloga riječi i duljenje posljednjeg sloga pred pauzom. Kod izračunavanja tempa artikulacije jednosložnih riječi prisutna su sva tri duljenja i primjenjuju se na jedini slog. Kod dvosložnih riječi efekt duljenja dijeli se na dva sloga. Što se više povećava broj slogova u riječi, efekti duljenja dijele se u postupku izračunavanja [tempa artikulacije] na veći broj slogova i time se njihovo djelovanje smanjuje. [[w]hen trying to explain the raise of tempo of articulation in function of number of syllables in a word […] some other factors which influence the duration of segments should be taken into account as well. Those are: greater duration of a stressed syllable, lengthening of the word-final syllable and lengthening of the last syllable before a pause. When calculating the tempo of articulation of monosyllabic words, all three lengthenings are present and they are applied to the only syllable. In the case of disyllabic words, the lengthening effect is divided onto two syllables. The more the number of syllables within a word increases, the lengthening effects are divided onto more syllables in the process of calculation [of the tempo of articulation] and thus, their effect is being reduced.] (Bakran 1996: 256)

Following this path of thought, one can conclude that in disyllabic words with the stressed first syllable, the stressed vowel does not undergo the effect of the lengthening of word-final syllable, nor the lengthening of the last syllable before the pause. Therefore, only two factors have effect onto changes in vowel duration in this case: reduction of syllable duration due to the increase of number of syllables in a word and the lengthening of stressed

syllables. The sections below will provide arguments which show that these two phenomena occur both in Croatian and in English.

3.1.1. Croatian language

According to Škarić (2009: 98), vowels are the mostly affected parts of syllables in terms of lengthening or shortening in Croatian:

> Dûlje se i krate s promjenom govorne brzine mnogo više samoglasnici nego suglasnici […]. [Vowels are lengthened and shortened much more than consonants with the change of the speed of articulation […].] (Škarić 2009: 98)

Moving over towards the phenomena in polysyllabic words in Croatian, Škarić observes the changes in syllable duration. He presents the following observations:

> Slog u jednosložnoj izdvojeno izgovorenoj riječi prosječno traje oko 0,5 s, u tako izgovorenoj dvoložnoj riječi 0,3 s, a u trosložnoj 0,23 s. [A syllable in a monosyllabic, separately pronounced word lasts on average 0,5 s, in a disyllabic word pronounced in the same manner 0,3 s, and in a trisyllabic word 0,23 s.] (Škarić, 2009: 98)

These statements are further supported by Bakran (1996: 254). He introduces the term *Tempo artikulacije [Tempo of articulation],* and defines it as:

8.

$$TA = \frac{n}{ta}$$

Legend:
TA = Tempo of articulation
n = number of syllables for which TA is being defined
ta = time of articulation

Later on, Bakran (1996: 255) presents the results of a study conducted among nine native speakers of Croatian, which showed that the TA-values increase with the number of syllables within a word; however, he also notices that:

> Povećanje tempa artikulacije, prema ovim podacima, nije linearna funkcija povećanja broja slogova. Vidi se po tome što TA poraste za dvosložne riječi u odnosu prema jednosložnim s faktorom 1.8, a od dvosložnih do trosložnih s faktorom 1.2. [Increase of the tempo of articulation, according to these data, is not a linear funtion of the

> increase of the number of syllables. This can be seen by the fact that TA increases by the factor of 1,8 for disyllabic words compared to the monosyllabic words and by the factor of 1,2 for disyllabic words compared to trisyllabic words.] (Bakran 1996: 255)

He supports this claim by presenting the following results of his experiment:

Table 17: Dependence of the tempo of articulation (TA) on the number of syllables in a word

number of syllables in a word	1	2	3
TA	1,98	3,60	4,42

Leaving the trisyllabic words aside, one can see that, in spite of the doubling of the number of syllables in the case of disyllabic words, the tempo of articulation itself does not increase two times, which would allow the syllables to be pronounced equally long as in a monosyllabic word. Instead, it is increased 1,8 times, which means that the syllables have to be reduced in their duration compared to the monosyllabic words.

As for the question to which extent stress influences the syllables in terms of duration, Škarić (2009: 82) claims that stressed syllables are by 20-30% longer than the unstressed syllables in Croatian – 20% in the case of prosodically short stress and 30% in the case of prosodically long stress.

3.1.2. English language

Clark & Yallop ([1995]: 334) claim that "[v]owel duration is […] the most significant component of syllable duration". Moreover, they also claim that duration of a vowel within a syllable is the most elastic component of syllable duration. They find the supporting arguments in the

> [s]tudies of vowel target reduction and undershoot by Lindblom (1963), Stevens and House (1963) and Stevens et al. (1966)[, which] have shown that as syllable [duration] is reduced, consonant transitions tend to be preserved at the expense of vowel target length[…]. (Clark & Yallop [1995]: 334)

As for the shortening of vowels, the same phenomenon occurs in English as in Croatian (cf. section 3.1.1.): Fox (2000) refers to Jespersen (1913: 180), who "notes the different

[durations] of [u:] in English *gloom, gloomy, gloomily,* or of [i:] in *feel, feeling, feelingly*" (Fox 2000: 17). Using these examples,

> Jespersen […] drew attention to the different [durations] of syllables […], where each word takes approximately the same amount of time to pronounce, and as a consequence the initial syllable becomes progressively shorter. (Fox 2000: 85)

Another observation on the matter of tempo is produced by Lehiste (1970: 38), who says that "[i]n [English], an increase in speech tempo is largely achieved by shortening unstressed syllables".

When talking about the characteristics of stressed syllables, Roach ([1998]: 85-86) mentions syllable length as one of the four factors which make the stressed syllable [in English] more prominent than the unstressed syllables – the other three being loudness, pitch and the quality of the stressed vowel. He adds that the experimental work has shown that length and pitch are the most powerful of these four factors. Taken in account that pitch is not a matter of investigation of this study, and thus concentrating only on length – or better to say: duration – it is safe to conclude that stressed vowels in English have greater duration values than the unstressed ones.

According to Škarić (2009: 82), the stressed syllables [in English] are 60% longer than the unstressed ones. Lehiste (1970: 36) refers to Parmenter & Treviño (1935) who "established that in English an average stressed vowel is approximately 50% longer than an average unstressed vowel." These observations show that stress has more impact onto the vowels which undergo it in English than in Croatian (cf. section 3.1.1.).

3.1.3. Comparison

The previous two sections can be summarized and compared by the following table:

Table 18: Comparison between Croatian and English in terms of the influence of stress and of the number of syllables in a word on duration of the stressed first syllable and its nucleus vowel

	Croatian	English
Vowels more prone to change in duration within syllables compared to other elements of the syllable	yes	yes
Syllables shorter in polysyllabic words than in monosyllabic words	yes	yes
Influence of stress on syllable duration	Syllables stressed by a long stress are 20% longer and the ones stressed by a short stress are 30% longer than the unstressed syllables	Stressed syllables 50% or 60% longer than the unstressed syllables[14]

The table shows that there are no differences between Croatian and English in terms of major principles of vowel shortening in disyllabic words as opposed to the vowels in monosyllabic words: In both languages, the element of a syllable which will undergo most changes in duration is its nucleus, which is a vowel. Also, in both languages, the same syllables are shorter in polysyllabic words than in monosyllabic words.

Taken in account the criteria mentioned above, the only difference between Croatian and English which can be elicited from the observations which were mentioned here is in terms of the difference of the impact of stress on the duration of the syllables: Stressed syllables – ergo, the vowels which are in their nuclei – are lengthened more in English than in Croatian.

[14] Two different authors present the two different data (cf. section 3.1.2.)

3.2. Research question and research hypothesis

3.2.1. Research question

Now that all the data concerning changes in duration of nucleus vowels of stressed syllables of disyllabic words are presented and discussed, a question arises: To which extent does the shortening of the stressed first vowels of disyllabic words occur in the case of Croatian speakers of English compared to the case of the native speakers of American English? Are there any regularities in terms of the ways in which such conditioned shortening occurs in those two groups?

3.2.2. Research hypothesis

The data which was presented in the previous sections can be presented by means of the following table:

Table 19: Comparison between Croatian and English in terms of shortening and lengthening of stressed syllables in disyllabic words relative to monosyllabic conditions and to the unstressed instance of a syllable

	Croatian	English
Relative to monosyllabic conditions	syllable is being shortened	syllable is being shortened
Relative to unstressed instance of a syllable	syllable is being lengthened by 20-30%	syllable is being lengthened by 50% or 60%

Taken these facts and the observation by Jespersen (1913: 180) that "each word takes approximately the same amount of time to pronounce" cited by Fox (2000: 85),[15] into account, one may conclude that in English disyllabic words, the stressed syllables, although being shortened as effect of the presence of the following syllable take up larger percentage in the duration of a disyllabic word than it is the case in Croatian words, where stressed syllable is lengthened less, and therefore takes up less space in the duration of the whole word.

[15] Cf. section 3.1.2.

Conclusively, the only difference in the ways in which the stressed syllables function in disyllabic words in terms of duration between Croatian and English is in terms of lengthening as a function of stress – which occurs to a greater extent in English than in Croatian. Out of these observations, one can assume that the shortening of the first stressed vowel will occur less prominently in the case of American speakers than in the case of Croatian speakers.

Therefore, a hypothesis will be produced that the effect of shortening of nucleus vowels of English disyllabic words produced by Croatian speakers, compared to the same vowels in monosyllabic conditions will more visible than it will be the case with the same words pronounced by American native speakers of English. In other words, nucleus vowels of the stressed first syllables of disyllabic words will be shorter compared to the same vowels in monosyllabic conditions when pronounced by Croatian speakers of English than when they are pronounced by American native speakers

This hypothesis can be presented by the following formula:

9.

$$\left(\frac{V_{MS}}{V_{DS}}\right)_C > \left(\frac{V_{MS}}{V_{DS}}\right)_E$$

Legend:

V_{MS} = vowel acting as a nucleus of a monosyllabic word

V_{DS} = vowel acting as a nucleus of the stressed first syllable of a disyllabic word

$_C$ = the case of Croatian speakers of English

$_E$ = the case of native speakers of English

Here, V_{MS} and V_{DS} represent the duration values of the vowels in monosyllabic words or in the stressed first syllable of disyllabic words, respectively. Using the two duration values and entering them into a formula $\frac{V_{MS}}{V_{DS}}$, duration ratios will be calculated for each of the pairs. Taken in account the hypothesis above, the difference between the V_{MS} value and the V_{DS} value should be greater in the case of Croatian speakers than in the case of American speakers, which should then, consequently, result in a greater duration ratio. Therefore, if

the duration ratios calculated for the case of Croatian speakers turn out to be greater than the duration ratios produced by the American speakers, that would serve as a proof that the hypothesis is correct.

More details on the experiment by which this hypothesis was tested will be presented in the following text.

3.3. Experiment

This section aims to test for differences in the duration of nucleus vowels of the stressed first syllables of disyllabic English words compared to their counterparts in monosyllabic words, as pronounced by Croatian speakers of English on the one hand and by the American native speakers on the other hand.

3.3.1. Participants

The same participants who took part in the first experiment which is described in this paper took part in this experiment. Cf. section 2.3.1. for more details on participants of this experiment.

3.3.2. Stimuli

Again, two lists of words were made. The first list consisted of monosyllabic carrier words of vowels of American English,[16] in which vowels were followed by voiceless alveolar stops and voiceless alveolar fricatives. In the second list, the same vowels occurred in the same immediate postvocalic conditions (i.e. the postvocalic consonants were same as in the first group) – this time, however, in the stressed first syllables of disyllabic words.

The words with a voiceless postvocalic consonant were chosen here as a basis, similarly to the previous experiment. Namely, in the last experiment, the V + C(-*voiceless*) underwent a process of lengthening due to the voicing of the postvocalic consonant. Therefore, for the sake of uniformity, the same set of monosyllabic V + C(-*voiceless*) is used here as well. This

[16] For a detailed description of the vowel inventory of Standard American English, cf. section 2.1.4.

time, they will supposedly undergo a process of shortening due to the presence of the second syllable in the disyllabic words. Thus, the same vowels are used in the same conditions, with a sole exception of the number of syllables which follow – 0 in monosyllabic words and 1 in disyllabic words.

The table below presents the choice of the carrier words:

Table 20: Carrier words which were used in the second part of the experiment (influence of the presence of the second syllable in a word on the duration of the nucleus vowel of the first stressed syllable of a word)

Vowel (GA)	Monosyllabic word	Disyllabic word
i+S	beat	beating
ɪ+S	bit	bitty
ɛ+S	bet	betting
æ+S	bat	patting
u+S	boot	booty
ʊ+S	put	putting
ɔ+S	brought	daughter
ʌ+S	butt	butter
i+F	peace	pieces
ɪ+F	kiss	kisser
ɛ+F	chess	Tessie
æ+F	pass	passer
u+F	goose	loosen
ʊ+F	wuss	pussy
ɔ+F	sauce	saucy
ʌ+F	bus	buster

Similarly to the first experiment, the words were presented to the interviewees not following any logical order, so that they would not notice any logical bonds between them. This way, the most natural articulation of the words possible was ensured, without any attempts to put accent on any similarities or differences between words.

3.3.3. Procedure

Since the same participants took part in both the experiment on the influence of the voicing of the postvocalic consonant and this one, the recording conditions of these two experiments were the same: Croatian speakers were recorded in an empty classroom of "Gornjogradska Gimnazija" high school in Zagreb and the American speakers were recorded at their temporary homes or workplaces in Croatia. Also, the recording process was conducted in the same way and by the same means as in the previous experiment.[17]

3.3.4. Measurements and the analysis of data

Similarly to the previous experiment, the files which were gained through the recording process were analyzed by means of the SFS/WASP software. Duration of each of the stressed vowels in disyllabic words was measured and entered into a table. As for the vowels in monosyllabic words, the duration values of vowels followed by voiceless consonants in monosyllabic words from the first experiment of this study were used. Again, pairs of words were built in which the first member of a pair was a monosyllabic word with the vowel followed by a voiceless consonant. The second member of a pair was a disyllabic word which had the same vowel followed by the same consonant as in the monosyllabic counterpart in its stressed first syllable.[18] The duration values of each of the respective vowels were sorted accordingly for each of the recordings. The members of each pair were then used to calculate the duration ratios according to the formula $\frac{V_{MS}}{V_{DS}}$, where V_{MS} stands for the duration of a vowel in a monosyllabic word and V_{DS} stands for the duration of a vowel in the stressed first syllable of a disyllabic word. That resulted in nine duration ratios per each vowel and each case (i.e. monosyllabic and disyllabic word, vowels followed by stops and the same case with vowels followed by fricatives)[19] in the CF group and nine in the AF group. The overall mean results for each of the word pairs were calculated and compared,

[17] Cf. section 2.3.3. for more details on the procedure of the experiment.

[18] Cf. section 3.3.2. for the list of the word pairs which were used in this part of the experiment.

[19] Cf. section 3.3.2.

and the statistical significance of the data was tested within a t-test, with the help of the SPSS software for statistical analysis. The sections which follow will show the results of the calculations and testing.

3.4. Results

In the previous sections a detailed description of the acquisition and measurement of audio data, organizing of the measurement results and calculation of duration ratios were presented. As already mentioned, the calculation was conducted following the formula

10.

$$\frac{V_{MS}}{V_{DS}}$$

Legend:
V_{MS} = vowel acting as a nucleus of a monosyllabic word
V_{DS} = vowel acting as a nucleus of the stressed first syllable of a disyllabic word

Here, V_{MS} stands for 'duration of a vowel acting as a nucleus of a monosyllabic word' and V_{DS} denotes 'duration of a vowel acting as a nucleus of the stressed first syllable of a disyllabic word'. The table below presents the mean duration ratio values, which were elicited during the calculation process:

Table 21: Duration ratios (influence of the presence of a second syllable on duration of vowels in stressed first syllables of disyllabic words)

	CF	AF
/i/+S	1,494594	1,289202
/ɪ/+S	1,302635	1,345749
/ɛ/+S	1,588353	1,460522
/æ/+S	2,043075	1,536054
/ɯ/+S	1,180564	1,388613
/ʊ/+S	1,941618	1,735545
/ɔ/+S	1,03448	0,801509
/ʌ/+S	1,282366	1,419095
/i/+F	1,639866	1,800079
/ɪ/+F	1,551511	2,29272
/ɛ/+F	1,391352	1,816643
/æ/+F	1,563664	1,712117
/ɯ/+F	1,799426	1,873476
/ʊ/+F	1,686761	1,874847
/ɔ/+F	1,375474	1,520614
/ʌ/+F	1,370817	1,699709

Here, the leftmost column of the table stands for each duration ratio case. For example, */æ/+S* represents the result of

11.

$$\frac{(/æ/_{MS})_S}{(/æ/_{DS})_S}$$

Where $(/æ/_{MS})_S$ stands for 'duration of the vowel */æ/* in a monosyllabic word, with the postvocalic consonant being a voiceless alveolar stop' and $(/æ/_{DS})_S$ means 'duration of the vowel */æ/* in the stressed first syllable of a disyllabic word, with the postvocalic consonant being a voiceless alveolar stop'. Logically, */æ/+F* would then stand for the result of

12.

$$\frac{(/æ/_{MS})_F}{(/æ/_{DS})_F}$$

in which case $(/æ/_{MS})_F$ means 'duration of the vowel */æ/* in a monosyllabic word, with the postvocalic consonant being a voiceless alveolar fricative' and $(/æ/_{DS})_F$ means 'duration of the vowel */æ/* in the stressed first syllable of a disyllabic word, with the postvocalic consonant being a voiceless alveolar fricative'.

3.5. Discussion

At this point, the data which was gained by the measurements and calculations so far will be analyzed with respect to the hypothesis which was presented in the section 3.2.2.. First, overall mean values of the duration ratios of each of the two groups (AF and CF, respectively) will be compared. Then, CF and AF results will be compared in terms of each respective vowel. Similarly to the previous experiment, the statistical significance of the elicited data will be tested by conducting a paired samples t-test for each of the comparisons. Whether or not the results are statistically significant will be decided depending on the level of statistical significance as calculated by the SPSS software. All the results which gain the Sig. value[20] greater than 0,05 will be treated as statistically insignificant and will be rejected and all the results which appear to have the Sig. value smaller than or equal to 0,05 will be treated as statistically significant and will therefore be accepted as valid.

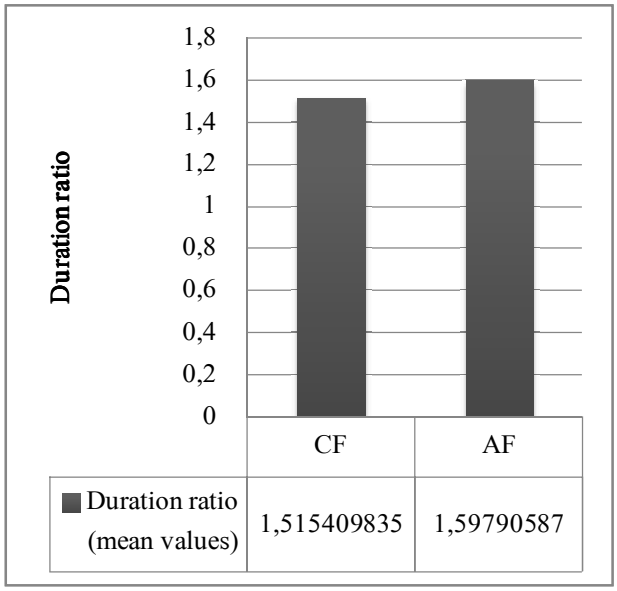
3.5.1. Analysis of the overall results

The hypothesis of this experiment predicted that the Croatian speakers would produce a greater duration ratio $\frac{V_{MS}}{V_{DS}}$ than the American speakers.[21] The results of the overall duration ratio comparison results, however, show the opposite. One can see from Figure 16 that the overall duration ratio for the AF group is greater than the overall CF ratio.

[20] 'Sig.' value is usually also marked with the letter 'p' in statistics.

[21] For details on the research hypothesis of this experiment, cf. section 3.2.2. of this paper.

Figure 16: Comparison of duration ratios (overall results – V_{MS} : V_{DS})



However, one has to notice that the difference of ~0,08 in favor of the AF group is a relatively small difference and it is questionable whether one can use such a relation as a valid basis for any solid conclusion. The outcome of the t-test also shows that the results presented in the chart above are statistically not significant:

Table 22: Results of the paired samples t-test (overall results – V_{MS} : V_{DS})

Paired Samples Test

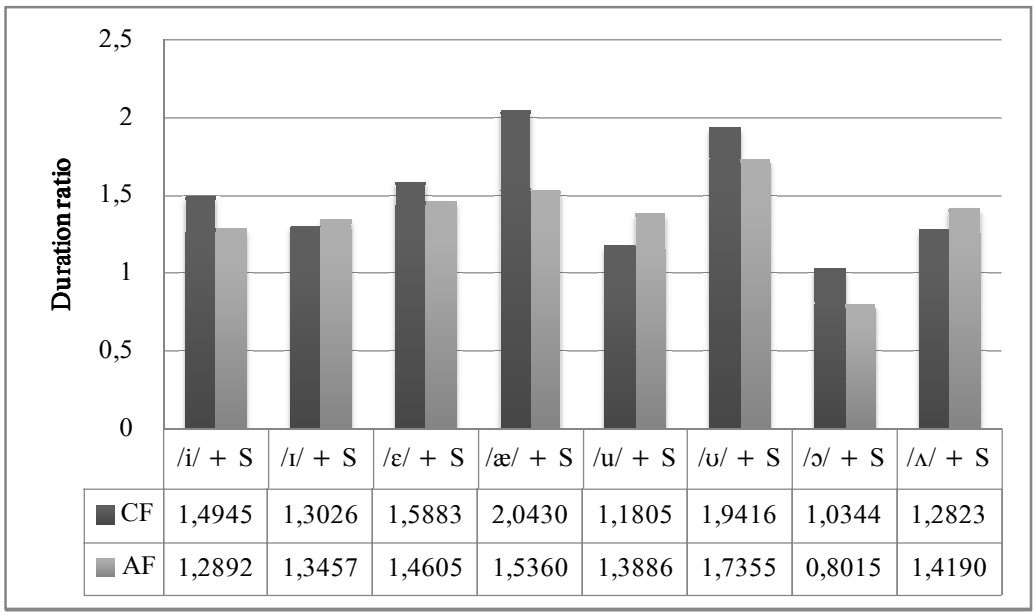
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 CF_all - AF_all	-,082496035	,541482143	,045123512	-,171691329	,006699259	-1,828	143	,070

The paired samples t-test comparing all the duration ratios from the CF group on the one hand to all the duration ratios from the AF group on the other hand resulted in the Sig. value 0,070, which indicates that the results of this comparison can not be accepted as statistically significant. Therefore, the hypothesis that the duration ratio between vowels in monosyllabic words and in the first stressed syllables of disyllabic words is greater in the case of Croatian speakers of English than in the case of American native speakers can not be confirmed as valid at the overall level.

3.5.2. Analysis of the results for each respective vowel

Although the results of the overall comparison have not managed to prove as statistically significant, it is worth exploring the possibility that some cases might act in favor of the hypothesis – that is, that the Croatian speakers of English will produce the greater duration ratio (ergo, a greater amount of shortening) when pronouncing stressed first vowels of disyllabic words compared to the same vowels in monosyllabic conditions. The results of these comparisons are presented below. In order to present the data more clearly, the results of this comparison will be presented by two charts: the first one with alveolar stops in the role of postvocalic consonants and the second one with alveolar fricatives in that position.[22]

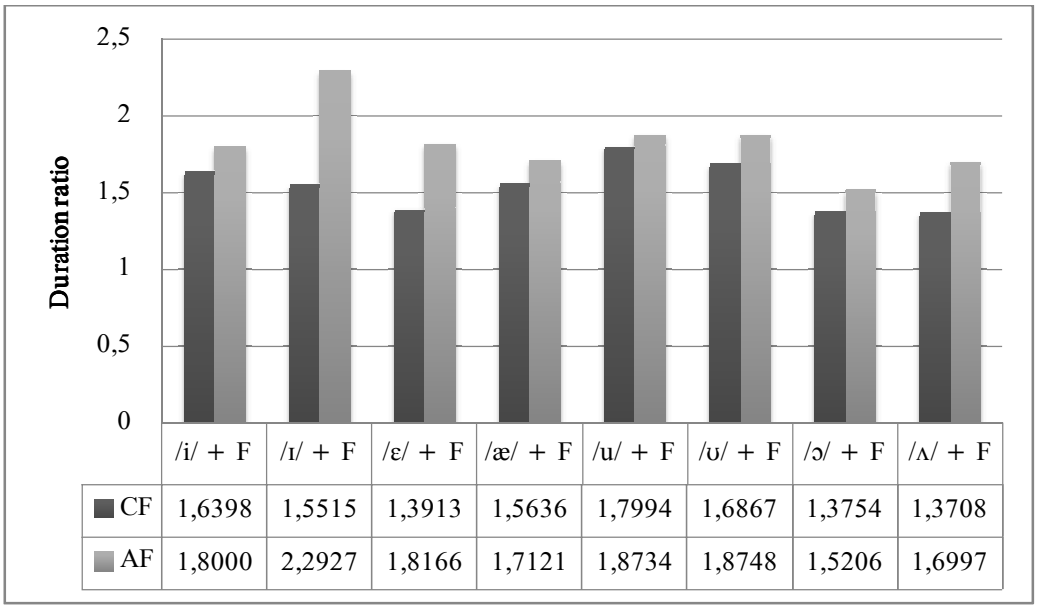
Figure 17: Comparison of duration ratios (separate cases – V_{MS} : V_{DS}; stressed vowel followed by an alveolar stop)



	/i/ + S	/ɪ/ + S	/ɛ/ + S	/æ/ + S	/u/ + S	/ʊ/ + S	/ɔ/ + S	/ʌ/ + S
CF	1,4945	1,3026	1,5883	2,0430	1,1805	1,9416	1,0344	1,2823
AF	1,2892	1,3457	1,4605	1,5360	1,3886	1,7355	0,8015	1,4190

[22] Cf. section 3.3.2. for the list of carrier words for this experiment.

Figure 18: Comparison of duration ratios (separate cases – V_{MS} : V_{DS}; stressed vowel followed by an alveolar fricative)



	/i/ + F	/ɪ/ + F	/ɛ/ + F	/æ/ + F	/u/ + F	/ʊ/ + F	/ɔ/ + F	/ʌ/ + F
CF	1,6398	1,5515	1,3913	1,5636	1,7994	1,6867	1,3754	1,3708
AF	1,8000	2,2927	1,8166	1,7121	1,8734	1,8748	1,5206	1,6997

The charts above show that the hypothesis is only partially confirmed in the case of words where the vowel is followed by a stop. In the case of vowel + fricative, there is no single evidence which supports the hypothesis – all the duration ratios are greater in the case of the American native speakers than in the case of Croatian speakers of English. However, in order to prove the statistical significance of these results, results of a paired samples t-test are presented below.

Table 23: Results of the paired samples t-test (separate cases – V_{MS} : V_{DS}; stressed vowel followed by an alveolar stop)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	beat_beating_CF - beat_beating_AF	,205391676	,443690870	,147896957	-,135659318	,546442670	1,389	8	,202
Pair 2	bit_bitty_CF - bit_bitty_AF	-,043113800	,435573796	,145191265	-,377925458	,291697858	-,297	8	,774
Pair 3	bet_betting_CF - bet_betting_AF	,127830560	,253072535	,084357512	-,066698211	,322359331	1,515	8	,168
Pair 4	bat_patting_CF - bat_patting_AF	,507021045	,737416118	,245805373	-,059807160	1,073849251	2,063	8	,073
Pair 5	boot_booty_CF - boot_booty_AF	-,208048251	,189521889	,063173963	-,353727671	-,062368831	-3,293	8	,011
Pair 6	put_putting_CF - put_putting_AF	,206073077	,674824919	,224941640	-,312643274	,724789428	,916	8	,386
Pair 7	brought_daughter_CF - brought_daughter_AF	,232970663	,315033773	,105011258	-,009185731	,475127057	2,219	8	,057
Pair 8	butt_butter_CF - butt_butter_AF	-,136728920	,358889184	,119629728	-,412595568	,139137728	-1,143	8	,286

As the table above shows, when observing the results of $\frac{V_{MS}}{V_{DS}}$ for the words in which the postvocalic consonant is an alveolar stop, the only result which proves to be statistically significant is the one of the boot-booty (vowel /u/) pair. Figure 17 shows that here, in the case of /u/, the American speakers produced a larger duration ratio than the Croatia speakers – in other words, they shortened the vowel as a function of an added syllable more than the Croatian speakers did. This is contrary to the hypothesis of this experiment.

Testing of all the other results here returned the Sig.-value greater than 0,05. Therefore they can not be observed as statistically significant nor taken into account when establishing claims as for whether the hypothesis can be confirmed or not.

As for the results for the words with postvocalic alveolar fricatives, the t-test returned the following results:

Table 24: Results of the paired samples t-test (separate cases – V_{MS} : V_{DS}; stressed vowel followed by an alveolar fricative)

Paired Samples Test

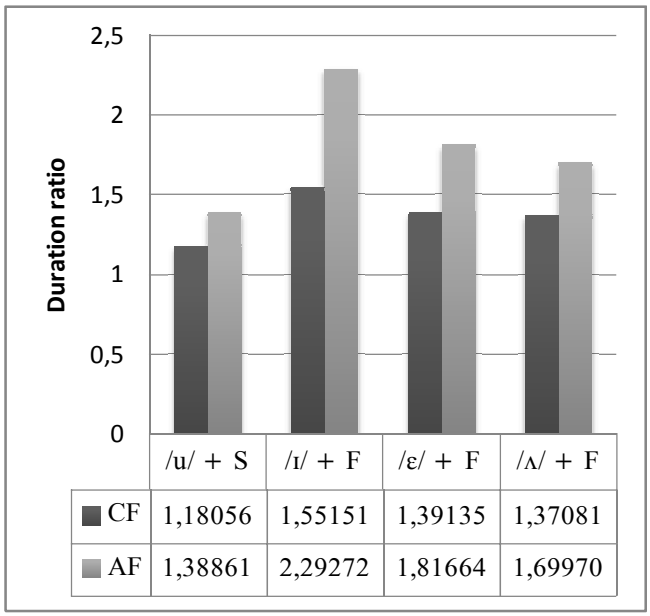
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	peace_pieces_CF - peace_pieces_AF	-,160212719	,541068814	,180356271	-,576115026	,255689589	-,888	8	,400
Pair 2	kiss_kisser_CF - kiss_kisser_AF	-,741208557	,658597335	,219532445	-1,247451283	-,234965832	-3,376	8	,010
Pair 3	chess_Tessie_CF - chess_Tessie_AF	-,425290653	,518272425	,172757475	-,823670105	-,026911201	-2,462	8	,039
Pair 4	pass_passer_CF - pass_passer_AF	-,148453013	,392321317	,130773772	-,450017873	,153111846	-1,135	8	,289
Pair 5	goose_loosen_CF - goose_loosen_AF	-,074050014	,330982083	,110327361	-,328465365	,180365336	-,671	8	,521
Pair 6	wuss_pussy_CF - wuss_pussy_AF	-,188085724	,747500969	,249166990	-,762665832	,386494384	-,755	8	,472
Pair 7	sauce_saucy_CF - sauce_saucy_AF	-,145139775	,353028467	,117676156	-,416501477	,126221927	-1,233	8	,252
Pair 8	bus_buster_CF - bus_buster_AF	-,328892153	,324806951	,108268984	-,578560877	-,079223429	-3,038	8	,016

Here, the t-test has shown that only the results for the testing of kiss-kisser (vowel /ɪ/), chess-Tessie (vowel /ɛ/) and bus-buster (vowel /ʌ/) pairs are statistically significant. In all the other cases, the t-test returned the Sig.-results greater than 0,05. Therefore, they can not be observed as statistically significant nor used as arguments in terms of proving the validity of the research hypothesis of this experiment.

3.6. Conclusion

The chart below presents the all the statistically significant results of this experiment.

Figure 19: Statistically significant results



	/u/ + S	/ɪ/ + F	/ɛ/ + F	/ʌ/ + F
CF	1,18056	1,55151	1,39135	1,37081
AF	1,38861	2,29272	1,81664	1,69970

These data show that the American speakers produced greater — duration ratios than the Croatian speakers did. In other words, these results show that the Croatian speakers shorten the vowels less than the American speakers. This is the very opposite of the hypothesis of this experiment, which predicted that the shortening of vowels as the effect of presence of the second syllable in a word would be greater in the case of Croatian speakers of English than in the case of American native speakers. Therefore, the initial hypothesis of this part of the study can not be confirmed.

Moreover, the results which, as already mentioned, show the totally opposite of this hypothesis, may be a motivation for another study which would predict the opposite of the present hypothesis and, if possible, include a larger number of speakers as well as a larger audio corpus – both in terms of types and of tokens. The suggested study might prove with a greater certainty that Croatian speakers of English shorten the vowels less than American native speakers as a function of the presence of a second syllable in a word. The present experiment, due to only four statistically significant pieces of data, can only indicate to that and open room for discussion on this topic.

4. Summary and general conclusion

The first part of this study dealt with differences between Croatian speakers of English and American native speakers in terms of the impact of voicing of the postvocalic consonant on vowel duration in English words. First of all, pieces of theory were presented, which claimed that, both in Croatian and in English, voicing of the postvocalic consonant influences the duration of the preceding vowel. According to previous research, in English, vowels are lengthened by 1,5 if followed by the voiced consonant as opposed to the voiceless one, and in Croatian, the statistically confirmed data show that the vowels are lengthened by 1,13 when they are followed by the voiced stops in comparison to the case when they are followed by the voiceless stops. No statistically significant data were found for the case of vowels followed by voiced vs. voiceless fricatives.

Therefore, a threefold research hypothesis was set: Firstly, Croatian speakers would produce a smaller amount of lengthening of the vowels as effect of the voicing of the postvocalic stop than the American native speakers. Secondly the same supposition was produced in the case of vowels being followed by voiced vs. voiceless fricatives. The third hypothesis predicted that the Croatian speakers would lengthen vowels as the effect of voicing of a stop more than as the effect of voicing of a fricative.

All the three hypotheses were tested empirically by recording American and Croatian speakers of English in controlled conditions and by consequently analyzing the recordings. The audio materials were used to test the hypotheses both on the general level and on the level of each respective vowel.

The first hypothesis was proven to be right on the general level, as the American speakers indeed produced greater duration ratio than the Croatian speakers did as the effect of the voicing of the postvocalic consonant. The statistical significance of the calculated data was confirmed by the means of a paired samples t-test. The analysis of the results for each

respective vowel also returned results which spoke in favor of the Hypothesis 1, however, the results of the t-test showed that the data which was elicited for the vowels /i/ and /ʌ/ can not be confirmed as statistically significant. Nevertheless, the hypothesis was confirmed by statistically significant data in the case of vowels /ɪ/, /ɛ/, /æ/, /u/, /ʊ/ and /ɔ/.

The overall comparison of V + F duration ratios returned the results which confirmed the second hypothesis as well: The American native speakers lengthened the vowels as the effect of the voicing of the postvocalic fricative more than the Croatian speakers did. The statistical significance of those data was confirmed as well. The results of the analysis on the level of each respective vowel have also confirmed the Hypothesis 2 – in all the cases but the one of the vowel /ɔ/, where the data was not confirmed as statistically significant.

The Hypothesis 3, however could not be proven as valid. The results of the comparison (V + S) vs. (V + F) in the case of Croatian speakers pronouncing English words differed to a very small extent on an overall level, and even that result was not statistically significant. The same occurred at the level of the analysis of each respective vowel: The only statistically significant data was in the case of the vowel /ʊ/. All the other results could not be proven as statistically significant. Therefore, the Hypothesis 3 could not be confirmed.

Conclusively, this part of the study confirmed that when speaking English, Croatian speakers do not lengthen the vowels as the effect of the voicing of the postvocalic consonant to the same extent as the American native speakers do. Instead, they lengthen the vowels to a lesser degree. This phenomenon was confirmed in majority of the cases, since all the results of the experiment apart from the cases of /i/ + S, /ʌ/ + S and /ɔ/ + F support the first two hypotheses of this part of the research.

Moreover, a comparison of the mean duration ratio values of the American native speakers and the Croatian speakers of English has shown that the greatest amount of lengthening due to the voicing of the postvocalic consonant in the case of Croatian speakers is still shorter

than the smallest amount of lengthening by the American speakers. This additionally confirms the first two hypotheses of this study.

The hypothesis that the Croatian speakers lengthen vowels as the effect of the voicing of the postvocalic stop more than they do as the effect of the voicing of the postvocalic fricative was not confirmed due to the lack of statistically significant data.

The second part of the study tested for the differences in the influence of the introduced second syllable on the duration of a vowel in a stressed first syllable of a word between the Croatian and the American native speakers of English. Again, the theory on this matter was studied and presented. It was shown that both in Croatian and in English, vowels are the most elastic part of syllables. It was also shown that in both languages, syllables are shortened due to the addition of further syllables to a word. The only difference which was found was the one in terms of stress: Namely, there is a greater contrast between stressed and non stressed vowels in English than in Croatian. That led to a thought that therefore, in disyllabic words, the stressed syllables would take up a greater amount of a word when pronounced by the American native speakers than in the case of Croatian speakers, where the stressed syllable would be longer than the unstressed one, but not as much. Taken in account that, as already said, the vowel is the most elastic part of the syllable, the hypothesis was produced that both American and Croatian speakers would shorten the vowels of stressed first syllables of disyllabic words as compared to the same vowels in the same postvocalic conditions but in monosyllabic words. The difference which was assumed by the hypothesis was that the Croatian speakers would shorten the vowels more than the American speakers.

Again, the results were observed both at the overall level and at the level of each vowel separately. The difference between overall mean duration was ~0,08 in favor of the American speakers. Not only that this is a very small difference, but the results of a t-test

showed that this result was not statistically significant. Therefore, the hypothesis of this part of the study was not confirmed at the overall level.

In terms of testing at the level of each respective vowel, the results were not unified – some spoke in favor of and some against the hypothesis. However, only four of the results were proven as statistically significant: /u/+S, /ɪ/+F, /ɛ/+F and /ʌ/+F. In those four cases, American speakers produced greater duration ratios than the Croatian speakers in terms of vowels in monosyllabic words versus the same vowels in disyllabic words. That not only did not confirm but it presented the totally opposite of the research hypothesis of this part of the study. Therefore, this hypothesis could not be confirmed.

In other words, this part of the study failed to prove that the Croatian speakers of English shorten the vowels as a function of the addition of a second syllable more than the American native speakers do.

The testing sample of this study was small: only 18 participants took part in it. Also, the recording conditions were not always ideal, in spite of the attempts to achieve the most studio-like conditions. Therefore, a possibility exists that more accurate or more statistically significant results would be gained if one tested the hypotheses of this study on a larger experimental sample and in studio conditions.

However, the study has proven that there are significant differences in the ways in which Croatian and American speakers pronounce the vowels of English with respect to their duration. It has also indicated to some possible further differences between those two groups of speakers. Therefore, it can be used as a valid starting point for further research on this topic.

Also, this study, although being a low-scale one, will hopefully provide basis for certain improvements in phonetic training of EFL learners in Croatia. It shows that the difference in the influence of voicing of the postvocalic consonant onto vowel duration is significant in

those two languages; therefore, the durational relations between nucleus vowels of monosyllabic words in terms of this influence are different in those two languages. The differences between the two languages in terms of the influence of the presence of the second syllable in a word onto vowel duration were not confirmed by this study; however, further research, of, possibly, a larger scale might provide results which confirm this difference as well.

It might be worth considering the possibility of introducing innovations into the EFL curriculum in Croatia, by which the learners would be made aware of the influence of the voicing of the postvocalic consonant onto vowel duration in English and on the differences between English and Croatian in those terms. Most probably, this would not drastically increase the level of competence of Croatian EFL learners, since there are already a large number of Croatian EFL speakers who use English proficiently in Lingua Franca contexts on a daily basis. However, it would be a useful contribution for those who tend to achieve the most native-like accent possible. They would become aware of one more element of Croatian which they should modify in order to get closer to sounding like a native speaker of American English.

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Appendix

Word list as presented to the participants [23]

bead	booze	chess
Liz	pudding	patting
bedding	causing	loosen
jazzer	god	brought
could	Tarzan	bus
cause	beating	cars
udder	kisser	
goddess	bat	
beat	goose	
kiss	putting	
betting	saucy	
passer	got	
put	passing	
sauce	teases	
butter	bed	
gotten	jazz	
tease	moody	
bidding	bosom	
prezzie	Bud	
mood	card	
wuzz	pieces	
broader	bet	
buzzer	pass	
Cardiff	booty	
peace	pussy	
bitty	butt	
Tessie	cart	
boot	bid	
wuss	says	
daughter	padding	
buster	loser	
cartridge	broad	
beading	buzz	
lizard	pass	
bad	bit	

[23] The participants of the experiment had to read all the words from this list; however, recordings of some of the words have not been used in the later course of the study, due either to a low quality of the recording, to an insufficient number of correctly pronounced tokens (in the case of Croatian speakers) or to additional findings over the later course of the study. The words which have been used as the valid stimuli are underlined in the list here.

Questionnaire for the CF group and the BF speaker

Participant: ……..

1. How long have you been studying English now?

   ……..

2. Have you ever been to an English-speaking country? If so, where, when and for how long?

   ……..

3. Do you like movies and music in English? From which countries are your favorite bands and movies? (You can name some of them.)

   ……..

   ……..

4. Which dialect of English do you speak (American English / British English / other)?

   ……..

5. Do you know anything about the length of vowels in English language (e.g. short and long vowels)? Do you know about any difference between English and Croatian on that matter?

   ……..

   ……..

   ……..

   ……..

Personal parameters of the test subjects

Table 25: Personal parameters of the test subjects (CF group)

Speaker	Years of learning English	Visits to or residence in English-speaking countries	Preference of music and movies in English	Preferred dialect	Knowledge on vowel duration.
CF1	9	UK, 4 days	UK, US and Irish bands, Movies: Brave Heart, Titanic, Harry Potter	Mostly AmE	None
CF2	15	UK, 4 days	Likes music and movies in Englisih No examples	Mostly AmE	Notices there is difference. Not specified in what terms.
CF3	11	None	UK and US bands and movies. Metallica, Iron Maiden, Movies: Love actually	AmE	Notices the difference between short and long vowels.
CF4	8	None	Movies from England and America	AmE	None
CF5	7	None	Prefers Croatian movies and music	AmE	None
CF6	10	Malta, 1 week	Both movies and music. Bands: Seether (New Zealand)	AmE	Notices only the difference in quality: "English sounds finer, rounder…"
CF7	9	Malta, 1 week	Music: Nickelback (Canada)	Mostly AmE	"Has difficulties explaining the differences."
CF8	7	None	Music: Rihanna, Pet Shop Boys Movies: Twilight Saga	AmE	None
CF9	13	Malta, 8 days	Likes movies and music in English. No examples	AmE and BrE	None
BF	18	Boston and Washington for 7 years and every summer	Blink 182, Bruno Mars	AmE	Notices the difference, but produces it "by ear".

Table 26: Personal parameters of the test subjects (AF group)

Speaker	Age	State of origin	Academic degree
AF1	24	North Dakota	B.A.
AF2	22	Pennsylvania	B.S.
AF3	24	Tennessee	B.A.
AF4	58	Ohio	M.A.
AF5	48	Oklahoma	B.A.
AF6	56	California	M.A.
AF7	27	Mississippi/Oregon	B.A.
AF8	22	Missouri	B.A.
AF9	36	Wisconsin/Virginia	M.A.

Vowel measurement results and duration ratios

Experiment 1

Monosyllabic words – CF

Table 27: Measurement results (duration in milliseconds) and duration ratios - V+S (part 1) – Croatian speakers

Speaker	bead	beat	Ratio		bid	bit	Ratio		bed	bet	Ratio		bad	bat	Ratio
CF1	173	194	0,89175		134	158	0,8481		171	166	1,03012		201	234	0,85897
CF2	241	193	1,2487		155	142	1,09155		212	187	1,13369		285	214	1,33178
CF3	219	214	1,02336		152	153	0,99346		221	185	1,19459		315	267	1,17978
CF4	216	135	1,6		116	105	1,10476		252	194	1,29897		248	210	1,18095
CF5	176	162	1,08642		191	175	1,09143		218	211	1,03318		237	193	1,22798
CF6	197	159	1,23899		179	122	1,46721		212	169	1,25444		229	221	1,0362
CF7	268	329	0,81459		236	208	1,13462		284	241	1,17842		366	366	1
CF8	238	159	1,49686		226	117	1,93162		204	149	1,36913		252	206	1,2233
CF9	229	198	1,15657		159	133	1,19549		226	187	1,20856		226	250	0,904
CF-mean			1,17303				1,20647				1,18901				1,10477

Table 28: Measurement results (duration in milliseconds) and duration ratios - V+S (part 2) – Croatian speakers

Speaker	mood	boot	Ratio		could	put	Ratio		broad	brought	Ratio		Bud	butt	Ratio
CF1	173	155	1,11613		135	92	1,46739		238	140	1,7		215	143	1,5035
CF2	234	209	1,11962		154	147	1,04762		184	151	1,21854		183	164	1,11585
CF3	217	209	1,03828		127	119	1,06723		258	213	1,21127		203	164	1,2378
CF4	209	127	1,64567		167	111	1,5045		235	139	1,69065		178	127	1,40157
CF5	207	160	1,29375		179	151	1,18543		143	172	0,8314		220	146	1,50685
CF6	239	210	1,1381		192	129	1,48837		156	175	0,89143		162	122	1,32787
CF7	285	228	1,25		185	153	1,20915		302	198	1,52525		218	326	0,66871
CF8	191	152	1,25658		183	120	1,525		223	176	1,26705		227	196	1,15816
CF9	216	153	1,41176		157	102	1,53922		185	220	0,84091		212	207	1,02415
CF-mean			1,25221				1,3371				1,24183				1,21605

Table 29: Measurement results (duration in milliseconds) and duration ratios - V+F (part 1) – Croatian speakers

Speaker	tease	peace	Ratio		Liz	kiss	Ratio		says	chess	Ratio		jazz	pass	Ratio
CF1	169	177	0,9548		141	124	1,1371		177	162	1,09259		272	276	0,98551
CF2	235	222	1,05856		180	170	1,05882		265	179	1,48045		271	239	1,13389
CF3	264	229	1,15284		235	143	1,64336		226	190	1,18947		357	292	1,2226
CF4	198	169	1,1716		208	119	1,7479		284	179	1,58659		270	221	1,22172
CF5	189	167	1,13174		159	169	0,94083		216	192	1,125		238	223	1,06726
CF6	264	181	1,45856		129	126	1,02381		253	168	1,50595		238	202	1,17822
CF7	292	272	1,07353		222	163	1,36196		280	141	1,98582		383	317	1,2082
CF8	208	197	1,05584		184	130	1,41538		197	226	0,87168		259	231	1,12121
CF9	183	194	0,9433		174	113	1,53982		191	180	1,06111		293	289	1,01384
CF-mean			1,1112				1,31878				1,32207				1,12805

Table 30: Measurement results (duration in milliseconds) and duration ratios - V+F (part 2) – Croatian speakers

Speaker	booze	goose	Ratio		wuzz	wuss	Ratio		cause	sauce	Ratio		buzz	bus	Ratio
CF1	232	220	1,05455		122	138	0,88406		211	175	1,20571		215	166	1,29518
CF2	247	204	1,21078		233	257	0,90661		273	252	1,08333		230	182	1,26374
CF3	262	215	1,2186		110	165	0,66667		294	250	1,176		219	158	1,38608
CF4	235	179	1,31285		183	120	1,525		249	255	0,97647		216	148	1,45946
CF5	223	193	1,15544		146	106	1,37736		234	199	1,17588		248	220	1,12727
CF6	258	175	1,47429		89	99	0,89899		258	181	1,42541		208	165	1,26061
CF7	331	326	1,01534		185	168	1,10119		385	330	1,16667		378	226	1,67257
CF8	255	244	1,04508		206	167	1,23353		253	182	1,39011		261	231	1,12987
CF9	245	214	1,14486		107	124	0,8629		248	212	1,16981		207	217	0,95392
CF-mean			1,18131				1,0507				1,1966				1,28319

Monosyllabic words – AF

Table 31: Measurement results (duration in milliseconds) and duration ratios - V+S (part 1) – American speakers

Speaker	bead	beat	Ratio		bid	bit	Ratio		bed	bet	Ratio		bad	bat	Ratio
AF1	277	148	1,87162		162	69	2,34783		180	120	1,5		258	185	1,39459
AF2	268	153	1,75163		198	77	2,57143		209	143	1,46154		338	193	1,7513
AF3	366	134	2,73134		236	167	1,41317		252	162	1,55556		318	214	1,48598
AF4	295	226	1,30531		181	118	1,5339		213	180	1,18333		304	271	1,12177
AF5	294	174	1,68966		180	116	1,55172		237	165	1,43636		311	248	1,25403
AF6	262	215	1,2186		230	189	1,21693		286	234	1,22222		337	250	1,348
AF7	284	174	1,63218		262	156	1,67949		266	192	1,38542		348	206	1,68932
AF8	270	218	1,23853		275	141	1,95035		279	200	1,395		388	189	2,05291
AF9	227	178	1,27528		189	105	1,8		232	171	1,35673		360	274	1,31387
AF-mean			1,63491				1,78498				1,38846				1,4902

Table 32: Measurement results (duration in milliseconds) and duration ratios - V+S (part 2) – American speakers

Speaker	mood	boot	Ratio		could	put	Ratio		broad	brought	Ratio		Bud	butt	Ratio
AF1	253	126	2,00794		186	93	2		264	137	1,92701		160	88	1,81818
AF2	271	186	1,45699		179	110	1,62727		245	153	1,60131		210	146	1,43836
AF3	269	159	1,69182		264	115	2,29565		242	162	1,49383		277	168	1,64881
AF4	319	196	1,62755		207	154	1,34416		252	201	1,25373		177	160	1,10625
AF5	236	144	1,63889		190	105	1,80952		247	161	1,53416		219	142	1,54225
AF6	237	228	1,03947		202	188	1,07447		266	166	1,60241		240	198	1,21212
AF7	306	189	1,61905		245	160	1,53125		297	123	2,41463		266	190	1,4
AF8	328	201	1,63184		298	141	2,11348		354	115	3,07826		252	225	1,12
AF9	268	161	1,6646		188	103	1,82524		303	134	2,26119		185	162	1,14198
AF-mean			1,59757				1,73567				1,90739				1,38088

Table 33: Measurement results (duration in milliseconds) and duration ratios - V+F (part 1) – American speakers

Speaker	tease	peace	Ratio		Liz	kiss	Ratio		says	chess	Ratio		jazz	pass	Ratio
AF1	325	148	2,19595		320	120	2,66667		253	184	1,375		318	176	1,80682
AF2	270	178	1,51685		239	120	1,99167		294	142	2,07042		318	209	1,52153
AF3	235	165	1,42424		280	133	2,10526		280	155	1,80645		335	206	1,62621
AF4	366	187	1,95722		232	192	1,20833		306	212	1,4434		346	296	1,16892
AF5	298	146	2,0411		241	111	2,17117		237	204	1,16176		388	242	1,60331
AF6	286	175	1,63429		258	184	1,40217		273	200	1,365		301	266	1,13158
AF7	374	197	1,89848		321	224	1,43304		332	175	1,89714		352	315	1,11746
AF8	333	189	1,7619		269	219	1,22831		290	138	2,10145		344	261	1,31801
AF9	317	150	2,11333		203	136	1,49265		285	130	2,19231		406	284	1,42958
AF-mean			1,83815				1,74436				1,71255				1,41371

Table 34: Measurement results (duration in milliseconds) and duration ratios - V+F (part 2) – American speakers

Speaker	booze	goose	Ratio		wuzz	wuss	Ratio		cause	sauce	Ratio		buzz	bus	Ratio
AF1	352	180	1,95556		172	108	1,59259		348	194	1,79381		240	141	1,70213
AF2	340	176	1,93182		228	127	1,79528		310	218	1,42202		263	168	1,56548
AF3	296	190	1,55789		290	162	1,79012		305	214	1,42523		332	194	1,71134
AF4	324	252	1,28571		96	66	1,45455		351	296	1,18581		269	213	1,26291
AF5	308	176	1,75		211	84	2,5119		311	207	1,50242		277	170	1,62941
AF6	299	215	1,3907		178	165	1,07879		293	286	1,02448		287	187	1,53476
AF7	359	246	1,45935		272	191	1,42408		397	272	1,45956		350	227	1,54185
AF8	384	208	1,84615		219	179	1,22346		290	254	1,14173		300	157	1,91083
AF9	259	225	1,15111		182	99	1,83838		322	297	1,08418		336	165	2,03636
AF-mean			1,59203				1,63435				1,33769				1,65501

Monosyllabic words – BF

Table 35: Measurement results (duration in milliseconds) and duration ratios - V+S (part 1) – bilingual speaker

Speaker	bead	beat	Ratio		bid	bit	Ratio		bed	bet	Ratio		bad	bat	Ratio
BF	280	172	1,62791		155	119	1,30252		175	141	1,24113		273	177	1,54237

Table 36: Measurement results (duration in milliseconds) and duration ratios - V+S (part 2) – bilingual speaker

Speaker	mood	boot	Ratio		could	put	Ratio		broad	brought	Ratio		Bud	butt	Ratio
BF	271	191	1,41885		171	131	1,30534		192	171	1,12281		152	174	0,87356

Table 37: Measurement results (duration in milliseconds) and duration ratios - V+F (part 1) – bilingual speaker

Speaker	tease	peace	Ratio		Liz	kiss	Ratio		says	chess	Ratio		jazz	pass	Ratio
BF	283	161	1,75776		178	129	1,37984		231	156	1,48077		313	246	1,27236

Table 38: Measurement results (duration in milliseconds) and duration ratios - V+F (part 2) – bilingual speaker

Speaker	booze	goose	Ratio		wuzz	wuss	Ratio		cause	sauce	Ratio		buzz	bus	Ratio
BF	231	169	1,36686		191	108	1,76852		302	259	1,16602		238	139	1,71223

Experiment 2

Monosyllabic vs. disyllabic words – CF

Table 39: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+S (part 1) – Croatian speakers

Speaker	beat	beating	Ratio		bit	bitty	Ratio		bet	betting	Ratio		bat	patting	Ratio
CF1	194	109	1,77982		158	91	1,73626		166	122	1,36066		234	135	1,73333
CF2	193	163	1,18405		142	136	1,04412		187	122	1,53279		214	142	1,50704
CF3	214	125	1,712		153	134	1,14179		185	140	1,32143		267	155	1,72258
CF4	135	107	1,26168		105	89	1,17978		194	126	1,53968		210	104	2,01923
CF5	162	106	1,5283		175	107	1,63551		211	141	1,49645		193	104	1,85577
CF6	159	114	1,39474		122	92	1,32609		169	104	1,625		221	84	2,63095
CF7	329	156	2,10897		208	145	1,43448		241	138	1,74638		366	103	3,5534
CF8	159	127	1,25197		117	122	0,95902		149	103	1,4466		206	140	1,47143
CF9	198	161	1,22981		133	105	1,26667		187	84	2,22619		250	132	1,89394
CF-mean			1,49459				1,30263				1,58835				2,04307

Table 40: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+S (part 2) – Croatian speakers

Speaker	boot	booty	Ratio		put	putting	Ratio		brought	daughter	Ratio		butt	butter	Ratio
CF1	155	140	1,10714		92	67	1,37313		140	167	0,83832		143	109	1,31193
CF2	209	183	1,14208		147	140	1,05		151	270	0,55926		164	176	0,93182
CF3	209	177	1,18079		119	61	1,95082		213	163	1,30675		164	125	1,312
CF4	127	86	1,47674		111	62	1,79032		139	145	0,95862		127	122	1,04098
CF5	160	132	1,21212		151	81	1,8642		172	145	1,18621		146	134	1,08955
CF6	210	188	1,11702		129	41	3,14634		175	155	1,12903		122	102	1,19608
CF7	228	180	1,26667		153	89	1,7191		198	227	0,87225		326	191	1,70681
CF8	152	173	0,87861		120	93	1,29032		176	150	1,17333		196	136	1,44118
CF9	153	123	1,2439		102	31	3,29032		220	171	1,28655		207	137	1,51095
CF-mean			1,18056				1,94162				1,03448				1,28237

Table 41: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+F (part 1) – Croatian speakers

Speaker	peace	pieces	Ratio		kiss	kisser	Ratio		chess	Tessie	Ratio		pass	passer	Ratio
CF1	177	106	1,66981		124	79	1,56962		162	103	1,57282		276	168	1,64286
CF2	222	154	1,44156		170	135	1,25926		179	202	0,88614		239	197	1,2132
CF3	229	129	1,77519		143	99	1,44444		190	120	1,58333		292	197	1,48223
CF4	169	81	2,08642		119	67	1,77612		179	132	1,35606		221	164	1,34756
CF5	167	130	1,28462		169	115	1,46957		192	171	1,12281		223	137	1,62774
CF6	181	138	1,31159		126	62	2,03226		168	103	1,63107		202	145	1,3931
CF7	272	117	2,32479		163	88	1,85227		141	129	1,09302		317	143	2,21678
CF8	197	153	1,28758		130	94	1,38298		226	130	1,73846		231	164	1,40854
CF9	194	123	1,57724		113	96	1,17708		180	117	1,53846		289	166	1,74096
CF-mean			1,63987				1,55151				1,39135				1,56366

Table 42: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+F (part 2) – Croatian speakers

Speaker	goose	loosen	Ratio		wuss	pussy	Ratio		sauce	saucy	Ratio		bus	buster	Ratio
CF1	220	90	2,44444		138	69	2		175	141	1,24113		166	126	1,31746
CF2	204	143	1,42657		257	147	1,7483		252	190	1,32632		182	147	1,2381
CF3	215	116	1,85345		165	80	2,0625		250	167	1,49701		158	137	1,15328
CF4	179	134	1,33582		120	76	1,57895		255	181	1,40884		148	139	1,06475
CF5	193	111	1,73874		106	108	0,98148		199	145	1,37241		220	147	1,4966
CF6	175	103	1,69903		99	61	1,62295		181	148	1,22297		165	121	1,36364
CF7	326	168	1,94048		168	87	1,93103		330	162	2,03704		226	168	1,34524
CF8	244	113	2,15929		167	133	1,25564		182	199	0,91457		231	157	1,47134
CF9	214	134	1,59701		124	62	2		212	156	1,35897		217	115	1,88696
CF-mean			1,79943				1,68676				1,37547				1,37082

Monosyllabic vs. disyllabic words – AF

Table 43: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+S (part 1) – American speakers

Speaker	beat	beating	Ratio		bit	bitty	Ratio		bet	betting	Ratio		bat	patting	Ratio
AF1	148	126	1,1746		69	70	0,98571		120	97	1,23711		185	141	1,31206
AF2	153	112	1,36607		77	101	0,76238		143	114	1,25439		193	144	1,34028
AF3	134	122	1,09836		167	78	2,14103		162	138	1,17391		214	142	1,50704
AF4	226	157	1,43949		118	105	1,12381		180	137	1,31387		271	196	1,38265
AF5	174	147	1,18367		116	89	1,30337		165	131	1,25954		248	146	1,69863
AF6	215	167	1,28743		189	95	1,98947		234	144	1,625		250	125	2
AF7	174	152	1,14474		156	102	1,52941		192	123	1,56098		206	158	1,3038
AF8	218	148	1,47297		141	117	1,20513		200	114	1,75439		189	146	1,29452
AF9	178	124	1,43548		105	98	1,07143		171	87	1,96552		274	138	1,98551
AF-mean			1,2892				1,34575				1,46052				1,53605

Table 44: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+S (part 2) – American speakers

Speaker	boot	booty	Ratio		put	putting	Ratio		brought	daughter	Ratio		butt	butter	Ratio
AF1	126	111	1,13514		93	59	1,57627		137	160	0,85625		88	104	0,84615
AF2	186	122	1,52459		110	84	1,30952		153	186	0,82258		146	122	1,19672
AF3	159	121	1,31405		115	76	1,51316		162	177	0,91525		168	117	1,4359
AF4	196	132	1,48485		154	89	1,73034		201	233	0,86266		160	128	1,25
AF5	144	114	1,26316		105	61	1,72131		161	169	0,95266		142	119	1,19328
AF6	228	145	1,57241		188	94	2		166	179	0,92737		198	111	1,78378
AF7	189	147	1,28571		160	84	1,90476		123	216	0,56944		190	132	1,43939
AF8	201	137	1,46715		141	80	1,7625		115	191	0,60209		225	126	1,78571
AF9	161	111	1,45045		103	49	2,10204		134	190	0,70526		162	88	1,84091
AF-mean			1,38861				1,73554				0,80151				1,41909

Table 45: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+F (part 1) – American speakers

Speaker	peace	pieces	Ratio		kiss	kisser	Ratio		chess	Tessie	Ratio		pass	passer	Ratio
AF1	148	73	2,0274		120	55	2,18182		184	76	2,42105		176	127	1,38583
AF2	178	104	1,71154		120	76	1,57895		142	109	1,30275		209	137	1,52555
AF3	165	123	1,34146		133	78	1,70513		155	94	1,64894		206	132	1,56061
AF4	187	131	1,42748		192	63	3,04762		212	96	2,20833		296	178	1,66292
AF5	146	67	2,1791		111	59	1,88136		204	101	2,0198		242	137	1,76642
AF6	175	112	1,5625		184	69	2,66667		200	100	2		266	163	1,6319
AF7	197	107	1,84112		224	79	2,83544		175	102	1,71569		315	160	1,96875
AF8	189	107	1,76636		219	80	2,7375		138	86	1,60465		261	146	1,78767
AF9	150	64	2,34375		136	68	2		130	91	1,42857		284	134	2,1194
AF-mean			1,80008				2,29272				1,81664				1,71212

Table 46: Measurement results (duration in milliseconds) and duration ratios – V_{MS} : V_{DS}, V+F (part 2) – American speakers

Speaker	goose	loosen	Ratio		wuss	pussy	Ratio		sauce	saucy	Ratio		bus	buster	Ratio
AF1	180	90	2		108	47	2,29787		194	135	1,43704		141	94	1,5
AF2	176	108	1,62963		127	83	1,53012		218	150	1,45333		168	116	1,44828
AF3	190	99	1,91919		162	71	2,28169		214	140	1,52857		194	114	1,70175
AF4	252	123	2,04878		66	71	0,92958		296	202	1,46535		213	112	1,90179
AF5	176	104	1,69231		84	59	1,42373		207	165	1,25455		170	96	1,77083
AF6	215	132	1,62879		165	74	2,22973		286	174	1,64368		187	97	1,92784
AF7	246	122	2,01639		191	75	2,54667		272	148	1,83784		227	112	2,02679
AF8	208	103	2,01942		179	83	2,15663		254	174	1,45977		157	116	1,35345
AF9	225	118	1,90678		99	67	1,47761		297	185	1,60541		165	99	1,66667
AF-mean			1,87348				1,87485				1,52061				1,69971

Zusammenfassung

Diese Studie beschäftigt sich mit dem Dauer der Vokale im Englischen und mit dem Einfluss zweier Faktoren auf die Vokaldauer: Betonung des postvokalischen Konsonanten und Präsenz der zweiten Silbe in dem Wort. Genauer gesagt, sie beschäftigt sich mit den Unterschieden im Einfluss dieser zwei Faktoren auf die Dauer der Vokale in englischen Worten, ausgesprochen von amerikanischen Muttersprachlern einerseits und englischsprachigen Kroaten andererseits.

Als ein Verusch, diese Unterschiede zu beweisen, wurde ein Experiment durchgeführt. Die Hypothesen dieser Arbeit basieren auf früheren Forschungen zu dem Thema. Bei dem Vergleich der Vokalsysteme dieser zwei Sprachen, wurden einige Unterschiede klar, auf denen die folgenden Hypothesen gebaut wurden:

1. Englischsprachige Kroaten verlängern die Vokale als Funktion der Betonung der postvokalen Plosiven weniger als amerikanische Muttersprachler.
2. Englischsprachige Kroaten verlängern die Vokale als Funktion der Betonung der postvokalen Frikativen weniger als amerikanische Muttersprachler.
3. Englischsprachige Kroaten verlängern die Vokale als Funktion der Betonung der postvokalen Frikativen weniger als sie die Vokale als Funktion der Betonung der postvokalen Plosiven verlängern.
4. Vokale, die Nuklei der betonten ersten Silben zweisilbiger Worte sind, sind kürzer verglichen mit denselben Vokalen in monosyllabischen Bedingungen, wenn sie von englischsprachigen Kroaten ausgesprochen werden, als wenn sie von amerikanischen Muttersprachlern ausgesprochen werden.

Diese Hypothesen wurden durch ein Experiment getestet: Eine Liste der englischen monosyllabischen und disyllabischen Worte, die als Vokalträger dienten, wurde

zusammengestellt. Die Wörter wurden so ausgesucht, dass nahezu das ganze Vokalinventar des standarden amerikanisch Englischen in der Liste enthalten war.

Zwei Sprechergruppen hatten die Aufgabe, diese Liste vorzulesen: Eine Gruppe der englischsprachigen Kroatinnen und eine Gruppe der Muttersprachlerinnen aus den USA. Jede Gruppe umfasste neun Personen. Sie waren bei dem Vorlesen dieser Liste aufgenommen, und die von ihnen produzierten Vokale waren mithilfe von SFS/WASP – Software für phonetische Analyse – gemessen. Die so erfassten Vokaldauer-Werte waren miteinander verglichen, und die Dauerverhältnisse wurden ausgerechnet. Letzendlich, wurden durch das Vergleichen dieser Werte die Hypothesen entweder bestätigt oder nicht bestätigt. Die statistische Signifikanz der Ergebnisse wurde auch getestet.

Die ersten zwei Hypothesen wurden bestätigt – sowohl auf der allgemeinen Ebene als auch auf der Ebene beinahe aller einzelnen Vokale: Alle Fälle ausser /i/ und /ʌ/ bei der ersten Hypothese und /ɔ/ im Falle der zweien Hypothese bestätigten die Hypothesen und waren statistisch signifikant.

Die dritte Hypothese konnte nicht bestätigt werden, da die einzigen statistisch signifikanten Ergebnisse diejenige im Falle des Vokals /ʊ/ waren. Alle andere Ergebnisse entweder unterstützten die Hypothese nicht oder waren statistisch nicht signifikant.

Die vierte Hypothese konnte auch nicht bestätigt werden, da die einzigen vier separaten Fälle, die statistisch signifikant waren, Beweise gegen der Hypothese darstellten.

Curriculum vitae

Personal data:

Name:	Davor Leš
Date of birth:	August 31st, 1980
Place of birth:	Našice, Croatia
Nationality:	Croatian

University education:

2003 – present:	University of Vienna: English and American Studies German studies
1998 – 2003:	Josip Juraj Strossmayer University, Pedagogical Faculty, Osijek, Croatia: English language and literature German language and literature

Secondary education

1994 – 1998:	High school "Isidora Kršnjavoga", Našice, Croatia (academic secondary school)

Primary education

1986 – 1994:	Primary school "Dore Pejačević", Našice, Croatia

Languages:

Croatian:	native speaker
German:	second language (seven years spent in Austria)
English:	excellent in speech and writing

Other education and achievements:

1989 – 1995:	Primary music school "Dore Pejačević", Musical instrument: Tamburica
2002:	C1 Certificate in German language (Mittelstufe Deutsch des Österreichischen Sprachdiploms Deutsch)