

# Stem and suffix durations in words of increasing length in children's spontaneous utterances

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## Introduction

Duration is a physical parameter of spoken language in that words exist in time. A great many studies discussed various factors that influence the duration of a word and the variability therein (e.g., Losiewicz 1995; Bell et al. 2009) including the effect of the increasing number of syllables within a word on the duration of the syllables. Individual syllables in a word become shorter as word length increases (e.g., Lehiste 1972; Bell et al. 2002; Tily et al. 2009). Age is also acknowledged to be of considerable importance when spoken words are considered. Young children were reported to show longer durations for words than groups of adults (e.g., Smith 1992) that is explained by their underdeveloped speech motor control. For words, produced in spontaneous utterances during language acquisition, the temporal interrelations of stems and suffixes might carry cue information in an agglutinating language about the children's lexical access and speech planning process of the articulation of lexemes.

In this study we seek to explore the internal temporal patterns of the words of various lengths across several ages (in terms of a cross-linguistic analysis). The core question of the study is whether there is a morphologically conditioned shortening of stems and suffixes across the increasing number of stem syllables, on the one hand, and whether this shortening phenomenon exists across various ages, on the other. Our current hypotheses are that (i) reduction of stems and suffixed words will occur as word length increases (equalization tendency), (ii) this reduction will take place after the age of 7, (iii) suffixes will not show durational changes irrespective of word length and age.

## Methodology

Thirty Hungarian-speaking children participated in the study forming three age groups (mean ages: 5, 7, and 14 years). Each group consisted of 10 speakers (with an equal number of males and females). More than 8 hours of spontaneous speech material was carefully hand-labeled using Praat (Boersma–Weenink 2014). Stems, suffixes and suffixed words were marked by one of the authors while the other author checked each word (with an agreement ratio of 98%). The word boundaries (between acoustically distinct regions in the signal) were identified in the

waveform signal and spectrogram display via continuous listening to the words.

Suffixed verbs and nouns with similar distribution (about 7,000 items) were selected according to the following criteria: (i) stems consisted of various numbers of syllables from 1 to 4, together with suffix syllables to 2 to 5, (ii) five frequent monosyllabic suffixes (*-ban/-ben* 'in', *-nak/-nek* 'for', *-val/-vel* 'with', *-tam/-tem* '1sg past', and *-nak/-nek* '3pl') were selected that indicated grammatical relationships, (iii) all suffixes were the last syllables of the words, (iv) all words occurred in the middle of phrases (in order to avoid phrase-final lengthening), (v) the suffixes occurred in similar ratios across stems and speakers. Durations of both the stems and suffixes were taken by measuring the phase between the onsets and the offsets of the stems, the suffixes and the whole words according to common acoustic-phonetic procedures. A specific script was written to obtain the values automatically. All data were normalized across speakers using the z-normalization method in order to avoid speech rate differences. To test statistical significance, linear regression analysis, repeated measures ANOVA and the Mann–Whitney test were used, as appropriate (using SPSS 19.0 version). Measured durations of stems, suffixes, and suffixed words were dependent variables while number of syllables of the stems and age were the independent factors. The confidence level was set at the conventional 95%.

## Results

As expected, the longest articulation of the suffixed words irrespective of word length were found with the five-year-olds followed by the older children while the fastest articulation was produced by the 14-year-olds. Duration of the suffixed words showed significant differences depending on both word length and age. The increasing number of syllables in the words had an effect on the duration of the syllables. Statistical analysis confirmed significant differences in the reduction of words between 14-year-olds and both groups of younger children. Five-year-olds produced words containing more than two syllables substantially longer than all the other participants. Five- and seven-year-olds articulated suffixed words with practically no reduction.

Durations of the stems also showed significant differences depending on both the number of syllables and age. As the length of stems increases the durational differences in the production of the stems

become significantly different across ages. The largest differences in the durations of both stems and suffixed words were found in those containing 5 syllables.

Suffixes had an average duration of about 380 ms across ages. Significant differences were found depending on age; however, groups of younger children showed similar values. The length of stems did not have any significant effect on suffix durations.

### Conclusions

This study revealed significant differences in the durations of stems and suffixed words depending both on word length and age. The equalization tendency of the duration of the syllables, however, was characteristic only of 14-year-olds. Immature speech motor control might explain the lack of syllable reduction of words in five- and seven-year-olds. However, speech motor control does not seem to explain the relatively stable durations of suffixes across the analyzed age groups. Slightly variable duration in suffixes may be supposed to be a consequence of the agglutinative character of Hungarian, in which coordination of stems and suffixes takes place relatively early in the process of language acquisition. Finally, we conclude that word duration is influenced by stem length, and reduction tendency in word production does not apply to all analyzed age groups.

### References

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