Acoustic correlates of the nasal vs. plosive quantity contrast in Hungarian

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Abstract: This study investigates the phonetic realization of consonant length in Hungarian. It is hypothesized that spectral structure differences between obstruents and sonorants may lead to distinct strategies in expressing quantity contrast. To test this hypothesis, intervocalic nasals (/n ɲ/) and plosives (/t k/) were analyzed in spontaneous speech from 20 monolingual Hungarian-speaking adults. Linear mixed-effects models and decision trees were applied to explore the effect of quantity, consonant type, and their interaction on various acoustic parameters, such as the durations of the target consonants and neighboring vowels, relative durations, and geminate-to-singleton ratio. Our findings indicate that nasals require more robust adjustments compared to plosives in the realization of the consonant length contrast. This study contributes to the understanding of phonetic variation in Hungarian and the distribution of geminates across languages.
Keywords: speech production, consonant length, nasal, stop, Hungarian

Introduction

A range of durational and non-durational acoustic parameters play a role in contributing to the quantity contrast, although the extent of their influence varies across languages (e.g., Al-Tamimi & Khattab 2018; Amano et al. 2021; Hermes et al. 2020).

Listeners have more difficulty distinguishing the length contrast in spectrally continuous sounds, like nasals compared to plosives (Kawahara & Pangilinan 2017). Different features are expected to contribute to the expression of quantity in obstruent vs. sonorant consonants.

In Hungarian, investigations into length contrast have concentrated on plosives (e.g., Deme et al. 2018; Neuberger 2023). No study has yet undertaken a comparison across different types of consonants in this regard.

Aim

To explore the acoustic parameters contributing to the length opposition in Hungarian nasals and plosives.

Hypothesis

Speakers use the durational parameter more robustly in expressing nasal quantity contrast than plosive quantity contrast or enhance the nasal quantity contrast with additional secondary acoustic features.

Methods

Material: Intervocalic nasal /n ɲ/ and plosive /t k/ singletons and geminates (N = 427). Sequences from spontaneous speech: 2-4 syllables, exclusion of initial and final segments; only lexical and word-internal assimilated geminates, no concatenated geminates (see Ridouane 2010; Neuberger 2023). Surrounding vowels: short /ɒ ɛ o/.

Participants: 20 monolingual Hungarian-speaking adults (10 males) using the BEA database (Neuberger et al. 2014).

Measurements: Acoustic parameters (Praat: Boersma & Weenink 2020):

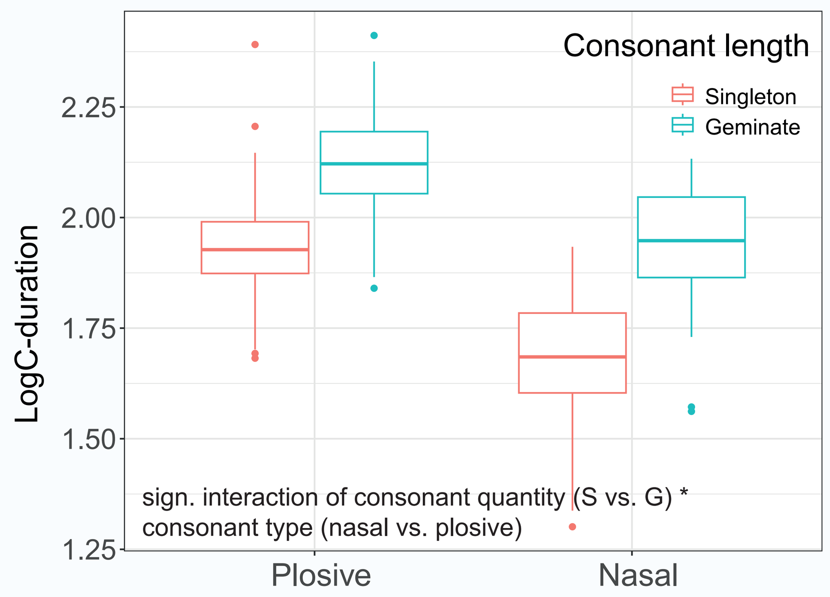
- Absolute duration of the target consonant (C): total duration of nasals and plosives (including closure duration, burst and release phase, i.e., VOT in voiceless plosives).
- Absolute duration of the preceding (V1) and the following vowel (V2): F2-based segmentation.
- Relative duration of consonants and vowels (C/V1, C/V2): duration related to preceding and following vowel duration.
- Geminate-to-singleton ratio (G/S): durational ratio calculated by each consonant and by each speaker.

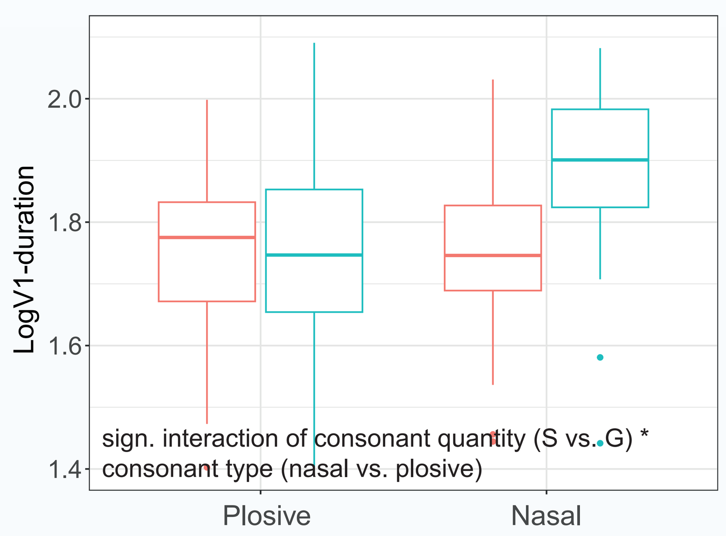
Statistical analysis: Linear mixed-effects models (lmer and lmerTest packages: Bates et al. 2014; Kuznetsova et al. 2017) in R (R Core Team 2018): for each acoustic parameter to investigate the effect of quantity (singleton vs. geminate), consonant type (nasal vs. plosive) and their interaction; speakers as random factor.

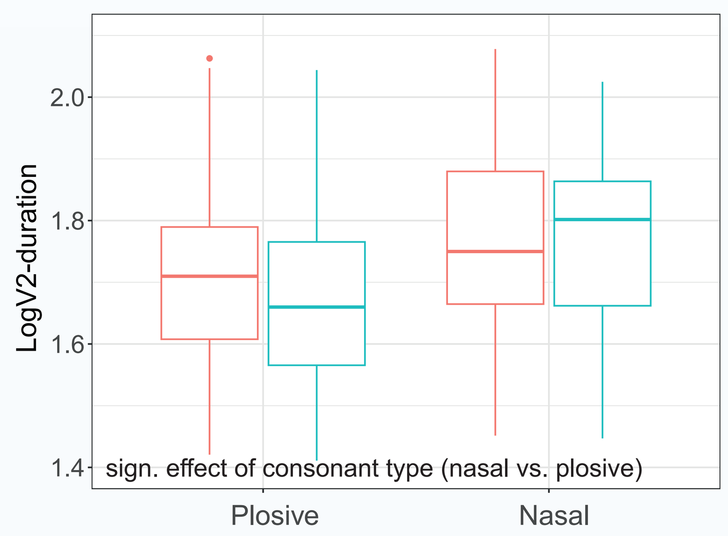
Decision trees: Scikit-learn 1.4.2 in Python (Pedregosa et al. 2011): to identify the most important features in distinguishing the two phonological length categories in nasals and plosives. Models trained on: logCdur, logV1dur, logV2dur, C/V1, C/V2.

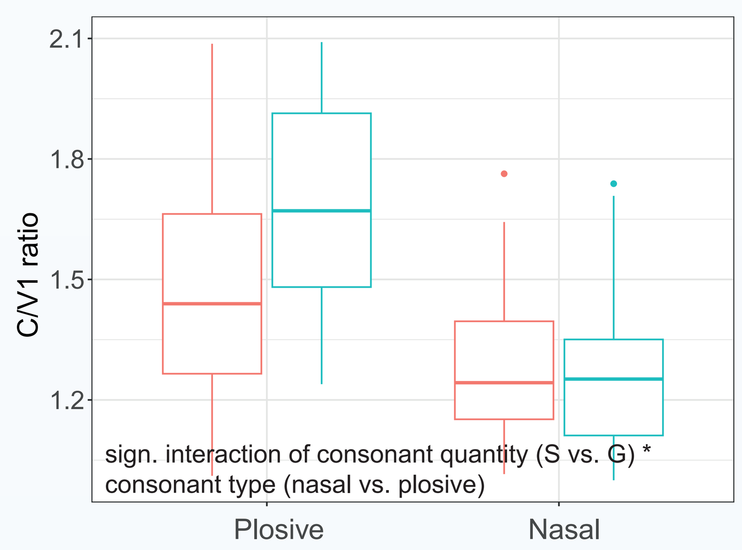
Results

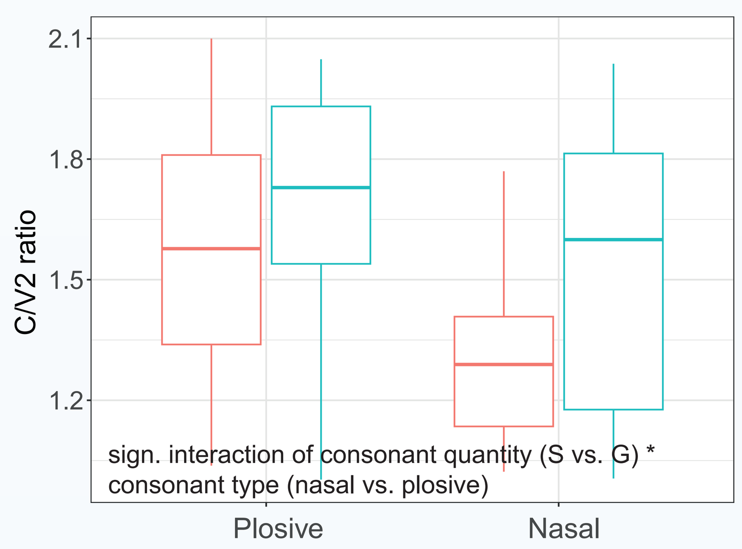
G/S ratio: significantly higher for nasals (1.89 ± 0.4) compared to plosives (1.57 ± 0.1)

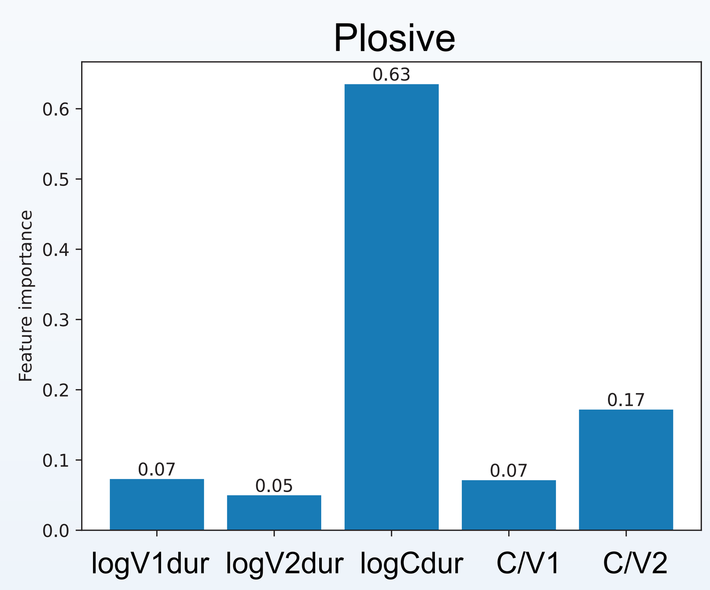


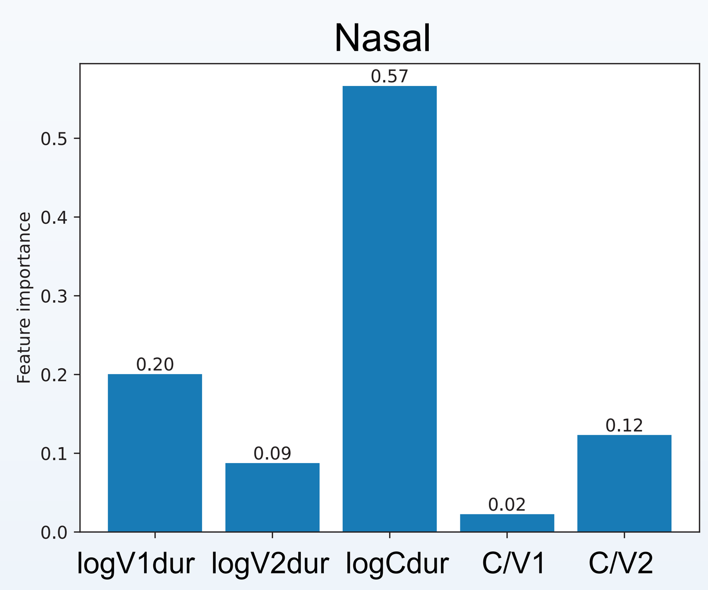












Conclusion

Speakers mark the quantity contrast producing different durational patterns depending on the consonant type: more robust time adjustments in nasals than in plosives.
Results reflect the previous perception findings (see Kawahara & Pangilinan 2017): distinguishing the length contrast in spectrally continuous sounds (like nasals) is more difficult - speakers put more effort into their production to ensure successful comprehension - higher G/S ratio in nasals and larger differences in vowel duration depending on whether the following consonant is a nasal or a plosive.
V1 is significantly longer before nasal geminates than before nasal singletons; however, it is not evident in plosives.
V2 showed an opposite trend according to consonant type: for plosives, it was shorter after geminate than after singleton, while for nasals it was longer after geminate than after singleton.
Findings may contribute to the question of the preferential hierarchy of geminate occurrences across languages, namely that obstruent geminates are more likely to occur in a language than nasal geminates.

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