VOICING ASSIMILATION AT ACCENTUAL PHRASE BOUNDARIES IN HUNGARIAN

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ABSTRACT

According to the traditional phonological literature, regressive voicing assimilation in obstruent clusters is an obligatory categorical, completely neutralising process in Hungarian, as long as no major prosodic boundary signalised by a longer pause intervenes between the target and the trigger. In the present experiment, the effect of minor prosodic boundaries, i.e. accentual phrases (AP) on the degree of voicing assimilation was investigated. According to the analysis, assimilation is weakened in stops, but not in fricatives before AP boundaries. Assimilation is blocked for both stops and fricatives if followed by a pause. Thus, the voicing assimilation process is sensitive both to the type of obstruents involved and to the strength of minor boundary marking.

Keywords: voicing assimilation, prosodic boundaries, accentual phrases, Hungarian

1. INTRODUCTION

Part of the variation in speech is induced by the prosodic structure of the utterance, thus assimilatory processes such as voicing assimilation often covary with prosodic boundary strength [7] and pitch prominence. It has also been demonstrated that glottalisation before vowel-initial words correlates with the strength of the prosodic boundary which precedes these words [12]. The present study investigates the influence of prosodic boundary on regressive voicing assimilation (RVA) in Hungarian.

Hungarian displays RVA in adjacent obstruents but preserves voicing contrast in word- and utterance-final position. According to the traditional phonological literature [13] RVA in Hungarian is an obligatory categorical, completely neutralising process as long as no major prosodic boundary signalised by a longer pause intervenes between the target and the trigger. In recent empirical studies the picture is more fine-grained. [4] found traces of contrast preservation of Hungarian obstruents in assimilatory contexts, especially before voiced obstruents. He observed that the length of the preceding vowel might also serve as a perceptual cue which is more prominent in the case of fricatives than for stops. [2] had similar results: they found that /s/ and /z/ significantly differ both in voicing and devoicing context due to the length of the preceding vowel. Nevertheless, the authors claim that RVA in Hungarian is almost fully neutralising. [10] analysing spontaneous speech argue that Hungarian RVA is a gradient and sometimes only partly regressive process. None of these studies investigated the role that different prosodic boundaries might play in RVA, and our study aims to fill this gap.

Note that our goal is not to decide whether RVA in Hungarian is fully or incompletely neutralising. Our test design does not permit for such an analysis as we chose minimal pairs which only contrast in the voice specification of the final obstruent. [3] investigating Catalan observed that voicing alternation is more likely to be nearly neutralised - as opposed to completely neutralised - in contexts where homophony would arise and cause semantic ambiguity. [6] also argues that phonological alternations are sensitive to how much homophony they create among distinct lexical items, and that neutralising rules create fewer homophones than expected. We opted for minimal pairs in our experimental design in order to control for as many phonetic parameters as possible and thus focus on the role of prosodic structure.

The question to what extent voicing assimilation is realised at prosodic boundaries is also important for the investigation of prosodic structure. Recent studies claimed that prosodic phrasing is sensitive to the presence of pitch accents in Hungarian [9, 8]. This means that a pitch accent automatically starts a new prosodic phrase, i.e. an accentual phrase (AP). According to [5], boundary markers between accentual phrases are weak, i.e. there is minor or no phrase-final lengthening.

In the following experiment we investigated whether the degree of voicing assimilation depends on the presence of an AP boundary. The questions are as follows: (1) What effect does the presence of a prosodic boundary have on RVA in Hungarian? (2) Is the degree of assimilation influenced by the presence of boundary markers such as short pauses?

2. MATERIAL AND METHODS

Two monosyllabic minimal pairs were used in which the final obstruent was either an alveolar fricative or a stop that differed solely by their phonological voicing: *mész* /meːs/, 'whitewash' vs. *méz* /meːz/, 'honey' and *rút* /ruːt/, 'ugly.noun' vs. *rúd* /ruːd/, 'bar'. The target consonants, i.e. C1 /s, z, t, d/ were followed by a voiced or voiceless obstruent that triggers voicing assimilation (C2) or by a vowel that does not (V).

Target consonants appeared in three different morphosyntactic environments: they were followed by (i) a suffix, (ii) a deaccented word or (iii) an accented word. Thus, the boundary between C1 and C2/V was either a morphological (*morph*), a word-level (*word*) or an accentual phrase (*AP*) boundary. All sequences were embedded in meaningful target sentences whose structure was identical within a given condition (e.g. target fricative followed by an AP boundary), but it varied across conditions.

In Hungarian, focus is marked syntactically, i.e. the focussed element is placed immediately before the finite verb. In such a structure the focus has a pitch accent, whereas the following verb is deaccented. In the word boundary condition, the target word was in focus position, and it was followed by a verb. In the AP boundary condition, the target word ending with C1 was in the topic part of the sentence followed by the accented focus. In order to enhance the narrow focus interpretation, AP-boundary sentences were preceded by a question. This sentence pattern guaranteed that C1 and C2/V belonged to the same accentual phrase in the word boundary condition, whereas they belonged to two subsequent APs in the AP boundary condition.

12 female speakers (20–22 years, without speech or hearing impairment) read the target sentences from a screen five times in randomised order, together with distractor sentences. Speakers received credit points for their participation. Recordings were made in a sound-proof room via a head-mounted cardioid microphone. 2160 sentences were recorded and analysed in total.

C1-C2/V sequences were segmented manually in Praat, and voicing was marked on a separate tier relying on the visual presence of a voice bar on the spectrogram. Potential pauses after C1 due to the prosodic boundary and laryngalisation (glottal stops or creaky voice) of the following segment were also labelled.

Analysis was based on the following measurements: (a) duration of C1, (b) absolute voicing duration in C1, and (c) relative voicing duration in C1 (voicing duration/C1 duration). Due to a high number of missing releases in stops, the closure and the release phase in stops were not analysed separately. Vowel durations before C1 were also analysed but will not be reported here due to space limitations.

Differences were tested by 2 × 3 repeated-measures MANOVAs with speaker as *within-subject* factor and voicing of C1 and boundary as independent variables. Due to diverging sample sizes, the influence of the presence of boundary markers on voicing was analysed by Welch- tests, in which the homogeneity of variances is not assumed. Significance level was defined as $\alpha = 0.05$.

3. RESULTS

3.1. Boundary and voicing assimilation

A durational effect of voicing on the obstruent itself and the preceding vowel has been observed across many languages. The aerodynamic law described by [11] is manifested in a shorter duration of voiced obstruents. In order to initiate or maintain voicing, the vocal folds must be in the right position (slightly adducted), and there must be sufficient air flowing through the glottis. When producing stops, a complete closure is made in the oral cavity, which means that the air flowing through the glottis accumulates in the oral cavity, thus oral pressure will approach and exceed subglottal pressure, and thus voicing is extinguished. In the case of fricatives an aperiodic turbulent noise is required, which needs a large volume velocity as well as a narrow constriction in the supraglottal vocal tract. As a result, the vocal folds are to be widely abducted, and supraglottal air pressure must exceed subglottal pressure. Voicing, on the other hand, requires the folds to be closely adducted, subglottal air pressure to be greater than supraglottal pressure, and the supraglottal vocal tract to be relatively open.

This durational effect was also observed in our data: phonemically voiced C1 segments were always shorter than voiceless ones in the same condition. All differences reached significance. Lengthening of C1 before the AP boundary was only present in two cases: for stops before voiced C2 (main effect of boundary: $p = 0.026$) and for phonemically voiceless fricatives when before voiced C2 (interaction: $p = 0.006$). At the same time, fricatives in the C1 position were *shorter* before AP boundaries if they were followed by a vowel or an unvoiced C2 (both voicing and its interaction with boundary were significant). Thus, C1 durations were sensitive to the boundary following them.

Figure 1: Absolute duration of voicing in fricatives in seconds followed by a voiceless C2 (top) and a voiced C2 (bottom).

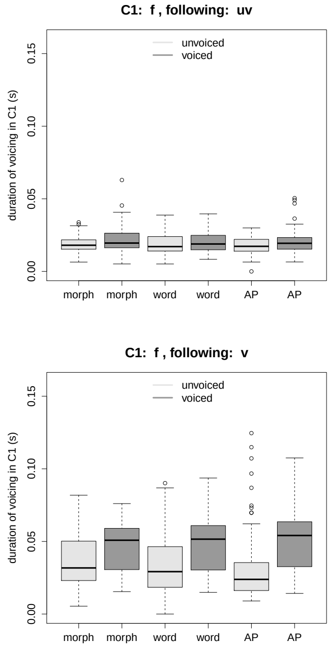
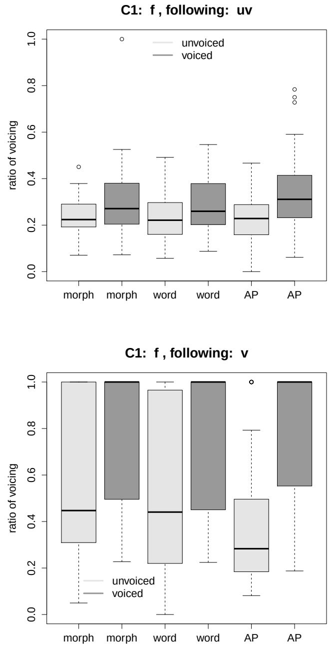
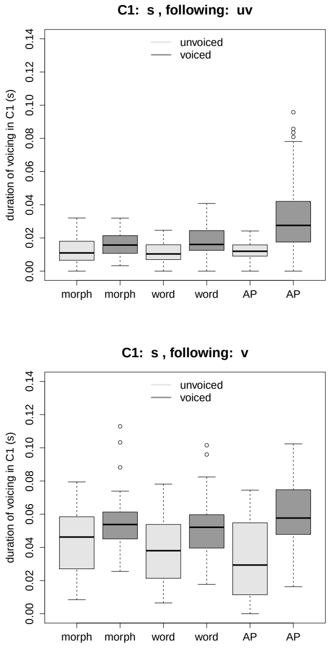


Figure 2: Relative duration of voicing in fricatives followed by a voiceless C2 (top) and a voiced C2 (bottom).



However, voicing turned out to have a different degree of sensitivity in fricatives and stops. Boundary type did not have a main effect either on the absolute or on the relative voicing in fricatives in any of the conditions, and the interaction of voicing and boundary did not reach significance level in any of the samples (Figs. 1 and 2). At the same time, the voicing contrast in stops decreased from the weakest, i.e. morpheme, to the strongest, i.e. AP boundary in terms of absolute and/or relative voicing: both the effect of boundary and its interaction with voicing were significant for relative voicing. The interaction was also significant for absolute voicing, and boundary had a main effect on C1 voicing before unvoiced obstruents (Figs. 3 and 4).

Figure 3: Absolute duration of voicing in stops in seconds followed by a voiceless C2 (top) and a voiced C2 (bottom).

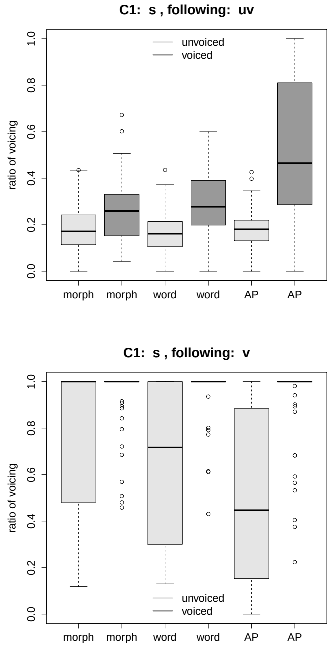


3.2. Assimilation at boundaries with a pause

150 pauses were found at AP boundaries out of 720 repetitions. The first syllable of the second word was glottalised in 133 cases. The cases in which the AP boundary was followed by a vowel (control condition) were omitted, thus, the following analysis is based on 47 occurrences of pauses and/or glottalisation.

No pauses or glottalisation were observed between voiced fricatives and voiceless C2. Unvoiced fricatives and a following voiced C2 were accompanied by a boundary marker in 13 cases, and the absolute voicing duration in C1 was significantly shorter

Figure 4: Relative duration of voicing in stops followed by a voiceless C2 (top) and a voiced C2 (bottom).



than in equivalent cases without a boundary marker (19 compared to 38 ms, $t(59) = -3.84, p = 0.0003$). The same tendency was found for unvoiced stops before voiced C2: mean absolute voicing duration was 8 ms (9 occurrences) compared to cases without boundary marking with a mean of 38 ms. The difference was highly significant ($t(59) = -9.12, p < 0.0001$). Pauses between voiced stops and voiceless C2 occurred in 5 cases, where absolute voicing duration was twice as long as in cases without boundary marking (66 ms vs. 30 ms, $t(59) = 2.89, p = 0.040$). Comparable results were found for the relative voicing ratio in C1.

Pearson's r was computed to test the correlation between the amount of voicing and pause duration in cases where a pause was present. The correlation was slightly negative for voiceless fricatives before voiced C2 ($r = -0.18$), while pause duration and voicing were not correlated for voiceless stops followed by a voiced C2 ($r = -0.06$). The amount of voicing in voiced stops before voiceless C2 substantially decreased with longer pause durations ($r = -0.58$). This shows that longer pauses at AP boundaries trigger the weakening of the assimilation, but only if C1 is voiced, whereas pause duration has no effect on voicing if the assimilated C1 is voiceless. In other words, voicing does not become stronger at AP boundaries. This is in line with previous findings on the general devoicing tendency in sentence-final obstruents (especially fricatives) where it is the duration of the previous vowel that maintains the voicing contrast [1].

4. DISCUSSION

In phonological models, the rule of voicing assimilation applies to fricatives, stops and affricates in Hungarian. While the assimilation process is supposed to be categorical, our data reveal a tendency for phonemically voiced C1 to be more voiced before voiceless C2 than for phonemically voiceless ones. This can possibly be explained by the fact that the study was based on minimal pairs in read sentences, and that the maintenance of phonemic contrast was task-related. Since perceptual cut-off values have not been specified for Hungarian obstruents so far, we cannot say without further investigation whether voicing due to assimilation can be distinguished from phonemic voicing in Hungarian.

The interaction between voicing and prosodic boundaries is manifested in rather different ways in fricatives as compared to stops. The degree of voicing in fricatives does not seem to be sensitive to the presence of an AP boundary apart from cases when a pause is inserted between the two consonants. On the contrary, stops show a strong boundary effect: voiced stops are more voiced and voiceless stops are less voiced when followed by an AP boundary and a C2 with opposite voicing that could trigger their assimilation. In other words, assimilation is partially blocked by the AP boundary. A possible explanation is that it is more difficult to produce voicing in fricatives [11] because the air flow through the constriction has to be guaranteed throughout the segment, while the supraglottal pressure increases gradually during the closure phase of stops. This difference could account for the relative stability of fricative voicing at AP boundaries. Note that voicing in fricatives on average never reaches 50%. However, this does not explain why phonemically voiced fricatives do not become less voiced at AP boundaries before voiced C2. Future investigations of Hungarian RVA will include tests on the perceptual relevance of voicing and a production test with more natural material.

5. ACKNOWLEDGEMENTS

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