Prosodic Rhythm and the status of vowel reduction in Greek

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Abstract

The present paper reports on a production experiment, in which the spectra and duration of the five Greek vowels were measured in trisyllabic and pentasyllabic words. The results suggest that vowel shortening and reduction in Greek vowels are extensive even in normal speech rates for all five vowels. Furthermore, a positive correlation was found between the number of syllables in a word and the likelihood of shortening and reduction: greater tendency for shortening and reduction was found in longer words. Finally, the rhythmic category of Greek was assessed to fall between stress timed and syllable timed languages.

Keywords: vowel reduction, variability, syllable timing, stress timing

1. Introduction

The term 'vowel reduction' refers to two parameters: duration and quality. Reduced vowels have been reported to have shorter duration and/or more centralized formants than non-reduced ones (Nord 1986; Van Bergem 1993; Moon & Lindblom 1994). The difference between reduced and non-reduced vowels contributes to prominence relations between syllables and it is one of the factors that contribute to the impression of language rhythm.

Traditionally, isochrony (the rhythmic property of having some interval with stable duration) was claimed to divide languages into two rhythmic categories: "stress timing" where intervals between stresses have stable duration, and "syllable timing" where syllables have stable duration (Pike 1945; Abercrombie 1967; Ladefoged 1975). Reduced vowels were assumed to occur commonly in stress-timed languages but rarely so in syllable-timed languages. The traditional ideas about language rhythm have evolved over the past decades. In the 1980s and 1990s, a number of acoustic studies examined the isochrony hypothesis and refuted it: neither did inter-stress intervals have equal length nor did syllables have stable duration. Furthermore, not much difference was found in syllable duration between the two types of languages (Roach 1982; Wenk & Wiolland 1982; Borzone de Manrique & Signorini 1983; Dauer 1983; Laver 1994, among others).

More recently, a number of studies report that the auditory impression of rhythm has an acoustic basis—variability in intervals smaller than the syllable, that is, vocalic and inter-vocalic ones (Deterding 1994; Low & Grabe 1995; Ramus, Nespor & Mehler 1999; Low, Grabe & Nolan 2000; Frota et al 2002; Grabe & Low 2002, Ramus 2002, among others). These studies report that stress timed languages exhibit greater vocalic and inter-vocalic duration variability than syllable timed ones. The new studies also established the existence of languages that exhibit mixed rhythmic characteristics, recognizing the need for a more fine-grained rhythm classification. Examples of languages with mixed rhythmic characteristics include languages like Catalan, which although traditionally labeled syllable timed, has highly variable vowel duration and languages like Polish which, although traditionally labeled stress timed, does not have highly variable vowel duration (Nespor 1990).

Dauer (1980) reports that only high Greek vowels reduce and that unstressed vowels are not phonetically reduced (i.e., centralized). While Dauer (1983) places Greek in the syllable timed category, later, in Dauer (1987), it is argued that languages are scattered along a rhythm continuum and that a language can't be rhythmically classified based on acoustic measurements of syllable durations. Arvaniti (1991), in a study of Greek stress, replicates the Dauer (1980) acoustic results[1] and further reports that reduction is more likely for stress-adjacent vowels (post-stress positions more likely to reduce than pre-stress positions), or vowels next to voiceless consonants, or word final vowels.

The results in Arvaniti's (1991)[2] study come in contrast with results of more recent acoustic studies, which although admittedly were not designed to study the process of vowel reduction, report variability both in duration and spectral characteristics for unstressed vowels (Fourakis et al 1999; Nicolaidis 2003; Baltazani 2006). Moreover, in a cross-linguistic study investigating speech rhythm characteristics of 18 languages, among them Greek, Grabe & Low (2002) measured durational variability of the vocalic and consonantal intervals in each language. In this study Greek was assessed to fall between stress timed and syllable timed languages. This classification should be re-evaluated, though, because it was based on duration measurements from one speaker alone reading a short passage, 'The North wind and the sun'. Clearly, data from more speakers as well as the addition of formant measurements are necessary.

A common characteristic of the previously mentioned studies is that their rhythm classification scheme is based on duration measurements alone without attention to spectral characteristics. These studies disagree on whether there is a rhythmic continuum that languages can be arranged on or whether instead there are several separate rhythmic categories. However, prominence relations, especially vowel reduction, are not always reflected on duration characteristics alone (see, for example, Nord 1986). Perception of prominence differences is more complex and can also arise out of spectral variability, therefore spectral information can provide further evidence for the classification.

For the above reasons, the acoustic experiment in this paper examines vowel reduction in Greek based both on duration and vowel quality measurements. Specifically, it examines the combined influence of three factors—intrinsic vowel quality, position in the word and word length—on reduction. The experimental results indicate that for Greek, vowel duration depends on whether the vowel is stressed, word length, and the position of the vowel relative to word stress. That is, vowel duration tends to shrink in longer words and the same vowel tends to be shorter if it occurs after

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[1] It should be noted here that in Arvaniti's study the criterion for labeling a vowel 'reduced' was "…only vowels which appear as friction in the waveform or are whispered (there are no elided vowels)." (Arvaniti 1991: 117)

[2] The results of this study are not based on formant frequency measurements, but only on duration measurements.

stress than before stress. Furthermore, the position of unstressed vowels in the F1xF2 space is affected by these three factors, namely stress, word length and position relative to stress. The results suggest that Greek vowels are variable, supporting previous reports to that effect (Fourakis et al 1999; Nicolaidis 2003; Baltazani 2006). The experimental corpus was also tested using the classification methods used in studies for rhythm and the results place Greek between stress timed and syllable timed languages, replicating Grabe & Low's (2002) findings. It should be stressed that this experiment alone is not enough for a firm classification of Greek rhythm, but makes a necessary step towards that direction.

In what follows, section 2 presents the experiment and section 3 is the conclusion.

2. Experimental study

2.1 Method and material

Three parameters were crossed to determine their effect on reduction: vowel quality (because of reports that only high vowels reduce), position before or after stress (because post-stress vowels are claimed to have a greater tendency to reduce), and word length (because a greater tendency for reduction in longer words has been reported).

The test words were 5 pairs of 3-syllabic words and 5 single 5-syllabic words. In the 3-syllabic pairs condition, both words in each pair have one of the five Greek vowels (*target vowel*) in the middle stressless syllable (Table 1)[3]. To test whether the position of the target vowel relative to the position of stress has any effect on reduction, the two words in each pair have stress in different positions—one word has initial stress and the other has final stress—so the target vowel in the middle stressless syllable occurs after stress in one word (left column in Table 1) and before stress in the other (right column). In the 5-syllabic condition each word carries stress on the middle syllable and the same target vowel occurs on either side of the stressed syllable.

Table 1. The test words used in the experiment

Target V	*3-syllables*		5-syllables
[i]	ép**i**kos	ep**i**kós	að**i**sóp**i**tos
[e]	pól**e**mos	pol**e**mó	al**e**ksísf**e**ros
[a]	aðín**a**tos	ðin**a**tós	ak**a**tást**a**tos
[o]	kát**o**çi	kat**o**çí	aft**o**krát**o**ras
[u]	kát**u**ro	kat**u**ró	vaθ**u**lón**u**me

[3] The word aðín**a**tos has an extra syllable which is the initial vowel. This was included because the previous word in the sentence ends in a vowel too (the vowel [i] in the word *leksi*) and it is known that in Greek there is vowel coalescence across word boundaries (Baltazani 2006), therefore the final vowel of the previous word together with the initial vowel of the word aðín**a**tos were expected to form one syllable and not affect the experiment. Indeed, as the results showed, this extra vowel did not affect speech rate or duration.

All words were placed in the carrier sentence *I leksi* ___ *silavizete efkola* 'The word ___ is easily syllabified'. (Each carrier sentence with a different target word filling the gap will from now on be called 'experimental sentence'). Ten speakers repeated each sentence 3 times. In this paper I report results from two female speakers, therefore no statistical analysis will be presented because the sample is too small. Sentences were read in a quiet environment and recorded directly on a hard disk. Altogether, there are 120 tokens of unstressed vowels examined (20 vowels x 3 repetitions x 2 speakers). Duration of the target vowels and F1, F2 at the mid point of the target vowel were measured using the *Praat* speech analysis program. The results of these measurements are presented in sections 2.2.1 and 2.2.2 respectively. Furthermore, the duration of all vocalic and intervocalic intervals was measured for the calculation of rhythm. The results of these measurements are presented in section 2.2.3.

The sentences used in the experiment were either 14 or 16 syllables long (depending on whether a 3-syllabic or 5-syllabic target word filled the gap) and across speakers, word lengths, and repetitions, the speech rate was fairly constant, as is shown in Table 2 below. This table presents the speech rate in terms of the number of syllables per second uttered by a speaker in each experimental sentence. The speech rate for each of the two speakers is shown separately, one in each column.

Table 2. Speech rate across speakers and experimental sentences. (Speech rate was calculated as the number of syllables per second uttered by a speaker in each experimental sentence)

Experimental sentence containing the word…	*Speaker 1*	*Speaker 2*	*Experimental sentence containing the word…*	*Speaker 1*	*Speaker 2*
pól**e**mos	10.36	10.08	að**i**sóp**i**tos	12.08	9.75
pol**e**mó	9.96	9.05	al**e**ksísf**e**ros	10.70	9.77
aðín**a**tos	11.54	9.81	ak**a**tást**a**tos	9.49	10.77
ðin**a**tós	10.70	9.84	aft**o**krát**o**ras	9.83	11.19
ép**i**kos	9.77	10.14	vaθ**u**lón**u**me	11.38	9.93
ep**i**kós	10.56	9.89			
kát**o**çi	11.57	10.39			
kat**o**çí	9.83	9.75			
kát**u**ro	10.13	9.60			
kat**u**ró	10.79	9.47			

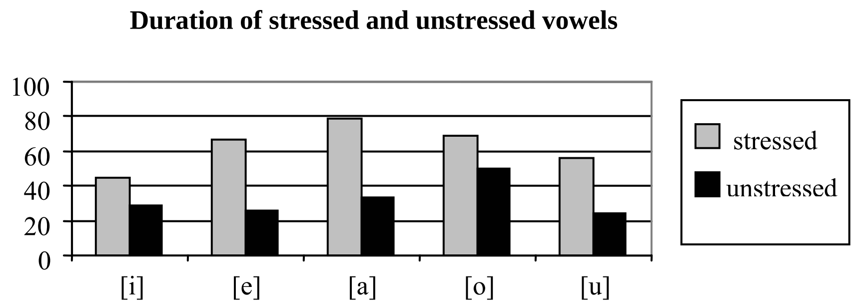
Since the speech rate did not show any particular variability, there was no need for normalization of the duration measurements. Notice that the measurements show syllables per *second*, not millisecond, and thus one - even two - syllables difference is not big, given that the whole sentence lasts 1,5 seconds on average.

2.2 Results

2.2.1 Duration

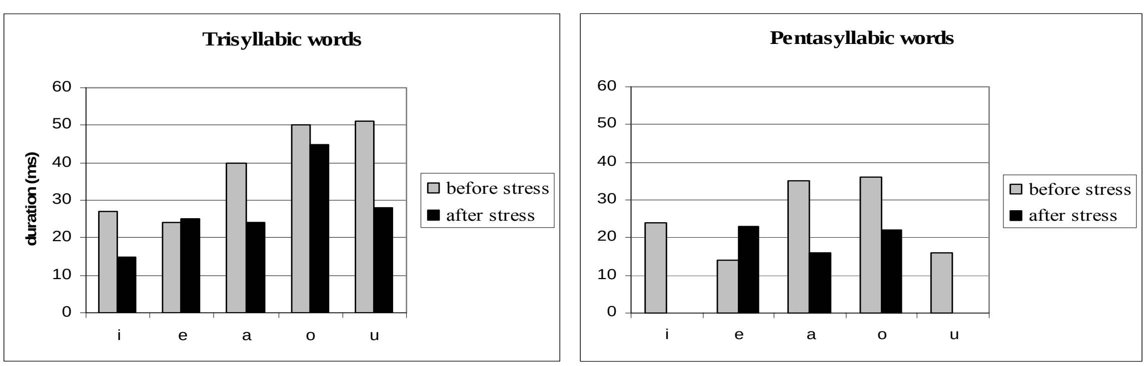
Figure 1 shows that stressed vowels are longer than unstressed ones, as has already been reported in the literature, (Fourakis et al 1999; Nikolaidis 2003). In this figure, the light bars show the stressed vowels and the dark ones the unstressed vowels. The values for unstressed vowels are averages across conditions.

Figure 1. Duration of stressed and unstressed vowels



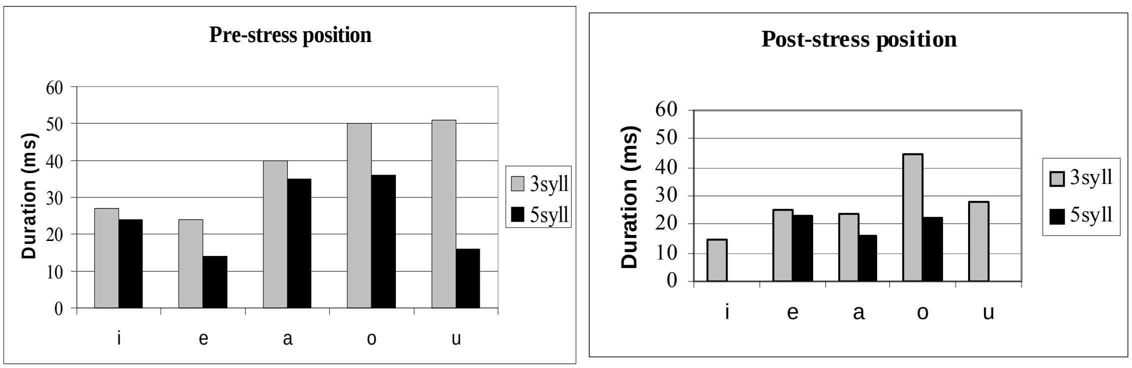
Among the unstressed vowels, pre-stress vowels are in general longer than post-stress ones, as has been shown before (Arvaniti 1991). Figure 2 shows the duration of each of the five vowels in words of different length: The left panel shows the vowel duration in trisyllabic words and the right one in pentasyllabic words. The light colored bars show the duration of vowels in the syllable before stress and the dark colored ones the duration of vowels after stress. All vowels are longer before stress, the only exception being the vowel [e], which in both word-length conditions is longer when it occurs after the stressed syllables. The reason for this difference remains unclear. Vowels [i] and [u] do not appear in the right panel because these vowels delete completely in that position, as has been reported before (Dauer 1980; Arvaniti 1991).

Figure 2. Duration in trisyllabic (left) and pentasyllabic words (right)



Another factor affecting vowel duration, in addition to the position of a vowel relative to stress, is the length of the word it is found in. In general, vowels in pentasyllabic words were shorter than vowels in trisyllabic words. This is indirectly evident in Figure 1, if one compares similar vowels across the two panels. Figure 3 below shows this difference more clearly. The left panel shows vowel duration in pre-stress position and the right panel in post-stress position. The light bars show vowels in trisyllabic words, while the dark ones show vowels in pentasyllabic words.

Figure 3. Duration in pre-stress (left) and post-stress vowels (right)



In summary, all 5 vowels undergo shortening in duration**.** More shortening is found in post-stress syllables than in pre-stress ones. More shortening is found in 5-syllable words than in 3-syllable words**.** Complete deletion of high vowels occurred in post-stress positions. It is worth emphasizing at this point that the data here come from controlled lab speech. It is well known that in such conditions speech is more carefully enunciated and slower. Despite these conditions, reduction was extensive.

2.2.2 Formants

Considerable variability was evident in vowel quality even within the same speaker and within the same word. For example, Speaker 1 produces [u] with F2 values from as back as 1118 Hz to 1587 Hz, a central position in the F1xF2 space (Table 3). All three repetitions were produced for the vowel in the same 5-syllabic word and for the same position within the word (before stress).

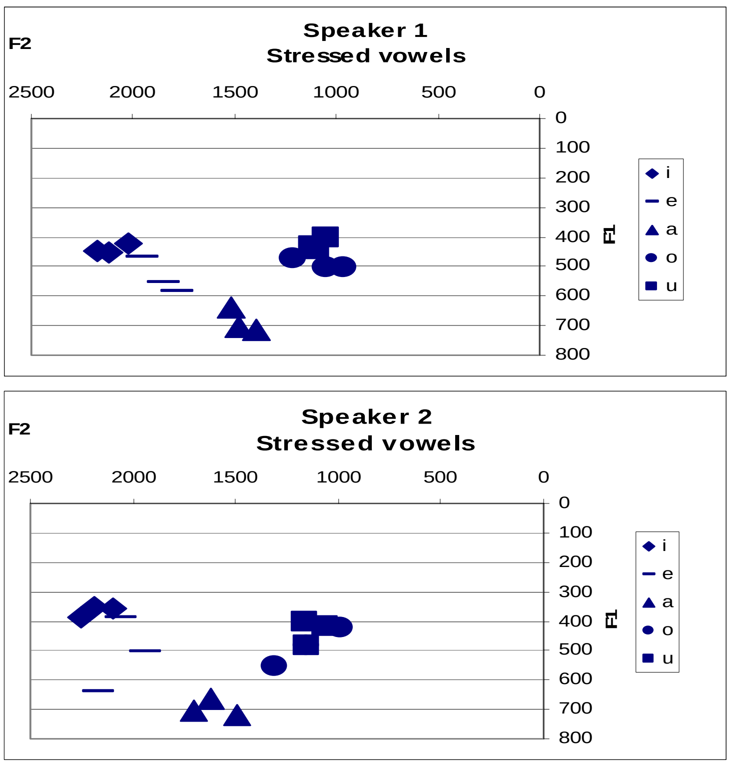
Table 3. Variability in the amount of centralization even within the same speaker and within the same word

	Vowel u in 5-syllabic words		
	Rep 1	*Rep 2*	*Rep 3*
F1	413	432	398
F2	1230	1118	1580

Despite the variability shown above, there are some clear trends in the spectral characteristics of the vowels in this experiment, presented below. Formant measurements are presented in two forms. First, formant plots are shown so that the spatial movement of the vowels can be pictorially appreciated. Second, the degree of centralization for each vowel is quantified through the use of the Euclidean distance of this vowel from the typical central vowel (*schwa*), whose F1 and F2 values are 500 and 1500 Hz respectively. This distance is the square root of the sum of squares of the difference between the vowel formant frequencies (ED= √ ((F1V1-F1V2)2 + (F2V1-F2V2)2), where V1 is any given experimental vowel and V2 is schwa.

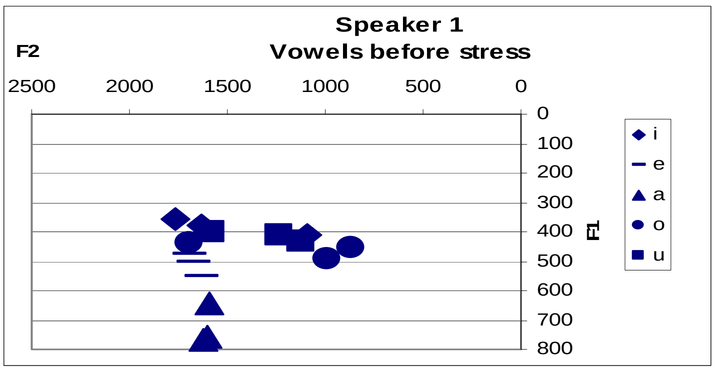
Figures 4-6 show the differences among three groups of vowels, separately for each of the two speakers. Figure 4 shows stressed vowels, Figure 5 unstressed vowels before stress, and Figure 6 unstressed vowels after stress.

Figure 4. The distributions of the five vowels in trisyllabic words in the F1xF2 space when they are stressed. The top panel shows values for Speaker 1 and the bottom one for Speaker 2.



To begin with, it is evident that in general (with a few exceptions) the stressed vowels occupy more peripheral positions than unstressed ones. Moreover, there is not as much overlap for the stressed vowels as there is for the unstressed vowels. If we consider the position that stressed vowels occupy in the F1xF2 space as the norm, then we can say that most unstressed vowels tend to centralize relative to the norm. Some vowels, however, move to positions other than the center: vowel [e] in the post-stress position moves downward to a lower position for both speakers; vowel [i] moves upward to a higher position in the post-stress position for Speaker 1; unstressed vowel [a] moves diagonally to a higher and more front position than schwa for both speakers. Finally, the pattern of displacement for unstressed vowels relative to stressed ones is different for each of the two speakers that were examined. For example, in the post-stress condition, vowel [i] moves to a much higher position (away from the center) for Speaker 1 whereas it stays close to the center for Speaker 2, and in the pre-stress position, vowel [a] moves closer to the center for Speaker 2, but stays in a relatively peripheral position for Speaker 1.

Figure 5. The distributions of the five vowels in trisyllabic words when they are unstressed and in a syllable before the stressed one. The top panel shows values for Speaker 1 and the bottom one for Speaker 2.



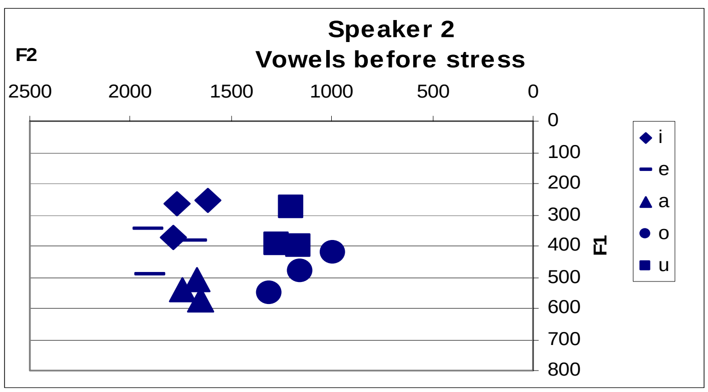
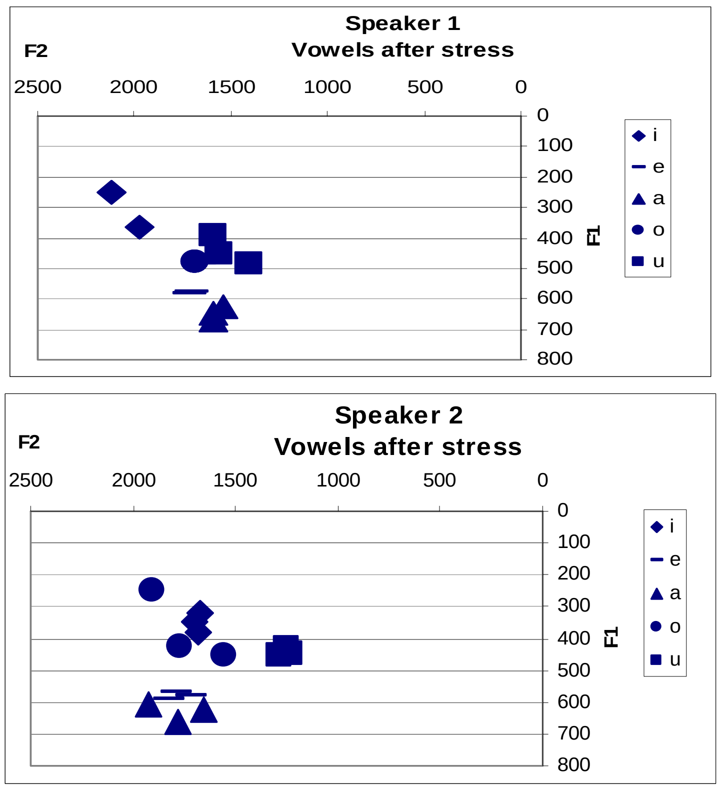


Table 4 presents the Euclidean distance of stressed and unstressed vowels from the typical central vowel. It is expressed in Hertz and can be used to quantify the idea of centralization and facilitate comparisons among vowels. Larger numbers in the Euclidean distance measure represent greater distance from the centre of the F1xF2 space with coordinates [500, 1500]. For example, in the columns for Speaker 1, the non-front vowels [a, o, u] in the 'After stress' column are closer to the center of the F1xF2 space (i.e., have smaller numbers) than the respective vowels in the 'Before stress' column. To give another example, the fact that vowel [i] moves upward to a higher position in the post-stress position for Speaker 1 is expressed by a larger number for that vowel. It is also evident that the two speakers realize their vowels differently from each other. In addition, there are some exceptions to the general tendency for vowels after stress to be more centralized than vowels before stress and, in turn, for vowels before stress to be more centralized than stressed vowels. In particular, vowel [a] before stress for Speaker 1 has a greater distance from the center than its stressed counterpart, because of its greater dispersion in F1. Also, vowel [a] after stress for Speaker 2 has a greater distance from the center than its counterpart before stress because it shows a lot more variability in its realization. Finally, vowel [o], which exhibits similar variability when placed before stress for both speakers, has greater distance than either its stressed or its after stress counterpart.

Figure 6. The distributions of the five vowels in trisyllabic words when they are unstressed and in a syllable after the stressed one. The top panel shows values for Speaker 1 and the bottom one for Speaker 2.



In summary, the distribution of the five vowels in trisyllabic words before and after stress suggests that very often unstressed vowels tend to cluster toward the center of the F1xF2 space, with some exceptions, mentioned above. The centralization and overlapping is much more pronounced after stress than before it. Moreover, the pattern of displacement for the vowels is different for each of the two speakers and among the different vowels.

Turning to pentasyllabic words, vowels exhibit the same behavior as in trisyllabic words regarding centralization. Figure 7 shows the vowel distributions for pre-stress positions in 5-syllable words separately for each speaker. Figure 8 shows the vowel distributions for post-stress positions. Relative to the position of the stressed vowels that was shown in Figure 4, the position that the unstressed vowels occupy is less peripheral in most cases. As was the case for the vowels in trisyllabic words, it is evident here too that each speaker realizes the vowels differently: Speaker 1 has more peripheral vowels in the pre-stress condition than Speaker 2, but in the post-stress condition there is more centralization and overlap for Speaker 1 than for Speaker 2.

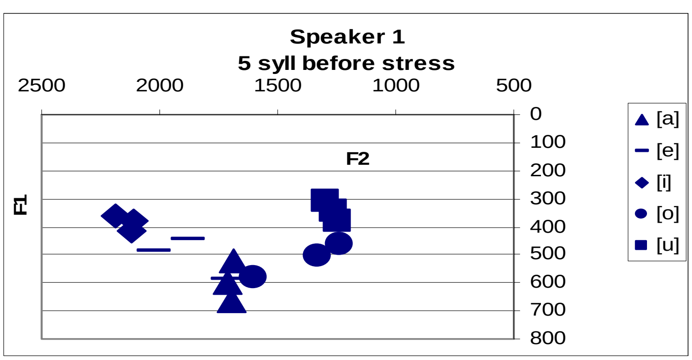
Table 4. The degree of centralization for each vowel, presented as the Euclidean distance of this vowel from the typical central vowel (F1 = 500, F2 = 1500)

	Speaker 1			*Speaker 2*		
	Stressed	*Before stress*	*After stress*	*Stressed*	*Before stress*	*After stress*
[i]	608	138	--	613	303	--
[e]	363	165	199	558	351	*319*
[a]	190	247	162	224	192	*436*
[o]	295	319	185	374	273	*364*
[u]	*395*	*209*	--	*352*	*250*	--

For both speakers, the centralization and overlapping is more pronounced in the post-stress vowels than in the pre-stress vowels. Among the pre-stress vowels for Speaker 1, only the back vowels show movement to a more central position: they are considerably fronted, their F2 occurring in the area between 1200 and 1500 Hz, when their 'default' F2 value is around 1000 Hz. As for the pre-stress vowels for Speaker 2, vowel [i] remains in the (400, 2000) region of its 'default' values, vowel [e] has moved to a more central position, vowel [a] to a higher position (F1 nearer 500 Hz), and the back vowels are considerably fronter, just like for Speaker 1. Among the post-stress vowels, [i] and [u] are missing because they were deleted in the produced tokens. The back mid-vowel [o] overlaps with [e] and [a] in the center of the F1xF2 space for both speakers, with more overlap for Speaker 1.

Comparison of the average formant values in trisyllabic and pentasyllabic words reveals that formant values for the pentasyllabic words are more centralized than those for trisyllabic ones in the post-stress condition, but not so in the pre-stress condition. In summary, non high Vs tend to centralize more when they occur after the stress in a word and there is more centralization in pentasyllabic than in trisyllabic words.

Figure 7. Vowel distributions for pre-stress vowels in 5-syllable words. The top panel shows values for Speaker 1 and the bottom one for Speaker 2.



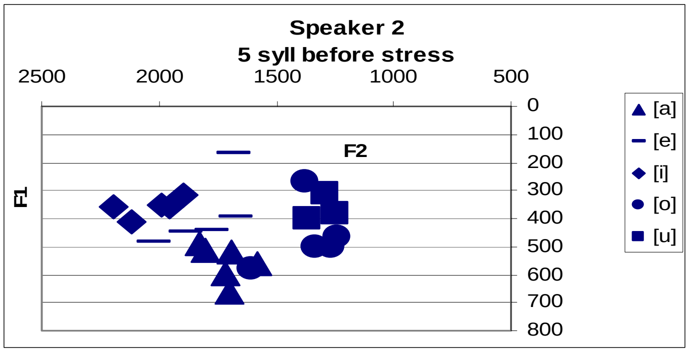
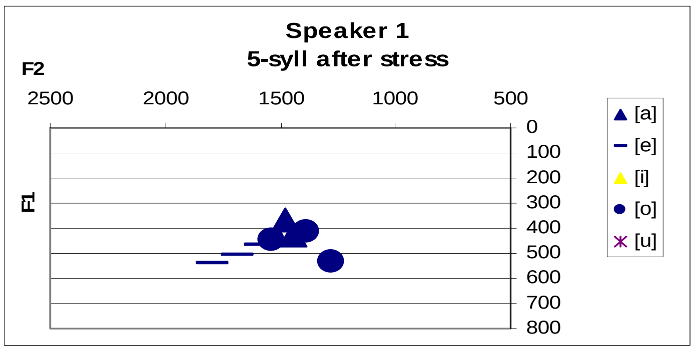
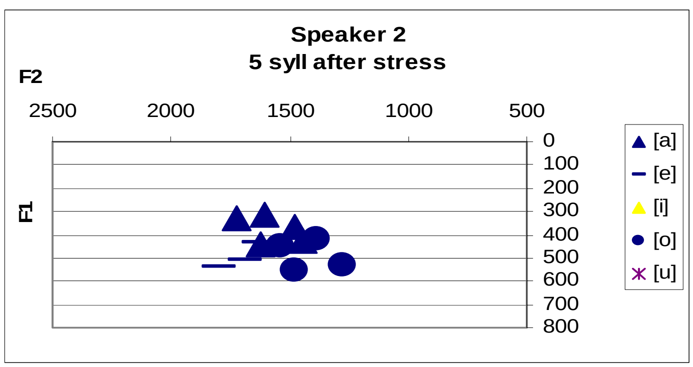


Figure 8. Vowel distributions for post-stress unstressed vowels in 5-syllable words. The top panel shows values for Speaker 1 and the bottom one for Speaker 2.





2.2.3 Rhythm

As has already been mentioned, several studies have related the auditory impression of rhythm to an acoustic measurement, namely, variability of vocalic and inter-vocalic intervals (Deterding 1994; Low & Grabe 1995; Ramus, Nespor & Mehler 1999; Low, Grabe & Nolan 2000; Grabe & Low 2002, Ramus 2002; Frota et al 2002, among others). These studies report that stress timed languages exhibit greater vocalic and inter-vocalic duration variability than syllable timed ones and give scales of rhythm along which languages can be classified. These studies also maintain that there are languages with mixed rhythmic characteristics, such as Polish, which has been classified as stress-timed but does not exhibit vowel reduction, and Catalan, which has been described as syllable-timed but has vowel reduction, and argue for a more fine-grained rhythm classification.

Among the most widely recognized and used metrics for the calculation of rhythm are those in the studies of Grabe and colleagues (op. cit.). The metric in Grabe & Low (2002) is the *Pairwise Variability Index* or PVI and it was one of the measurements adopted for this paper. This index[4] expresses variability in successive measurements and it is compiled by calculating the difference in duration between each pair of successive measurements, taking the absolute value of the difference and dividing it by the mean duration of the pair.

Following this method, I calculated the variability index for the vocalic and the intervocalic intervals in the experimental material. According to these calculations, the PVI for vowels is 45 and that for consonants is 68. In order to get some idea of how Greek compares with other languages whose indices have been computed, let us examine the PVIs of a syllable timed and a stressed timed language. Spanish, a typically syllable timed language, has a vocalic PVI of 30 and an intervocalic one of 58, whereas German, a typically stress timed language, has a vocalic PVI of 60 and an intervocalic one of 55. According to this metric, Greek comes between stress and syllable timed languages[5].

Another method for the calculation of rhythm is the one adopted in Ramus, Nespor & Mehler (1999) and Ramus (2002), (RNM). In this method there are three separate variables, which are taken to be acoustic correlates of rhythm classes: %V, the proportion of time devoted to vocalic intervals in a sentence, ΔV, the standard deviation of vocalic intervals over a sentence, and ΔC, the standard deviation of consonantal intervals over a sentence. These three variables define a three-dimensional space in which every language occupies a different position, depending on the proportion of its vocalic and consonantal intervals. According to the RNM results, the position a language occupies in the [%V by ΔC] plane has the highest correlation with the traditional rhythm classes, but the other two planes of the three dimensional space, namely the [%V by ΔV] plane and the [ΔV by ΔC] plane provide information on which finer rhythmic distinctions can be made. I applied the RNM metrics on the Greek data and the calculations showed that for Greek, the proportion of time devoted to vocalic intervals in a sentence (%V) is 40, the average standard deviation of vocalic intervals over a sentence (ΔV) is 3.0 and the average standard deviation of consonantal intervals over a sentence (ΔC) is 5.3. In comparison, English has approximately the same %V and ΔC measures as Greek, 40.1 and 5.35 respectively, but a much higher ΔV measure, 4.64. Interestingly, the Polish measures are similar to Greek in all three variables (%V = 41, ΔV = 2.51, and ΔC = 5.14). As a result, the positions of Greek and Polish in all three planes mentioned above are close to each other and can be seen to form a separate

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4 The equation for this index is: *n* , where *m* is the number of items in an utterance and *d* is the duration of the *k*th item.

5 It should be stressed once more that these calculations were based on measurements from only two speakers and that in order to arrive at more reliable conclusions more speakers should be examined.

cluster from the traditionally syllable-timed and stress-timed languages, giving further support to the RNM classification.

3. Discussion and conclusion

The results of this study suggest that vowel reduction is extensive in Greek. Unstressed vowels were found to be shorter than the corresponding stressed ones. Two aspects of reduction were measured, the amount of duration shortening and the amount of spectral centralization. Both were affected by the length of the word that the vowels were found in and also by the position of the target vowels relative to stress.

Among the unstressed vowels, there were differences in duration between post-stress vowels and pre-stress ones, with vowels after the stress being shorter. In addition, more centralization was found in post-stress vowels than pre-stress ones. This phenomenon could be seen as a difference in prosodic strength between syllables before stress and syllables after stress, with post-stress syllables being weaker, therefore shorter and more centralized. A similar phenomenon occurs in Greek intonation, where syllables after the sentence nucleus are de-accented. We could thus state a more general rule in Greek prosody, according to which units that occur after the main prominence become prosodically weak, whether at the word or at the sentence level.

Another factor that affected the degree of centralization was word length: vowels in longer words centralized more than vowels in shorter ones. It should be stressed, however, that the amount of centralization was variable and vowels even within the same condition displayed varying amounts of centralization. Furthermore, the pattern of displacement for the vowels was different for each of the two speakers and among the different vowels. These results should be viewed with caution since they are based on data from only two speakers, a fact that did not allow for statistical analysis. A more extensive database should be examined to arrive at a robust conclusion.

Which rhythmic category does Greek belong to? This question cannot be answered conclusively in this paper. However, some preliminary conclusions can be drawn. In particular, it is clear that Greek exhibits vowel reduction, a property not characteristic of syllable timed languages. Moreover, the calculations of the RNM measures and the Pairwise Variability Index in section 2.2.3 give a further indication that Greek is not syllable timed. The comparison of these indices for Greek to those of other languages suggests that Greek belongs in a different category from languages traditionally labeled either stress timed or syllable timed. RNM conclude, correctly, that more phonological properties of languages should be taken into consideration for the rhythmic classification of languages. Among the languages that they examined, Polish appeared to be related to stress timed languages on the [%V by ΔC] dimension but clearly different from them on the ΔV dimension. Greek displays the same behavior as Polish and it seems that these two languages form a separate category from the two traditional ones. This finding gives further support to the Nespor (1990) conclusions about the status of Polish on one hand and about the need for more rhythmic categories on the other. In order to arrive at a more accurate rhythmic classification of Greek, however, it is necessary to base the conclusions on measurements from more speakers.

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