# Stress, tonal alignment and syllabification in Greek

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# Abstract

The present study is an experimental investigation of tonal alignment and syllabification as a function of stress production in Greek. The results of a production experiment show that the onset of the tonal rise alignment of the stressed syllable is within a 0-48 ms region. This tonal alignment is associated with the first intervocalic consonant, unless the phonotactic structure of the syllable on the right is violated. These findings indicate that tonal production structure and tonal alignment are major acoustic correlates of syllabification. On the other hand, the phonotactic structure of the syllable on the right overrides any syllabification on the basis of the open syllable structure, which is predominant in Greek.

Key words: Greek, stress, tonal alignment, syllabification, prosody, intonation

## Introduction

This is an experimental study of tonal alignment and syllabification as a function of stress production in Greek. One production experiment was caried out to investigate tonal alignment in lexical stres production context with reference to different combinations of intervocalic cluster consonants.

Lexical stress production in Greek is associated with a variety of acoustic parameters. However, these acoustic parameters do not have constant associations with lexical stress production but are heavily dependent on different prosodic contexts (e.g. Botinis 1989, Fourakis, Botinis, Katsaiti 1999). With reference to neutral focus contexts, the production of lexical stress is associated with a tonal rise, which is aligned with the beginning of the syllable, be that consonant or vowel. Thus, the tonal rise of stress production in neutral focus contexts is presumably an acoustic correlate of syllabification in Greek, as well as in many languages with a similar tonal structure, i.e. a L\*H in autosegmental notation (e.g. Gussenhoven 2004).

Greek has a dominant open syllable structure, according to which syllables and thus lexical words end as a rule in a vowel. Except for acronyms and foreign words, the only consonants that may appear at the end of words are the sibilant [s] and, to a much lesser extend, the nasal [n]. However, even words with the nasal [n] ending, most commonly appear with an allomorphic ending with the epenthesis of the vowel [e] (e.g. ['pinun] ~ ['pinune] '(they) drink'). Given the open syllable structure of Greek, one intervocalic consonant is always syllabified on the right (e.g. [ka.li.'me.ra] (good morning). However, when a consonant cluster is in intervocalic position, a question of syllabification is raised, especially whenever the open syllable structure on the left violates the phonotactic syllable structure on the right.

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#### **Experimental methodology**

One production experiment was carried out in order to investigate segmental durations in different lexical stress and syllable structure contexts. The speech material consists of 23 experimental words in the carrier sentence ['elejes \_\_\_\_\_\_ ðina'ta] ("You were saying \_\_\_\_\_ loudly"). All experimental words carry lexical stress on the second syllable, and have the same (C)VCCV segmental structure, according to which the two intervocalic consonants have different syllable hosts. Five female and five male speakers, in their twenties, with standard Athenian pronunciation and no known speech disorders, produced the speech material at a normal tempo. The speech material was recorded at the recording studio of the University of Athens Laboratory of Phonetics and analysed with the Praat sofware. Three segmental F0 measurements, as well as segmental duration measurements were taken with standard criteria, in accordance with visual inspection of the soundwave and spectrogram. The results were subjected to statistical analysis with the SPSS software.

## Results

The results of this study are presented in the Figures 1-2 and Table 1.In Figure 1, tonal alignment is associated with the first intervocalic consonant, unless the phonotactic structure of the syllable on the right is violated. In Figure 2, percentages of syllable boundaries are illustrated in relation to permitted or non-permitted phonotactic structure of the consonant cluster. The offset of the first intervocalic consonant was set as zero point, and the duration (ms) was measured up to the point were intonation starts rising, either to the righ (positive) or to the left (negative).

In Table 1 mean length (in ms) of syllable rise alignment is presented (measured from the offset of the first consonant up to the point were intonation starts rising), in relation to both consonants' manner of articulation, to syllable boundary alignment (positive, negative zero) and to phonotactic structure (permitted – Y, not permitted – N).

Both Figure 2 and Table 1 show that in most cases, when the consonant cluster does not violate the phonotactic structure of the syllable on the right, the first intervocalic consonant is syllabified on the right (negative or zero), while when the phonotactic structure does not permit the consonant cluster, the first intervocalic consonant is syllabified on the left (positive or zero).

Regarding the case of left syllabification of the first intervocalic consonant (positive), and taking into consideration the manner of articulation of the second consonant, according to the independent samples t-test, there is a significant difference in duration only between fricative (M=37.6, SD=18) and nasal (M=23.7, SD=19) conditions; t(43)=2.041, p < .05 With regards to right syllabification of the first intervocalic consonant (negative), and taking into consideration the manner of articulation of the first consonant, there is a

significant difference in duration only between fricative and stop (Bonferroni post hoc test); F (2, 123) = 8.792, p < .0001 (one-way Anova).





Figure 1. Mean tonal values of Figure three measurements per with regards to the (V) and two consonants (C).

2. Percentages of segment syllable boundaries in relation to speech phonotactic structure (permitted/not material consisting of two vowels permitted): zero = syllabification at the boundary of the 1<sup>st</sup> consonant, negative left syllabification, = positive = right syllabification.

Table 1. Mean length (in ms) of syllable rise alignment, based on manner of articulation (C1, C2), in relation to syllable boundary alignment (positive, negative, zero) and to phonotactic structure (permitted-Y, not permitted-N).

C1	C2	Positive		Negative		Zero	
		Y	N	Y	Ν	Y	Ν
fricative	fricative	45		-38		0	
	lateral			-36			
	nasal	25		-42	-43	0	
	trill			-28		0	
lateral	fricative		48				0
	nasal		25				0
nasal	fricative		27				0
	nasal			-26		0	
stop	lateral			-25			
	trill			-23			
trill	fricative		37				0
	lateral		16		-17		0
	nasal		22		-21		0

#### Discussion

In the present investigation, evidence has been provided that tonal variation associated with lexical stress production may be a major acoustic correlate of syllabification in Greek. An experimental methodology has been applied in order to enlighten theoretical issues and linguistic structure at syllabic level.

Syllable is the foremost basic linguistic unit in the context of which a very limited number of segmental units, i.e. consonants and vowels, may be combined in different ways. Furthermore, the phonetic rules are usually applied with reference to phonotactics and syllable structure in general in compositional morphology and lexical consituency. Open syllable structure languages are far more common than closed syllable structure languages. However, this typological dichotomy is fairly relative and thus languages rather have tendencies, to a greater or lesser extend, with reference to open or closed syllable structures. On the other hand, even in fairly closed syllable structure languages, such as English or Swedish, the open syllable structure tends to be abandoned in lexical morphology. Thus, the CV structure is the canonical and most frequent syllable structure across different languages.

Syllabification is among the most controversial areas in linguistic analysis based, in the first place, on intuition and the knowledge of language. Traditionally, syllabification is related to three main principles: (1) syllable structure openness, (2) phonotactic structure on the right and (3) phonotactic structure on the left. In accordance with these principles, consonant clusters are syllabified rightwards unless there is a phonotactic constraint. In case of phonotactic constraint on the right, consonants may syllabify on the left if there is no phonotactic constraint. However, the Greek lexicon abandons words, the syllabification of which does not comply with all these principles. In words like ['alsos] ('park') the syllable structure openness is in conflict with the phonotactic structure on the right. On the other hand, the syllabification of the consonant [1] on the left violates the phonotactic structure on the left. In accordance with the results of the present investigation, the phonotactic structure on the right is the predominant principle of syllabification in Greek (i.e. ['al.sos]).

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