The singleton-geminate contrast in Hungarian: acoustic investigation of voiceless stops
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Introduction
Many languages express semantic differences by using contrastive phonemic consonant length (Maddieson 1984). Previous research has confirmed that duration is the main acoustic cue to the distinction between singleton and geminate consonants (Ham 2001; Khattab 2007; Ridouane 2007). In Hungarian, length is a phonologically relevant feature in the consonant system; for example: ép 'healthy' : ép p 'right now'. However, phonemic length is not clearly manifested in the phonetic durations. In other words, duration of short consonants show overlaps with that of their long counterparts (e.g., Beke & Gyarmathy 2010; Siptár & Gráczi 2014). Moreover, a few studies that analyzed duration of segments with complex internal structure, such as affricates, showed that phonetic and phonological lengthening target different portions of the internal structure of these consonants (Pycha 2009, 2010).

In this study, durational differences between Hungarian single and geminate consonants are discussed. In addition, we distinguished underlying, derived true and fake geminates (see Oh & Redford 2012). We focused on the duration of the Hungarian voiceless stop consonants /p, t, k/ as well as the duration and ratio of their internal structure components. The main question is how temporal cues play a role in the distinction between singletons and various types of geminates.

Methodology
Seven adult males participated in this study (ages: 20–29 years, mean age: 24,1 years). All participants are monolingual, native speakers of standard Hungarian. The corpus consisted of spontaneous speech samples from the BEA database (Gósy 2012). The data set contained 855 manually segmented, intervocalic stop consonants (in V_V or V_#V positions). The following acoustic parameters were analyzed: total duration of consonants, closure duration, closure ratio, and voice onset time (VOT). Annotation and measurements were conducted using Praat software, statistical analysis was carried out using SPSS.

Results
Statistical results (Wilcoxon signed-rank test) showed significant differences between the total duration of singletons and geminates in the case of /p, t, k/. The ratio of durational change was 140% in bilabial, 150% in alveolar, and 149% in velar consonants. Temporal difference was proved in closure duration of all the three stops, and the closure ratio of geminates also showed significant increase (64–79% in singletons, 74–84% in geminates). VOT seemed to be invariant and therefore irrelevant parameter in the distinction of short and long consonants. The analysis of the different geminate types also revealed some differences; there was a tendency that fake geminates are realized with longer (total and closure) durations than underlying and true derived geminates (Fig. 1.).

Conclusion
In Hungarian, phonological length contrast is expressed in different durations of singleton vs. geminate stops; in general, geminates are one and a half times longer than single consonants. The most important cue in the length distinction of stops is closure duration. Acoustic correlates of fake geminates differ from underlying or true geminates to some extent. Durational correlates of the stop length distinction may play an important role in the perceptual distinction of the contrasting sounds. Results of this study may contribute to various speech applications or second language learning.
Figures

![Diagram showing durational differences among geminate types](image)

**Figure 1.** Durational differences among geminate types (normalized values of total duration)

References


