Prescriptive Accentual Norms Versus Usage in Croatian: An Acoustic Study of Standard Pronunciation*

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Abstract: The divergence of actual spoken usage from the prescriptive Croatian accentual norm has been widely noted, but such observations are largely impressionistic. Relatively little acoustic data is available for the realization of lexical prosodic features specifically in Croatian, as opposed to other closely related varieties, and previous studies have focused mainly on measurements of isolated forms produced by "model" speakers, chosen specifically for their ability to reproduce the standard accentuation. The current study analyzes samples of connected speech taken from recordings of the program *Govorimo hrvatski* on Croatian Radio 1, comparing the results to those in previous acoustic studies of Croatian or Serbian accentuation. The implications of these findings for the viability of the current prescriptive norm are considered within the Croatian sociolinguistic context.

1. Introduction

As is well known within Slavic linguistics, standard Croatian and other closely related standardized varieties used in successor states to the former Socialist Federal Republic of Yugoslavia (Bosnian, Serbian, Montenegrin) have a complex prosodic system that distinguishes rising and falling pitch accents as well as long versus short vowels. The basic system of lexical prosodic distinctions is identical in all of these standardized varieties, although there are differences in the prescriptive accentuation of certain forms. (Here "accentuation" is used as a cover term subsuming place of accent, pitch, and quantity. Traditional descriptions conflate these features and describe the standard accentuation as a "four-accent system"; see section 2.) The standard accentuation

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is taught in the educational system, and actors, radio and television announcers, and other public speakers have traditionally received specialized training in reproducing the prescriptive accentuation. Local, nonstandardized varieties often have accentual systems that differ significantly from the prescriptive norm—this is especially true within Croatia—and acquisition of the standard accentuation can be especially difficult for speakers of these varieties.[1]

The ability of speakers to perceive the accentual distinctions of the prescriptive norm or to reproduce the standard accentuation has previously been questioned by scholars. Magner and Matejka (1971) tested the ability of high-school students in cities throughout the former Yugoslavia to distinguish between accentual minimal pairs and concluded that "the accentual system presented in Serbo-Croatian grammars, dictionaries, and textbooks has little or no relationship with the accentual system(s) employed in many urban areas" (Magner and Matejka 1971: 191).[2] Note, however, that their methodology and interpretation of the results have been criticized by other linguists (e.g., Browne 1972). Ivo Škarić and colleagues at the University of Zagreb have described a number of tendencies in modern Croatian usage that represent departures from the codified accentual norm: the failure to distinguish rising versus falling pitch accents on short vowels, the occurrence of falling accents on non-initial syllables, and the reduction or elimination of quantitative distinctions in post-accentual syllables (Škarić et al. 1987, Škarić et al. 1996, Škarić 1999, Škarić 2002, Škarić and Varošanec-Škarić 2003, Škarić 2007). In her study of pragmatic and positional effects on word prosody, Rajka Smiljanić's subjects from Zagreb and Karlovac did not exhibit systematic lexical contrasts in vowel length or pitch (Smiljanić 2004).

On the other hand, other studies have reported consistent differences in duration and fundamental frequency corresponding to the phonological distinctions of the prescriptive norm in Croatian or the other closely related varieties that were previously all considered to be part of a single standard Serbo-Croatian language. However, this research has certain limitations. The primary focus has typically been to describe the phonetic characteristics of the standard accentual system, so the speakers whose production is analyzed have usually been chosen precisely for their ability to reliably distinguish

[1] In the part of the South Slavic dialect continuum where these standardized varieties are spoken, there are three main dialect groups: štokavian, kajkavian, and čakavian, named for the different words for 'what' (*što*, *kaj*, and *ča*). Kajkavian and čakavian dialects are essentially limited to Croatia. The most widespread dialect type in this region as a whole is termed "new štokavian (neoštokavian)", defined by its specific prosodic features, and this serves as the dialectal base for all of the standardized varieties. Dialects may be further classified as ekavian, ikavian, and ijekavian, according to the reflexes of the Common Slavic vowel **ě*. See Ivić 1958 for more information.

[2] Cf. also Magner (1981), who refers to the standard four-accent system as a fiction.

pitch and quantity in their speech; for example, they often come from areas where these features are known to be present in the local varieties (e.g., parts of Serbia or Bosnia-Herzegovina) and/or were selected to participate because they had received special training in phonetics or diction. The standard methodology adopted in these studies requires the participants to read carefully selected test words in frame sentences or as a list.[3] The nature of the experiment is not concealed from the participants, so they may consequently pay special attention to their production of prosodic features or perhaps even exaggerate them.

For example, the most comprehensive study of "Serbo-Croatian" accentuation to date, Lehiste and Ivić 1986, draws on a number of experimental studies dating back as far as the 1960s. Their acoustic analysis is based on recordings of a main informant, Ivić himself, plus additional recordings by 12 other speakers. Ivić was recorded pronouncing 464 words in the frame sentence *Forma .... data je kao primer* 'The form .... is given as an example', plus almost all of the same words in nine other frame sentences designed so that different inflected forms would occur in a natural context, for a total of 877 utterances. The additional 12 speakers read from two different lists of forms (51 or 65 test words, consisting mainly of words also in the list recorded by Ivić), in the same basic frame sentence given above (Lehiste and Ivić 1986: 36).[4] The main informant Ivić, in addition to being a linguist specializing in the Serbo-Croatian language who taught at the University of Novi Sad, was a native of Vojvodina in Serbia (of which Novi Sad is the regional capital), where the prosodic systems of local varieties are generally very similar to the prescriptive accentual norm.[5] The other informants consisted of six radio announcers in Novi Sad and six students in the Department of Serbo-Croatian at the University of Novi Sad, all of whom are described as speaking "the same dialect of modern standard literary Serbo-Croatian as the main informant, with only minor exceptions" (Lehiste and Ivić 1986: 35). The informants were therefore all Serbian (ekavian) speakers living in Novi Sad at the time the recordings

[3] Surveys of the relevant literature are given by Lehiste and Ivić (1986) and Smiljanić (2004).

[4] These speakers also read certain test words in several other frame sentences designed to put these test words in different positions in the sentence and to study the possible effects of sentence intonation; these results are described separately in Lehiste and Ivić 1986.

[5] The main differences involve restrictions on the occurrence of unaccented long vowels; for example, in the speech of Ivić long vowels "never occur immediately after a long falling accent or after another unaccented long vowel" (Lehiste and Ivić 1986: 35).

were made.[6] Two additional speakers who were originally recorded as part of this group were excluded from the analysis because their pronunciation of the four-accent system of the standard language was deemed "artificial", with numerous mistakes in pronunciation and divergences from the prescriptive norm, which were attributed to the influence of their native local varieties (Ivić and Lehiste 1963: 32, 1965: 78).

Similarly, a more recently published study is based on an analysis of the pronunciation of three *uzorna* (model) speakers, whose accentuation is considered to represent contemporary standard Croatian usage (Pletikos 2003: 321, 324). One of the informants is a specialist in accentuation teaching at the University of Zagreb, the second is an announcer on Croatian Radio, and the third is an actor and teacher of diction at the Academy of Dramatic Arts in Zagreb. They were recorded reading words from a list organized according to accentual categories. It seems that a frame sentence was not used, but this is not explicitly stated in the description of the methodology (Pletikos 2003: 325).

In addition to the relative paucity of acoustic data specifically for Croatian as opposed to other varieties,[7] another notable gap in the literature is the almost complete absence of data concerning the production of prosodic features in connected speech, and where the attention of the speakers is not focused on

[6] Three of the informants are described here as having a western (ijekavian) štokavian background (Lehiste and Ivić 1986: 35), but in the first published analysis of these data the authors state that these three subjects speak ekavian in their daily lives in Novi Sad just like the other informants. One was born in Brčko in Bosnia and moved to Novi Sad around the age of 11; the second was born in a Serbian community in the Lika region of Croatia and moved to Novi Sad around the age of 17; the third was born near Novi Sad to a family that had migrated from Lika (Ivić and Lehiste 1965: 78–81).

[7] In addition to the acoustic studies mentioned above, Jacobsen 1967 analyzes the speech of four informants (three born in Serbia, one born in Croatia but who grew up in Bosnia and Serbia); Rehder 1968 is based on 12 informants from Belgrade; Peco and Pravica 1972 is based on recordings of 29 students at the University of Belgrade, almost all of whom are from neoštokavian-speaking areas (mostly from Serbia, a few from Bosnia-Herzegovina and Montenegro, and one from Banat) and whose accentuation was considered to be standard; Purcell 1973 is based on five informants from Herzegovina. More recently, Godjevac 2000 is based on data from nine Serbian speakers, focusing on sentence intonation and the syntax-phonology interface, and Zsiga and Zec 2013 is based on recordings of three speakers from Belgrade. Pletikos's unpublished dissertation (2008) provides an acoustic analysis of target words read in a frame sentence by a much larger group of Croatian speakers, but I discovered this work only after the present article was accepted for publication; this dissertation is discussed in the conclusion (section 5). Cf. also Pletikos and Vlašić 2007, which analyzes the accentuation of words pronounced by 20 speakers. Only those forms that were judged by the authors to be correctly pronounced (52% of the 900 total forms in the corpus) are included in the acoustic analysis; the methodology of this study is otherwise similar to Pletikos 2008 and it appears to be a pilot for this larger project.

accentuation due to the nature of the process of data collection itself. Bakran (1986) measured the duration of prescriptively long and short vowels in samples of speech from news broadcasts read by two radio announcers. Zgrabljić and Hršak (2003) compared the speech of five radio announcers and five journalists on Croatian Radio for their adherence to the prescriptive accentual norm, but their analysis was apparently based solely on the auditory impressions of the authors (no acoustic analysis is mentioned in the article, and the authors simply describe the accentuation of individual forms as correct or incorrect). Krešić and Arapović (2010) conducted a similar impressionistic study comparing the pronunciation of speakers on broadcasts of Radio Mostar with the standard Croatian accentual norm.

The present study addresses these gaps in the literature by analyzing samples of connected speech produced by educated Croatian speakers. Like the subjects in some of these previous studies, these speakers are experts with specialized knowledge of the norms of the standard language, but in the recordings analyzed here their attention is not focused specifically on the correct reproduction of the standard prosodic features. Therefore, while they were speaking in a context that demands standard usage, their realization of pitch and quantitative distinctions should be free of any conscious exaggeration. The acoustic data from this sample are compared with the results of previous studies, which aimed to establish the acoustic correlates of the different pitch accents and their correct phonological analysis, and are analyzed to determine whether the Croatian speakers in this sample exhibit consistent differences in duration or fundamental frequency corresponding to the standard accentuation.

This analysis of more naturalistic samples of read speech, which provides data on the realization of prosodic features in a context that more closely approximates normal usage, leads to the second major goal of the present study. As stated above, deviations from the existing prescriptive accentual norm have been widely noted. In addition to providing acoustic data that can confirm impressionistic accounts or the results of other types of studies, the present work will consider the implications of these findings with respect to the feasibility of prescribing and implementing such norms of pronunciation in the Croatian sociolinguistic context. The rest of the article is organized as follows. Background information on the prescriptive accentual norm is given in section 2, followed by a description in section 3 of the materials and methodology used in the present study. Section 4 presents the results of the analysis, with a discussion and conclusions in section 5.

2. The Prescriptive Croatian Accentual Norm

The contemporary Croatian accentual norm, as described in prescriptive handbooks, reflects the specific historical development of the standard lan-

guage. Near the end of the 19th century influential Croatian linguists adopted the model of the standard language proposed by Vuk Stefanović Karadžić for Serbian, with the goal of establishing a unified standardized norm for both the Croats and the Serbs. The accentual system presented by Vuk in his works and elaborated later by his disciple Đuro Daničić was based primarily on Vuk's native variety of Tršić in western Serbia, which belongs to the eastern Herzegovinian neoštokavian dialect group. The Karadžić-Daničić system of accentuation was adopted by Tomislav Maretić in his Croatian or Serbian grammar and style manual (Maretić 1899) and Ivan Broz and Franjo Iveković in their Croatian dictionary (Broz and Iveković 1901), which became the foundation of the Croatian standard variety in the first half of the 20th century. The accentuation of certain forms in these works is not typical for western neoštokavian dialects spoken in Croatia, but western (Croatian) accentual variants were introduced only in later handbooks of what was officially treated as a single standard Serbo-Croatian language up until the collapse of the Socialist Federal Republic of Yugoslavia in 1991 (see Vukušić, Zoričić, and Grasselli-Vukušić 2007: 17–21; Martinović 2014: 11–19 for overviews of the history of normative accentuation). Further complicating the picture, local varieties in many parts of Croatia belong to other dialect groups ("old" štokavian, čakavian, and kajkavian) with accentual systems that differ significantly from the neoštokavian type, making it difficult for speakers from these areas to acquire the standard accentual system. There are also tendencies towards analogical leveling to simplify patterns of accentual alternations (which some attribute, at least in part, to interdialectal contact; see Vukušić 2012: 123). As a result, contemporary handbooks of standard Croatian sometimes allow accentual variants or have internal inconsistencies in the accentuation of related forms, and different handbooks may disagree about the accentuation of words.

In the accentual system that serves as the basis for the traditional prescriptive norm, the features of pitch (or tone), quantity, and place of accent are phonologically distinctive.[8] There is one accented syllable per word (with certain limited exceptions), and pitch distinctions are restricted to accented syllables. The distinctive features are conflated in traditional descriptions, which

[8] Croatian sources usually cite *silina* 'force' as the third distinctive prosodic feature, but here this should be interpreted as the opposition between accented and unaccented syllables, and not specifically as intensity. Lehiste and Ivić (1986: 56–59) did not find any consistent relationship between intensity and the type or place of accent; accentedness seems to be indicated by duration and fundamental frequency. Pletikos (2003: 21–22) found greater intensity for the accented as opposed to the first post-accentual syllable and differences in the changes in intensity related to the type of accent, but also noted that the intensity data showed greater variability than the frequency data and that the pretonic syllable in trisyllabic words also had a high level of intensity. We will focus here on the type of accent (rising versus falling) and phonological quantity, rather than the place of accent, so measurements of intensity are not included.

use the following terms and symbols: long rising accent (LR, marked with an acute: á); long falling accent (LF, marked with an inverted breve: â); short rising accent (SR, marked with a grave: à); and short falling accent (SF, marked with a double grave: ȁ). Because there are four possible combinations of quantity and pitch, the system found in the standard language and in neoštokavian dialects in general is traditionally referred to as a four-accent system. Unaccented long vowels are marked with a macron (ā), and unaccented short vowels are unmarked.[9] Examples of minimal pairs are given in Table 1 on the following page.

The distribution of these prosodic features is restricted. Long vowels occur only in accented and post-accentual syllables. The accent may fall on any nonfinal syllable, but the falling accent can occur only on initial syllables, and monosyllabic forms can only carry a falling accent, so the rising vs. falling opposition is limited to the initial syllable of di- or polysyllabic words. These restrictions are the result of the historical development of the neoštokavian prosodic systems, in which the place of the accent shifted toward the beginning of the word by one syllable where possible, resulting in a rising pitch contour on the newly accented syllables. When a form is preceded by a proclitic, an initial falling accent should shift to this proclitic; e.g., *kȕća* 'house', *ù kuću* 'into the house'; *znâm* '(I) know', *nè znām* '(I) don't know'.[10] Foreign borrowings are adapted to this accentual system in the traditional norm; e.g., *rezi̍mē* → *rezìmē* 'résumé, summary'.

It is somewhat difficult to find different lexical items that are distinguished solely by prosodic features, and there does not seem to be any comprehensive list of such forms in the literature on "Serbo-Croatian" accentuation. Many of the minimal pairs that have been cited in earlier works actually have a limited distribution in Croatian, with one of the forms being stylistically marked or regional, according to contemporary sources. In other pairs both members have the same accentuation in Croatian, at least for some speakers; and other forms are simply not attested in contemporary dictionaries and handbooks. To cite a few classical examples: *tȕča* 'hail' is more frequent in contemporary Croatian than *grȁd* 'hail', which is said to form a minimal pair with *grâd* 'city'; for the pair *ȍrao* 'plow.L-PTCP.M.SG': *òrao* 'eagle', the more common accentuation for the *l*-participle in Croatian is *òrao* 'plowed'; for the pair *pàs* 'dog': *pâs*

[9] The standard orthography does not indicate the prosodic features (except optionally for purposes of disambiguation), but these symbols are used in normative handbooks and dictionaries as well as in scholarly works.

[10] A restricted group of stems belonging to Proto-Slavic accentual type C had a stress on the first syllable of the prosodic word (i.e., a free word-form plus any accompanying clitics) prior to the neoštokavian retraction of the accent. These forms should have a falling rather than a rising accent on a proclitic (e.g., *grâd* 'town, city', *ù grād* 'into the city').

Table 1. Minimal pairs illustrating the distinctive prosodic features

Quantity	
SF	LF
lìsta ‘list’	lîsta ‘leaf.GEN.SG’
lùk ‘onion’	lûk ‘bow, arch’
SR	LR
bòba ‘bean.GEN.SG’	bóba ‘berry’
slàgati ‘to tell a lie’	slágati ‘to put in order, stack up’
IN UNACCENTED SYLLABLES	
jäbuke ‘apple.NOM.PL’	jäbukē ‘apple.GEN.SG’
práva ‘right, justice, law.GEN.SG’	právā ‘right, justice, law.GEN.PL’
súsjedom/sùsjedom ‘male neighbor.INS.SG’	súsjedōm/sùsjedōm ‘female neighbor.INS.SG’
Pitch	
SF	SR
gòrī ‘worse’	gòrī ‘burn.PRS.3SG’
jàrica ‘young female goat’	jàrica ‘spring wheat’
stäjati ‘to stop’	stàjati ‘to stand’
LF	LR
cr̂nī ‘black.PRS.3SG’	cŕnī ‘turn black, dark.PRS.3SG’
kûma ‘godfather.GEN.SG’	kúma ‘godmother’
râdio ‘radio’	rádio ‘work.*L*-PTCP.M.SG’
Place of accent	
cr̀venī ‘red.PRS.3SG’	crvènī ‘turn red.PRS.3SG’
òbaviti ‘do, perform’	obàviti ‘wind around, wrap’
ìmānje ‘having’ (verbal noun)	imánje ‘estate’

'belt', some dictionaries treat the latter as stylistically marked and refer users to *pȍjās*; for the pair *sûda* (GEN.SG of *sûd* 'vessel'): *súda* (GEN.SG of *sûd* 'judgment; court'), the former is more typical of Serbian, and the form considered standard in Croatian is *pȍsuda* 'vessel'. Standard Croatian grammars typically list only a handful of minimal pairs in their discussion of prosodic features, and these often involve different grammatical forms of the same word. This would seem to indicate that lexical minimal pairs are limited in number, and as seen in the examples cited here, such pairs often involve forms that would be infrequent in most speakers' everyday usage.[11]

According to standard sources, prosodic alternations occur in the inflection of many lexemes, resulting in minimal or near-minimal pairs; e.g., *grâdu* 'city.DAT.SG': *grádu* 'city.LOC.SG' *jȁbuka* 'apple.NOM.SG': *jȁbūkā* 'apple.GEN.PL'; *zelènē* 'green.F.GEN.SG.INDEF.': *zèlenē* 'green.F.GEN.SG.DEF.'; *pòlomī* 'break up.PRS.3SG': *pȍlomī* 'break up.AOR.2/3SG': *polòmi* 'break up.IMPV.2SG'. However, as mentioned above there is a tendency to simplify many of these alternations in the modern language, so standard handbooks often admit accentual variants or disagree about the accentuation of individual forms. Prosodic alternations are also characteristic of many word-formation processes, and these are another potential source of discrepancies. The overall complexity of the system, together with these and other factors previously mentioned, have created a situation where there is no single universally accepted norm for the pronunciation of many words, including relatively frequent forms. Table 2 on the following page shows examples of a few of the accentual variants encountered in the texts analyzed here and the way they are prioritized by sources consulted for this research.

3. Materials and Methods Used in This Study

The present study is based on a corpus of recordings of *Govorimo hrvatski* (*We speak Croatian*), a short language-advice feature broadcast five days a week on Croatian Radio (HR) 1, the main public radio station in Croatia. Archived versions of the broadcasts are available as .mp3 files on the Croatian Radio-Television website.[12] Although the recordings are compressed for streaming online,

[11] Browne (1972) alludes to this problem in his review of Magner and Matejka 1971. After showing that some of the supposedly minimal pairs used in their perceptual experiment are not minimal pairs for all speakers, he goes on to say: "Readers may expect a critic at this point to come forward with a more satisfactory pair for ` vs. ˝. That is unfortunately easier said than done..." (Browne 1972: 507). Of course, the small number of minimal pairs does not mean that there is no contrast.

[12] http://radio.hrt.hr/arhiva/govorimo-hrvatski/200/, last accessed 6 June 2017. Older recordings are periodically repeated, and only a certain number (about 130) are available on the website at any given time.

Table 2. Examples of accentual variants in some standard handbooks[13]

Šonje 2000	**Vukušić et al. 2007**	**Barić et al. 1999**	**Hrvatski jezični portal**	
äko (àko)	àko	—	äko	'if'
knjïžēvnōst	knjïžēvnōst/ knjižévnōst	knjìžēvnōst	knjïžēvnōst (knjižévnōst)	'literature'
kòliko (kolìko)	kòliko	kòliko/ kolìko	kolìko	'how much?'
krátak (krätak)	krátak/ krâtak	krätak/ krátak	kràtak	'short'
mòžda	mòžda/ mòžda	mòžda/ mòžda	mòžda	'maybe'
òpēt	òpēt	—	òpēt	'again'
pȍput (pòput)	pòpūt/ pȍpūt	pȍput	pȍpūt	'like, as'
rjȅčnīk (rjèčnīk)	rjêčnīk/ rjèčnīk	rjêčnīk	rjêčnīk	'dictionary'
škȍlskī	škòlskī/ škôlskī	—	škòlskī	'school.ADJ'
unátoč (ùnatōč)	unátoč/ ùnātoč/ unàtoč	ùnatoč/ unátoč	unátoč (ùnatoč)	'in spite of'
zâpadnī (západnī)	západnī/ zàpadnī/ zâpadnī	zâpadnī/ západnī	zâpadnī (západnī)	'western'

research has shown that standard lossy compression algorithms maintain virtually identical fundamental frequency (F_0) values, yielding perfect correlations with the uncompressed signal, and even at the lower end of quality such recordings can still be reliably used for pitch and formant measurements (Gonzalez and Cervera 2001; van Son 2005).

[13] Barić et al. (1999) is an enormous guide to proper spelling and usage, rather than being a traditional dictionary; as such, it only lists forms that the authors consider to be potentially problematic in some way, so many commonly used words are not included. The *Hrvatski jezični portal* is an online dictionary using the lexical database

The recordings all follow the same format: after a short introduction, a specialist in the Croatian language reads a brief text offering advice on some question of "proper" Croatian usage. For example, an episode broadcast on 11 February 2014 discusses several commonly used words for 'button': *dugme* (borrowed from Turkish), *gumb* (borrowed from Hungarian), *botun* (borrowed from Italian), and *puce* (of Slavic origin). It concludes that in official and more careful usage *puce* should be preferred, and this should be considered the only standard Croatian form precisely because it is Slavic rather than foreign in origin. The readers are usually professional linguists employed at Croatian universities or research institutes; others are employed by Croatian Radio as language editors (*lektori*).[14] Starting on a randomly chosen date, the first six female speakers were selected, and additional broadcasts were downloaded for each speaker until a sufficient amount of material was collected. Each segment lasts about two and a half minutes (including the introduction), and at least four full recordings were collected and analyzed for each speaker. However, due to a variety of factors, the number of usable vowel tokens varied from broadcast to broadcast. Some speakers often shifted to creaky phonation at the ends of phrases, making it impossible to accurately measure the fundamental frequency, and vowels for which the prescriptive pitch or quantity was uncertain were excluded (see below). Certain vowels are less common in specific environments, so individual words or phrases from additional broadcasts were added to supplement the original recordings that were selected for each speaker. However, there were not enough recordings available to create uniform sample sizes for all speakers.[15]

of the publisher Novi Liber, including dictionaries by Anić (2003 and earlier editions); Anić and Goldstein (2000); and Anić et al. (2003) (see http://hjp.znanje.hr/index.php?show=baza).

[14] Croatian media outlets and publishers traditionally employ special editors known as *lektori*, who are tasked specifically with ensuring adherence to the norms of the standard language.

[15] See Appendix 1 for more information on the recordings that were analyzed. One reviewer requested information about the number of word tokens and lexemes that were included in the analysis, the number of words with accentual variants that were excluded, and the percentage of such forms compared to the total number of words. The method of data coding and analysis here, which focused on individual vowels, makes it impossible to give a precise answer to these questions. Word boundaries were not marked in the annotation of the Praat files, and the script used to extract the acoustic measurements reported results for individual segments. Every attempt was made to include all usable portions of words, whenever practical, so the number of words that were included or omitted is not directly relevant. The number of vowel tokens analyzed in each category is reported below, and information about the number of words in the samples is given in Appendix 1.

The analysis here focuses only on the monophthongs *i*, *u*, *e*, *o*, *a*. Although *r* can function as a syllable nucleus with the same pitch and quantity distinctions as vowels, according to the prescriptive norm syllabic *r* occurs less frequently than the vowels. In addition, syllabic *r* only occurs as short in many varieties of Croatian, which may influence speakers' pronunciation in the standard language, so it was excluded from the analysis. Standard Croatian also has a diphthong *je* (spelled *ije* when long, but still pronounced as a single syllable nucleus in the standard language), but since diphthongs are inherently longer than other vowels *je* was also not included in the data.

The recordings were transcribed and the prescriptive accentuation of the individual words was noted. Several standard sources were consulted (Barić et al. 1999; Šonje 2000; Vukušić, Zoričić, and Grasselli-Vukušić 2007; and the *Hrvatski jezični portal*), and when these sources gave variants or disagreed about the length of vowels or the type of accent, the word (or relevant portion of the word) was excluded from the analysis.[16] The recordings were converted from stereo to mono and saved as .wav files. Segment boundaries were labeled manually in Praat (Boersma and Weenink 2017), with reference to the spectrograms and waveforms, and were verified through audio playback. Boundaries between consonants and vowels were usually clearly visible, based on changes in intensity and spectral features, and consistent criteria were applied in making these annotations. In instances when the boundaries could not be easily determined (especially in sequences involving the glide /j/ and sometimes with other sonorants, due to the low amplitude of the signal or background noise), these vowels were excluded from the analysis of duration. Vowels in phrase-final syllables were also excluded from the analysis of duration because phonological differences in quantity are potentially obscured here by phrase-final lengthening.[17] A Praat script (Hirst 2009) was used to automatically extract vowel durations and F_0 values (minimum, maximum, and mean).

According to Lehiste and Ivić (1986), the F_0 movement within the accented syllable itself often does not conform to the traditional labels of "rising" and "falling". Based on their acoustic data, they conclude that the primary difference between the rising and falling accents is the relationship between the F_0

[16] For example, if sources disagreed about the quantity of a post-accentual vowel, this vowel would be omitted from the analysis of quantity, but the accented vowel could still be included in the analysis of both pitch and quantity. If the difference involved the place of accent and it was clear from the recording which variant was intended, the form was included.

[17] As in the earlier studies cited above, no effort was made to control for the rate of speech beyond the parameters imposed by the task itself (i.e., reading words as a list or in a frame sentence in earlier studies). Many factors can affect the rate of speech, but since the speakers here are reading prepared texts for radio broadcast, it is assumed that each individual speaker will read at a fairly consistent rate.

of the accented syllable and the immediately following syllable. For rising accents, the maximum F_0 level of the post-accentual syllable is as high or higher than that of the accented syllable, while for falling accents the maximum F_0 level of the post-accentual syllable is substantially lower (1986: 55). The results of several perception experiments provided support for their interpretation of the acoustic data, although one of these also revealed some variation, which Lehiste and Ivić attribute to regional differences (it should be noted, however, that there were only 11 participants in this particular experiment). For some speakers it appears that the primary cue for distinguishing rising from falling accents is the F_0 contour of the accented syllable, for others it is the F_0 relationship between the accented and post-accentual syllable, and some speakers make use of both types of cues (Lehiste and Ivić 1986: 170). Nevertheless, Lehiste and Ivić argue that the primary difference between the rising and falling accents is the F_0 relationship between the accented and post-accentual syllable, since the language does not allow pitch contrasts on monosyllabic words. This indicates that the pitch contour of the accented syllable is not a sufficient cue for the phonological distinction rising/falling, and that the domain of the accentual patterns in neoštokavian varieties is a disyllabic sequence (1986: 170–71).

Other scholars have described the rising and falling accents in various ways. For example, some have reported consistent differences in the F_0 contours on accented syllables, or they describe the falling/rising opposition in term of the early or late alignment of the peak F_0 relative to some reference point, such as the beginning of the accented syllable nucleus. There are also reports of differences in duration and (less commonly) intensity for the rising and falling accents. However, the acoustic data in these studies are generally also consistent with Lehiste and Ivić's interpretation (see Lehiste and Ivić 1986: 128–68 for a discussion of earlier research), which is not surprising. A rising contour entails a late F_0 peak, and also means that the next syllable is likely to begin at a level similar to the maximum F_0 of the accented syllable, or possibly higher, although this is not necessarily the case. Based on Lehiste and Ivić's work, it also appears that even if the overall F_0 contour of the accented syllable is level or slightly falling, a relatively high F_0 on the following syllable causes it to be perceived as a rising accent. For falling accents the reverse is true. The data reported by Pletikos (2003), who made a more detailed analysis of the F_0 contours (based on measurements every 10 milliseconds over the duration of the vowel, rather than just the beginning, peak, and final F_0) in recordings of words pronounced by three Croatian speakers, also support Lehiste and Ivić's conclusions. The long falling accent is markedly falling, with a lower F_0 on the following syllable. The short falling is usually falling, but is also sometimes level or slightly rising; however, the post-accentual vowel is lower than the

average F_0 of the accented syllable.[18] The short and long rising accents generally have more or less level F_0 contours on the accented syllable, and the F_0 of the post-accentual syllable is about the same as that of the accented syllable. Although there is a considerable amount of variation in the actual F_0 contours, it occurs within a small frequency range. The average F_0 contours for the different accents given by Pletikos (2003: 332, Fig. 3) show that the peak F_0 on the accented and post-accentual syllables is approximately the same (less than 0.1 octave difference) for both rising accents, while for the falling accents the peak F_0 of the accented syllable is markedly higher than that of the post-accentual syllable.[19]

Therefore, although other cues no doubt also play a role (probably to a greater or lesser degree depending on the region or the individual speaker), the F_0 relationship between the accented and post-accentual syllable appears to be a consistent acoustic correlate of the pitch accents, so this will be the focus of the analysis here. To facilitate comparison across speakers, this relationship will be expressed as the percent change in the maximum F_0 between the accented and post-accentual syllables. While it is not possible to control for phrasal intonation with these data, the texts consist mainly of declarative sentences. Words in phrase-final position (where the effects of intonational contours are generally the greatest) are analyzed separately. The large number of tokens analyzed should help ensure that the data are not substantially skewed by differences in intonation.

[18] Both the short and long falling accents may have a rising-falling contour (usually when the onset is a sonorant or voiced obstruent), with the peak F_0 in the first half of the vowel's duration.

[19] The data in two other recent studies, Smiljanić 2004 and Zsiga and Zec 2013, cannot be directly compared to Lehiste and Ivić 1986 due to the different methodologies used. Both focus on the location of the peak F_0 relative to different reference points (the end of the first vowel in Smiljanić 2004 and the beginning of the word in Zsiga and Zec 2013), and most of their target words have only sonorant consonants, in order to obtain continuous F_0 tracks. Consequently, the peaks are measured wherever they occur, not just within the syllable nucleus as in Lehiste and Ivić 1986. Nevertheless, their descriptions are also largely consistent with Lehiste and Ivić's conclusions. In Zsiga and Zec 2013 all of the target words are either disyllabic or trisyllabic, with the accent on the first syllable, and occur in sentence-final position. They state that the peak always occurs within the accented syllable for falling accents, while for rising accents the peak occurs in the post-accentual syllable for trisyllabic words. In disyllabic words the peak occurs within the first syllable for both types of accent, but on long vowels the rising and falling accents are still distinguished by the location of the peak within the syllable. With a short initial vowel, the peak location does not differ. This is attributed to the interaction of lexical tone with phrasal intonation; the phrasal boundary tone links to the final syllable, forcing the lexical tone to shift to the preceding syllable (Zsiga and Zec 2013: 80). The methodology used in these studies is not practical for the data analyzed here, so their results will not be considered further.

4. Analysis

The following analysis will first examine the realization of prescriptive quantity distinctions in accented and post-accentual syllables (4.1). If the speakers in the sample consistently observe the prescriptive quantity distinctions, then the measured durations of prescriptively long vowels should be significantly longer than prescriptively short vowels, and these differences should be large enough to be perceptible. Section 4.2 examines the realization of prescriptive pitch distinctions. In accordance with the preceding discussion, if speakers make a distinction between the prescriptive rising and falling accents, we expect to find either a modest positive percent change between the peak F_0 of the accented and post-accentual syllable or little to no change in the case of the rising accents, and a larger negative percent change between the peak F_0 of the accented and post-accentual syllable for the falling accents.

4.1. Quantity Distinctions

Distinctions in quantity are generally more likely to be observed in accented syllables. For Croatian, quantitative distinctions are reported to be more consistently maintained in this environment, so we will consider accented and unaccented vowels separately, beginning with the former. A visualization of the combined data for all speakers (4209 observations of accented vowels, Figure 1 on the following page) does not show a bimodal distribution, which we would expect if long and short vowels represent two distinct groups whose realization is independent of other factors. The average durations for long and short vowels are different (short: 91 ms, long: 120 ms), although there is considerable overlap between the actual durations observed for each category, as shown in the boxplot in Figure 2 on the following page. Not surprisingly, given the large number of observations and the size of this difference, an independent one-tailed t-test with Welch's correction indicates that the difference in the means here is significant ($t = 26.278$, $df = 1778.8$, $p < 0.001$). However, the data are not normally distributed, so a simple comparison of the mean duration values is not the most appropriate measure; we should also consider individual speaker variation and any additional factors that may influence duration.[20]

[20] Figure 1 shows that the combined data are positively skewed, and the Shapiro-Wilk test confirms that this overall distribution is not normal ($W = 0.967$, $p < .001$); similarly, the duration values for short and long vowels considered separately are also not normally distributed (short: $W = 0.986$, $p < 0.001$; long: $W = 0.979$, $p < 0.001$). A logarithmic transformation of the data, in this case the natural log, visibly reduces the skewness, although the distribution is still not normal (short $W = 0.993$, $p < 0.001$; long: $W = 0.996$, $p = 0.005$). However, given this improvement, it seems more appropriate to

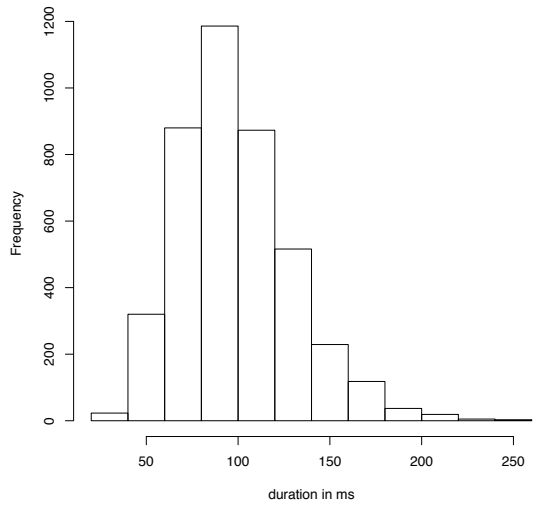

Figure 1. Histogram of duration values for accented vowels

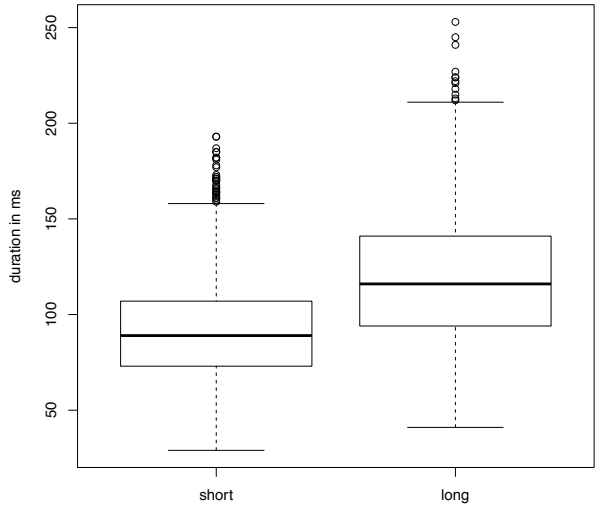

Figure 2. Boxplot of duration values for accented vowels

use log-transformed data for the subsequent statistical tests, although the actual mean durations will also be reported in the discussion of the results. All statistical tests were conducted and figures created using the software package R (R Core Team 2017), with the assistance of consultants at the University of Georgia Statistical Consulting Center.

Assuming that the prescriptively long and short vowels are different from one another, we can construct a fixed main effects model for each group to determine which additional factors should be considered in the subsequent analysis: log(duration) ~ speaker + vowel [a, e, i, o, u] + prescriptive phonological pitch [rising versus falling]. The ANOVA output indicates that all variables are highly significant (Tables 3 and 4).

Table 3. ANOVA output for fixed main effects model of 1215 observations of accented long vowels

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Speaker	5	5.50	1.100	17.80	< 0.001	***
Vowel	4	20.94	5.234	84.69	< 0.001	***
Pitch	1	1.43	1.431	23.15	< 0.001	***
Residuals	1204	74.42	0.062			

Table 4. ANOVA output for fixed main effects model of 2994 observations of accented short vowels

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Speaker	5	11.56	2.312	31.83	< 0.001	***
Vowel	4	12.33	3.082	42.43	< 0.001	***
Pitch	1	5.48	5.480	75.45	< 0.001	***
Residuals	2983	216.65	0.073			

Although a post-hoc Tukey test for each model shows that not all pairs of speakers are significantly different from one another, the results are not identical for prescriptively long and short vowels. Data will therefore be presented separately for each speaker. This is in contrast to some earlier studies, which reported average values for groups of speakers, thus obscuring individual variation, which is a focus of the present work. Likewise, most previous studies have reported average duration data for all vowels together, although it is well known that the intrinsic duration of vowels differs (all things being equal, high vowels tend to be shorter than low vowels; Lehiste 1970: 18–19), and these differences may be great enough to be perceptible (Reetz and Jongman 2009: 215). In the data analyzed here almost all pairs of vowels differ significantly in duration, but again there are some differences in the results for long versus short vowels, which also vary from speaker to speaker. There

is a general tendency for vowels (especially prescriptively short vowels) to be longer under a rising accent, although the differences are usually below the threshold of discrimination for duration, and this also varies depending on the speaker and the individual vowel (see the full data in Appendix 2). Given the potential significance of these factors, duration data for individual vowels under the different pitch accents will also be analyzed here, in addition to the aggregated data, although this sometimes results in small sample sizes. Although the surrounding consonants may also affect vowel duration (Lehiste 1970: 19–27), it was not practical given the nature of the data to attempt to control for this factor.[21]

If we examine the mean durations for all prescriptively long and short accented vowels taken together (Table 5 on the opposing page), it appears that all speakers distinguish these two categories, although the large interquartile ranges (IQRs) show that there is a high degree of variation;[22] in other words, the actual durations of long and short vowels overlap substantially. An independent one-tailed t-test with Welch's correction was performed to compare the mean log-transformed durations.[23] On average, the prescriptively long vowels have significantly greater durations than prescriptively short vowels for all six speakers.

However, we should note that the differences in the average durations for short and long vowels for some speakers are near the perceptual threshold. Although in controlled laboratory experiments researchers have sometimes reported smaller discrimination thresholds, the smallest just noticeable difference for speech sounds is generally thought to be about 10% of the reference duration, although this number is not necessarily constant for sounds of different durations. In the normal range of durations for speech sounds (approximately 30–300 ms), Lehiste (1970: 13) states that the just noticeable differences are in the range of 10–40 ms. Klatt (1976: 1219) suggests 25 ms, or a change of about 20%, as a more reasonable minimum for perceptually significant differences under natural speech conditions.

[21] We should also note that vowel quality may contribute to the perception of quantitative distinctions, since short vowels in štokavian varieties tend to be more centralized compared to their long counterparts. Lehiste and Ivić (1986: 63–68) reported this for accented /e/, /o/, and to a lesser degree /a/; Pletikos (2003: 330–31) also notes some small differences in vowel quality, although she does not consider them significant.

[22] The IQR (the difference between the 3rd and 1st quartiles) is used here rather than the standard deviation, since this is a more appropriate measure of dispersion for data that are not normally distributed (Levshina 2015: 49).

[23] See ftn. 20. Although the log-transformed durations also do not necessarily have a normal distribution, the sample sizes are large enough to justify the use of a parametric test. The Wilcoxon test (equivalent to the Mann-Whitney U test) yields the same significance levels.

Table 5. Comparison of mean durations for all accented vowels

Speaker	Quantity	N	Mean dur in ms	IQR	Mean log(dur)	t	Df	p
1	long	203	125	46.50	4.78	15.772	347.47	< 0.001
	short	418	85	27.00	4.41			
	(L:S ratio 1.5:1)							
2	long	152	115	39.25	4.71	9.074	324.32	< 0.001
	short	328	92	31.25	4.49			
	(L:S ratio 1.3:1)							
3	long	161	116	39.00	4.72	12.282	263.22	< 0.001
	short	539	87	28.00	4.44			
	(L:S ratio 1.3:1)							
4	long	171	106	40.50	4.62	6.721	290.16	< 0.001
	short	447	88	34.50	4.43			
	(L:S ratio 1.2:1)							
5	long	238	131	46.75	4.84	12.102	486.81	< 0.001
	short	606	102	39.00	4.59			
	(L:S ratio 1.3:1)							
6	long	290	119	52.25	4.73	13.493	539.44	< 0.001
	short	656	88	35.25	4.44			
	(L:S ratio 1.3:1)							

Phonemically long vowels have been reported to be from 1.3 to 2 times longer than short vowels, on average, for many languages (see Lehiste 1970: 33–34; Reetz and Jongman 2009: 215). Previous studies of neoštokavian accentuation have also reported values in this range. According to Lehiste and Ivić (1986: 59–62), for their main informant (Ivić himself), long accented vowels in disyllabic words are 1.4 to 1.6 times as long as short accented vowels, on average (for rising vs. falling accents, respectively). For the remaining twelve speakers the average ratio for long to short accented vowels is 1.7:1 (1986: 59–62). In the data in Pletikos 2003 for three Croatian subjects, the average ratio is at least 2:1. Mildner (1994: 165) reports an average ratio of approximately 1.6:1 for the long vs. short falling accent, based on measurements of several tokens of *pâs* and *pȁs* uttered by two speakers from Zagreb, with ranges of duration of 90–140 ms for the short falling accent and 170–250 ms for the long falling (note that there is no overlap between these two categories, unlike the data in the present study). As seen in Table 5, the average ratios for prescriptively long versus short vowels here are on the low end of the range, and the average durations are also shorter in the data here than in these other studies of neoštokavian accentuation, which were based on carefully controlled recordings. However, the results here are similar to the findings of Bakran (1986), who analyzed 20 minutes of news broadcasts read by two different speakers; in his data the average ratio of long to short vowels was 1.26:1, and the average durations were even shorter than those reported here (as cited by Pletikos 2003: 329).

If we take into account the inherent differences in the durations of individual vowels, we see a slightly different picture. Again, a one-tailed t-test was used to compare the mean log-transformed durations, but here the means for individual vowels under the different accents (short falling *ȁ* versus long falling *â*, short rising *à* versus long rising *á*, etc.) were tested, yielding 10 comparisons for each speaker. The results of these tests are summarized in Table 6 on the following page (for the full data, see Appendix 2).

All subjects except Speaker 1 have some conditions where the prescriptive quantitative distinctions appear to be neutralized. While this could be attributable to small sample sizes in some cases, the dispersion of the data is not always greater in these instances. Especially for Speaker 4, there are instances where quantitative distinctions are clearly not maintained (see Figure 3 on page 266): the mean duration for LF *â* (102 ms, N = 26) is practically identical to that of SF *ȁ* (103 ms, N = 60), and the mean duration for LR *í* (84 ms, N = 30) is not significantly different from that of SR *ì* (78 ms, N = 28); the difference in the average values here is also below the perceptual threshold. However, no generalizations can be made about the effect of vowel quality or pitch accent on the neutralization of quantitative distinctions for the group of speakers here as a whole.

Table 6. Comparison of differences in mean log-transformed durations corresponding to prescriptive length distinctions for accented vowels: Number of significant differences, by speaker, vowel, and type of accent

	Accent type	Significant	Borderline	Insignificant
speaker 1	falling	5		
	rising	5		
speaker 2	falling	3	2	
	rising	5		
speaker 3	falling	3		2
	rising	4		1
speaker 4	falling	1		4
	rising	2	2	1
speaker 5	falling	4		1
	rising	5		
speaker 6	falling	4		1
	rising	4	1	

significant: $p < 0.05$, borderline: $p = 0.05–0.15$, insignificant: $p > 0.15$

To summarize, although the speakers analyzed here generally differentiate between prescriptively long and short vowels in accented syllables, the two categories are less clearly distinct in these samples of connected speech than in the data from controlled studies, where the speakers' attention was focused on prosodic distinctions while pronouncing isolated words or sentences. The results here are more similar to those reported by Bakran (1986), who also analyzed samples of connected speech from radio broadcasts.

For quantity distinctions in post-accentual syllables, a comparison of the aggregated data (4821 observations) suggests that there is no significant difference between prescriptively short and long vowels; the mean duration for short vowels is 58 ms, versus 61 ms for long vowels, and the distributions overlap almost completely, as shown in Figure 4 on the following page.

A preliminary analysis of the aggregated data indicates once again that the variables of speaker and vowel are significant (Tables 7 and 8 on page 23). The prosodic features of the preceding syllable also appear to play a role. The significance of the preceding syllable accent (rising, falling, unaccented) is assumed here to be due primarily to the presence versus absence of an accent rather than the pitch of the accented vowel. Although post-hoc

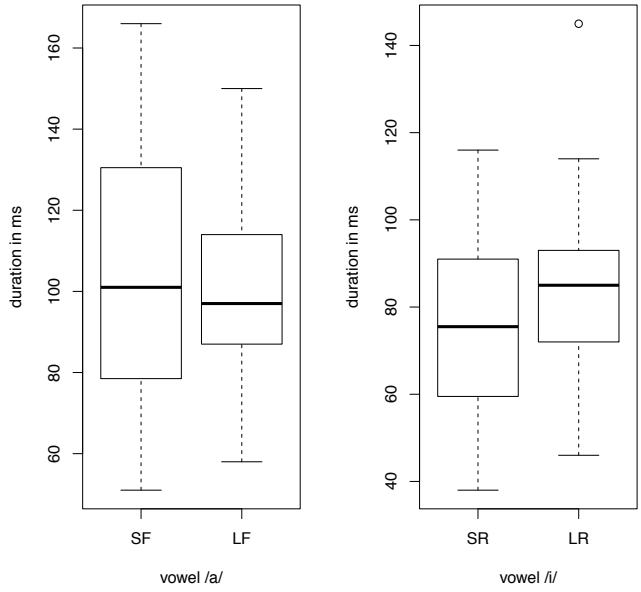

Figure 3. Boxplots for two accented vowels, Speaker 4

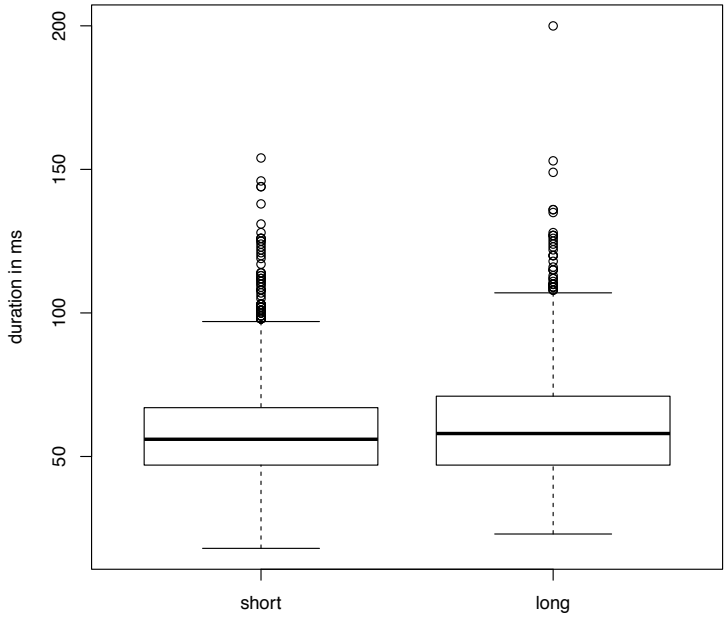

Figure 4. Boxplot of duration values for unaccented vowels

Tukey tests indicate that the pitch accent of the preceding syllable may be significant for the duration of long post-tonic vowels, an examination of the data shows that the differences in the average durations for individual vowels and speakers are usually small and the direction is not consistent (e.g., for Speaker 1 the average duration for /a:/ is 81 ms after a short falling accent and 84 ms after a short rising; for /e:/ the relationship is reversed, with an average duration of 66 ms after a short falling accent and 64 after a short rising). Given this inconsistency and the fact that the number of observations is sometimes small when broken down by speaker and vowel, the possible effect of the pitch accent of the preceding syllable will not be considered here.

Table 7. ANOVA output for fixed main effects model of 1615 unaccented observations, long vowels

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Speaker	5	14.48	2.896	42.310	< 0.001	***
Vowel	4	17.20	4.301	62.842	< 0.001	***
Prec. syll. quantity	1	0.36	0.356	5.196	0.023	*
Prec. syll. accent	2	0.89	0.447	6.526	0.002	**
Residuals	1602	109.64	0.068			

Table 8. ANOVA output for fixed main effects model of 3206 unaccented observations, short vowels

Variable	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Speaker	5	7.41	1.482	22.367	< 0.001	***
Vowel	4	25.91	6.477	97.760	< 0.001	***
Prec. syll. quantity	1	0.10	0.104	1.569	0.210	
Prec. syll. accent	2	2.77	1.384	20.885	< 0.001	***
Residuals	3193	211.54	0.066			

A more detailed analysis of the data reveals that none of the speakers consistently make quantity distinctions in the first post-accentual syllable, although Speaker 1 performs notably better than the other subjects. Table 9 on the following page summarizes the results of one-tailed t-tests, comparing the mean log-transformed durations of each of the five long versus short vowels in syllables immediately following a short or long accented vowel (total of 10 comparisons per speaker; see Appendix 3 for the full data). Of these 60 com-

parisons, the differences in the average durations are usually below the just noticeable difference (in only 13 cases were the differences greater than 10 ms), and frequently the average duration of prescriptively short vowels is greater than or equal to that of prescriptively long vowels (in 24 cases).

Table 9. Comparison of differences in mean log-transformed durations corresponding to prescriptive length distinctions for vowels in the first post-accentual syllable: Number of significant differences, by speaker, vowel, and quantity of the preceding syllable

	Significant	**Borderline**	**Insignificant**	**NA**
speaker 1	6	1	2	1
speaker 2	3	0	6	1
speaker 3	0	3	6	1
speaker 4	0	2	8	0
speaker 5	2	2	6	0
speaker 6	1	3	6	0

significant: $p < 0.05$, borderline: $p = 0.05–0.15$, insignificant: $p > 0.15$
NA indicates that there are not enough attestations of a particular pair to make any comparison.

The picture is even more stark for prescriptive quantitative distinctions in post-accentual syllables that do not immediately follow the accent. As Table 10 on the opposing page shows, there are very few significant differences in the durations of prescriptively long versus short vowels here; although the number of observations for individual vowels is sometimes small, the overall pattern is clear. Again, the average differences in the durations are usually too small to be perceptible (in only 15 out of 60 cases they are greater than 10 ms), and the prescriptively short vowels have greater average durations than prescriptively long ones almost half of the time (28 out of 60 comparisons; see Appendix 4 for details). If we examine the individual cases, Speaker 1 may distinguish short and long /a/ in this environment, and the other long vowels generally have a slightly longer duration than their short counterparts for this speaker.

The results here indicate that quantity distinctions are only partly maintained in the first post-accentual syllable, and only by some speakers. The evidence for quantitative distinctions in other post-accentual syllables is not convincing. On the whole, for most speakers here the durations of post-accen-

Table 10. Comparison of differences in mean log-transformed durations corresponding to prescriptive length distinctions for vowels in other post-accentual syllables: Number of significant differences, by speaker, vowel, and quantity of the preceding syllable

	Significant	Borderline	Insignificant	NA
speaker 1	2	1	7	0
speaker 2	0	0	8	2
speaker 3	1	1	7	1
speaker 4	0	0	9	1
speaker 5	0	3	6	1
speaker 6	1	2	6	1

significant: $p < 0.05$, borderline: $p = 0.05–0.15$, insignificant: $p > 0.15$
NA indicates that there are not enough attestations of a particular pair to make any comparison.

tual syllables do not systematically correspond to the prescriptive quantitative distinctions.

4.2. Pitch Distinctions

As with duration, there are intrinsic differences in the fundamental frequency of different vowels. All things being equal, higher vowels tend to have a higher fundamental frequency (Lehiste 1970: 68–71). Preceding consonants also influence pitch, with vowels following a voiced consonant generally beginning at a lower fundamental frequency (Lehiste 1970: 71–74). As noted above in the discussion of duration, it was not practical to attempt to control for the consonantal environment in these data. Previous studies mention slight changes in the pitch contours of vowels based on the nature of the preceding consonant, but have assumed that pitch is independent of vowel quality. In any case, since the comparison here is based on the percent change in peak fundamental frequency from the accented to the post-accentual syllable averaged over a large number of examples, this variation should not substantially affect the results. Since researchers have reported that pitch distinctions are often not maintained on short vowels, the quantity of the accented vowel will be taken into account. Data for each speaker will be presented separately, as in section 4.1 for quantity. Here again we see a considerable amount of interspeaker variation.

Table 11. Pitch distinctions, words in phrase-initial or medial position

Speaker	Pitch/ Quantity	N	Avg % Δ in F_0	IQR	t	Df	p
1	SR	160	3.4%	12.17	6.235	316.15	< 0.001
	SF	163	-4.4%	14.42			
	LR	89	3.5%	8.93	4.520	65.68	< 0.001
	LF	48	-7.4%	23.83			
2	SR	195	13.9%	14.48	9.349	270.53	< 0.001
	SF	145	-1.8%	19.12			
	LR	80	13.6%	20.51	8.706	73.51	< 0.001
	LF	33	-10.4%	14.53			
3	SR	194	5.0%	18.53	0.987	378.03	0.162
	SF	189	3.5%	19.01			
	LR	78	6.4%	20.32	1.713	48.75	0.047
	LF	29	0.7%	18.31			
4	SR	168	-0.7%	18.14	0.150	323.93	0.560
	SF	158	-0.4%	16.95			
	LR	62	6.0%	17.80	2.633	75.01	0.005
	LF	36	-2.1%	16.95			
5	SR	238	12.9%	18.78	8.821	429.72	< 0.001
	SF	198	-0.3%	16.34			
	LR	142	13.5%	12.34	6.652	55.66	< 0.001
	LF	45	-7.2%	20.58			
6	SR	237	11.3%	18.82	5.687	440.99	< 0.001
	SF	213	-1.0%	20.26			
	LR	91	10.6%	19.96	3.766	173.97	< 0.001
	LF	88	-2.4%	27.52			

For words that are not in phrase-final position, on average the prescriptive rising accents are rising and the falling accents are falling for most speakers, as shown by the positive or negative change in peak F_0 from the accented to the following syllable (see Table 11 on the following page). An independent one-tailed t-test with Welch's correction was performed to compare the mean percent change in F_0, which indicates that the differences between the rising and falling accents are significant for speakers 1, 2, 5, and 6.[24] On average, these differences are also large enough to be phonologically significant. While the just noticeable difference for changes in fundamental frequency is quite small under laboratory conditions (0.3–0.5% for synthetic speech stimuli in the range typical for male voices), studies have shown that speakers of languages with phonologically distinctive pitch ignore small variations in fundamental frequency; differences of less than 3–5% are not likely to be phonologically significant (Howard 1991: 75; see also Huang and Johnson 2010: 249). However, there is a considerable amount of variation in the realizations of the differ-

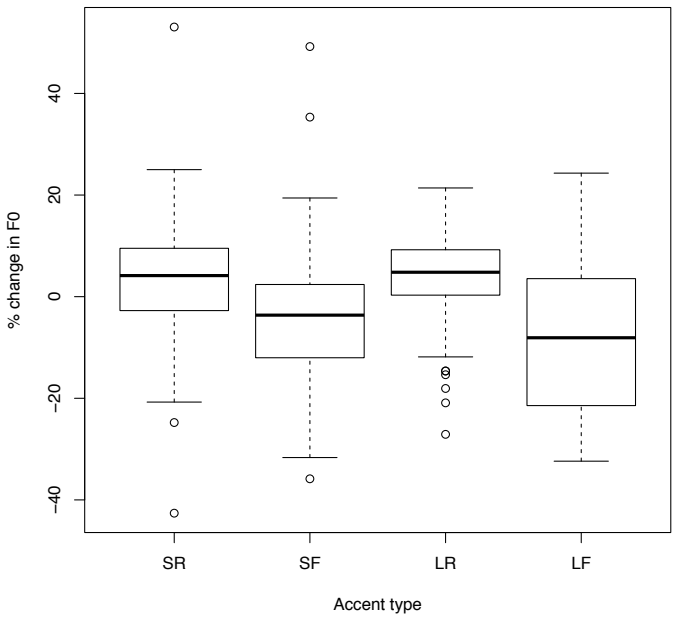

Figure 5. Realization of rising and falling accents, Speaker 1

[24] The percent changes in fundamental frequency for the different accents are usually not normally distributed, but the number of observations is large enough to justify using a parametric test in all but one instance, which falls just below the accepted threshold of 30. The results of the Wilcoxon test are similar, except as noted in the following discussion.

ent pitch accents, as indicated by the often large interquartile ranges in Table 11. Although the average values are different for most speakers, the individual realizations of falling and rising accents are not always distinct, as illustrated by the overlap in interquartile ranges for Speaker 1, shown in Figure 5. Given the overlap in IQRs seen for all speakers, the findings of statistically significant differences may in some instances be due to the large number of tokens analyzed.

For the rising accents, the average difference in the peak F_0 for accented and post-accentual syllables in the data reported by Lehiste and Ivić (1986: 40–41, 51–53) is similar to the data here. For Pavle Ivić and the six other low-pitched speakers the short and long rising accents are level to slightly rising (ranging from -2.1% to +9.5% change on average for di- and trisyllabic words), while for the medium- to high-pitched speakers they are rising (with an average change of +11.3% to +17.7%). However, in their data the change in F_0 for the falling accents is generally much more pronounced than in the data here, with average values ranging from -16.8% to -31.7%. While Pletikos (2003) does not provide the actual F_0 averages, she reports that the average F_0 of the post-accentual syllable is about the same as that of the accented syllable for rising accents, while for falling accents the post-accentual syllable has a significantly lower F_0 compared to the accented syllable (a difference of 20–30 Hz; Pletikos 2003: 333). In the data analyzed here, we see instead that the difference in F_0 for the falling accents is generally smaller, on average, ranging from -0.3%

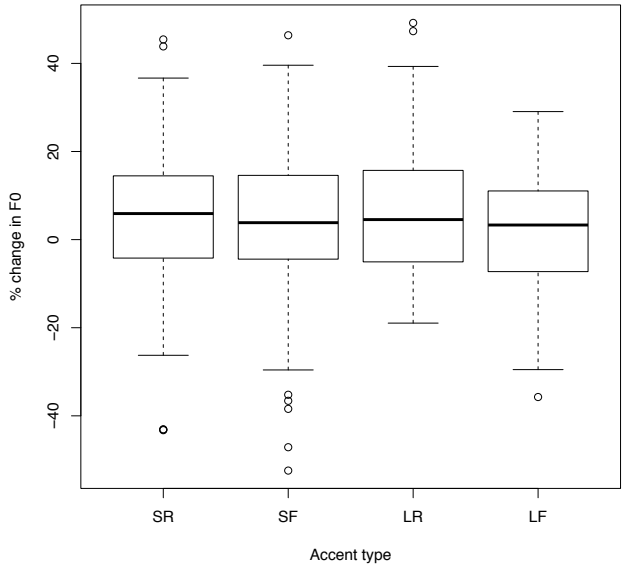

Figure 6. Realization of rising and falling accents, Speaker 3

to -10.4%. This may be due to the fact that these data come from connected speech, rather than isolated words or sentences.

Speaker 3 does not appear to have any significant differences in the realizations of the prescriptive rising and falling accents, which are all slightly rising on average (see Table 11 and Figure 6). For the LR versus LF opposition the p-value from the one-tailed t-test is just below the 0.05 significance level, but here the result of the Wilcoxon test is different (W=1301.5, p = 0.116) and may be more accurate in this case. Speaker 4 does not distinguish pitch on short vowels, and the realizations of the LR and LF accents overlap substantially (Figure 7).

In phrase-final position within a sentence, most speakers in the data here exhibit no significant differences in the change in peak F_0 for the different accents (see Table 12 on page 30). For Speakers 1 and 2, there are differences in the results of the Wilcoxon test compared to the t-test results shown in the table. For Speaker 1, the Wilcoxon test indicates that the difference in the LR and LF accents may be significant (W = 236.5, p = 0.037), which is what one would expect if this speaker distinguishes SR and SF accents in this environment. For Speaker 2, there are not enough examples of the LF accent in this context to draw any conclusions; the Wilcoxon test result is slightly above the 0.05 significance level in this case (W = 60, p = 0.075). Both the rising and falling accents have an increase in peak F_0 from the accented to the post-accentual syllable for all except Speaker 2. This presumably is the result of a rising intona-

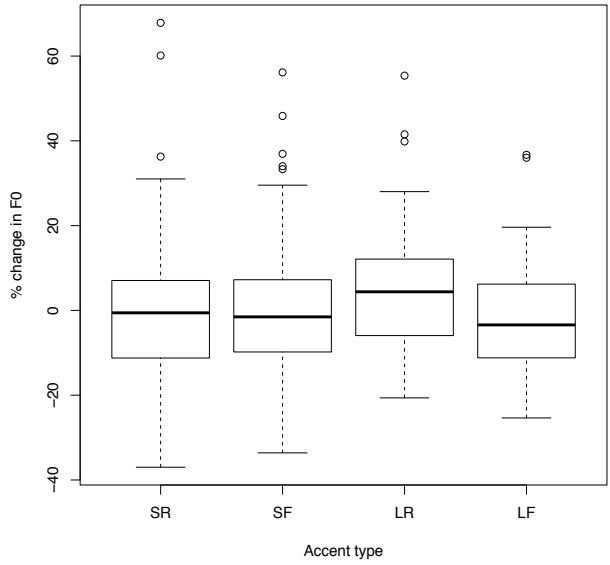

Figure 7. Realization of rising and falling accents, Speaker 4

Table 12. Pitch distinctions, words in phrase-final position

Speaker	Pitch/ Quantity	N	Avg % Δ in F_0	IQR	t	Df	p
1	SR	38	11.2%	24.46	2.091	70.40	0.020
	SF	35	0.4%	20.55			
	LR	29	9.3%	12.42	0.836	15.87	0.208
	LF	12	2.9%	12.51			
2	SR	28	17.1%	19.27	2.734	34.24	0.005
	SF	19	-0.9%	15.33			
	LR	26	12.0%	30.05	3.273	7.447	0.006
	LF	3	-6.1%	6.76			
3	SR	70	12.6%	20.25	0.575	45.27	0.716
	SF	30	15.8%	37.70			
	LR	36	16.8%	19.89	0.445	14.01	0.332
	LF	11	13.1%	18.84			
4	SR	45	15.7%	20.77	0.722	83.14	0.764
	SF	44	19.3%	30.76			
	LR	47	20.6%	17.80	0.785	10.65	0.775
	LF	10	30.2%	43.13			
5	SR	73	19.7%	22.30	0.138	69.98	0.445
	SF	45	19.1%	29.83			
	LR	63	24.0%	25.52	0.517	13.06	0.307
	LF	12	18.0%	42.55			
6	SR	78	14.9%	39.51	0.287	110.29	0.613
	SF	53	16.7%	36.49			
	LR	47	28.2%	47.14	0.721	28.99	0.238
	LF	21	20.2%	48.64			

tional contour, which normally occurs before a sentence-internal pause.[25] In

[25] It is possible that in this environment the distinction between the rising and falling accents could be reflected in the contours of the accented syllables themselves, rather than the F_0 relationship between the accented and post-accentual syllable, due to tonal crowding as suggested by Zsiga and Zec (2013). However, in their data this

sentence-final position, the falling intonation for declarative sentences often results in creaky phonation of the final syllables or even entire words, making accurate measurement of the fundamental frequency impossible. Words in absolute sentence-final position were therefore not analyzed.

To summarize the results, some speakers do on average have different phonetic realizations of the rising and falling accents in phrase-initial or medial position, although the two categories overlap to some extent: both the prescriptive rising and falling accents may have realizations that are basically level or slightly rising in a considerable number of examples, when one compares the peak F_0 of the accented and post-accentual syllable. On the whole, the average decrease in F_0 from the accented to post-accentual syllable for falling accents is not as pronounced in the data from connected speech as in previous studies, where speakers were uttering isolated words or phrases and their attention was focused on the prescriptive accentuation. For all speakers there are some realizations of rising or falling accents that are precisely the opposite of what would be expected (note the ranges for the first and fourth quartiles and the outliers in Figure 5, for example). Two of the speakers (3 and 4) do not distinguish the rising and falling accents of the prescriptive norm, based on these measurements, except possibly on long vowels. In phrase-final position, lexical distinctions of pitch are neutralized for two more of the speakers (5 and 6).

5. Discussion and Conclusions

As shown in the data analyzed here, even experts with specialized knowledge of the standard language do not always conform to the prescriptive accentual norm. All speakers in this sample show some tendency to neutralize prosodic distinctions. Together with the lexical variability mentioned in section 2 and the fact that apparently few minimal pairs are distinguished solely by these features (apart from inflected forms, where there also seems to be a growing tendency towards leveling prosodic alternations), this indicates that pitch and

only occurred with long accented syllables in disyllabic words in sentence-final position. The words in the data here vary in length and occur in phrase-final rather than sentence-final position. The investigation of such possible differences in the relative significance of different phonetic cues in different environments is beyond the scope of the current study. The results here are consistent with Lehiste and Ivić's conclusion, based on their experiments and a review of previous research: "there are certain cases in which the signals of sentence intonation are so prominent that differences in word accents are completely absent" (1986: 236).

quantity in standard Croatian may represent a case of marginal phonological contrast.[26]

In some instances here the prescriptive prosodic distinctions appear to be entirely absent. This is especially striking given the particular context of these recordings, in which the speakers are reading prepared texts for radio broadcast that provide advice to listeners about questions of standard usage. If they do not clearly distinguish pitch and quantity here, then their pronunciation in less formal contexts is likely to diverge even further from the prescriptive norm. In particular, Speakers 3 and 4 do not consistently make these distinctions in the recordings analyzed here, even in contexts where the other speakers do; one possible explanation is that these speakers have not mastered the accentual distinctions of the standard, perhaps due to its differences from their native local varieties, despite their specialized training.[27] These results, based on the production of language experts who are speaking publicly, as arbiters of standard usage, may lead us to question the viability of this norm for the general population.

Although the attention of both experts and the general public in Croatia has tended to focus more on other features of the standard language (especially the lexicon and orthography; for a comprehensive discussion of recent efforts at language planning in Croatia, see Langston and Peti-Stantić 2014), pronunciation has not been ignored. Here the most common complaints or warnings have to do precisely with "improper" accentuation. For example, we may cite the following comments about the language used on Croatian television:[28]

> The most common mistakes, however, are in bad accentuation. Here we encounter various categories of nonstandard accents. (Brozović 2002)

> The language that we hear on television today is horrifying and has no connection with the standard Croatian language [...] Young people and

[26] For a concise overview of research on marginal contrasts, see Renwick and Ladd 2016: 1–4.

[27] Based on publicly available biographical information, Speaker 3 was born in a kajkavian-speaking area (with a different type of prosodic system) and completed high school and college in Zagreb, where the local variety does not have pitch distinctions. Speakers 1, 2, 5, and 6, on the other hand, all seem to be originally from areas where neoštokavian dialects are spoken, although this cannot be stated with absolute certainty for all of them due to the limited information available. No biographical information is available for Speaker 4, apart from the fact that she works as a *lektorica* for Croatian Radio and for various publishers.

[28] All direct quotes from Croatian texts here and below are my own translations.

> children learn the language from television, and what is even more appalling, from advertisements, where we hear bad Croatian more than anywhere else. I hear accentuation that makes my hair stand on end. Our directors go through Croatian courses at the Academy [of Dramatic Arts] in such a way that they learn nothing about the Croatian language and accentology. (Smiljanić 2013)

> I warn all participants in the program—both professionals (hosts, journalists, reporters) and guests in the studio or in the field—about the most frequent violation of one of the norms of the Croatian standard language, the orthoepic norm (or stated more simply, accents). Since the broadcast is seen and heard throughout Croatia, there are parts [of the audience] that definitely notice deviations from this norm, complaining that they are most often being served kajkavian (Zagreb) accents, which, of course, is not acceptable. (Opačić 2017)

Adherence to the prescriptive accentual norm is typically described as a hallmark of precise and cultivated usage:

> Without precise accentuation it can be somewhat more difficult to determine the meaning [of a word], but in any case its integrity is violated. Correct accentuation is also always a question of the culture of speaking... (Zoričić 1998: 337)

The language used by politicians, perhaps not surprisingly, is also subject to particular scrutiny. For example, during the 2014–15 presidential campaign in Croatia, an analysis of the speech of the two candidates remaining in the second round of voting (written by the director of the Institute for the Croatian Language and Linguistics) appeared in the major daily newspaper *Večernji list*. Regarding accentuation, the author noted that Kolinda Grabar Kitarović "has almost completely mastered the neoštokavian four-accent system of the western type" [i.e., the standard accentual norm]; the other candidate, Ivo Josipović, was also described as "an excellent speaker of all four neoštokavian accents", although he was said to exhibit some forms with accentuation typical of Zagreb conversational speech (Jozić 2015). In another article discussing a broadcast of the first session of the Croatian parliament in 2008, the author complains that regardless of the different political agendas of the speakers, "they were all agreed on one thing: the incorrect accentuation of the word *program*," which was "corrupted in the typical Zagreb manner" (Pofuk 2008). On the whole, however, the mass media, rather than political figures, have been the most common target of complaints, and the media are felt to have a special responsibility here because of their potential to influence the everyday usage of Croatian speakers. According to Zgrabljić and Hršak (2003:

143), "care for the Croatian standard language, which also means nurturing the culture of speech and of standard pronunciation, is one of the obligations of the public media [...]."

Despite this concern with correct pronunciation, and particularly correct accentuation, as an important component of linguistic culture in Croatia, it is not clear that pronunciation can ever truly be standardized. Milroy and Milroy (1985: 26), among other sociolinguists, have questioned whether such a thing as a "spoken standard language" even exists. This is not to say that there are no norms of pronunciation, but spoken language is more variable than written language, and even in its written form a standard language is an abstraction; to quote Milroy and Milroy (1985: 22–23), it is more accurate to think of standardization "as an ideology, and a standard language as an idea in the mind rather than a reality—a set of abstract norms to which actual usage may conform to a greater or lesser extent."

Scholars in Croatia generally recognize that many if not most speakers of Croatian do not conform to the codified accentual norm even in contexts where the standard language is expected. As a consequence, discussions of the accentual norm often contrast the **prescriptive** or **codified norm** with what is often referred to as the **customary norm** or the **norm of usage** (*uzusna/uporabna norma*, although the terms employed here vary considerably; see Martinović 2014: 24–27 for an overview). However, this distinction between the standard accentuation found in handbooks and the standard accentuation used in speech still privileges the pronunciation of those who are considered to be "competent" or "model" speakers of the standard language: typically, speakers who are well educated, whose profession requires them to speak publicly, who often have special training in pronunciation—or in other words, those whose realization of the prosodic features in (careful) speech is judged to be acceptable by language experts because they do not deviate too far from the prescriptive norm (see Martinović 2014: 27).

Škarić goes somewhat further in distinguishing three types of word prosody in what he refers to as "general", not regionally marked Croatian usage: (1) the "classical" type, which represents an internally consistent neoštokavian prosodic system as originally codified by Karadžić, Daničić, and Maretić, although with preference given to certain western neoštokavian variants; (2) the "accepted" type, which Škarić describes as the pronunciation normally used in various spheres of public life (e.g., in the educational system, the government, the media); and (3) the "acceptable" type, which represents a sort of compromise between the first two (see Babić et al. 2007: 122–29). Škarić himself says that the accepted type of prosody cannot be rigidly and explicitly defined, since it has developed through communication rather than by prescriptive statements, and the basis for his characterization of this third acceptable type of prosody is not clear. Essentially it appears to represent the classical norm with some exceptions or variants that more closely reflect contempo-

Table 13. Comparison of Škarić's three types of word prosody (adapted from Babić et al. 2007: 129)

Classical type	Acceptable type	Accepted type
Four-accent system (pitch distinctions on both long and short vowels)	Four-accent system (pitch distinctions on both long and short vowels)	Three-accent system (pitch distinctions only on long vowels)
Falling accents are restricted to initial syllables, which entails the consistent shift of falling accents to a proclitic and the prosodic adaptation of loanwords.	Falling accents are restricted to initial syllables, with the exception of certain forms (primarily compounds and more recent borrowings); the falling accent may shift to a proclitic, but this is not obligatory.	Falling accents may occur on any syllable, including final syllables; no shift of the accent to a proclitic.
Quantity is distinctive in both accented and post-accentual syllables.	Long vowels may occur in post-accentual syllables, especially when length occurs under accent in related forms, but quantitative distinctions are often neutralized after the accent.	Quantity is distinctive only in accented syllables.
Systematically reflects the historically expected neoštokavian forms.	The historical neoštokavian system is reflected inconsistently.	Simplification of the neoštokavian system; tendency to eliminate accentual alternations.

rary usage. The main features of the three types are defined in Table 13 on the following page.

Standard handbooks generally recognize at least some deviations from the classical norm, although they may characterize them as informal or conversational variants, and they disagree about the extent to which these innovations should be accepted as part of the standard language. Some scholars have argued that the prescriptive accentual norm should be simplified so that it more closely reflects the normal speech of the majority in the language community (e.g., Pranjković 2001), while others are in favor of maintaining the current norm (e.g., Kapović 2007—who, it should be noted, is nevertheless not a prescriptivist). Kapović acknowledges the range of variation in actual usage, saying that "Croatian standard accentuation should be viewed not as something that everyone must obligatorily master, but rather as an ideal towards which everyone more or less aspires when attempting to speak the standard language and which they approximate to a greater or lesser extent, according to their needs and abilities" (2007: 70).

However, it is questionable to what degree Croatian speakers really aspire to the existing accentual norm. The classical pronunciation may actually be perceived as rural and uncultured, at least in large urban centers such as Zagreb (which together with the surrounding metropolitan area represents about one quarter of the population of Croatia as a whole; see Mićanović 2004 and references there).[29] The acceptability or prestige of the norm among the general public must therefore also be taken into account, as well as its learnability. The traditional accentual norm requires considerable effort for many Croatian speakers to master because of its differences from their local varieties, and in almost all instances the use of non-standard accentuation does not hinder communication.

The production of the speakers analyzed here, all trained specialists in Croatian, is more similar to Škarić's acceptable or accepted types than to the current prescriptive norm, as represented in various standard handbooks. Quantitative distinctions are only marginally observed in post-accentual syllables, and two of the speakers do not make pitch distinctions, at least on short accented vowels. Even for the other speakers, individual realizations of the falling and rising accents are not always distinct. As shown by the data from words in phrase-final position, pitch distinctions may also be more generally neutralized, due to the influence of phrasal intonation. On the whole, the differences between long and short vowels or rising and falling accents are smaller than have been reported in most previous studies; this may be due to the fact that the speakers are reading connected texts rather than focusing consciously on producing individual forms with the correct accentuation.

[29] The classical neoštokavian accentuation may also be perceived as non-Croatian; e.g., as Bosnian or Herzegovinian (see Milas 2014).

The use of previously recorded material available online allows us to analyze a larger number of individual forms compared to previous studies. However, there are obvious trade-offs in the approach used here: while interspeaker variation, inherent differences in the duration of different vowels, and certain other contextual factors were taken into account in the analysis, it was not practical to attempt to control for many other factors that could also affect the realization of prosodic features. Nevertheless, the results of the analysis here are consistent with data reported by Pletikos 2008.[30] The latter work provides an acoustic analysis of the speech of 89 subjects, primarily students in the departments of Phonetics, Linguistics, or Croatian Language and Literature at the University of Zagreb, who read 41 test words in a frame sentence. All of the speakers had lived in Zagreb for at least one year prior to recording, and the largest single group of subjects (24) was from Zagreb, while the other speakers were originally from other towns and cities across Croatia, plus a handful of locations in Bosnia and Herzegovina. The speakers were divided into groups based on an auditory analysis by four experts prior to the acoustic analysis: 36 were classified as having a pitch-accent system, mostly with an identifiable neoštokavian dialect background; 30 were classified as having a stress accent system (no pitch distinctions, and often with no quantity distinctions in accented syllables); and 23 were described as transitional between the former two systems, with no pitch distinctions on short vowels and a different phonetic realization of the long rising vs. long falling opposition than speakers in the first group. Pletikos 2008 also found no systematic relationship between the durations of vowels and prescriptive quantitative distinctions in post-accentual syllables. It should be noted, however, that this group of subjects is skewed towards Zagreb and other kajkavian-speaking areas of northern Croatia, and many of them have some specialized linguistic knowledge from their programs of study at the University of Zagreb. It would be desirable to conduct a similar study of linguistically naive speakers actually residing in different parts of Croatia.

Although pronunciation in particular is not amenable to rigid standardization, speakers of a given language often desire to avoid regionally marked pronunciations or to emulate pronunciations that are deemed to be prestigious. The ideology of standardization plays an important role in society, and as Cameron (1995) has argued at length, there is a popular culture of correct usage. Speakers of a language routinely make value judgments about what forms of expression are and are not acceptable. Therefore, prescriptivism is in this sense a natural part of language, and the concept of standardization is arguably just as valid with respect to spoken language as it is to written language. In purely practical terms, however, codified norms are not useful

[30] See footnote 7 above; cf. also Pletikos Olof 2013, which analyzes a subset of these data.

if they diverge so far from common practice as to be unrealistic; they must be acceptable to the majority of speakers and accepted by them. The number and types of accentual variants found in current handbooks (see Table 2 above) also point to the relative instability of the existing Croatian norm. Based on the results of the analysis here and what we know of the current linguistic situation in Croatia in general, arguably a more realistic accentual standard would simply specify the place of accent and the quantity of accented vowels, with pitch as an optional feature for those speakers whose local varieties have this distinction.

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Appendix 1. Additional information on recordings used in this study

Table 1. Additional data on recordings analyzed

	Total length of recordings analyzed	Total number of word tokens	Number of word tokens with accentual variants		Number of distinct lexemes
Speaker 1	8.5 minutes	1054	86	(8.2%)	392
Speaker 2	9.5 minutes	1113	102	(9.2%)	477
Speaker 3	10.3 minutes	1159	144	(12.4%)	437
Speaker 4	9.4 minutes	1264	98	(7.8%)	471
Speaker 5	14.2 minutes	1590	252	(15.8%)	499
Speaker 6	14.8 minutes	1930	288	(14.9%)	616

Because of the way that the subjects were chosen (to avoid cherry-picking individuals based on their realization of the prosodic features), the number of available recordings varied, and the amount of usable material in each recording was unpredictable. The annotations of the recordings in Praat marked only segment boundaries, so the number of word tokens/lexemes and the number of word tokens with accentual variants were calculated based on the transcripts for each speaker. The assignment of tokens to different lexemes and tagging of accentual variants (which were marked in different ways in the text transcriptions) were done by hand. Words or portions of words could also be excluded for other reasons, as described in the main text, so the figures here are approximate and do not reflect the number of words actually included in the analysis.

After the initial processing of the data, a number of isolated words were extracted from additional recordings in an attempt to get at least five tokens of each vowel under each condition, but this was not always possible. These additional items are not included in the totals here.

The precise number of vowel tokens analyzed is reported in the body of the paper and in the remaining appendices.

Appendix 2. Quantity Distinctions in Accented Syllables

Table 1. Speaker 1, Duration of accented vowels

	SF ầ	LF â	SR à	LR á	SF ề	LF ê	SR è	LR é	SF ì	LF î	SR ì	LR í
N	51	27	43	47	54	19	25	16	35	18	27	35
Mean dur	86.2	147.4	98.8	137.2	80.1	121.8	91.8	116.3	77.0	98.1	76.5	101.9
SD	17.4	38.1	22.5	28.6	17.0	28.2	20.8	40.7	17.4	18.1	17.9	20.7
Mean log(dur)	4.43	4.96	4.57	4.90	4.36	4.78	4.49	4.71	4.32	4.57	4.31	4.61
SD	0.22	0.28	0.22	0.22	0.21	0.22	0.24	0.28	0.23	0.18	0.22	0.19
t-test p value	< 0.001		< 0.001		< 0.001		0.007		< 0.001		< 0.001	

	SF ồ	LF ô	SR ò	LR ó	SF ừ	LF û	SR ù	LR ú
N	52	10	85	7	25	13	21	11
Mean dur	81.9	115.8	87.3	161.3	80.3	142.0	89.0	114.2
SD	18.8	57.6	20.9	61.3	31.3	48.1	16.0	17.7
Mean log(dur)	4.38	4.65	4.44	5.02	4.33	4.90	4.47	4.73
SD	0.23	0.45	0.25	0.40	0.34	0.34	0.19	0.16
t-test p value	0.045		0.004		< 0.001		< 0.001	

Table 2. Speaker 2, Duration of accented vowels

	SF ȁ	LF â	SR à	LR á	SF ȅ	LF ê	SR è	LR é	SF ȉ	LF î	SR ì	LR í
N	39	15	41	25	30	6	23	9	24	9	18	35
Mean dur	89.6	125.2	102.2	135.7	81.6	102.7	93.7	105.8	84.2	96.7	77.7	96.9
SD	31.5	21.6	19.4	21.1	19.9	25.0	21.8	14.6	18.7	22.4	23.6	18.4
Mean log(dur)	4.43	4.82	4.61	4.90	4.37	4.61	4.51	4.65	4.41	4.55	4.31	4.56
SD	0.37	0.17	0.19	0.17	0.26	0.24	0.24	0.14	0.24	0.23	0.30	0.20
t-test p value	< 0.001		< 0.001		0.030		0.025		0.071		0.002	

	SF ȍ	LF ô	SR ò	LR ó	SF ȕ	LF û	SR ù	LR ú
N	47	12	62	11	33	17	11	13
Mean dur	89.9	101.3	103.9	139.8	85.6	124.4	94.8	114.9
SD	23.9	25.9	21.9	44.5	23.3	24.4	25.3	23.0
Mean log(dur)	4.47	4.59	4.62	4.89	4.42	4.80	4.52	4.73
SD	0.24	0.26	0.21	0.32	0.26	0.21	0.26	0.20
t-test p value	0.081		0.009		< 0.001		0.022	

Table 3. Speaker 3, Duration of accented vowels

	SF à	LF â	SR à	LR á	SF è	LF ê	SR è	LR é	SF ì	LF î	SR ì	LR í
N	63	21	68	61	51	4	43	7	50	6	46	34
Mean dur	88.1	114.1	100.0	135.7	80.8	110.0	90.7	101.3	78.7	89.7	79.2	95.8
SD	27.1	22.4	21.9	25.5	19.0	10.1	17.6	22.9	11.9	23.0	16.4	20.1
Mean log(dur)	4.42	4.72	4.58	4.89	4.36	4.70	4.49	4.59	4.35	4.47	4.35	4.54
SD	0.35	0.21	0.22	0.18	0.24	0.09	0.20	0.24	0.15	0.27	0.20	0.20
t-test p value	< 0.001		< 0.001		< 0.001		0.151		0.178		< 0.001	

	SF ò	LF ô	SR ò	LR ó	SF ù	LF û	SR ù	LR ú
N	66	8	96	11	20	3	36	6
Mean dur	86.6	88.4	95.1	113.6	79.8	121.3	76.3	108.7
SD	22.7	22.5	19.2	32.1	23.6	8.3	16.5	17.5
Mean log(dur)	4.43	4.46	4.53	4.70	4.34	4.80	4.31	4.68
SD	0.26	0.24	0.21	0.27	0.28	0.07	0.22	0.16
t-test p value	0.384		0.037		< 0.001		< 0.001	

Table 4. Speaker 4, Duration of accented vowels

	SF ȁ	LF â	SR à	LR á	SF ȅ	LF ê	SR è	LR é	SF ȉ	LF î	SR ì	LR í
N	60	26	53	53	53	3	47	17	38	19	28	30
Mean dur	102.9	101.5	99.6	132.9	77.4	87.3	88.9	103.2	69.0	94.9	77.7	84.3
SD	30.9	26.2	20.4	29.2	19.4	31.5	18.3	13.7	16.5	27.1	20.7	19.9
Mean log(dur)	4.58	4.59	4.58	4.86	4.32	4.42	4.46	4.63	4.21	4.51	4.32	4.41
SD	0.32	0.26	0.23	0.23	0.25	0.39	0.24	0.13	0.24	0.30	0.28	0.24
t-test p value	0.475		< 0.001		0.345		< 0.001		< 0.001		0.097	

	SF ȍ	LF ô	SR ò	LR ó	SF ȕ	LF û	SR ù	LR ú
N	44	8	83	5	26	2	15	8
Mean dur	90.7	97.6	91.7	98.0	72.4	80.0	75.8	87.4
SD	23.5	52.7	25.3	29.4	17.6	26.9	14.8	19.0
Mean log(dur)	4.47	4.45	4.48	4.55	4.25	4.35	4.31	4.45
SD	0.27	0.55	0.30	0.31	0.26	0.34	0.19	0.23
t-test p value	0.545		0.324		0.373		0.091	

Table 5. Speaker 5, Duration of accented vowels

	SF ằ	LF â	SR à	LR á	SF ề	LF ê	SR è	LR é	SF ì	LF î	SR ì	LR í
N	69	26	66	66	66	20	74	12	49	15	47	67
Mean dur	107.1	138.9	121.3	147.8	98.0	145.8	106.4	137.3	90.7	113.6	90.5	111.2
SD	36.0	34.8	27.0	24.5	28.7	41.1	21.5	14.4	19.4	41.1	22.6	26.9
Mean log(dur)	4.61	4.90	4.77	4.98	4.54	4.94	4.65	4.92	4.49	4.68	4.47	4.68
SD	0.38	0.27	0.22	0.17	0.33	0.30	0.20	0.10	0.21	0.31	0.26	0.25
t-test p value	< 0.001		< 0.001		< 0.001		< 0.001		0.015		< 0.001	

	SF ồ	LF ô	SR ò	LR ó	SF ừ	LF û	SR ù	LR ú
N	62	12	100	4	36	3	37	13
Mean dur	105.5	112.1	102.1	137.5	92.7	148.0	95.7	128.7
SD	31.4	30.7	28.9	23.3	19.8	34.0	24.7	24.5
Mean log(dur)	4.61	4.69	4.58	4.91	4.50	4.98	4.53	4.84
SD	0.31	0.25	0.33	0.19	0.23	0.25	0.27	0.19
t-test p value	0.191		0.015		0.036		< 0.001	

Table 6. Speaker 6, Duration of accented vowels

	SF à	LF â	SR à	LR á	SF è	LF ê	SR è	LR é	SF ì	LF î	SR ì	LR í
N	84	77	83	67	59	20	55	13	55	17	56	47
Mean dur	78.0	126.8	97.6	143.5	77.4	98.7	96.8	153.0	79.9	101.4	80.4	96.3
SD	28.5	34.7	26.1	29.7	22.6	20.2	23.1	47.1	21.3	27.6	23.9	25.7
Mean log(dur)	4.29	4.80	4.54	4.94	4.31	4.57	4.55	4.98	4.35	4.58	4.34	4.53
SD	0.38	0.29	0.27	0.21	0.28	0.22	0.23	0.34	0.27	0.32	0.30	0.26
t-test p value	< 0.001		< 0.001		< 0.001		< 0.001		0.006		< 0.001	

	SF ò	LF ô	SR ò	LR ó	SF ù	LF û	SR ù	LR ú
N	103	19	116	8	27	10	18	12
Mean dur	93.0	87.2	96.6	111.3	81.8	107.0	89.6	108.3
SD	24.1	15.3	22.8	24.3	24.1	37.9	19.6	23.7
Mean log(dur)	4.50	4.45	4.54	4.69	4.37	4.61	4.47	4.66
SD	0.27	0.19	0.25	0.22	0.28	0.38	0.24	0.23
t-test p value	0.808		0.050		0.042		0.020	

Appendix 3. Quantity Distinctions, First Post-Accentual Syllable

(S = prescriptively short, L = prescriptively long, V = any accented vowel; length indicated by a colon)

Table 1. Speaker 1, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	**S-L V-a:**	**L-S V:-a**	**L-L V:-a:**	**S-S V-e**	**S-L V-e:**	**L-S V:-e**	**L-L V:-e:**	**S-S V-i**	**S-L V-i:**	**L-S V:-i**	**L-L V:-i:**
N	55	37	22	20	38	21	14	10	62	39	28	10
Mean dur	68.4	82.8	68.3	71.3	59.2	64.4	54.9	71.1	55.8	60.6	46.1	97.4
SD	14.7	22.0	16.9	15.9	12.4	19.3	21.3	22.5	15.4	13.7	13.4	54.5
Mean log(dur)	4.20	4.38	4.20	4.25	4.06	4.13	3.94	4.22	3.99	4.08	3.79	4.44
SD	0.21	0.28	0.24	0.18	0.20	0.28	0.36	0.33	0.27	0.22	0.31	0.57
t-test p value	< 0.001		0.217		0.167		0.034		0.031		0.003	

	S-S V-o	**S-L V-o:**	**L-S V:-o**	**L-L V:-o:**	**S-S V-u**	**S-L V-u:**	**L-S V:-u**	**L-L V:-u:**
N	46	18	12	4	14	14	8	1
Mean dur	57.8	69.7	54.2	63.3	60.2	74.3	57.9	44.0
SD	14.7	19.7	12.8	14.2	13.8	18.3	9.5	NA
Mean log(dur)	4.02	4.21	3.97	4.13	4.08	4.28	4.05	3.78
SD	0.26	0.27	0.21	0.22	0.21	0.24	0.17	NA
t-test p value	0.010		0.135		0.012		NA	

Table 2. Speaker 2, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	30	33	15	9	20	24	8	6	41	26	15	6
Mean dur	70.1	83.2	62.5	69.2	63.9	63.1	58.3	58.2	53.3	60.0	47.1	51.8
SD	14.7	14.0	9.9	17.4	15.0	16.3	14.6	12.3	13.8	10.7	12.7	11.3
Mean log(dur)	4.23	4.40	4.12	4.21	4.13	4.12	4.04	4.04	3.95	4.08	3.81	3.93
SD	0.22	0.19	0.16	0.23	0.25	0.24	0.23	0.22	0.24	0.18	0.29	0.20
t-test p value	< 0.001		0.164		0.568		0.492		0.007		0.152	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	54	17	12	12	20	11	7	1
Mean dur	60.4	72.4	72.1	62.4	59.4	62.9	61.0	75.0
SD	12.7	18.3	19.5	14.7	13.5	17.5	15.0	NA
Mean log(dur)	4.08	4.25	4.24	4.11	4.06	4.11	4.09	4.32
SD	0.20	0.28	0.29	0.26	0.20	0.27	0.22	NA
t-test p value	0.017		0.884		0.322		NA	

Table 3. Speaker 3, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	86	53	28	10	48	17	7	14	70	28	33	4
Mean dur	61.4	60.7	61.2	57.1	51.8	55.7	51.1	50.6	52.0	50.1	49.8	63.3
SD	15.0	15.7	14.1	8.2	11.3	10.2	8.6	7.0	13.7	14.9	11.6	19.2
Mean log(dur)	4.09	4.08	4.09	4.03	3.92	4.00	3.92	3.91	3.92	3.88	3.88	4.11
SD	0.25	0.24	0.24	0.15	0.23	0.19	0.17	0.14	0.26	0.27	0.23	0.33
t-test p value	0.606		0.785		0.088		0.540		0.748		0.132	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	45	20	11	3	31	16	6	0
Mean dur	59.0	55.5	53.5	44.3	54.6	60.0	48.8	NA
SD	19.6	11.8	16.5	10.6	15.5	16.8	18.1	NA
Mean log(dur)	4.03	3.99	3.93	3.77	3.96	4.06	3.83	NA
SD	0.29	0.21	0.33	0.25	0.28	0.27	0.36	NA
t-test p value	0.727		0.796		0.128		NA	

Table 4. Speaker 4, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	56	37	24	6	44	17	11	9	62	22	18	7
Mean dur	59.7	56.6	73.9	67.7	51.7	50.4	51.8	46.2	48.3	50.3	43.9	50.3
SD	15.2	12.2	14.8	4.8	9.7	11.5	17.9	9.2	10.6	15.6	9.9	11.4
Mean log(dur)	4.05	4.01	4.28	4.21	3.93	3.90	3.89	3.82	3.85	3.87	3.75	3.89
SD	0.30	0.23	0.21	0.07	0.20	0.22	0.36	0.20	0.21	0.32	0.25	0.23
t-test p value	0.758		0.898		0.687		0.718		0.410		0.106	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	40	8	14	6	12	10	7	2
Mean dur	54.4	53.4	50.1	64.2	60.8	52.0	56.1	60.0
SD	17.3	12.0	6.8	18.2	15.6	9.4	9.8	15.6
Mean log(dur)	3.96	3.96	3.90	4.12	4.07	3.94	4.01	4.08
SD	0.28	0.22	0.14	0.36	0.27	0.18	0.18	0.26
t-test p value	0.498		0.110		0.917		0.398	

Table 5. Speaker 5, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	65	39	27	16	66	36	17	18	99	43	40	13
Mean dur	58.1	70.9	59.4	61.1	53.4	61.8	48.0	53.2	47.5	47.5	44.4	46.2
SD	12.1	21.4	12.1	13.2	17.5	15.1	12.0	14.1	12.7	11.2	13.4	10.6
Mean log(dur)	4.04	4.22	4.06	4.09	3.93	4.09	3.84	3.94	3.83	3.83	3.75	3.81
SD	0.20	0.28	0.22	0.22	0.31	0.25	0.25	0.25	0.27	0.23	0.32	0.25
t-test p value	<0.001		0.348		0.002		0.119		0.428		0.244	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	77	21	53	10	13	11	6	3
Mean dur	53.8	51.4	60.4	58.4	55.9	67.7	39.2	38.7
SD	15.3	15.1	12.5	12.3	13.9	25.9	3.4	11.0
Mean log(dur)	3.95	3.90	4.08	4.05	3.99	4.16	3.66	3.63
SD	0.27	0.28	0.21	0.19	0.26	0.34	0.09	0.29
t-test p value	0.757		0.675		0.098		0.577	

Table 6. Speaker 6, Duration of unaccented vowels, first post-accentual syllable

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	77	41	34	32	54	35	16	17	70	42	26	10
Mean dur	67.1	70.6	63.6	75.6	61.0	66.3	60.6	58.9	54.3	56.6	49.7	50.5
SD	15.4	14.4	18.4	22.0	15.1	18.2	16.9	14.8	13.3	16.8	13.9	12.9
Mean log(dur)	4.18	4.24	4.11	4.28	4.08	4.16	4.07	4.04	3.97	4.00	3.87	3.90
SD	0.23	0.20	0.28	0.30	0.25	0.28	0.29	0.29	0.24	0.29	0.28	0.22
t-test p value	0.084		0.012		0.093		0.599		0.293		0.374	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	95	14	41	7	20	10	6	6
Mean dur	60.6	54.6	57.2	55.4	57.2	55.1	57.8	66.7
SD	17.1	23.1	12.9	16.2	13.9	14.5	13.1	8.7
Mean log(dur)	4.07	3.93	4.02	3.97	4.02	3.97	4.04	4.19
SD	0.26	0.36	0.24	0.32	0.25	0.30	0.23	0.13
t-test p value	0.905		0.637		0.656		0.093	

Appendix 4. Quantity Distinctions, Other Post-Accentual Syllables

(S = prescriptively short, L = prescriptively long, V = any unaccented vowel; length indicated by a colon)

Table 1. Speaker 1, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	22	5	20	15	12	13	9	6	49	16	8	6
Mean dur	71.8	79.4	65.1	89.9	64.4	76.5	72.3	59.0	57.1	57.8	52.8	56.7
SD	18.6	6.4	12.0	19.9	14.7	29.1	24.6	9.7	22.7	14.8	22.7	12.2
Mean log(dur)	4.24	4.37	4.16	4.48	4.14	4.27	4.24	4.07	3.98	4.02	3.89	4.02
SD	0.25	0.08	0.18	0.22	0.22	0.37	0.30	0.17	0.36	0.26	0.42	0.20
t-test p value	0.031		< 0.001		0.148		0.908		0.293		0.229	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	32	12	16	14	13	5	8	3
Mean dur	61.6	62.8	61.4	65.6	59.2	65.0	61.4	67.0
SD	13.3	19.0	12.6	17.2	17.7	13.4	23.4	20.0
Mean log(dur)	4.10	4.11	4.10	4.15	4.04	4.16	4.06	4.18
SD	0.21	0.24	0.20	0.29	0.29	0.23	0.34	0.28
t-test p value	0.451		0.295		0.201		0.297	

Table 2. Speaker 2, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	25	4	15	17	7	7	11	2	38	15	4	5
Mean dur	69.4	63.8	75.5	70.1	65.6	63.1	56.9	53.5	51.7	53.1	49.5	58.4
SD	11.8	16.3	13.7	15.0	21.2	12.0	5.3	5.0	9.5	8.9	11.7	11.4
Mean log(dur)	4.23	4.13	4.31	4.23	4.14	4.13	4.04	3.98	3.93	3.96	3.88	4.05
SD	0.16	0.29	0.18	0.21	0.32	0.21	0.09	0.09	0.19	0.17	0.24	0.21
t-test p value	0.731		0.873		0.533		0.740		0.287		0.154	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	15	5	15	7	6	1	1	0
Mean dur	66.7	55.0	65.7	65.1	74.7	80.0	67.0	NA
SD	11.6	2.5	16.0	12.0	17.0	NA	NA	NA
Mean log(dur)	4.19	4.01	4.16	4.16	4.29	4.38	4.20	NA
SD	0.18	0.04	0.24	0.19	0.23	NA	NA	NA
t-test p value	0.999		0.487		NA		NA	

Table 3. Speaker 3, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	34	4	14	14	21	7	14	4	35	22	8	21
Mean dur	63.7	74.0	63.6	73.1	55.1	55.6	53.7	47.0	57.1	51.4	42.3	54.7
SD	15.5	22.0	16.7	20.3	13.9	15.0	9.9	8.5	21.6	14.4	11.7	14.8
Mean log(dur)	4.13	4.27	4.11	4.25	3.98	3.99	3.97	3.84	3.99	3.90	3.71	3.96
SD	0.24	0.29	0.32	0.29	0.26	0.26	0.18	0.20	0.34	0.28	0.26	0.30
t-test p value	0.198		0.116		0.463		0.859		0.844		0.021	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	29	12	18	9	24	3	0	3
Mean dur	55.8	49.3	68.2	47.4	55.2	55.7	NA	66.3
SD	12.3	6.2	23.2	8.3	9.0	1.2	NA	5.7
Mean log(dur)	4.00	3.89	4.17	3.85	4.00	4.02	NA	4.19
SD	0.21	0.13	0.33	0.18	0.17	0.02	NA	0.09
t-test p value	0.975		0.999		0.282		NA	

Table 4. Speaker 4, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	43	13	8	12	12	10	7	0	42	19	9	7
Mean dur	66.2	65.4	55.4	57.9	57.2	65.8	65.1	NA	57.2	52.2	50.2	43.3
SD	21.3	16.5	10.6	13.7	13.4	20.6	13.8	NA	14.0	13.6	11.8	11.9
Mean log(dur)	4.15	4.15	4.00	4.03	4.01	4.15	4.16	NA	4.02	3.93	3.89	3.73
SD	0.28	0.26	0.20	0.24	0.28	0.30	0.21	NA	0.25	0.24	0.23	0.28
t-test p value	0.508		0.359		0.153		NA		0.903		0.872	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	23	9	13	5	10	2	4	2
Mean dur	58.8	52.9	61.1	50.0	64.5	68.5	55.5	64.0
SD	16.2	7.3	23.1	18.2	17.5	13.4	12.4	28.3
Mean log(dur)	4.04	3.96	4.06	3.86	4.13	4.22	4.00	4.11
SD	0.26	0.14	0.31	0.37	0.27	0.20	0.24	0.46
t-test p value	0.860		0.843		0.333		0.395	

Table 5. Speaker 5, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	52	4	14	16	26	16	21	7	62	35	10	18
Mean dur	65.4	58.3	63.0	56.8	52.4	57.9	59.2	49.7	51.2	47.5	39.9	44.2
SD	18.4	11.3	11.3	15.2	16.1	15.5	12.4	10.4	13.5	16.8	8.2	7.5
Mean log(dur)	4.15	4.05	4.13	4.01	3.92	4.02	4.06	3.89	3.90	3.80	3.67	3.77
SD	0.26	0.18	0.16	0.25	0.28	0.27	0.21	0.19	0.27	0.34	0.20	0.18
t-test p value	0.806		0.938		0.119		0.963		0.925		0.093	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	29	26	11	7	16	4	0	6
Mean dur	56.3	47.4	67.7	51.4	52.6	67.8	NA	63.5
SD	14.3	9.7	24.7	15.7	13.2	25.7	NA	14.6
Mean log(dur)	4.00	3.84	4.17	3.90	3.93	4.16	NA	4.13
SD	0.25	0.20	0.32	0.31	0.26	0.37	NA	0.25
t-test p value	0.995		0.949		0.149		NA	

Table 6. Speaker 6, Duration of unaccented vowels, other post-accentual syllables

	S-S V-a	S-L V-a:	L-S V:-a	L-L V:-a:	S-S V-e	S-L V-e:	L-S V:-e	L-L V:-e:	S-S V-i	S-L V-i:	L-S V:-i	L-L V:-i:
N	28	16	7	18	24	8	20	8	48	25	7	4
Mean dur	70.8	78.7	72.3	66.1	67.2	68.5	75.9	59.0	51.2	54.4	45.9	44.3
SD	18.7	21.6	14.7	18.0	23.5	16.5	17.9	15.8	13.1	10.9	6.8	16.5
Mean log(dur)	4.22	4.33	4.26	4.15	4.16	4.20	4.30	4.05	3.90	3.98	3.82	3.74
SD	0.28	0.30	0.21	0.30	0.29	0.25	0.24	0.25	0.27	0.21	0.14	0.38
t-test p value	0.136		0.844		0.365		0.986		0.097		0.646	

	S-S V-o	S-L V-o:	L-S V:-o	L-L V:-o:	S-S V-u	S-L V-u:	L-S V:-u	L-L V:-u:
N	23	15	22	10	11	3	5	1
Mean dur	64.4	51.7	66.0	44.8	53.7	83.3	70.8	34.0
SD	16.2	19.0	17.4	11.0	22.9	24.8	15.6	NA
Mean log(dur)	4.14	3.90	4.16	3.78	3.92	4.39	4.24	3.53
SD	0.25	0.32	0.24	0.22	0.36	0.29	0.24	NA
t-test p value	0.990		1.000		0.038		NA	