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CUES FOR CONSONANT VOICING: ITS ASSIMILATION IN WORD JUNCTURE

Priebalsių balsingumo požymiai.
Asimiliacija žodžių sandūroje

ANNOTATION

The paper consists of two parts. The first one considers the general acoustic cues for voicing of obstruents (i.e. cases of the consonants in word juncture are not detailed). Acoustic peculiarities of the *lenis/fortis* dichotomy are mentioned. Relatively simple visual cues for voicing (acoustical expressions of a component of phonation) identifiable from oscillograms and spectrograms are discussed. Problems of the techniques of such identification are pointed out. The quantitative indexes for voicing of fricatives and stops are suggested and applied for analysis of the consonant voicing in standard Lithuanian.

The second part is focused on the close assimilation of the consonants in word juncture taking place in the Southern Aukštaitians. Drawing on the above mentioned techniques examples of spontaneous oral speech are analyzed.

ANOTACIJA

Straipsnį sudaro dvi dalys. Pirmojoje nagrinėjami bendrieji akustiniai triukšminių priebalsių (t. y. neišskiriant žodžių sandūros priebalsių) balsingumo požymiai. Aptariami *lenis / fortis*

KEYWORDS: voiced consonant, voiceless consonant, assimilation, word juncture.

ESMINIAI ŽODŽIAI: skardusis priebalsis, duslusis priebalsis, asimiliacija, žodžių sandūra.

dichotomijos akustiniai savitumai, sąlygiškai paprasti balsingumo požymiai (fonacijos komponento akustinės išraiškos), identifikuojami iš oscilogramų ir spektrogramų, pažymimos tokio identifikavimo metodikos problemos. Toliau siūlomi kiekybiniai pučiamųjų ir sprogstamųjų priebalsių balsingumo rodikliai. Naudojant juos atliekama lietuvių bendrinės kalbos priebalsių balsingumo analizė.

Antroje straipsnio dalyje dėmesys sutelkiamas į pietų aukštaičių šnektose vykstančią žodžių sandūros dalinę priebalsių asimiliaciją. Remiantis anksčiau aptarta metodika, praktiškai analizuojami sakininės spontaninės kalbos pavyzdžiai.

In standard Lithuanian and dialects, consonants adjust according to the activities of the vocal folds, palatalism, and the place of articulation. Assimilation is established taking into account several characteristics: the distance between the adjusting sounds (close, distant), direction of adjustment (regressive, progressive), and degree (full, partial). This phonetic phenomenon can be complex. In other words, consonants can be assimilated both according to one of the features and by several features simultaneously. Additionally, degemination is often inseparable from this phenomenon (LKG I 93–94; Pakerys 2003: 178–189).

Usually linguists have no doubts about the consonant assimilation in words according to the activities of the vocal folds. The adjustment of voiced and voiceless consonants in word junctures is more complicated; therefore it is important to ascertain whether and in what cases this type of coarticulation is systemic for the position mentioned, as well as the degree of the change. In standard language, when a dependent word is next to an independent one, the laws for word junctures are the same as those for the combination inside a word; however, according to the mentioned feature, consonant assimilation in junctures of two independent words (like degemination) is facultative (Pakerys 2003: 180). The regularities of these phenomena in the Lithuanian dialects can be revealed from transcribed dialectal texts and sound recordings, as well as from notes of various dialectologists, but no attempt has been made to verify the regularities experimentally.

The main goal of this article is to discuss partial close regressive consonant assimilation in word junctures according to the action of vocal folds, drawing on the results of experimental research. The research goals are: 1. to discuss general experimental methods of research of the consonant voicing in word juncture and its identification issues; 2. to establish some regularities of the close regressive consonant assimilation characteristic of word junctures in the Southern Aukštaitians.

The types and cases of the assimilation of the consonants of the Southern Aukštaitians have been determined drawing on the sound recordings from the Dialects Archive of the Research Centre of Geolinguistics at the Institute of the Lithuanian

Language as well as on the published texts (Markevičienė 1999; Leskauskaitė 2004; MŠT). Five recordings (the total duration of them exceeds ten hours) of spontaneous spoken language of Southern Aukštaitians¹ were employed for sound analysis; Praat software was applied for this purpose.

For the analysis of voicing in standard Lithuanian, utterances recorded from a single Lithuanian male speaker were applied²; the obtained values of acoustic parameters were employed as certain reference points in the succeeding study on dialectal speech.

NUANCES IN TERMINOLOGY

The dichotomy of terms *voiced* and *voiceless (unvoiced)* points to the presence or absence of phonation as the main cue for discrimination. This is a well-known paradigm. However, to be precise, before the proceeding to further examination of consonant voicing, we should be aware of certain problems with such a simple description. We should remember that the full-scale vocal component is not always obligatory for the discrimination discussed. Moreover, some languages (for instance, some Finno-Ugric languages) do not employ phonation at all in their ‘voiced’ consonants. The main cue for the discrimination in the analogous contrasting consonant pairs is considered to be the strength of articulatory efforts which is less for the ‘voiced’ consonants and bigger for the ‘voiceless’ consonants. James M. Pickett (1999: 125) notes the conventional attitude that “the constrictions of unvoiced consonants are articulated with more force or tension than for the voiced consonants”. Therefore it is common to use a more general description of the dichotomy of voiced/voiceless consonants and to consider the dichotomy of *lenis/fortis* instead. In the subsequent discussion, we will mean mostly the ‘real’ voicing/not voicing typical for the Lithuanian language. However, sometimes we will refer to the issues just mentioned.

¹ ČŠ, Vainežeris, Lazdijai district, sound record LM222806; VB, Miškiniai, Lazdijai district, sound record LK061101, LK061102; PD, Dainava, Varėna district, sound record LM230505; JP, Margionys, Varėna district, sound record LK161501, LM222906; VM, Kapčiamiestis, sound record Nr.693. Viktoras. Miciulevičius.WAV. All recordings are kept at the Dialects Archive of the Research Centre of Geolinguistics at the Institute of the Lithuanian Language.

² An actor Juozas Jaruševičius; the sound recordings provided in the CD as supplement for the book by Pakerys and Pupkis (2004). For visualization of the general cues for voicing (isolated sounds and nonsense VCV-patterns; see Figs. 1–4 and 7), additional recordings were prepared by one of the authors, male speaker Rytis Ambrazevičius.

SIMPLE VISUAL CUES

The component of phonation appears in acoustical graphs in several ways. In the oscillograms of frication phases (cases of fricatives and affricates), it is identified from the partial periodicity of a waveform (Fig. 2, top; compare to Fig. 1, top).³

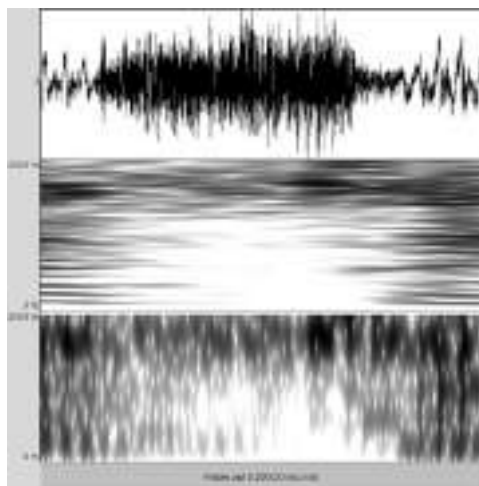


FIGURE 1. Intervocal voiceless sibilant *š* with small portions of adjacent vowels (*aša*): oscillogram, narrow- and wide-band spectrograms⁴

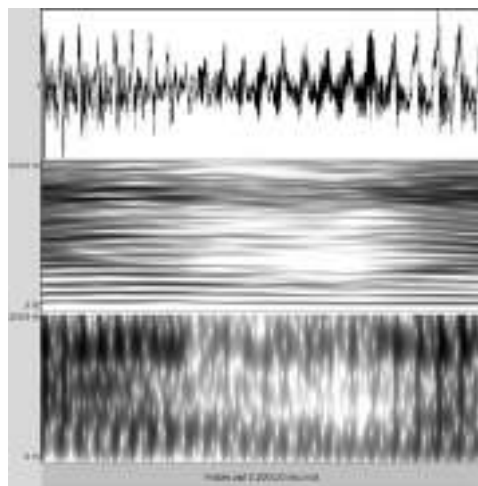


FIGURE 2. Intervocal voiced sibilant *ž* with small portions of adjacent vowels (*aža*): oscillogram, narrow- and wide-band spectrograms

Similarly, in the oscillograms of gap phases (cases of stops and affricates), the periodicity of a waveform, as opposed to the complete silence or more realistic weak noise, means the additional component of phonation (Fig. 4, top; compare to Fig. 3, top)⁵.

This component can be also identified from spectrograms. In the narrow-band spectrograms, it appears as the corresponding structure of harmonics (Figs. 2, 4; mids). In the wide-band spectrograms, pulsing is the marker of phonation (Figs. 2, 4; bottoms). Thus, briefly, “the presence or absence of voicing energy is the dominant cue for the perception of the voicing contrast in fricatives” (Kent, Read 2002: 161); and this presence or absence is clearly depicted in certain acoustical graphs. Therefore the

³ For all acoustical measurements and the graphs, Praat software was employed. MS Excel provided basis for the statistical generalizations and the graphic representation of the results.

⁴ In Figs. 1–4, isolated VCV-patterns are presented. Both vowels are accented.

⁵ Affricates will not be considered further in this chapter. In prospect, a mixture of the methods used for fricatives and stops could be applied in the study of voicing of affricates.

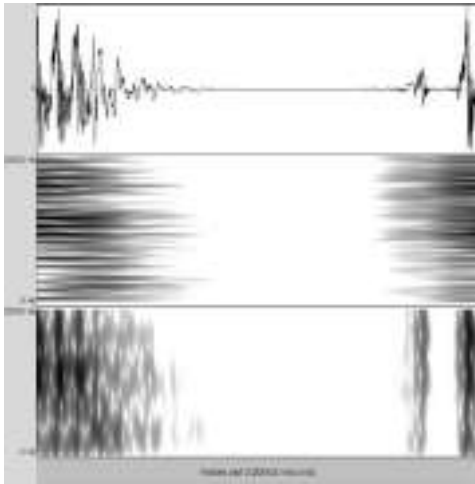


FIGURE 3. Intervocalic voiceless stop *p* with small portions of adjacent vowels (*apa*): oscillogram, narrow- and wide-band spectrograms

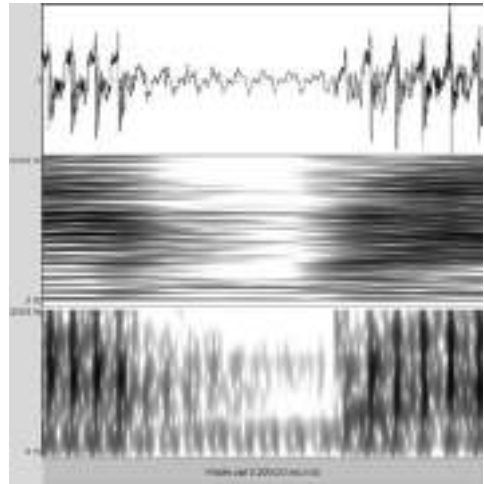


FIGURE 4. Intervocalic voiced stop *b* with small portions of adjacent vowels (*aba*): oscillogram, narrow- and wide-band spectrograms

identification of voicing seems to be quite simple task based on the simple observations of the acoustical graphs.

However, here we come back to the issues mentioned in the beginning of the paper. For instance, in certain cases, a fricative is perceived as voiced even if it contains a segment of devoicing (Fig. 5). Then the question arises where the boundary between the voiced and voiceless fricatives is, i.e. what duration of the devoiced segment (or other characteristics) corresponds to the boundary between the voiced and voiceless counterparts. Moreover, this boundary is expected to be dependent on a certain language and even on some specific nuances of speech flow.

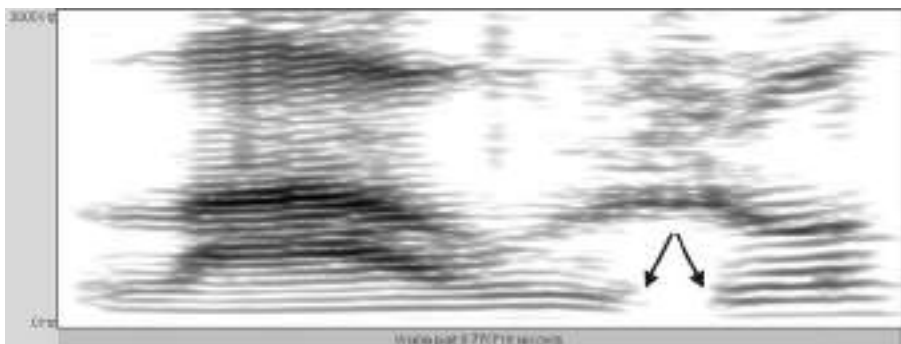


FIGURE 5. Spectrogram of the word *lá.užu* ‘fire (sing. instr.)’. The segment of devoicing is marked

A good example is VOT (Voice Onset Time) used frequently as the differential cue for the English stops. The boundary between the voiced and voiceless English stops is said to be at approximately 30 ms (Fig. 6).⁶ On the contrary, our preliminary observations showed that, for the Lithuanian voiced stops, VOT is always negative. If the stop is preceded by a pause, an epenthetic vowel is formed. If the stop is intervocal, voicing is not interrupted, i.e. it fills the entire gap phase. In some cases, seemingly, some very short devoiced segments are formed somewhere around the noise bursts, yet these are hardly identifiable from the acoustic graphs.

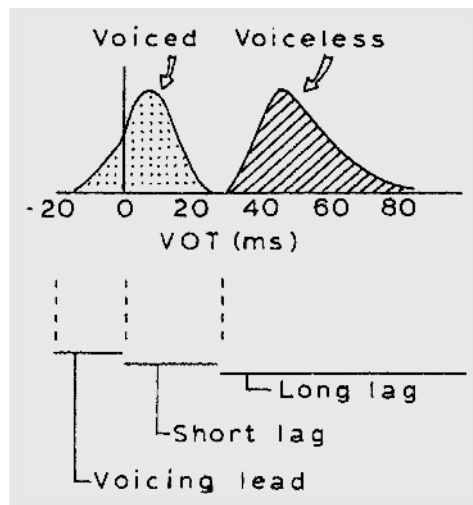


FIGURE 6. Discrimination of voiced and voiceless stops by VOT (Kent, Read 2002: 151)

All this shows that certain quantitative indexes for the differentiation of voiced and voiceless consonants are highly desirable. The characteristic values of the indexes (and especially the boundary values) could be obtained from the acoustical measurements of the real utterances of clear instances of the voiced/voiceless counterparts, as well as from the perceptual evaluations of the continua of synthesized sounds.

QUANTITATIVE CUES: FRICATIVES

Several differential indexes and algorithms for the evaluation of voicing of fricatives were proposed by different authors. One should mention, for instance, *HNR* (Harmonic-to-Noise Ratio; Boersma 1993; Hamann, Boersma, Čavar 2010) and intensity and temporal parameters of the first harmonic (Pirello, Blumstein, Kurowski 1997; Stevens et al 1992). Based on generally appropriate assumptions, these methods have certain shortcomings which make their applicability for the study more or less problematic. On the one hand, *HNR* shows illogical boundary values (<http://uk.groups.yahoo.com/group/praat-users/message/2533>). On the other hand, the evaluations of dynamics of fundamental including measurements of durations, extraction of fundamental, measurements of its *SPL* at several time

⁶ Incidentally, refer to the quote of Kent and Read: while stating on “presence or absence of voicing energy” as “the dominant cue for the perception of the voicing contrast” they mean fricatives but not stops.

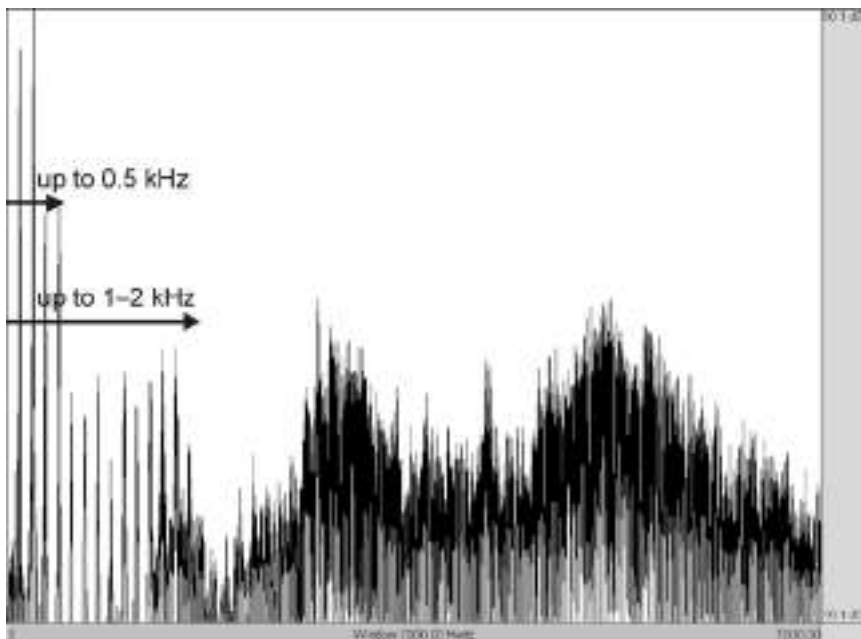


FIGURE 7. Spectrum of a prolonged isolated sibilant ž

points, and the successive comparisons of *SPLs* take considerable time resources and therefore are probably suitable in the cases of single instances, but hardly practical in the cases of large samples.

A set of the algorithms employs quite distinct separation of the voice/noise frequency bands (Childers 2000; Balbonas, Daunys 2005; etc.). On the one hand, structure of low harmonics up to 1–2 kHz (with the most intense band up to approximately 0.5 kHz) is characteristic of the spectra of voiced fricatives. On the other hand, the noise of frication is characteristic of significantly higher frequencies (Fig. 7). For instance, for English voiceless sibilants, noise is significantly more intense for > 2.5 kHz. The most intense spectral peaks are at about 3 kHz (š) and about 4 kHz or higher (s) (Pickett 1999: 119, 139; Kent, Read 2002: 163, 168, etc.).

Based on this difference, a simple *LHR* method was proposed (Low-High-Ratio index; i.e. ratio of intensities of low and high frequency bands; Ambrazevičius 2013). *LHR* was defined by the following expression:

$$LHR \text{ (dB)} = 10 \lg (I_L/I_H) = -10 \lg \left(10^{\frac{L-L_L}{10}} - 1 \right);$$

here I_L , I_H , L , and L_L stand for, correspondingly, the intensities of low (0–0.5 kHz) and high (>0.5 kHz) frequency bands, the total *SPL*, and *SPL* of the low band.

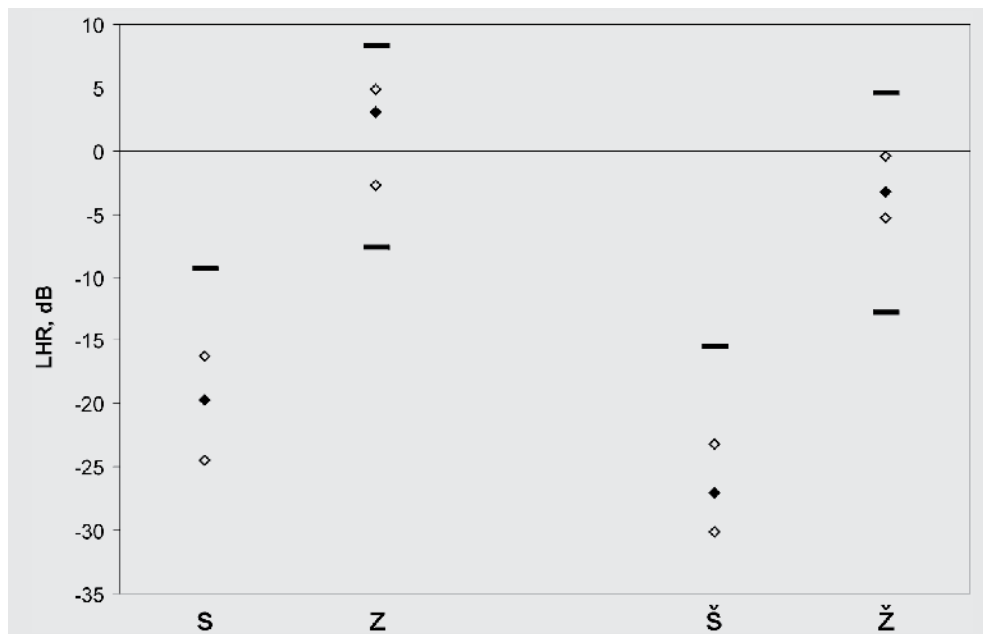


FIGURE 8. *LHR* for the Lithuanian sibilants⁷

The method was applied for the evaluation of voicing of 201 sibilant in standard Lithuanian⁸; the utterances of male speaker presented in the recordings of Pakerys and Pupkis 2004 were examined. It was estimated that the boundary between the voiced and voiceless sibilants corresponds roughly to $LHR = -10$ dB (Fig. 8).

QUANTITATIVE CUES: STOPS

The logic of evaluation of low frequency bands could be also applied in the case of stops. We suggest the relative *SPL* of the low-pass filtered intervocal gap (Fig. 9) as the differential index:

$$\Delta L_L \text{ (dB)} = L_{LC} - L_{LV} ;$$

⁷ Here and further: medians – black diamonds, interquartiles – white diamonds, extremes – dashes. Values less than -30 dB not depicted. The results for *z* are somewhat preliminary because of quite a small sample size.

⁸ Therefore the results differ slightly from those presented in Ambrazevičius 2013 which included 188 sibilants.

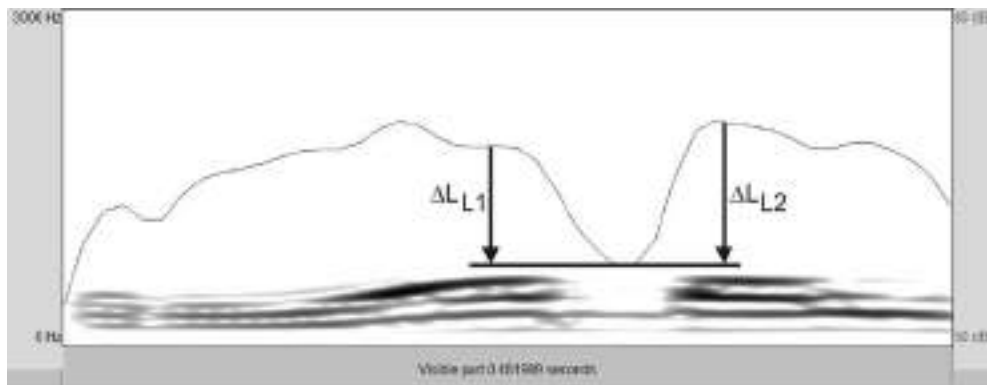


FIGURE 9. Utterance *príeba...* (from *príebalsis*): SPL track and narrow-band spectrogram of low-pass (0–0.5 kHz) filtered recording

here L_{LC} and L_{LV} are, correspondingly, $SPLs$ of low (0–0.5 kHz) frequency bands of a consonant gap and the adjacent vowel or vowels. $SPLs$ of the preceding vowel, succeeding vowel, or their average, can be used depending on whether the consonant is postvocal, prevocal, or intervocal (see also the discussion below).

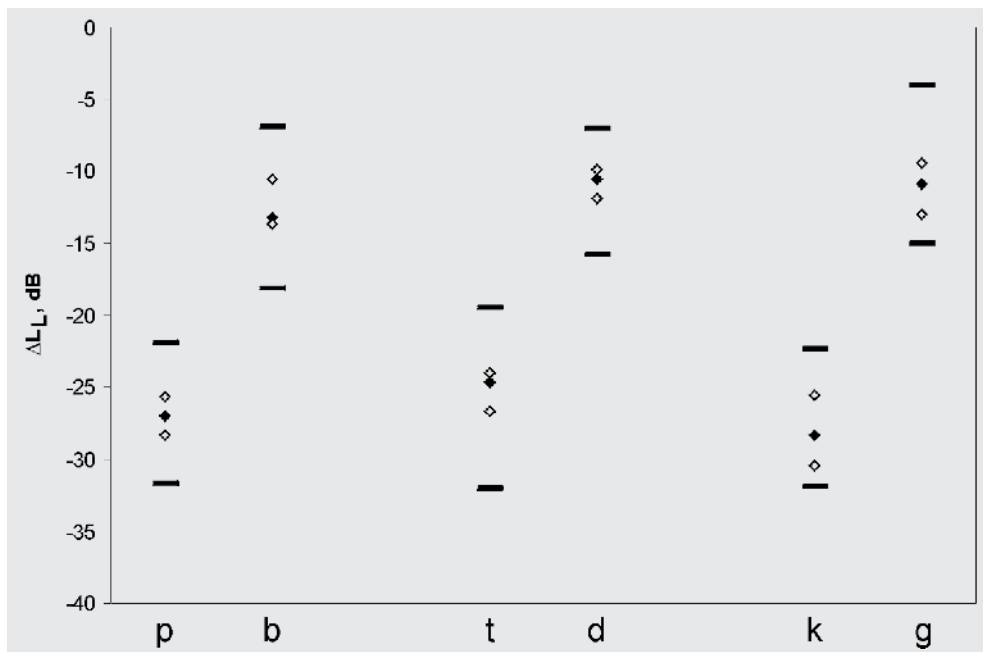


FIGURE 10. ΔL_L for the Lithuanian stops

The higher values of ΔL_L are expected for the voiced stops, whereas the lower values presumably correspond to the voiceless stops. Indeed, this presumption was verified by the measurements of Lithuanian consonants. 120 stops from already mentioned source (male speaker; Pakerys, Pupkis 2004) were examined. The voiced/voiceless boundary values for ΔL_L were found at approximately -20 dB (Fig. 10).

Some problem of the ΔL_L index is its dependence on certain adjacent vowels. That is, for weak vowels (say, typically, *us*) an intervocal stop with the same acoustical characteristics will show higher ΔL_L values compared to the case of more intense vowels (say, typically, *a:s*). Possibly, this shortcoming could be resolved if some averaged SPL of the longer segment of a recording instead of the averaged SPL of the adjacent vowels were applied. In this case, the ΔL_L ranges for voiced and voiceless stops would be more distinctly separated.

Possibly the ΔL_L index could be equally employed in the case of fricatives as well. This possibility should be tested, yet at the moment we prefer to stay with the *LHR* index instead because of the reasons just mentioned. Vice versa, ΔL_L cannot be substituted with *LHR* for stops as this index would show hardly reliable scattered values (especially in the cases of voiceless gaps characteristic of extremely weak and background-dependent sound signal).

In line with the above-named statements, the issue of quality of sound recording should be mentioned. Obviously, the indexes will show more or less different values if considerable amount of background noise is added. Therefore technically neat recordings with the noise background as weak as possible are preferable. Constant and not extremely intense background noise can be also successfully filtered out with almost no distortion of the speech signal to be analyzed.

Another similar problem is reverberation of the room used for the recording. Obviously, rooms with only short reverberation times are preferable since long RTs make additional vowel-like tails in the phases of stop gaps. Therefore an inadequately intense component of phonation may be registered in the measurements. If it is the case, the measurements of SPLs in the very end of a stop gap (i.e. when reverberation decays) could provide a partial solution.

Voicing of a consonant influences also other parameters of the consonant and its environments, such as durations of the consonant and preceding vowel, SPL of the consonant, and pitch in the beginning of the succeeding vowel. However, these parameters can be considered only as epiphenomenal non-differential cues, i.e. they show some statistical tendencies, yet they do not work as cues for discrimination (Ambrazevičius 2013: 11–14).

CONSONANTS IN THE WORD JUNCTURES OF SOUTHERN AUKŠTAITIANS

In the word junctures of standard Lithuanian and dialects, two types of the close regressive assimilation according to the vocal folds' activities – full and partial – are possible. This is also characteristic of Southern Aukštaitians' dialects. The regressive assimilation of both types takes place in two cases: a) putting a dependent word next to an independent one; b) in a juncture of independent words.

The full close regressive assimilation is less frequent than the partial one. It is linked with another phonetic phenomenon – degemination (Table 1). In such cases, there is obvious change in the boundaries of a phonologic syllable.

TABLE 1. Full close regressive assimilation and degemination in word junctures

Type of assimilation	Dialectal examples
1) fricative ← fricative	$s \leftarrow \dot{z}$ <i>viena(s) žmogùs</i> 'a one man' (Rudnia); <i>pa(s) žřdu. pùsri.-cėi gerì bì-ž.</i> 'breakfast at the Jew's was good' (Zervynos); <i>kž.kė(s) žvirùs ar mólis</i> 'some gravel or clay' (Kučiūnai)
	$k \leftarrow g$ <i>ríkšřtu. bìvž.</i> <i>šėpž.n kie(k) ganà</i> 'there were enough [many] switches in the closet' (Zervynos); <i>ię.m viš cíe(k) gėraĩ.</i> 'he feels good just the same' (Veisiejai); <i>bitėš turėj ĩ ci(k) gabėšnis gabėšnis viėnas kėtas ká.imž.</i> <i>žmžgùs</i> 'only one or two smarter villagers kept bees' (Kučiūnai)
2) stop ← stop	$g \leftarrow k$ <i>kžjž.(s) sulì(g) kuĩ.nž.</i> 'the legs are up to the knees' (Kapčiamiestis); <i>prisrá.uge dāũ.(g) kž.přřtu. žiėmu.</i> '[they] make a lot of sauerkraut in the winter' (Zervynos)
	$p \leftarrow b$ <i>ka(p) bėrdavž. geràšņė. galvà</i> 'when the head was better' (Zervynos); <i>kžlu.kis ka(p) bìvž. sustųėris tai píėvas višàs pā-ė.mė.</i> 'when the kolkhoz was established all the meadows were taken over' (Rudnia)
	$t \leftarrow d$ <i>jė.m priku.rí(t) dá.vė. gėraĩ.</i> 'he was chided' (Kabeliai); <i>vaiķaĩ. gĩki(t) *daržinėũ. ški.ni.mañ.</i> 'children, drive [the cattle] to the Daržinėliai clearing' (Kabeliai)
	$d \leftarrow t$ <i>ė ka(d) tũ visuř. buvai</i> 'you were everywhere' (Kabeliai)
3) stop ← affricate	$d \leftarrow c$ <i>àš mišnāu ka(d) cė šarnaĩ.</i> 'I thought these were wild boar' (Rudnia)

Sometimes the regressive assimilation and degemination may not take place in the word junctures, in the Southern Aukštaitians' subdialects (cf. Markevičienė

1999: 31). This is usually determined by a longer logic pause to strengthen the importance of what is being said and stronger isolation of independent words (1) or situational transforming of a dependent word to an independent one (2), cf.:

- (1) *kat_vilkūr aṛkē.s žibā* | *āš nežinójāu* 'that wolves' eyes shine, I didn't know' (Puvočiai); *kíeku. mǎ.tu. á.jom* | *ko.lá.ik galē.jem* 'so many years we went, as long as we could' (Rudnia); *avà bastrīs* † *bastrīs* 'here, a bastard, bastard' (Kapčiamiestis);
- (2) *turù ir_žō.lūr* | *bèt dukṭē prīveža_ir* | *kalvarō.lō.* | *ir_valerijō.nu.* 'I also have herbs but my daughter brings me corvalol and valerian' (Marcinkonys); *apsimatōji. apliņ.k.gá.lou.* | *raņkās susmatōji. ir_vīs liņģuōje liņģuōje sēdēdami* [žydai] 'with their heads swathed in scarves, hands folded sat and rocked [Jews]' (Marcinkonys); *kāp.padā.rō. tu.skēlbi.* | *tai.anā* | *tuōsa.mǎ.žuosa* | *tō.kūs* † *kap.me(s).sá.kō.m zō.viēšai* | *sūkala* 'when they make that hole in those trees over there, then as we say, hinges are driven in' (Kapčiamiestis).

The partial close regressive consonant assimilation in word junctures according to the vocal folds' activities is not completely the same for different dialects. For instance, in the subdialects of the Western Aukštaitian of Kaunas, voiceless and voiced consonants in the junctures of dependent and independent words are systematically assimilated. At independent word junctures, however, the assimilation of these sounds can be full, partial or does not take place at all (ŠŠT; GAT; JAT). Irena Kuopienė and Genovaitė Kačiuškienė (2012: 345) discussed the phenomena of external sandhi in the subdialects of the Northern Panevėžys area and pointed out that the accommodation of consonants according voicing is twofold in the word junctures: it is quite regular when occurs between the dependent or monosyllabic words and independent words while it is very rare in the case of both independent words. According to the authors, such assimilation of consonants is also absent in the case of reduced vowel succeeding the end consonant of a word. Voiceless consonants *k, p, t, s*, preceding voiced consonants in word endings become fully or partly voiced in the flow of speech of Eastern Aukštaitians' of the Vilnius area and that of (MAT 35ff.; DAT 31ff.; DuAT 22ff.; LzT 24ff.). To be precise, Vytautas Kardelis noticed that this phonetic phenomenon is not automatic as depends on speech rate and intonation breaks (MAT 35ff.; DAT 31ff.).

In the Southern Aukštaitians', partial close regressive consonant assimilation in word junctures is more frequent and various (Table 2). Additionally, degrees of the assimilation are different – both weak (e.g.: $\zeta < s \leftarrow b, \xi < \check{s} \leftarrow d$) and strong (e.g.: $d < t \leftarrow d, b < p \leftarrow d$).

Out of the mentioned six types of partial close regressive assimilation, cases of the second type (fricative \leftarrow stop) are most frequent. Most often the fricative *s* and stops *g, d, b* are in regressive correlation. This is linked with the frequent use of the word endings *-s*.

TABLE 2. Partial close regressive consonant assimilation in word junctures

Type of assimilation		Dialectal examples
voiced ← voiceless		
1) stop ← stop	$d \leftarrow k$	<i>kàt kùpstas</i> ‘than hummock’; <i>kàt katrìej</i> ‘than which’
	$d \leftarrow p$	<i>kat_prašíta</i> ‘than asked’; <i>kat_pař.daõâu</i> ‘than sold’
	$g \leftarrow p$	<i>dãũ.k pripjãuna</i> ‘much mown’; <i>nuok_pelĩr</i> ‘against mice’; <i>priek_pãbalõ</i> . ‘by a swamp’
	$g \leftarrow t$	<i>nuok_tu_mã.tu</i> . ‘from that year’
2) stop ← fricative	$d \leftarrow s$	<i>kat_skrìst</i> ‘than flew’; <i>kat_sakít</i> ‘than told’
	$d \leftarrow š$	<i>kat_šitep</i> ‘in this way’
	$g \leftarrow s$	<i>dãuk_stalĩr</i> ‘many tables’; <i>nuok_skãũ.dulõ</i> . ‘for pain’
voiceless ← voiced		
1) stop ← stop	$k \leftarrow d$	<i>iej cig_dũ senẽ.lej bũ-õ</i> . ‘they were only two old people’ (Kapčiamiestis); <i>tõs lakõs cig_dã.li. paliẽka adarĩtu</i> . ‘only part of the bee entrance slot is left open’ (Kučiũnai)
	$k \leftarrow b$	<i>senũkas cig_bũõ. numĩrĩ.s</i> ‘the old man had just died’ (Zervynos); <i>kĩekẽ bũ-õ vandenẽlo</i> . ‘there was so much water’ (Rudnia)
	$p \leftarrow d$	<i>vẽjes_tas kab_dẽjõ. tai_nugrõvẽ. klĩonu</i> . ‘the gust of wind was so strong that it pulled down the barn’ (Veisiejai); <i>kab_dař.te.s mašino.m tai_graĩ.tai nuvažũoje</i> ‘now by car, it takes not so much time’ (Rudnia)
	$p \leftarrow g$	<i>šitep_galĩ žmõ.gũs dagi.vẽ nc</i> ‘man can finish his life’ (Zervynos); <i>miškañ teb_gražũ</i> ‘it’s so nice in the wood’ (Rudnia)
	$t \leftarrow b$	<i>bu.d_bũũi. tẽ vaš gĩ vas</i> ‘if father had been alive’ (Marcinkonys); <i>bed_baisũlej vĩrai gi_vã šitai bũ-õ</i> . ‘but the men were giants’ (Seirijai)
2) fricative ← stop	$s \leftarrow b$	<i>vĩenas tãkẽš bũ-õ. priešingãš bėrnas</i> ‘there was one obstinate chap’ (Kapčiamiestis); <i>tõkõ(s) šũkẽ.s bũõ</i> . ‘there were such shards’ (Zervynos); <i>gã.tvẽ.s vĩsõ.s brukũotõ.s bũ-õ</i> ‘all the streets were cobbled’ (Seirijai); <i>bru.zgũliš buvãũ. kap_raĩ.ke</i> ‘I was fast very-moving’ (Vingrėnai)
	$s \leftarrow g$	[sũris] <i>cẽ gražũš geltõnas tõ.kès</i> ‘[cottage cheese] was nice, yellow’ (Kapčiamiestis); <i>zũrikiš gũli</i> ‘a hare is lying’ (Veisiejai); <i>nũvežẽ.m paz_gĩdi.tõ.ji</i> . ‘took [him] to the doctor’ (Seirijai)

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Type of assimilation		Dialectal examples
2) fricative ← stop	$s \leftarrow d$	<i>á rklús tɛ vùkaʃ du paĩ.davɛ</i> . ‘father sold the horses’ (Zervynos); <i>kàʃ dírba ta(i)ir gi.vɛ.na gerai</i> ‘those who work, live well’ (Rudnia); <i>sukčùʃ dá.rɛ</i> . ‘made rolled meat’ (Vingrėnai); <i>màn.v. saseĩ.ʃ dukťɛ</i> ‘my sister’s daughter’ (Lazdijai)
	$ʃ \leftarrow g$	<i>àʃ gimđáú</i> ‘I gave birth’ (Rudnia); <i>mɛ.zi. pasidɛda virʃ galvõs</i> ‘puts timber on a trestle above the head’ (Kučiūnai)
	$ʃ \leftarrow d$	<i>aʃ dár dabaĩ. kap kadù usimanáú</i> . ‘even now I sometimes crave [for it]’ (Seirijai)
3) stop ← fricative	$t \leftarrow ʒ$	<i>beť žinõsit ar pažinõ</i> ‘but you’ll know if you have recognised’ (Kapčiamiestis)
	$k \leftarrow ʒ$	<i>cig žinõj ti. paviĩ.ʃum biški. kat nemõžna kõ</i> ‘only knew a little that something was forbidden’ (Kučiūnai); <i>cig žináú kad bũ-ɔ. ráudõnas skĩscis</i> ‘I only know that there was red liquid’ (Kučiūnai)
	$p \leftarrow ʒ$	<i>visì meļi.nai kaškàp žĩzi</i> ‘all have blue blooms’ (Rudnia)
4) fricative ← affricate	$s \leftarrow dz$	<i>ti. sá.mciʃ židelis</i> ‘there was a large ladle’ (Zervynos); <i>sto.gai àbdenkta sõdaʃ židelĩs</i> ‘the roofs are covered, the garden is large’ (Rudnia); <i>arúodaʃ židelis</i> ‘a large grain bin’ (Kučiūnai)
5) affricate ← stop	$c \leftarrow g$	<i>tau galù parõzi.ç gi. dá.r</i> ‘I can still show you’ (Zervynos); <i>viẽto.m tai bũna brá.ižõ.ç gá.lima</i> ‘in some places you can wade’ (Rudnia)
	$c \leftarrow b$	<i>cĩpkamešni</i> [aviliai] <i>palikç bitɛ.m</i> ‘more suitable hives leave for the bees’ (Kučiūnai); <i>cĩkľuku. turi usidɛc apsáugõ.ç búrnũ</i> . ‘you have to use a net, to protect your face’ (Kučiūnai)
	$c \leftarrow d$	<i>kèpç dúona</i> ‘bake bread’ (Puvočiai)
6) affricate ← fricative	$c \leftarrow ʒ$	<i>macĩç žairũ ne-išmetɛ</i> . [sesuo] ‘it seems [the sister] had not thrown out the embers [sister]’ (Marcinkonys)

Further on those cases of partial close regressive assimilation (most frequently discovered in the spontaneous speech of respondents of the Southern Aukštaitians) will be discussed. Drawing on the most convenient methods of the determination of consonant voicing in standard language discussed above, the following types of word junctures have been analyzed: $S \leftarrow T^s$: $S \leftarrow T^d$ and $T \leftarrow T^s$: $T \leftarrow T^d$. Altogether

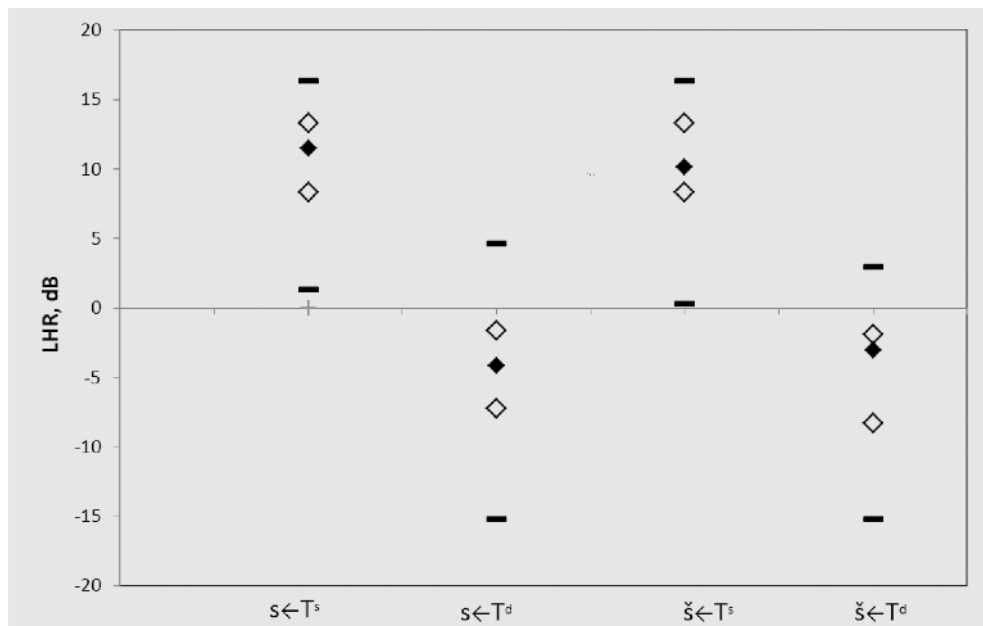


FIGURE 11. *LHR* for the Southern Aukštaitians' sibilants *s*, *š* in word junctures

334 assimilation/non-assimilation occurrences⁹ of fricatives *s*, *š*, and 83 occurrences of stops *k*, *p*, *t* were collected for the research.

Types $S \leftarrow T^s$ and $S \leftarrow T^d$ ¹⁰. Taking into account the conclusions of the research of fricatives in standard language, the index *LHR* (corresponding roughly to the ratio of the voice and noise components' energies) was chosen as a differential cue for voicing. Two sound recordings were used – the original and low-pass filtered (0–500 Hz).

The results of the measurements and calculations of *LHR* showed that regressive assimilation of the consonants *s* and in the subdialects of the Southern Aukštaitians according to the vocal folds activities in word junctures is really not systematic – the obtained ranges of values of assimilated and non-assimilated consonants partly overlap (Fig. 11).

⁹ Over 500 consonant occurrences used in word junctures were selected for the research; however, some of them were rejected due to the causes already pointed out when discussing the consonant voicing in standard language; also because of weak or unclear acoustic realizations. Study of the sound recordings of the informants VB and JP was more complicated as the sound quality was worsened by reverberation and noise made by the recording equipment.

¹⁰ T^s – voiced stop, T^d – voiceless stop.

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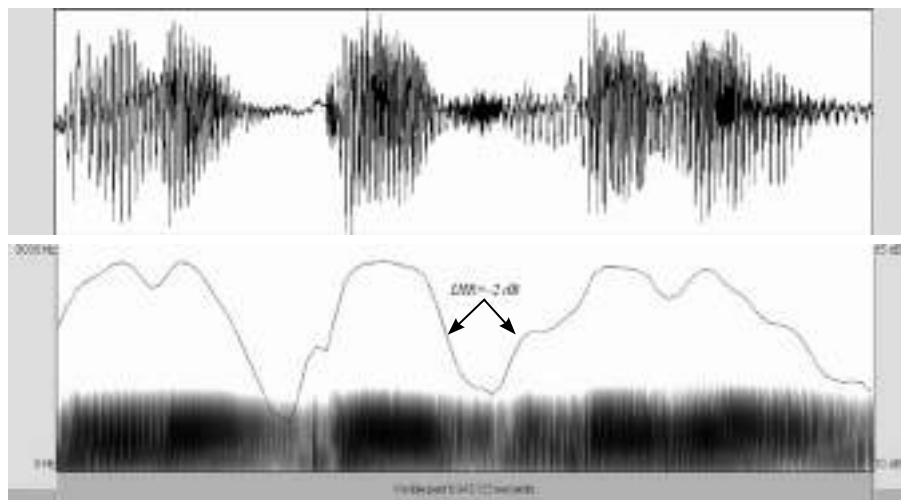


FIGURE 12. Utterance *likis bũv.* 'had remained'. Top: oscillogram, bottom: SPL track and wide-band spectrogram of low-pass (0–0.5 kHz) filtered recording

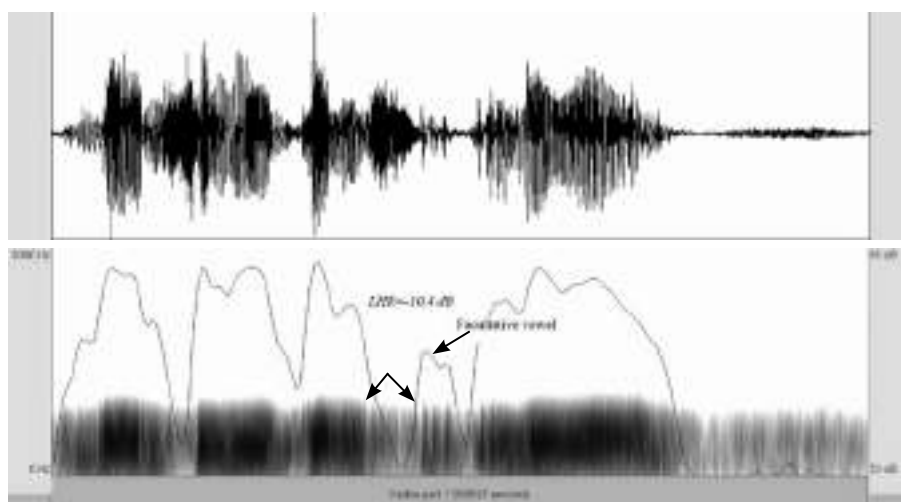


FIGURE 13. Utterance *viř.řini.kas bũv.* 'the chief was'. Top: oscillogram, bottom: SPL track and wide-band spectrogram of low-pass (0–0.5 kHz) filtered recording

Both generalized *LHR* values and the values for separate occurrences of sibilants *s*, *ř* in word junctures of spontaneous language show that these sibilants most often become voiced *z*, *ž*, therefore regressive assimilation is obvious. However, this phenomenon is not intense in some cases, therefore the sibilants *s*, *ř* are identified as only partially voiced. It is not always easy to estimate the degree of voicing by ear.

The consonants *s*, *š* used before voiced consonants in word junctures can remain almost completely voiceless. For example, in the phrase *likis b̄iwɔ*, the sibilant *s* has a naturally weak shade of *z* – its *LHR* equals -2 dB (Fig. 12)¹¹. This sound did not undergo regressive assimilation since, because of the dispersive influence of the context, it was pronounced as rather short (about 60 ms), while reverberation was stronger.

If a facultative vowel is inserted in word juncture, the sibilant consonant before a further voiced stop does not undergo regressive assimilation. For example, *LHR* value for the consonant *s* in Figure 13 is -10.4 dB. It corresponds approximately to the median of *LHR* for all cases of the voiceless *s* (cf. Fig. 11). Therefore the fricative is really voiceless in this case.

Types $T \leftarrow T^s$ and $T \leftarrow T^d$. The tendency of interaction of the voiceless stops *k*, *p*, *t* and the following voiced stops *g*, *b*, *d* in word junctures is similar to that of fricatives (Fig. 14). In this case, the degree of voicing is estimated basing on the ΔL_L index discussed earlier.

Fig. 14 shows that the ranges of the ΔL_L values of consonants *k*, *p*, *t* influenced by the voiced consonants *g*, *b*, *d* and those which did not experience partial close regressive assimilation intersect. Therefore it is impossible to indicate the boundary of separation of voicing and unvoicing between them. It can be surmised that, as in case of fricatives, assimilation of these consonants in word junctures can be of different degree, with similar reasons like those characteristic of fricatives discussed above.

Since the ΔL_L index did not show a very obvious difference between assimilated and nonassimilated stops, additionally the low frequency energy values of these sounds were compared (i.e. not taking into account vowel context; Fig. 15). A clear separation is seen only for the occurrences of labial consonant *p* preceding voiced and voiceless stops – the corresponding ranges of the L_L values do not intersect. Obviously, in the position discussed, the voicing/unvoicing of the consonants *k* and *t* was greatly influenced by the context and other factors.

It was already mentioned that, because of scanty data hardly sufficient for reliable statistical evaluation, other types of assimilation in word junctures have not been discussed. However, the discussed phenomena seems to be analogical in the Southern Aukštaitians' subdialects as well as the Lithuanian language. Therefore possibly similar general tendencies could be identified.

It should be noted that the sound recordings of spontaneous Southern Aukštaitians' speech contained fewer cases of the types $T \leftarrow T^s$ and $T \leftarrow T^d$ compared to $S \leftarrow T^s$: $S \leftarrow T^d$, therefore the samples of their usage are not large. This circumstance can influence the credibility of the results obtained.

¹¹ The *LHR* of the fricative consonant *s* of the word junctures in pictures 12 and 13 have not been included in the general results of measurements algorithms calculation.

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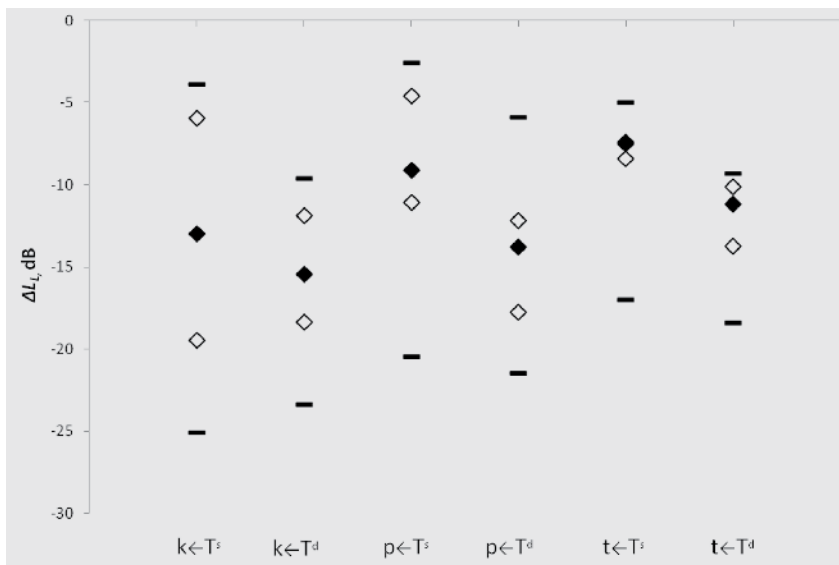


FIGURE 14. ΔL_L for the Southern Aukštaitian stops in word junctures¹²

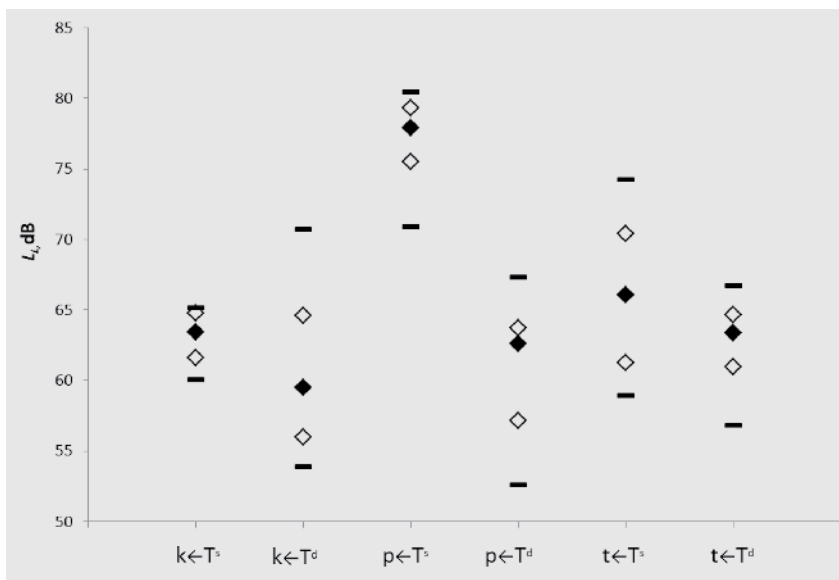


FIGURE 15. L_L ; sound pressure level for the low-pass (0–0.5 kHz) filtered Southern Aukštaitians' stops in word junctures

¹² Here the type T←T^s seemingly lacks the third quartile as it is blended with median. It may be linked to the scanty occurrences of the position researched.

CONCLUSIONS

It is well known that “the presence or absence of voicing energy is the dominant cue for the perception of the voicing contrast in consonants” (rehashed from Kent & Read 2002: 161). However, one encounters not simply two dichotomic cases “a consonant with voicing energy” and “a consonant without voicing energy”, but rather entire continuum of fractions of voicing energy in the whole spectra of the consonants considered. The boundaries between *fortis* and *lenis* categories are individual for different languages. Moreover, the perception of voicing is complicated as includes not only spectral but also temporal cues. All this makes the procedure of the objectivized evaluation of voicing not trivial.

The paper introduces two relatively simple techniques of identification of voicing: the indices *LHR* (case of fricatives) and ΔL_L (case of stops), both based on the evaluation of energy of low frequencies in the consonants (or their temporal segments). Referring to the abovementioned complications of the objectivized evaluation of voicing, these indices work generally quite well as differential cues for voicing. Nevertheless, because of the complications, a certain caution should be noted again when employing these techniques: the boundaries between the voiced and voiceless counterparts are individual for the discussed cases. Additionally, the results could be distorted by some extrinsic technical causes, such as intense background noise and room reverberation. This should be taken into account both when choosing the sound recordings for analysis and when applying the techniques of acoustical measurements.

The indicated techniques of analysis could be employed in the study of phenomena of consonant assimilation in the Lithuanian dialects too. The research carried out into the examples of the spontaneous Southern Aukštaitians’ speech (types $S \leftarrow T^s$: $S \leftarrow T^d$ ir $T \leftarrow T^s$: $T \leftarrow T^d$) essentially gives proof for the statements presented here. It is obvious that, from the point of view of acoustics, consonant assimilation in word juncture is quite complex phenomenon and its study requires precision.

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Priebalsių balsingumo požymiai. Jų asimiliacija žodžių sandūroje

SANTRAUKA

Paprastai ir tradiciškai sutariama, kad skardžiuosius ir dusliuosius priebalsius skiria fonacijos (balso klosčių veiklos), t. y. balso, balsingojo komponento buvimas ar nebuvimas. Tai ne visai tikslu. Kai kurių kalbų (pavyzdžiui, kai kurių ugrofinių kalbų) priebalsiai, sudarantys analogiškas kontrastines poras, skiriasi ne arba ne tiek balsingumo požymiais, o tam tikrais (mūsų požiūriu – iš lietuvių kalbos fonetikos pozicijų) antriniais požymiais. Atkreipus dėmesį į skirtingas artikuliacines pastangas tariant skardžiuosius ir dusliuosius priebalsius (ar jų dichotominius analogus), pirmuosius kartais linkstama vadinti neįtemptaisiais (*lenis*), antruosius – įtemptaisiais (*fortis*). Straipsnyje aptariami pavyzdžiai, kur diferencijuojant *fortis–lenis* poras balsingumo požymis yra bent kiek nors reikšmingas.

Pagrindinis akustinis skardžiuosius priebalsius nuo dusliųjų skiriantis požymis – fonaciją rodantis komponentas: kvaziperiodiniai virpesiai oscilogramose, papildomos balso harmonikos spektrogramose. Tačiau net ir nutrūkus fonacijai pučiamasis priebalsis išlieka skardžiuoju. Fonacijos požiūriu labai skiriasi, pavyzdžiui, lietuvių ir anglų kalbų sprogstamieji priebalsiai. Tokiais pavyzdžiais iliustruojami kalbiniai *fortis–lenis* skirtumai ir argumentuojami kiekybinių metodų privalumai.

Siūlomi kiekybiniai balsingumo rodikliai. Skardžiųjų pučiamųjų priebalsių spektre išryškėja žemadažnės harmonikos. Tuo pasinaudota apibrėžiant pučiamųjų priebalsių *LHR* (*Low-High-Ratio*) rodiklį, lygų priebalsio žemadažnės (iki 500 Hz) ir aukštadažnės (per 500 Hz) energijos santykiui. Kiek kitaip, bet pasiremiant panašiu reiškiniu (žemadažnės energijos vyravimas skardžiųjų priebalsių spragos fazėje), konstruojamas sprogstamųjų priebalsių ΔL_L rodiklis – santykinis (priebalsio artimame ar tolimame kontekste) žemadažnio komponento garso lygis.

Minėta metodika panaudota ir analizuojant pietų aukštaičių dusliųjų ir skardžiųjų priebalsių sąveiką žodžių sandūroje. $S \leftarrow T^s : S \leftarrow T^d$ ir $T \leftarrow T^s : T \leftarrow T^d$ tipų analizė parodė, kad dalinė artimoji regresyvinė asimiliacija aptariamojoje pozicijoje nėra vienoda, o kai kuriais atvejais ir apskritai nevyksta. Be to, norint atlikti patikimą spontaniškos kalbos priebalsių asimiliacijos analizę svarbu atkreipti dėmesį į garso įrašo techninę kokybę, įrašymo patalpos reverberaciją ir kitus veiksnius.

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