Slovenski jezik – Slovene Linguistic Studies 6 (2007): 195–207

Peter Jurgec
Center for Advanced Study in Theoretical Linguistics, Universitetet i Tromsø
in/and
Inštitut za slovenski jezik Frana Ramovša ZRC SAZU, Ljubljana

Acoustic Analysis of Tones in Contemporary Standard Slovene: Preliminary Findings

V članku so predstavljeni predhodni rezultati obsežnejše akustične študije o prozodiji slovenščine. Pričujoča raziskava o akustičnih lastnostih leksikalnega tona v slovenščini obravnava trajanje samoglasnikov, jakost in osnovno frekvenco. Statistično značilnih razlik ni bilo med prvima, medtem ko so bile razlike v F0 visoko statistično značilne. Rezultati se precej razlikujejo od predhodnjih. Dvozložnice se razlikujejo v relativnem F0 posameznih samoglasnikov. V trizložnicah z naglasom na prvem zlogu se F0 najbolj razlikuje v zadnjem zlogu.

The author presents preliminary findings of a larger acoustic study into prosodic structure of Slovene. This investigation in acoustic properties of tones in Slovene addresses vowel duration, intensity and fundamental frequency. Although no statistical differences between both lexical tones (or pitch-accents) were found in the first and second variable, the third was found highly significant. The results differ greatly from what was previously established. Disyllables differ in F0 of the individual vowels. In trisyllables with antepenultimate stress, the F0 difference is the highest in the final syllable.

1 Introduction

It is a general consensus in the field of Slovene studies that Slovene has two lexical tones, or pitch accents, historically termed *acute* and *circumflex*.[1] The tones only appear in some (mainly central) Slovene dialects, and as an option also in the standard language. Traditionally, these tones have been indicated by a diacritic mark on the stressed vowel only (or a consonant when vowel is not present in the spelling), and termed *tonemes*. This suggests that tone was seen as a property of the stress, further motivated by diachronic findings, cf. Toporišič, 2000. However, stress is an independent prosodic feature in Slovene, realized as increased duration (Srebot Rejec, 1988), different vowel quality, spectral tilt (Jurgec, 2005b, 2006) and other characteristics (e.g. phonation, cf. Jurgec, 2005c). Also, in the "non-tonal" dialects, stress is indicated primarily by a rise in fundamental frequency. As this investigation is not one into phonological properties of the lexical tones in Slovene, the existence of the two lexical classes shall not be questioned.[2]

[1] The author would like to thank Michael Becker, Martin Krämer, Grant Lundberg, Bruce Morén, David Odden, Curt Rice, Dragana Šurkalović, Christian Uffmann, the anonymous reviewer, and the participants of the 38th National Convention of the American Association for the Advancement of Slavic Studies (Washington, D.C., November 18, 2006) for useful suggestions and comments. All remaining errors, if any, are the author's. – Author's address: Universitetet i Tromsø, N-9037 Tromsø, Norge.

[2] For phonological interpretation of the present acoustic analysis, see Becker & Jurgec (in preparation).

Although Slovene tones have been investigated acoustically since the 1930's, the results of the studies were inconclusive, often contradictory and generally not representative. The studies so far limited the scope of analysis to fundamental frequency alone. Duration was also mentioned, although not considered systematically (Srebot Rejec, 1988).

The first acoustic description of Slovene tones on the basis of actual measurements can be traced to Bezlaj (1939).[3] It was not until another two decades, that a proper acoustic investigation was conducted (Vodušek, 1961). Vodušek recorded a limited number of tokens and investigated speakers of different dialectal background, chiefly linguists. No actual numeric data was presented, however, pitch diagrams were also published and provide an empirical evidence of author's claims. Vodušek found two different realizations of both tones, dependent on the background (dialect) of the informant. Feature, common to both variants, is a general Low of the acute tone and a general High of the circumflex tone (stressed vowels only). Author also notes that tones may be realized over the stressed and the post-tonic syllable, and that monosyllables are distinctive in Central Upper Carniolan, Horjul and Zilja dialects.

A later study by Toporišič (1968) offered a more in-depth view, with more tokens analyzed and discussed in detail, although only one speaker was analyzed. In order to capture the F0 contours, Toporišič resorted to five variables, the most important of them is the relative height of F0 of the stressed and the post-stonic syllable(s). (However, typically only the immediately post-tonic syllable was analyzed, and in words with final stress at the end of the Prosodic Phrase, the difference between the first and the second part of the syllable.) This parameter was found the most consistent, and resistant to influences of sentence intonation. This led to the phonological interpretation in the later works by the author, that both tones differ in F0 of the stressed (tonic) and the immediately post-stressed (post-tonic) vowel only. In acutes, F0 is Low on the stressed vowel, and High on the post-stressed; in circumlexes the opposite is true. In the final position of the Prosodic Word, the post-tonic syllable is omitted, such that acute is realized as Low tone, and circumflex as High (1).

(1) Slovene lexical tones after Toporišič (1968, 2000)

	Stressed σ	Post-stressed σ (if any)
Acute	Low	High
Circumflex	High	Low

It is also worth mentioning that Toporišič was the first to report that the distinction between the stressed syllable and the final syllable was actually the greatest in terms or relative F0 values (Toporišič, 1968: 11). As we will see, this has unnecessarily disregarded as trivial.

Neweklowsky (1973) analyzed tone in Carinthian dialects. He also found F0 differences significant (as well as duration). Roughly, F0 peak was found the most indicative of both tones, acute having it in the post-tonic and circumflex in the tonic syllable. The most important finding of Neweklowsky was, that dialects in the same dialectal group may differ dramatically, acoustically and phonologically.[4]

[3] A general overview of early auditory judgments of phonetic characteristics of Slovene tones is available in Toporišič (1967). This paper is intended to present only acoustically relevant data, such that non-experimental data is disregarded.

[4] The tones in Ovčja vas (Valbruna) were analyzed as a part of a phonetic description of the speech by Jurgec (2005a).

Toporišič's findings remain the most widely accepted view of Slovene tones, although a more systematic and quantitatively better analysis was subsequently conducted by Srebot Rejec (1988). She investigated both duration and F0, and compiled an extensive corpus of sentences by three male speakers from Ljubljana. As regards the prosody, she concludes the following: (1) quantity is no longer distinctive in Standard Slovene, (2) tone is marginally, but still significantly distinctive, although probably not in the final syllable Srebot Rejec (2000), (3) tones are typically realized as contours. Both tones are ideally realized with a peak in F0 at about two thirds of the duration of the stressed vowel (circumflex) or at the end of the post-tonic syllable (acute). The domain of tone is a foot, consisting of two syllables or a single syllable in case of final stress.[5]

Srebot Rejec's analysis is phonetically the most accurate so far. Similar to Neweklowsky, she took three points of measurements, in the beginning, middle and end of the vowel.[6] Coupled with the well documented loss of vowel quantity contrast (Srebot Rejec, 1988; Petek et al., 1996; Jurgec, 2005b), prosodic system of contemporary Slovene that has been described by methods of acoustic phonetics, has been completely ignored by Slovene linguists, and has not received proper description so far.

Although more recent sources indicate progressive loss of tone in Slovene dialects (Lundberg, 2001; Vera Smole and Roberto Dapit, p.c.), it is still believed that tonal Slovene is widely spoken. Recent perceptual study (Jurgec, in preparation) concluded, that tones are perceived well above the chance levels by the native speakers, contrary to what was reported by Šuštaršič & Tivadar (2005).

In this paper, we try to answer some of the outstanding issues as regards acoustic characteristics of Slovene tones. Three acoustic parameters are investigated: fundamental frequency, duration and intensity.[7] The article is structured as follows. First, an overview of the experiment method is described. Then the results of the experiments are presented. The final section interprets and compars the results with previous studies and concludes the article.

2 Experiment

In order to properly observe tonal phenomena, segmental influences, sentence intonation and speaker variability should be minimized already when preparing the data-set. In a controlled experiment such as this, the prepared list of words should be compiled carefully. It is known that non-vocalic segments influence F0, duration and intensity. For example, while nasals influence F0 minimally, other sonorants have a greater influence, and obstruents (particulary stops) a considerable one, that should be avoided. On the other hand, highly sonorous segments are the most difficult to delimitate from the preceding or the following vowel, while obstruents are not. This leads to a paradoxical situation. Alternatively, minimal pairs in tone can be found, and thus segmental influence minimized. In Slovene, fewer than 100 non-morphologically related minimal pairs in tone exist, and the majority of them is rather peripheral. This differs from other typologically similar languages considerably (cf. more than 500 such pairs in Swedish). For this experiment,

[5] As in all the previous studies, the measurements are presented in great detail, which makes it harder to get a proper overview, abstracted from individual utterances and their acoustic measurements.

[6] Slovene tones were also investigated by Woznicki (2006). She confirmed Srebot-Rejec's observation that Slovene as spoken in Ljubljana is in the process of tone loss. However, she also found speakers that had contrastive tone. Generally, her findings were inconclusive.

[7] As this is a preliminary report of a larger study of Slovene prosody, only the main results are presented.

only a very limited amount of minimal pairs is required. From the dictionaries available, 16 minimal pairs of mono- to trisyllables were selected (a few of them are morphologically related). The following consonant and vowel patterns were observed: CV.CV as a basic tamplate, CVC.CV and CV.CVC as templates with closed syllables, monosyllable CVC and tri-syllables CV.CV.CV. The complete list of words with both tones[8] is listed in Table 1.

Form	Class I	Class II
ˈkila	*'hernia'*	*'kilogram'*
ˈkuɾa	*'chicken'*	*'medical treatment'*
ˈruta	*'scarf'*	'FEM *name Ruta, Ruth'*
ˈmula	*'mule'*	*'Muslim priest'*
ˈlisa	*'cow'*	*'patch'*
ˈslaʋa	*'fame'*	'FEM *name Slava'*
ˈwɾana	'FEM *crow'*	'ACC SG MASC *crow'*
ˈʒarək	*'stale'*	*'ray'*
ˈtuɾna	'GEN SG *tower'*	'ADJ FEM SG *'tour'*
ˈrɔtʃka	*'handle'*	*'cup handle'*
ˈmatʃka	'ACC SG MASC *cat'*	'FEM *cat'*
ˈʋaltʃək	*'waltz'*	'DEM*wave'*
pot	*'path'*	*'sweath'*
ˈstikati	*'search for'*	*'talk'*
ˈʃalitsa	'DEM *joke'*	*'cup'*
ˈʃibitsa	*'match'*	'DEM *whip'*

Table 1: Tonal minimal pairs used in the experiment.

From the list one can see that all words have word-initial stress. Based on the previous findings (see previous section), pre-stressed syllables were not analyzed.

The words were then put in frame sentences, using actual contexts of the selected words, based on the text corpus Nova beseda (Jakopin, 2000−2006). The sentences were randomized and put into a Power Point presentation, to be later used in the experiment (read by the subjects).

Next, the subjects were selected. Eight speakers from central Slovenia, residents of Ljubljana, some of them originally form different parts of Lower (2), Upper Carniola (1) and Carinthia (1). All were educated past high school, four of them female and four male. Median age at the time of the experiment was 38 years. However, it was later established that minimal pairs of two male speakers do not differ significantly at all, so they must not be speakers of the tonal variety Slovene. Both speakers were excluded from the analysis completely, and so only the tones of six speakers (four females and two males) were acknowledged.[9]

[8] From here on, Class I refers to traditionally called the acute and Class II to the circumflex.

[9] This causes a typical frequency bias, such that average F0 would be higher than otherwise. It is not the absolute values that are at question here, but relative pitch contours.

The subjects were instructed first to read the sentences that appeared on the computer screen. These were cues for contextualizing relevant words (minimal pairs in tone). After reading the sentence, a word changed the color on the screen and then disappeared. The speakers were instructed to read those words in a carrier sentence (2), which was only presented to them in a spoken form by the investigator. They were instructed to repeat each sentence twice.

(2) Carrier sentence
Reci [kila] **navadno**, ne posebno.
'Say [kila] regularly*, not in a special way.'*

The recordings took place in several sound-proof rooms (usually radio studios, different locations). Recording was digital, with a standard sampling frequency of 44.1 kHz, at a 16 bit rate. Recordings were stored on digital storage devices and later transferred to a computer for acoustic analysis. For acoustic analysis Praat software program (Boersma & Weenink, 1992−2006), was used. Relevant words were segmented manually, and then analyzed using modified scripts. Normally the first utterance of the carrier sentence was analyzed. Duration was measured for all stressed and post-stressed vowels, as well as time-normalized F0 and intensity contours. For each vowel, 11 points of intensity and F_0 were measured.[10] The window of each point of measurement for fundamental frequency was determined by the duration of the vowel, such that it was 2/11 of the total duration of the vowel. (Elsewhere Praat's defaults were used.) In this manner, 192 words were obtained for analysis, i.e. 96 minimal pairs, or 408 vowels. However, 9 words (4.7%) were excluded from the analysis because of various reasons (e.g. incorrect pronunciation, irregular or non-detectable F0).

3 Results

3.1 Duration

Durations of individual vowels (not whole syllables nor voiced parts thereof) in the observed words were measured, ratios calculated and averaged. The results are presented in Table 2.

The results indicate, that the stressed vowel is slightly longer in Class I words, such that difference is independent of any segmental, (sentence) intonational and even speaker dependent influences. Moreover, it is consistent across all word types. Also, the difference is never statistically significant ($0.1 < p < 0.6$). This leads to the conclusion, that no statistically significant differences between both tonal types were detected.

3.2 Intensity

Cross-linguistically, intensity contours are known to complement tonal contours. In Slove-ne, however, no statistically significant differences ($p > 0.3$) in intonation contours were detected, see Figure 1.[11]

As intensity was not studied systematically in connection to Slovene so far at all, it is and interesting finding, that in words with antepenultimate stress, a secondary intensity

[10] Intensity and F0 themselves were not normalized, as they did not differ significantly from the absolute values.

[11] Here, only CVCV and CVCVCV words are presented, as the results for all words were similar.

Word	Class I				Class II				Ratio
type	Dur	$\%v_1$	$\%v_2$	$\%v_3$	Dur	$\%v_1$	$\%v_2$	$\%v_3$	II/I
cv.cv	235	51.3	48.7		220	52.9	47.1		.937
cvc.cvc	218	61.0	39.0		201	61.8	38.2		.921
cv.cv.cv	243	35.4	30.0	34.6	219	38.6	31.3	30.1	.902
cvc	122				109				.893

Table 2: Duration of vowels with respect to tone. Abbreviations: Dur – averaged sum of individual vowel durations in a word, $\%v_1$ – percentage of the first vowel with respect to the sum of durations of all vowels in a word, Ratio II/I – Ratio of average total vowel durations of Class II with respect to Class I words.

peak in the final syllable/vowel was found. This may be indicative of secondary stress, also connected to tonal prominence of final vowels (see Section 3.3). Increase in intensity is displayed in Figure 2.

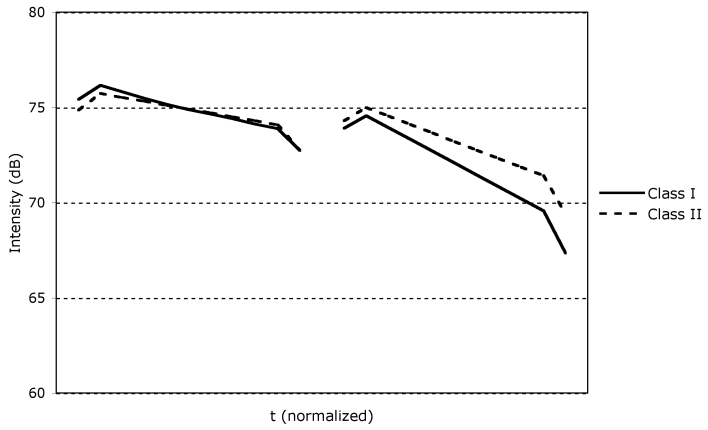

Figure 1: CVCV intensity contours (for each vowel).

3.3 Fundamental frequency

Previous studies have already established that Slovene tones differ primarily in F0. However, they disagree how this difference is realized and how it should be interpreted phonologically.

An average 'CVCV word was realized as presented in Figure 3. As evident from the graph, stressed syllables do not differ in F0 (at least not significantly), whereas post-stressed syllables have higher F0 in Class I words, and both contours are falling. Differ-

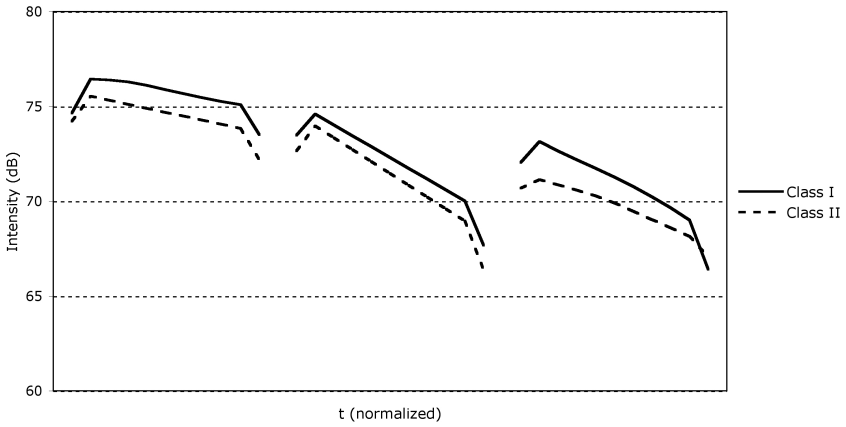

Figure 2: CVCVCV intensity contours (for each vowel).

ence in the poststressed syllable is statistically highly significant ($p < 0.005$). However, in the closed syllables, situation is somewhat different. Class I tone is realized with a lower F0 than Class II. This might be to the fact, that not the whole F0 contour is visible (or was analyzed). Yet, both tones are distinctive in this case, see Figure 4.

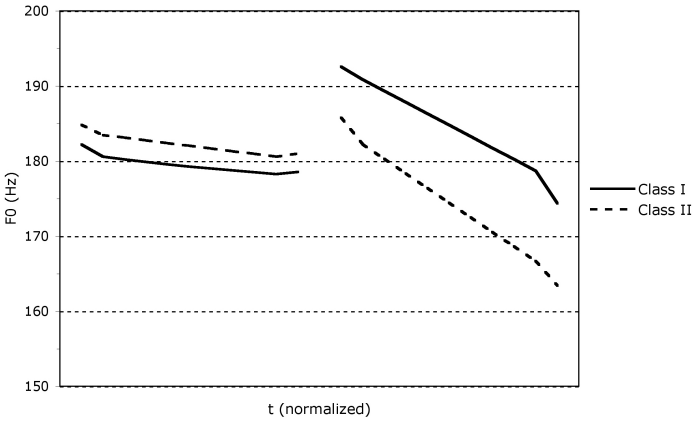

Figure 3: CVCV F0 contours (for each vowel).

Tones in trisyllables also differ highly significantly ($p < 0.001$). The distinction is limited to the stressed (antepenultimate) and the final syllable, the former having lower F0 in Class I tone, and the latter being considerably higher, see Frigure 5. This is a

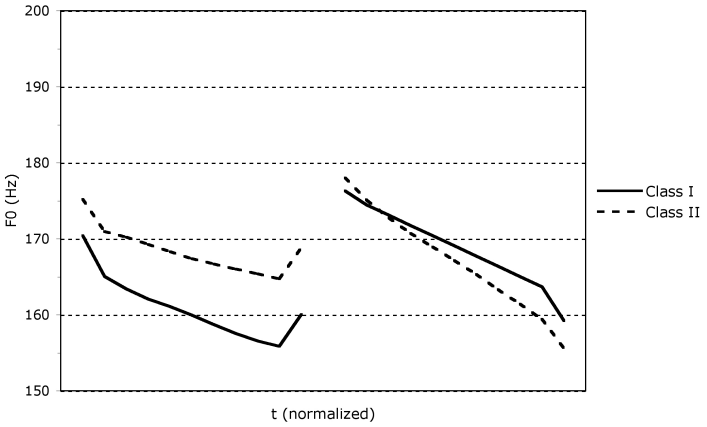

Figure 4: CVC(C)V(C) F0 contours (for each vowel).

surprising finding, since acoustic phoneticians who studied Slovene tones so far only considered the stressed and the immediately post-stressed syllable, but not the rest of the Prosodic Word.[12]

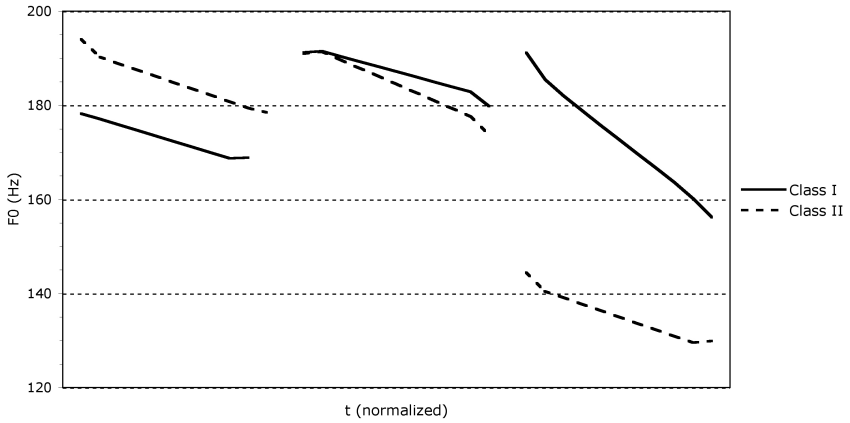

Figure 5: CVCVCV F0 contours (for each vowel).

[12] Vodušek (1961) mentions the possibility of tones being realized phonetically on all post-tonic vowels, but does not offer a tangible analysis.

Monosyllables differ only marginally significantly (p = 0.042), although a clear tendency is visible in Figure 6: Class I has a rising contour, while Class II has a falling one. This seems to be in accordance with the findings in Vodušek (1961) and Srebot Rejec (1988, 2000): in the speech of Central Slovenia, tonal differences are neutralized in monosyllables. The question, whether this is phonological proper (l.c.), effectively neutralizing all tonal contrast in final-stressed words, positionally phonological or just phonetic, remains beyond the scope of this article. The results should be interpreted with caution: only six tokens were analyzed for each tone, and only one monosyllabic word.[13]

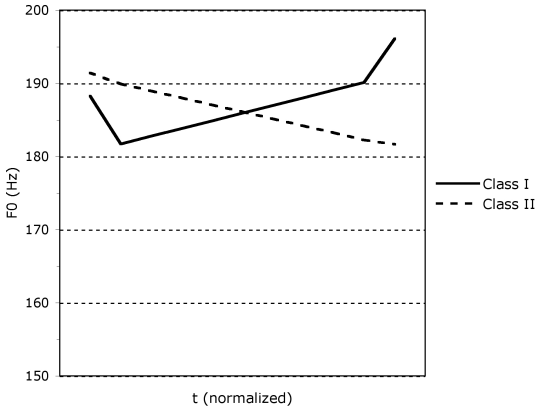

Figure 6: CVC F0 contours (for the vowel).

4 Discussion and conclusion

The results of the experiments are summed up in (3).

(3) The conclusions of the present acoustic analysis
- a. There is no significant difference in duration between both tones
- b. There is also no significant difference in intensity
- c. Fundamental frequency of both lexical classes differs considerably
  - (i) The differences in mean F0 integrated over the entire final vowel were greatest in trisyllables, comparing the two tone classes (> 40 Hz)
  - (ii) Monosyllables also differ in tone (in the range of 10 Hz)
- d. Contemporary Standard Slovene as spoken by educated speakers in Ljubljana is tonal

All these findings were connected to the questions addressed in the course of acoustic investigation of Slovene tones in the 20th century. For example, vowels two or more

[13] There is a small number of other monosyllables that are minimal pairs in tone (e.g. wrat 'GEN PLdoor vs. neck'), but all were deemed inappropriate because of segmental variance in realization or the distribution of the tone among Slovene dialects and/or standard speech.

syllables after the stressed vowel were never properly analyzed. The present findings suggest that it is not the post-stressed syllables but rather final syllables that are actually phonetically (and phonologically) relevant.[14] Now it is also clear, that Slovene tones do not simply translate into High or Low tone (as suggested by Toporišič) on the stressed vowel, and that all other tonal information is predictable, viz. phonetic. Actual realizations are much more complex (4). The acoustic data from the antepenultimates cannot be explained by any of the theories so far. Instead, High vs. Low is distributed on the head of the Prosodic Word (i.e. the stressed vowel) and the right edge of the Prosodic Word. I shall constrain myself from further conclusions until a larger acoustic study is conducted and more material is available for analysis.

(4) Prosodic notation, most consistent with the findings

	Final stress	Penultimate stress	Antepenult stress
Class I	pŏt	ˈkìlâ	ˈʃàlítsâ
Class II	pôt	ˈkílâ	ˈʃálítsà

Further investigation is needed. First, the status of pre-stressed syllables should be established. At this point we cannot conclude that it is either High, Low or extra-tonal (the latter is stipulated traditionally). The role of sentence intonation should also be investigated. From a broader perspective, genetically related (e.g. Pletikos (2003) for Standard Croatian), typologically similar and European tone languages in general are vastly underdescribed, and much work is yet to be done (van der Hulst, 1999; Gussenhoven, 2004; Yip, 2002). The same is true for the majority of Slovene dialects. Finally, acoustic data is in need of a proper phonological account that would capture the facts about contemporary Slovene as actually spoken.

References

Becker, Michael & Peter Jurgec (in preparation). Tone and Stress in Slovenian. Unpublished manuscript.

Bezlaj, France (1939). *Oris slovenskega knjižnega jezika*. No. 17 in Razprave znanstvenega društva v Ljubljani, Ljubljana: Znanstveno društvo.

Boersma, Paul & David Weenink (1992−2006). Praat. http://www.praat.org.

Gussenhoven, Carlos (2004). *The Phonology of Tone and Intonation*. Research Surveys in Linguistics, Cambridge: Cambridge University Press.

Jakopin, Primož et. al. (2000−2006). Nova beseda. http://bos.zrc-sazu.si/s_beseda.html.

Jurgec, Peter (2005a). Fonetični opis govora Ovčje vasi / Descrizione fonetica della parlata di Valbruna. In Vera Smole & Nataša Komac (eds.) *Ovčja vas in njena slovenska govorica / Valbruna e la sua parlata slovena*, SKS Planika, Založba ZRC, ZRC SAZU. 60–84.

Jurgec, Peter (2005b). Formant Frequencies of Standard Slovenian Vowels. *Govor* **22**. 127–144.

Jurgec, Peter (2005c). Začetne opombe k laringalizaciji v slovenščini. *Slovenski jezik / Slovene Linguistic Studies* **5**. 135–168.

[14] Pre-antepenultimate stress with respect to tone should be further investigated. Native Slovene roots do not permit pre-antepentultimate stress, but it can surface in the derivation or inflection.

Jurgec, Peter (2006). Formant Frequencies of Vowels in Tonal and Non-Tonal Standard Slovenian. *Slavistična revija* **54**. 467–478.

Jurgec, Peter (in preparation). Perception of Tones in Slovenian. Unpublished manuscript.

Lundberg, Grant H. (2001). Typology of Tone Loss in Haloze, Slovenia: An Acoustic and Autosegmental Analysis. *Slovenski jezik / Slovene Linguistic Studies* **3**. 169–189.

Neweklowsky, Gerhard (1973). *Slowenische Akzentstudien: Akustische und linguistische Untersuchungen am Material slowenischer Mundartenaus Kärnten*. Wien: Verlag der Österrechischen Akademie der Wissenschaften.

Petek, Bojan, Rastislav Šuštaršič & Smiljana Komar (1996). An Acoustic Analysis of Contemporary Vowels of the Standard Slovenian Language. In *Proceedings ICSLP 96: Fourth International Conference on Spoken Language Processing, October 3–6, 1996, Philadelphia, PA, USA*. University of Delaware, 133–136.

Pletikos, Elenmari (2003). Akustički opis hrvatskih standardnih naglasaka. *Govor* **20**. 321–345.

Srebot Rejec, Tatjana (1988). *Word Accent and Vowel Duration in Standard Slovene: An Acoustic and Linguistic Investigation*. No. 226 in Slavistische Beiträge, München: Otto Sagner.

Srebot Rejec, Tatjana (2000). Ali je današnja knjižna slovenščina še tonematična. In *Razprave II. razreda*, SAZU, vol. 17. 51–66.

Toporišič, Jože (1967). Pojmovanje tonemičnosti slovenskega jezika. *Slavistična revija* **15**. 64–108.

Toporišič, Jože (1968). Liki slovenskih tonemov. *Slavistična revija* **16**. 315–393.

Toporišič, Jože (2000). *Slovenska slovnica*. Maribor: Obzorja.

van der Hulst, Harry (ed.) (1999). *Word Prosodic Systems in the Languages of Europe*. Berlin: Mouton de Gruyter.

Vodušek, Božo (1961). Grudsätzliche Betrachtungen über den melodischen Verlauf der Wortakzente in den zentralen Slowenischen Mundarten. *Linguistica* **4**. 20–38.

Šuštaršič, Rastislav & Hotimir Tivadar (2005). Perception of Tonemicity in Standard Slovene. *Govor* **22**. 23–35.

Woznicki, Katherine (2006). An Acoustic Analysis of Word Prosody in Ljubljana Slovene. Unpublished. https://kb.osu.edu/dspace/bitstream/1811/6628/1/KW-BA_Thesis.pdf.

Yip, Moira (2002). *Tone*. Cambridge: Cambridge University Press.

Prispelo decembra 2006, sprejeto marca 2007
Received December 2006, accepted March 2007

Akustična analiza tona v sodobni standardni slovenščini: Predhodne ugotovitve

Avtor predstavlja predhodne rezultate, ki so del obsežnejše akustične študije o prozodiji slovenščine. Leksikalni ton v slovenščini je obravnavalo več slovenskih jezikoslovcev prejšnjega stoletja. Bezlaj (1939) je prvi obravnaval ton akustično. Vodušek (1961) je ugotovil, da sta za slovenski ton pomembna relativna višina osnovne frekvence in/ali

njegova smer. Toporišič (1967, 1968, 2000) je prvi interpretiral ton tudi opisno fonološko na podlagi akustični podatkov. Študija T. Srebot Rejec (1988) je prinesla natančnejše podatke o tem, kako je ton realiziran fonetično, tj. da je odločilen položaj vrha F0, ki je v drugi polovici naglašenega samoglasnika pri cirkumfleksu in na koncu ponaglasnega zloga pri akutu. Namen te raziskave je pridobiti natančnejše akustične podatke z uporabo sodobnih orodij za akustično analizo govora.

Za analizo je bilo izbranih 16 tonskih minimalnih. Besede so bile prebrane kot del nosilnega stavka, predtem pa so govorci prebrali kontekstne stavke, iz katerih je bil razviden pomen besede. Izbrane besede so bile vedno naglašene na prvem zlogu in enodo trizložne. Osem govorcev iz Ljubljane smo posneli digitalno v studiu. Dva govorca sta bila kasneje izločena, tako da je bilo na koncu upoštevanih 181 besed, kakor so jih izgovorili štiri ženske in dva moška govorca. Besede so bile analizirane v programu Praat (Boersma & Weenink, 1992−2006). Izmerili smo trajanje samoglasnikov, jakost in osnovno frekvenco. Pri zadnjih dveh smo izbrali 11 enakomerno porazdeljenih točk.

Rezultati so naslednji: Trajanje in jakost nista bila statistično značilna. Nasprotno pa so bile razlike v osnovni frekvenci visoko statistično značilne. Največja razlika je bila v zadnjem zlogu trizložnic (>40 Hz), sledil je prvi zlog. V dvozložnicah so bile razlike statistično značilne v obeh zlogih (oz. vsaj v enem, odvisno od segmentnega konteksta). Enozložnice se razlikujejo mejno. V celoti torej rezultati kažejo, da so vsi ponaglasni zlogi potencialno pomembni za realizacijo tona. V nadaljevanju je treba odgovoriti na vprašanje, kakšen je ton prednaglasnih zlogov in pa kakšne so interakcije med leksikalnim tonom na eni strani ter frazno in stavčno intonacijo na drugi.

Acoustic Analysis of Tones in Contemporary Standard Slovene: Preliminary Findings

The author presents preliminary findings of a larger acoustic study into prosodic structure of Slovene. Lexical tones in Slovene have been investigated by several linguists in the past century. Bezlaj (1939) was the first to measure the tones by means of acoustic phonetics. Vodušek (1961) established that the height and/or direction of F0 is acoustically relevant for distinguishing the tones in Slovene. Toporišič (1967, 1968, 2000) posited the first phonological interpretation of tones in Slovene on the basis of actual phonetic data. Srebot Rejec (1988) provided more detailed account how vowels are encoded phonetically, viz. with F0 peak in the second half of the stressed vowel in circumflexes and at the and of the post-tonic syllable in the acutes. The aim of the present analysis is to provide more detailed acoustic description using contemporary speech analysis tools.

Speech corpus consisted of 16 minimal pairs in lexical tone. The words were read in a frame sentence and introduced by a context sentence. These words all had initial stress, and were mono-, di- and trisyllabic. Eight speakers, residents of Ljubljana, were recorded digitally. Two speakers were later excluded from the analysis, and the data of the total of 181 words, as pronounced by four female and two male speakers, were analyzed using Praat software program (Boersma & Weenink, 1992−2006). Three variables were measured: duration, intensity and fundamental frequency. For intensity and fundamental frequency 11 points of measurements were made.

The results are as follows: Duration and intensity differences between both tones were found not statistically significant. On the other hand, fundamental frequency was found highly significant. The difference was the highest in trisyllables, in the final vowel (> 40 Hz), followed by the initial vowel. In disyllables, differences in both syllables were found significant (depending on the segmental structure). Monosyllables differ

marginally. All in all, results indicate that all post-tonic syllables are potentially the domain of the tone. Further investigation should address the pre-tonic syllables as well as interaction with phrase and sentence intonation.