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The Non-neutralizing Nature of Hungarian Voicing Assimilation

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0. Introduction
In this paper we report on a pilot experiment designed to assess whether the process of regressive voicing assimilation in Hungarian applies in a categorically neutralizing manner, as implied by recent phonological analyses, e.g. Szigetvári (1998), Ritter (2000), Siptár & Törkenczy (2000), or whether it is better modelled as a gradient, phonetic rule (cf. Ernestus 2000 and Jansen 2001 on Dutch).

Our results, based on acoustic data from two speakers, indicate that Hungarian regressive voicing assimilation is not a neutralisation phenomenon. Whilst there is clear evidence of assimilation on the phonetic voicing of target obstruents and the preceding vowels, underlying distinctions in obstruents targeted by the process are still detectable in some of these features. In addition, we observe mismatches between the behaviour of voicing and segmental duration in obstruent clusters that contradict the predictions of the phonological accounts mentioned above.

Hungarian is a Uralic (Finno-Ugric, Ugric) language spoken by around 15 million people in Hungary and (as a minority language) in several of the surrounding states. The obstruent system of Hungarian is bifurcated into a set of tense and lax sounds in a manner that is similar to that of the surrounding Slavonic languages and Romanian (Kenesei et al. 1998; Siptár & Törkenczy 2000). Unlike many of these languages, however, Hungarian maintains laryngeal contrast word finally before sonorants and prepausally, as in (1).

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2 The terms tense/fortis, lax/lenis, and [+/-tense] are used here as descriptive labels instead of (phonologically) voiceless vs. (phonologically) voiced and [+/-voice]. The latter represent more common terminology, but they obscure the difference between phonetic voicing (the acoustic result of vocal fold vibration) and lexical ‘voicing’ contrast, which is normally supported by a host of phonetic cues in addition to voicing.
In mixed tense + lax and lax + tense sequences, Hungarian word-final obstruents are subject to a process of regressive voicing assimilation (RVA). This process devoices lax obstruents followed by a tense plosive or fricative (2), and voices fortis obstruents before a lax plosive or fricative (3). As long as no pause intervenes, regressive assimilation is said to apply in sandhi clusters created by the morphology, by compounding (e.g. rabszolga ‘slave’, from rab ‘prisoner’, and szolga ‘servant’, in which underlying /bs/ assimilates to [ps]), and between independent words (e.g. nyolc gyerek ‘eight children’, with medial [dʒ] from underlying /tsj/). The majority of researchers claim that this process is both obligatory and neutralising, and is not dependent on speech rate.³

(1) nád /naːd/ [naːd] *[naːt] reed
rág /raːɡ/ [raːɡ]*[raːk] he chews
láz /laːz/ [laːz]*[laːs] temperature
lágy /laːj/ [laːj]*[lɑː] soft

(2) rabtól /rɔbː+/tɔːl/ [ɾɔptɔːl] from (a) prisoner
kádtól /kaːdː+/tɔːl/ [kaːtɔːl] from (a) bathtub
habszifon /hɒbː+/ʃifən/ [hɒpsifon] cream-maker
hadserég /hɒdː+/ʃɛɾɛɡ/ [hɒʃɛɾɛɡ] army

(3) kalapban /kɒlɑpː+/bɒn/ [kɒlɔbːɔn] in (a) hat
kútban /kʊtː+/bɒn/ [kʊdbɒn] in (a) well
szép zenész /sɛːpː+/ zenɛsɛː/ [seːbzɛnesɛː] beautiful musician
vak zenész /vɔkː+/ zenɛsɛː/ [vɒgzɛnesɛː] blind musician

It would thus appear that the basic facts of laryngeal contrast and voicing assimilation in Hungarian are straightforward. Indeed Sauvageot (1951:27) typifies many commentators on this phenomenon when he states of Hungarian that “L’assimilation désonorisatrice et sonorisatrice est d’un mécanisme fort simple”. The experiment reported below was designed to put this assertion to the test.

2. Methods
2.1 Speakers
Two subjects, K9 and M15, both female, took part in the experiment. The first speaker was 26 years old and had been a resident of Budapest for approximately 8 years at the time of recording. This subject grew up in Heves county and describes her own accent as ‘standard Hungarian’. She is fluent in English. The second subject was 30 years old at the time of recording and although having

³ See, for example, Hall (1944), Sauvageot (1951), Kálmán (1972), Lotz (1988), Kenesei, Vago and Fenyesi (1988), Olsson (1992), and Siptár & Törkenczy (2000). A small number of authors, however, have suggested that voicing assimilation is not entirely obligatory: Kolmár (1821) and Vago (1980) suggest it is speech rate dependent, whilst Tompa (1961) believes that it can be suspended in foreign words and when the trigger consonant belongs to a contrastively stressed word.
moved frequently around Hungary describes her own accent as 'standard Hungarian'. She is fluent in English and French. Both speakers report normal hearing.

2.2 Stimuli
The stimuli for the experiment consisted of consonant clusters combining a /k, g, s, z/ C₁ and a /t, d, s, z/ or liquid /l/ or /ɾ/ C₂. Stimuli containing a sonorant consonant were included to create baseline conditions for the comparison of the relative effects of fortis vs. lenis C₂ on the properties of a preceding obstruent. C₁ consonants were preceded by a long vowel or short vowel + glide sequence (phonetic diphthong) from the set /eː, aː, uː, oj/, or one of the following short vowels: /i, ɔ, ø/. For reasons of space we will only consider clusters starting with /k, g/ here. The behaviour of clusters starting with a fricative is documented in Jansen & Toft (2002) and Jansen (submitted).

The clusters were located at subject noun + verb boundaries in carrier sentences. Subject + noun boundaries were chosen over other possible word boundary environments on grounds of the available carriers for C₁, which had to be similar in overall phonological make-up whilst exhibiting a robust contrast between /k, g/ (and therefore had to be unsuffixed). It was impossible to construct all carrier sentences according to the neutral word order for the propositions they expressed. This raised the possibility that the subjects would assign different prosodic structures to different stimulus sentences. However, all responses were pronounced with a F₀ peak on the subject noun carrying C₁, whilst the verb acting as the C₂ carrier never received any pitch prominence. Two sample stimuli appear in (4).

(4) a. A vak darabolta a húst
   /ɔ vak dɔrɔbolto ɔ huːst/  
The blind man minced the meat

b. A rák zabálta a kis halacskát
   /ɔ rak zɔbaːltɔ a kis halaʃkat/  
The crab wolfed down the little fish

2.3 Procedure
The stimuli were presented to the subjects in a quasi-randomised order to avoid consecutive stimuli with identical consonant clusters. Each subject read the list of stimuli three times and was asked to read a stimulus again if she produced a mistake or hesitation that was clearly audible to the experimenter. In total, 2 (C₁) * 5 (C₂) * 6 (stimuli) * 3 (repetitions) * 2 (speakers) = 360 utterances with a plosive C₁ were recorded.

Recordings were made onto minidisk in a sound-proofed room using a Brüel and Kjær condenser microphone (Type 4165) and measuring amplifier (Type 2609), and digitised at 22.5 kHz. Segmentation and acoustic measurements were carried out using PRAAT version 4.0, as, for example, in (5). 36 utterances had to be discarded because they contained small speech errors, (hesitation) pauses
between C₁ and C₂, or because the target cluster could not be internally segmented (plosive + plosive clusters with unreleased C₁). Note that our aim is to investigate the phonetic properties of Hungarian RVA, not the contexts in which it occurs. As most descriptions of the process assert that it is blocked by a physical pause this meant that it was important to exclude tokens with a pause intervening between C₁ and C₂: a failure to do so would have introduced a potential bias towards incomplete neutralisation in our corpus.

In addition, all 29 responses to stimuli that contained the C₁ carrier word jog ‘law, right’ were excluded from the analysis below because the mean duration of its vowel was felt to be exceptionally low. Tokens of this word were segmented such that nearly all of the F₂ fall from the palatal approximant into the mid back vowel was included with the latter, but nevertheless the mean duration of its vowel across C₂ environments was 75 ms, which is more than 2 standard deviations below the overall mean for the remaining lexically short vowels (cf. 8 below). This left 295 utterances for further analysis.

(5) Sample broad brand spectrogram of a /kd/ cluster. Speaker: K9 (female)

![Sample broad brand spectrogram](image)

2.4 Segmentation and measurements

Segment boundaries and voicing intervals were determined by visual inspection of waveforms and broadband spectrograms. Voicing intervals were determined on the basis of periodicity in the waveform and the presence of a voice bar in the spectrogram. The closure and release phases of plosives were labelled separately (cf. 5). In the (few) instances in which the release phase of a plosive C₁ was visually completely obscured by the onset of a following fricative C₂, all of the aperiodic noise signal was assigned to the fricative, even if a release was (faintly) audible in it. The most important segmental boundaries were defined as follows:

- V₁ - plosive C₁: rapid decrease of higher frequency energy in the spectrum
- Plosive C₁/C₂ closure phase - plosive C₁/C₂ release phase: onset of release burst (defined as initial transient + following friction noise)
- Plosive C₁/C₂ release phase - C₂/V₂: end of release burst

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- Onset and offset of C₂ fricative: onset and offset of aperiodic noise that could not be assigned to the release burst of a preceding stop

The following measurements were made on the basis of the hand-segmented speech samples: V₁ duration, C₁ closure duration, C₁ release duration and C₂ duration (closure and release separately for /t, d/); duration of voiced intervals during C₁ and C₂.⁴ Obstruent duration, obstruent voicing duration and preceding vowel duration are all uncontroversial phonetic correlates of the tense-lax contrast in postvocalic contexts, although they are not always used to the same extent in different languages (see Keating 1984; Kingston & Diehl 1994 for overviews and references).

3. Results
3.1 Phonetic features of C₂ (the triggers)
Hungarian /t, d, s, z/ behave as might be expected on the basis of the phonetic literature on the realisation of tense-lax contrasts: the lax obstruents /t, d/ contrast with their tense counterparts in terms of voicing/VOT, and (closure and release) duration. The set of C₂ obstruents thus exhibits the same inverse behaviour of segmental duration and voicing duration that was found for C₁ obstruents in the baseline context (see below). In (6), C₂ voicing is expressed as closure voicing to facilitate comparison of fricatives (for which VOT is rarely used as a descriptive measure) and plosives.

(6) Duration and voicing of /t, d, s, z/. Left: closure voicing (ms); bottom: closure duration and (for plosives only) release duration (ms)

![Diagram showing voice and closure duration for /t, d, s, z/]

However, since it is a very common measure of plosive voicing we also calculated the VOTs for /t/ (23 ms, standard deviation = 7 ms) and /d/ (-51 ms, standard deviation = 11 ms).⁵ These values put Hungarian firmly in the class of

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⁴ In addition, we measured F₁ at 10 ms intervals between 50 and 10 ms before C₁ onset and between 10 and 50 ms after C₂ (release) offset. For reasons of space we cannot comment on the behaviour of this parameter here, but note that it does not affect our overall conclusions.

⁵ The VOT of /d/ may seem somewhat small in the light of the values reported elsewhere for lenis stops of the prevocalized type (e.g. Lisker & Abramson 1964; Keating 1984) but note that these
languages that realise the contrast between tense and lax plosives as voiceless unaspirated vs. prevoiced (cf. Lisker & Abramson 1964; Keating 1984), and this is consistent with the literature on Hungarian.

T-tests confirm that all observed differences are highly significant: plosive C₂ closure duration, \( t(115) = 5.81, p < .001 \); plosive C₂ release duration, \( t(115) = 7.81, p < .001 \); plosive C₂ VOT, \( t(115) = 43.45, p < .001 \); fricative C₂ duration, \( t(114) = 14.71, p < .001 \); fricative C₂ voicing, \( t(114) = -17.94, p < .001 \).

### 3.2 Duration and voicing of C₁ (the targets)

The table in (7) below provides the overall duration and the duration of the voiced intervals for the closure and release phases of /k, g/ across C₂ contexts. The patterning of C₁ phonetic voicing shows unmistakable signs of regressive voicing assimilation to both tense and lax obstruents, and there is evidence that C₁ release duration is subject to assimilation too, albeit to a lesser extent. However, it is hard to interpret the behaviour of C₁ closure duration in assimilatory terms, and there is some indication that both this parameter and C₁ (release) voicing maintain the underlying distinction between /k/ and /g/ when followed by a lax obstruent.

Consider first the phonetic contrast between the tense and lax velar stop in the baseline pre-liquid context. Here, all of the parameters represented in (7) contribute to the phonetic expression of the lexical opposition between /k/ and /g/ in the expected fashion: the closure and release of /k/ are considerably longer than those of /g/, whilst its voiced intervals are shorter (the difference in overall voicing is 28 ms). T-tests confirm that the differences between the means for /k/L/ and /g/L/ are statistically significant: C₁ closure duration, \( t(60) = 11.16, p < .001 \); C₁ release duration, \( t(60) = 4.62, p < .001 \); C₁ closure voicing, \( t(60) = -4.83, p < .001 \); C₁ release voicing, \( t(60) = -8.16, p < .001 \); C₁ overall voicing, \( t(60) = -11.52, p < .001 \).

Of these parameters, those related to C₁ voicing show the clearest sign of assimilation to a following obstruent. Thus, before the lax obstruents /d, z/ the voicing of /k/ increases vis-à-vis its voicing in the baseline context, and there is a decrease in the voicing of /g/ compared with the relevant baseline values. As far as obstruent clusters are concerned, there appears to be little trace of the underlying distinction between /k/ and /g/: differences within the minimal pairs /kt/ - /gt/, /kd/-/gd/, /ks/-/gs/ are all equal to or smaller than 4 ms, whilst /g/ has 6 ms more closure voicing than /k/ when /z/ follows. Before a tense C₂ differences in C₁ release voicing are also virtually neutralised, but when a lax obstruent follows /k/ has 8 ms less voicing than /g/. Added to the differences in voicing during the closure stage this yields differences in overall voicing between the tense and lax velar stop of 10 ms before /d/, and 14 ms when the lax fricative /z/ follows. This suggests that whilst Hungarian word final stops are subject to RVA, this process is not completely neutralising across C₂ environments.

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values often concern postpausal or utterance initial plosives. On aerodynamic grounds the presence of a preceding obstruent is likely to have had some negative influence on the amount of voicing of /d, z/, whilst the relatively short mean closure duration of /d/ naturally places an upper bound on its mean VOT.
A series of ANOVAs was carried out on the C₁ voicing data to gauge to what extent these impressionistic observations are supported by statistical tests. First, a three-way ANOVA for C₁ laryngeal specification (k/ vs. /g/) * C₂ laryngeal specification (t, s/ vs. /d, z/) * C₂ manner (t, d/ vs. /d, z/) was performed on the C₁ closure voicing data (pre-liquid baseline environments excluded). This ANOVA reveals a highly significant effect of C₂ laryngeal specification, F(1,225) = 69.16, p < .001, but only a weakly significant effect of C₁ laryngeal specification, F(1,225) = 5.74, p < .02, which implies that regressive assimilation is near-neutralising with regard to this parameter (there were no other significant effects).

(7) Duration and voicing of C₁ (all measures in ms; standard deviations in brackets)

<table>
<thead>
<tr>
<th>C₁C₂</th>
<th>C₁ closure duration (ms)</th>
<th>C₁ release duration (ms)</th>
<th>C₁ closure voicing (ms)</th>
<th>C₁ release voicing (ms)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>/kt/</td>
<td>57 (13)</td>
<td>31 (10)</td>
<td>28 (7)</td>
<td>0 (2)</td>
<td>31</td>
</tr>
<tr>
<td>/kd/</td>
<td>57 (19)</td>
<td>28 (8)</td>
<td>40 (11)</td>
<td>17 (11)</td>
<td>31</td>
</tr>
<tr>
<td>/ks/</td>
<td>56 (10)</td>
<td>16 (7)</td>
<td>27 (7)</td>
<td>0 (0)</td>
<td>30</td>
</tr>
<tr>
<td>/kz/</td>
<td>59 (20)</td>
<td>22 (14)</td>
<td>37 (11)</td>
<td>14 (15)</td>
<td>29</td>
</tr>
<tr>
<td>/kl/</td>
<td>75 (12)</td>
<td>31 (11)</td>
<td>29 (9)</td>
<td>2 (3)</td>
<td>32</td>
</tr>
<tr>
<td>/gt/</td>
<td>52 (12)</td>
<td>32 (10)</td>
<td>29 (11)</td>
<td>1 (5)</td>
<td>30</td>
</tr>
<tr>
<td>/gd/</td>
<td>43 (11)</td>
<td>24 (8)</td>
<td>43 (11)</td>
<td>25 (8)</td>
<td>25</td>
</tr>
<tr>
<td>/gs/</td>
<td>50 (11)</td>
<td>14 (10)</td>
<td>31 (14)</td>
<td>0 (0)</td>
<td>28</td>
</tr>
<tr>
<td>/gz/</td>
<td>44 (10)</td>
<td>23 (12)</td>
<td>43 (10)</td>
<td>22 (13)</td>
<td>29</td>
</tr>
<tr>
<td>/gl/</td>
<td>42 (11)</td>
<td>19 (10)</td>
<td>41 (12)</td>
<td>17 (10)</td>
<td>30</td>
</tr>
</tbody>
</table>

However, three-way ANOVAs for C₁ laryngeal specification * C₂ laryngeal specification * C₂ manner on the C₁ release voicing and C₁ overall voicing data (baseline environment excluded) show stronger effects of C₁ laryngeal specification which indicate that the underlying distinction between /k/ and /g/ is retained before lax obstruents even if RVA does apply. Thus, the ANOVA on the C₁ release voicing data shows significant main effects of C₁ laryngeal specification, F(1,225) = 11.89, p < .005, C2 laryngeal specification, F(1,225) = 284.63, p < .001, and an interaction of C₁ laryngeal specification * C₂ laryngeal specification, F(1,225) = 10.04, p < .005. Unsurprisingly, the ANOVA on the C₁ overall voicing data shows the same set of significant effects: C₁ laryngeal specification, F(1,225) = 16.10, p <.001; C₂ laryngeal specification, F(1,225) = 289.63, p < .001; C₁ laryngeal specification * C₂ laryngeal specification, F(1,225) = 6.38, p <.015.

As before, the effects of C₂ laryngeal specification indicate that the voicing of Hungarian word-final stops is subject to assimilation to a following obstruent, but the highly significant effects of C₁ laryngeal specification indicate that assimilation does not erase all the distinctions between underlying /k/ and /g/. The latter conclusion must be qualified somewhat in light of the significant interactions of the two main factors, which are most likely due to the fact that
there are no differences in $C_1$ release and overall voicing between underlyingly
tense and lax velar stops before /t, s/ whilst there are differences when a lax
obstruent follows. These interactions support the idea that Hungarian RVA is non-
neutralising in a subset of environments (i.e. before lax obstruents only). Finally,
the absence of any effect related to $C_2$ manner of articulation indicates that
Hungarian RVA is symmetric with respect to the plosive-fricative distinction:
both classes of obstruent appear to trigger assimilation in equal measure.\(^6\)

Now if regressive assimilation affects $C_1$ (release and closure) duration as well
as $C_1$ voicing, this would result in a decrease of the duration of /k/ before /d, z/
vis-à-vis the baseline environment, and an increase in the duration of /g/ before
the tense obstruents /t, s/. As can be gleaned from (7), this expectation is only
borne out by the $C_1$ closure duration data. First, the closure stage of /k/ is
considerably shortened before both lax and tense obstruents relative to the 75 ms
observed in the pre-liquid context, and second, the [±-tense] value of an obstruent
seems to have little impact on the closure duration of a preceding /k/. Only the
behaviour of /g/, which exhibits lengthening before /t, s/ is suggestive of
regressive assimilation. Another partial parallel between $C_1$ closure duration and
$C_1$ (overall) voicing is that the underlying distinction between /k/ and /g/ is better
preserved before /d, z/ where there is a 14-15 ms contrast, than before /t, s/, where
the difference in closure duration is 4-5 ms. Nevertheless the behaviour of $C_1$
closure duration fails to match that of $C_1$ (closure) voicing, which shows tense-
symmetric assimilation to a following obstruent. This indicates that these two
acoustic parameters reflect distinct (phonological and/or articulatory) control
mechanisms.

Next, the first generalisation to emerge from (7) concerning the behaviour of
$C_1$ release duration is that the release of /k/ and /g/ is relatively short before
fricatives. As hinted in section 2 above, this is likely to be a labelling artefact
caused by the overlap of release and friction noise in the acoustic signal, and it
therefore seems safer to exclude cases involving a fricative $C_2$ from further
analysis. This leaves the obstruent sequences ending in a /d/ or /t/. The data for
these clusters seem to show a (small) effect of regressive assimilation: on average
the release of /k, g/ is 8 shorter before /d/ than before /t/.

A three-way ANOVA for $C_1$ laryngeal specification * $C_2$ laryngeal
specification * $C_2$ manner on the $C_1$ closure duration data (baseline context
excluded) confirms the impression that this parameter behaves differently from
the $C_1$ voicing measures: it reveals a highly significant main effect of $C_1$
laryngeal specification, $F(1,225) = 31.79$, $p < .001$ as well as an interaction
between $C_1$ laryngeal specification and $C_2$ laryngeal specification, $F(1,225) =$
6.84, $p < .001$, but no other significant effects. The main effect of $C_1$ laryngeal
specification indicates that $C_1$ closure duration maintains the distinction between
/k/ and /g/, whilst the absence of a main effect of $C_2$ laryngeal specification
supports the observation that, unlike $C_1$ voicing, this phonetic feature is not
subject to RVA. Finally, the interaction between $C_1$ laryngeal specification and
$C_2$ laryngeal specification is likely to be due to the fact that the difference

\(^6\) Using (closure and release) voicing ratio (voicing duration divided by overall duration) instead
of absolute voicing duration as an index of voicing assimilation leads to very similar conclusions.
between /k/ and /g/ is larger before tense obstruents than before lax obstruents, and this, therefore, confirms the impression that incomplete neutralisation of the contrast between these two plosives is again restricted to one particular class of C₂ obstruents.

By contrast, a two-way ANOVA for C₁ laryngeal specification * C₂ laryngeal specification on the C₁ release duration data (only cases with a C₂ plosive included) yields a highly significant main effect of C₂ laryngeal specification, F(1,113) = 11.87, p < .001 but no other effects, indicating that this variable is subject to neutralising regressive voicing assimilation.

3.3 V₁ duration
The table in (8) presents mean values for V₁ duration by C₁ + C₂ context and separately for lexically long (/eː; aː; uː, əj/) and short (/i, ə, o/) vowels. Although long and short vowels were balanced across C₁ and C₂ contexts in the stimulus set, the fact that a number of responses had to be discarded resulted in some slight imbalances in the corpus. For example, there were more tokens of C₁ = /g/ + C₂ = /L/ preceded by a short vowel (12) than tokens of C₁ = /k/ + C₂ = /L/ (14). Since this might distort the value for V₁ duration in the second context to an artificially low value, they are presented separately here.

The behaviour of V₁ duration is different from the phonetic features discussed above in that at least in the corpus under consideration here, and with respect to plosive C₁ consonants, it is the only correlate of [tense] that assimilates in neutralising fashion across C₂ contexts.⁷

(8) V₁ duration (ms) for lexically short and long vowels/diphthongs (standard deviations in brackets)

<table>
<thead>
<tr>
<th>C₁C₂</th>
<th>V₁ duration (ms)</th>
<th>Short vowels</th>
<th>N</th>
<th>Long vowels</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>/kt/</td>
<td>101 (14)</td>
<td>14</td>
<td>17</td>
<td>128 (20)</td>
<td>17</td>
</tr>
<tr>
<td>/kd/</td>
<td>115 (11)</td>
<td>16</td>
<td>15</td>
<td>138 (27)</td>
<td>15</td>
</tr>
<tr>
<td>/ks/</td>
<td>106 (14)</td>
<td>13</td>
<td>17</td>
<td>135 (22)</td>
<td>17</td>
</tr>
<tr>
<td>/kz/</td>
<td>109 (12)</td>
<td>12</td>
<td>17</td>
<td>134 (35)</td>
<td>17</td>
</tr>
<tr>
<td>/kL/</td>
<td>98 (13)</td>
<td>14</td>
<td>18</td>
<td>125 (22)</td>
<td>18</td>
</tr>
<tr>
<td>/gt/</td>
<td>105 (20)</td>
<td>12</td>
<td>18</td>
<td>129 (21)</td>
<td>18</td>
</tr>
<tr>
<td>/gd/</td>
<td>115 (13)</td>
<td>8</td>
<td>17</td>
<td>148 (34)</td>
<td>17</td>
</tr>
<tr>
<td>/gs/</td>
<td>105 (15)</td>
<td>11</td>
<td>17</td>
<td>137 (23)</td>
<td>17</td>
</tr>
<tr>
<td>/gz/</td>
<td>114 (7)</td>
<td>11</td>
<td>17</td>
<td>148 (28)</td>
<td>17</td>
</tr>
<tr>
<td>/gL/</td>
<td>111 (8)</td>
<td>12</td>
<td>18</td>
<td>153 (33)</td>
<td>18</td>
</tr>
</tbody>
</table>

In the baseline pre-liquid environment, the speech of our two subjects conforms to the near-universal generalisation that vowels are longer before lax obstruents than before tense obstruents (Chen 1970; Kluender et al. 1988): note

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⁷ This conclusion may have to be modified once a larger set of contexts and speakers is taken into account. See Jansen & Toft 2002 and Jansen (submitted) for details.
that the difference appears to be somewhat larger for lexically long vowels (28 ms) than for short vowels (13 ms). A two-way ANOVA for $V_1$ lexical length (short vowels vs. long vowels) * $C_1$ laryngeal specification confirms that lexical distinctions in vowel length and the distinction between /k/ and /g/ both affect the phonetic duration of $V_1$. There are highly significant main effects of $V_1$ lexical length, $F(1,58) = 34.69$, $p < .001$ and $C_1$ laryngeal specification, $F(1,58) = 12.85$, $p < .005$, but there is no significant interaction, which indicates that contrary to appearances, lexically long and short vowels mark the [tense] contrast on following obstruents in essentially the same way.

However, when $C_1$ is followed by an obstruent, $V_1$ duration seems to signal [tense]-contrasts in $C_2$ rather than in $C_1$: except in /k/ + fricative sequences $V_1$ is consistently longer before a lax $C_2$ than before a tense $C_2$. It is true that, on average, lexically long vowels are somewhat longer when followed by /g/ (140 ms) than when followed by /k/ (134 ms), but a four-way ANOVA for $V_1$ lexical length * $C_1$ laryngeal specification * $C_2$ laryngeal specification * $C_2$ manner of articulation shows that this difference is not statistically significant. The only significant effects revealed by this analysis are main effects of $V_1$ lexical length, $F(1,217) = 91.05$, $p < .001$, and $C_2$ laryngeal specification, $F(1,217) = 9.67$, $p < .005$, which indicates that before obstruent clusters, phonetic vowel duration is controlled by phonological length and regressive assimilation.

This result might be interpreted as evidence for the idea that there is a unitary mechanism of regressive voicing assimilation (or more appropriately tense-assimilation) that governs the behaviour of all phonetic exponents of [tense]. Current generative analyses of regressive voicing assimilation propose that this unitary mechanism consist of the spreading or ‘agreement’ of the phonological feature that represents the contrast between tense and lax obstruents at the lexical level (e.g. autosegmental [voice]). However, such analyses predict that all the individual cues to [tense] behave in parallel, and this prediction is not supported by the current data: $C_1$ (overall) voicing assimilates across contexts, but in non-neutralising fashion before lax obstruents whereas $V_1$ duration assimilates in neutralising fashion across contexts and $C_1$ closure duration does not assimilate at all.

4. Discussion and conclusions
Hungarian RVA has typically been described as a process that neutralises underlying fortis-lenis distinctions in the obstruents it targets. The aim of the pilot experiment reported in this paper was to assess to what degree this view can be supported by quantitative acoustic data. The results of this experiment indicate that voicing and the closure duration of plosives partially preserve underlying tense-lax distinctions in assimilation, despite the presence of a clear assimilation effect on voicing and on the duration of preceding vowels. Furthermore, different cues participate in different ways in the assimilation process. These observations raise questions about the viability of models that represent RVA as a single lexical-feature-spreading operation and support the more phonetic view of the phenomenon as alluded to in our introduction. Thus, this study contributes to a growing body of instrumental research demonstrating incomplete neutralisation.

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effects of voicing assimilation rules (O. Thorsen 1966; N. Thorsen 1971; Charles-Luce 1993; Burton & Robblee 1997; Barry & Teifour 1999).

Nevertheless, we want to emphasise that the data reported above should be treated as preliminary observations that need to be supported by a larger-scale study of the phonetics of Hungarian obstruent clusters. Moreover, a number of empirical issues need to be explored before a more robust verdict can be delivered on the nature of the Hungarian regressive voicing assimilation rule. We think it is possible, for example, that this rule may be sensitive to juncture strength and operates in a neutralising fashion at relatively weak morphosyntactic or prosodic boundaries (e.g. in sandhi clusters created by the morphology). It is also important to establish whether the residual traces of underlying tense-lax distinctions in assimilation targets that we observe in the acoustic signal are perceived as cues to lexical phonological representations by listeners.

References


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