

The perception of voicing in fricatives

Zsuzsanna Bárkányi
Hungarian Academy of Sciences, Research Institute for Linguistics
bzsuzs at nytuud dot hu

Katalin Mády
Hungarian Academy of Sciences, Research Institute for Linguistics
mady at nytuud dot hu

This study aims to explore how much voicing is needed for an utterance-final alveolar fricative in Hungarian to be perceived as voiced and what other phonetic details cue fricative voicing in this context. Hungarian is not a final-devoicing language, i.e. there are minimal pairs which differ in the voicing quality of the word-final obstruent: *mé[z]* 'honey' - *mé[s]* 'lime'. Recent studies show that although there is contrast preservation, utterance-final voiced fricatives are realized with little phonation. In an earlier study (Bárkányi—Kiss—Mády 2009) it has been found that on average 76% of the fricative interval is devoiced in the case of utterance-final /z/, while utterance-final /s/ is unvoiced in 87%. This suggests that in contrast preservation other (secondary) cues such as fricative length, vowel length, etc. play an important role — in accordance with earlier observations in other languages (e.g. Jones 1957; Chomsky & Halle 1968; Wells 1982). In this study we are going to test the role of fricative length and vowel length, more precisely the importance of their ratio in the perception of utterance-final fricative voicing. Since speakers typically talk at different rates, the absolute durations of the segments are highly variable. It has been found, however, for English and German for instance (Port & Dalby 1982, Port & Leary 2005) that the ratio of vowel duration to stop closure or fricative constriction remains rather constant in words with the same voicing feature.

In Experiment 1 we aimed to find out how much voicing is really needed for a fricative in order to be perceived as voiced. Synthesized (HLSyn) *mé*+fricative words were used in which the duration of the segments was identical to the mean duration of the segments in the previous acoustic study. The initial voiced proportion of the final fricative ranged from 0 to 100%, voicing increased in 10% steps. 20 native speakers of Hungarian were presented with a forced choice test (they had to decide whether they heard *mé[z]* 'honey' or *mé[s]* 'lime') in Praat ExperimentMFC. The inflection point turned out to be at 30% voicing, i.e. if less than 70% of the fricative interval is devoiced the segment is more likely to be perceived as voiced. (Note that in the acoustic study final /z/ was realized unvoiced in 76% of the fricative interval, vs. 87% in /s/. The question arises whether speakers are sensitive to small amount of voicing (appr. 10%) in this region or it is a mere chance that the inflection point and the results of the acoustic experiment are so close. In order to clarify this point we carried out a second experiment.

In Experiment 2, we tested whether the ratio of the vowel duration and the fricative duration acts as a cue additionally to the amount of voicing in the fricative. In this experiment, both the overall duration of the vowel and the fricative plus the voicing amount were kept constant. Based on the median V + C ratio in the production experiment, the duration of V + C was set at 360 ms. The median V/C duration ratio for unvoiced segments was 0.82 and 1.66 for voiced ones. In this experiment, V/C ratio ranged from 0.57 to 1.77. The minimal segment duration for both vowels and consonants was 130 ms, the maximum 230 ms. The amount of voicing in the fricative was again constant and set to 30% (at this amount of voicing there is exactly 50% chance that a speaker perceives /z/ or /s/).

Target words were again *méz* 'honey' and *mész* 'lime', and stimuli were again synthesised in HLSyn. The perception experiment was run in Praat's ExperimentMFC modul. Our preliminary results show that a voicing amount of 30% in the fricative is not sufficient to enhance the perception of voicing *by itself*. If the V/C ratio was lower than 0.7, participants identified the target fricative as unvoiced, even though it contained 30% voicing. Ratios between 0.7 and 1.0 led to controversial results, ratios higher than 1.0 resulted in the perception of a voiced fricative.

These results show that the V/C ratio that was found to be the primary cue for voicing perception in previous experiments does play a role in categorisation, at least if the amount of voicing is set to a borderline value. It is yet to be tested how the V/C ratio changes if the amount of voicing is set to a lower value that typically enhances the perception of an unvoiced fricative or to a higher value that is perceptually connected to voiced segments

References

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