Inter-dialectal Insights into Greek Rhythm: The Case of Standard Modern Greek vs. Kozani Greek

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1. Introduction and aims

The traditional rhythm class typology categorises languages into stress-timed, syllable-timed and mora-timed (Pike 1945, Abercrombie 1967, Ladefoged 1975). This categorization is based on the notion of isochrony of the organizing units postulated for each rhythm category. For stress-timed languages, such as English and German, it is claimed that the temporal interval between stresses (or feet) is of relatively equal duration; for syllable-timed languages, such as French and Spanish, syllables are postulated to recur at relatively regular temporal intervals while for mora-timed languages, such as Japanese, there is relatively even temporal spacing between successive moras. Subsequent experimental studies have however failed to provide support for isochrony; for example, inter-stress intervals have been found to be longer when they contain more syllables, i.e. they are proportional to the number of syllables they contain. Inter-stress intervals do not appear more regularly in stress-timed compared to syllable-timed languages (Bolinger 1965, Lehiste 1977, Dauer 1983, 1987). Syllables and moras are not of nearly equal length in syllable- and mora-timed languages (Roach 1982, Dauer 1983, 1987). In view of such findings, Dauer (1983) proposed that rhythmic differences between languages are a consequence of language structure. Stress-timed languages typically have more varied syllable types and hence more variation in syllable length. They also exhibit extensive reduction phenomena in the absence of stress. Dauer (1987) presented a set of parameters that differentiate rhythm types and on the basis of these she proposed that languages are placed on a continuum from least to most stress-timed.

More recent research has introduced the use of rhythm metrics to classify languages into different rhythm types by quantifying consonantal and vocalic variability (e.g. Ramus, Nespor & Mehler 1999, Grabe and Low 2002, White and Mattys 2007). Ramus Nesport & Mehler (1999) have shown that there is greater consonantal variation in stress-timed languages while in syllable-timed languages a higher percentage of the overall utterance is vocalic. Grabe and Low (2002) using a different pair of variability indices have shown that stress-timed languages are characterized by relatively high values in vocalic and intervocalic (i.e. consonantal) intervals. This reflects variability in syllable structure, e.g. presence of clusters in onset or coda position, as well as reduced vowels in unstressed position. Syllable-timed languages on the other hand show low values for the variability indices due to the fact that they commonly have a simple CV structure and there is little vowel reduction resulting in low durational variability between successive vowels.

The results of these studies have however shown that there are several classification problems and thus limitations from the use of metrics. For instance, the metrics used by Ramus, Nespor & Mehler (1999) and by Grabe and Low (2002) classify some languages differently, e.g. Polish, Greek. In addition, while the metrics used by Grabe and Low (2002) classify appropriately languages such as English and Spanish, which have been prototypically described as stress- and syllable-timed respectively, they encounter problems with other non-prototypical languages some of which remain unclassified.

On the basis of findings from her research and a review of the results from previous studies, Arvaniti (2009) provides a detailed account of the limitations of rhythm metrics

and argues why they cannot classify languages reliably. She also discusses several factors that can influence metric scores, e.g. the choice of speech materials. She claims that metrics based on durational measurements reflect timing; this can be affected by various factors, e.g. stress, focus, context, etc. Timing relates to rhythm but it is not its exclusive component. She proposes an alternative account according to which language rhythm is based on the principles of grouping and prominence. Among other languages, she puts forth evidence from Greek to support her claims. Greek is an interesting case because it has been classified as syllable-timed, stress-timed, mixed or remained unclassified (Barry and Andreeva 2001, Baltazani 2007, Tsiartsioni 2008, Johnson & Sinabaugh 1985, Grabe & Low 2002). As mentioned above, Dauer's (1983) findings showed that the duration of inter-stress intervals was similar between stress-timed languages, such as English, and syllable-timed ones, such as Spanish. Differences were however evident in the number of syllables present in the intervals. While stresses appeared at relatively regular intervals in all languages, languages such as Spanish, Italian and Greek had more syllables than English between stresses. In line with Dauer's view that rhythm is stress-based, i.e. languages are placed on a more or less stress-timed continuum, Arvaniti claims that "one difference between languages called stress-timed and those called syllable-timed may have to do with the spacing of prominences, not in terms of duration but in terms of number syllables; in this respect, prominences may be sparser in syllable-timed languages" (2009: 59). The relative regularity in the occurrence of prominences is the result of language specific factors including reduction phenomena and speaking rate differences.

Such different approaches in the research of rhythm can have important implications for its study among different languages as well as for the cross-dialectal study of rhythm within a particular language. Variation in rhythm among dialects may actually be an important factor that contributes to their differentiation. Cross-dialectal variation in rhythm has been reported, among others, for Taiwan and American English (Jianm, (2004), Singapore and British English (Ling, Grabe & Nolan 2000), Bari, Naples and Pisa varieties of Italian (Barry, Andreeva, Russo, Dimitrova & Kostadinova 2003), European and Brazilian Portuguese (Frota & Vigario 2001), Peruvian Spanish (O' Rourke 2008), Eastern and Western varieties of Arabic (Ghazali, Hamdi & Barkat 2002), Cantonese, Beijing Mandarin, Cantonese-accented and Mandarin-accented English (Mok & Dellwo 2008).

To date, there has been no research on the rhythm of different Greek dialects. The current study investigates the speech rhythm of Kozani Greek (KG) and Standard Modern Greek (SMG). KG is a typical Northern Greek dialect displaying the raising of unstressed mid /e, o/ to high [i, u], and the deletion of unstressed underlying /i, u/ (see Dinas 2005). Vowel deletion (VD) leads to the creation of a variety of consonantal sequences which are both more numerically and longer segmentally when compared to those found in SMG. Thus, KG can present a more complex syllable structure than SMG. As noted above, complex syllable structure and vowel reduction are two factors that may affect a language's rhythmic classification. It may be expected therefore that there is variation in rhythm between KG and SMG.

Two approaches will be used in the current study: (a) rhythm metrics, in particular the vocalic and consonantal Pairwise Variability Indices (PVIs) proposed by Grabe and Low (2002), and (b) inter-stress intervals (ISI), in particular the measurement of the number of syllables between stresses, in line with the prominence-based theoretical framework proposed by Arvaniti (2009). The study aims to compare and evaluate the findings from the two approaches. It also aims to look into speaker and speech material variability.

The paper is structured as follows: Section 2 presents the methodology used in the study. Section 3 presents the results of the two approaches including evidence for inter-dialectal and inter-speaker variation. Section 4 provides a discussion of the results and expounds on the basic principles of the ISI approach.

2. Methodology

2.1. Subjects

Two KG speakers (TL: male, KS: female) and two SMG speakers (TT: male, BT: female) were recorded. The speakers were between 58 to 66 years of age. The KG speakers were born, raised and lived in Kozani. Of the SMG speakers, BT was born and raised in Athens in a SMG environment. TT was born in Kozani and left for Athens at the age of 11 where he grew exclusively monodialectal in SMG. Both his parents were speakers of SMG, although his mother and other family had been exposed to KG.

2.2. Recording materials and procedure

The speech material consisted of (a) a text written in SMG which the subjects were asked to read at a comfortable speaking rate, and (b) quasi-spontaneous speech produced during a picture-description task. The text was a short narrative designed to include many potentially VD undergoing words, e.g. /skulici/ 'worm', /ɣurúɲa/ 'pigs', /ðuʎa/ 'work' (see Appendix). These were expected to be realised differently by the speakers of the two dialects, i.e: [sku'lici], [ɣu'ruɲa], [ðu'ʎa] by SMG speakers and ['sklic], ['ɣruɲa], ['ðʎa] by KG speakers. Picture description was chosen over entirely free speech so that data from the two dialects were more comparable, since similar vocabulary was expected to be used by all speakers. These two types of elicitation tasks were included in the present study in order to investigate possible variation in speech rhythm due to speech material (cf. Arvaniti 2009, Ferjan et al 2008, Ross et al 2008a, 2008b).

The SMG speakers were recorded in a quiet room at their home, whereas the KG speakers were recorded in a quiet room in a cultural centre. The researchers who conducted the recordings were familiar to the speakers. The subjects of both dialects were given some time before the recordings to practise reading the text and make sure they were fluent enough for the reading task. They were also given some time to look at the picture before the recordings.

2.3. Data analysis

2.3.1. PVI

The Pairwise Variability Indices (i.e. consonantal and vocalic PVIs) which express durational variability in successive vocalic and intervocalic intervals were used in this study (Grabe and Low 2002). These metrics were selected because they have been commonly used in the literature thus enabling the comparison of the results of the current study to findings from previous literature. Grabe and Low (2002: 524) define vocalic intervals as 'the stretch of signal between vowel onset and vowel offset regardless of the number of vowels included in a section' and intervocalic intervals as 'the stretch of signal between vowel offset and vowel onset, regardless of the number of consonants included'. Low PVIs indicate that variability in duration is low, i.e. the duration of successive measurements is relatively similar as expected in the co-called syllable–timed languages. In contrast, high variability indices are anticipated in stress-timed languages reflecting complex syllable structure and reduced vowels.

To compute the PVIs, consonantal and vocalic intervals were segmented using PRAAT (Boersma and Weenik 2007) in line with the aforementioned criteria as described in Grabe and Low (2002). Figure 1 illustrates segmentation of the word /skuliki/ 'worm' produced by a speaker of SMG and KG.

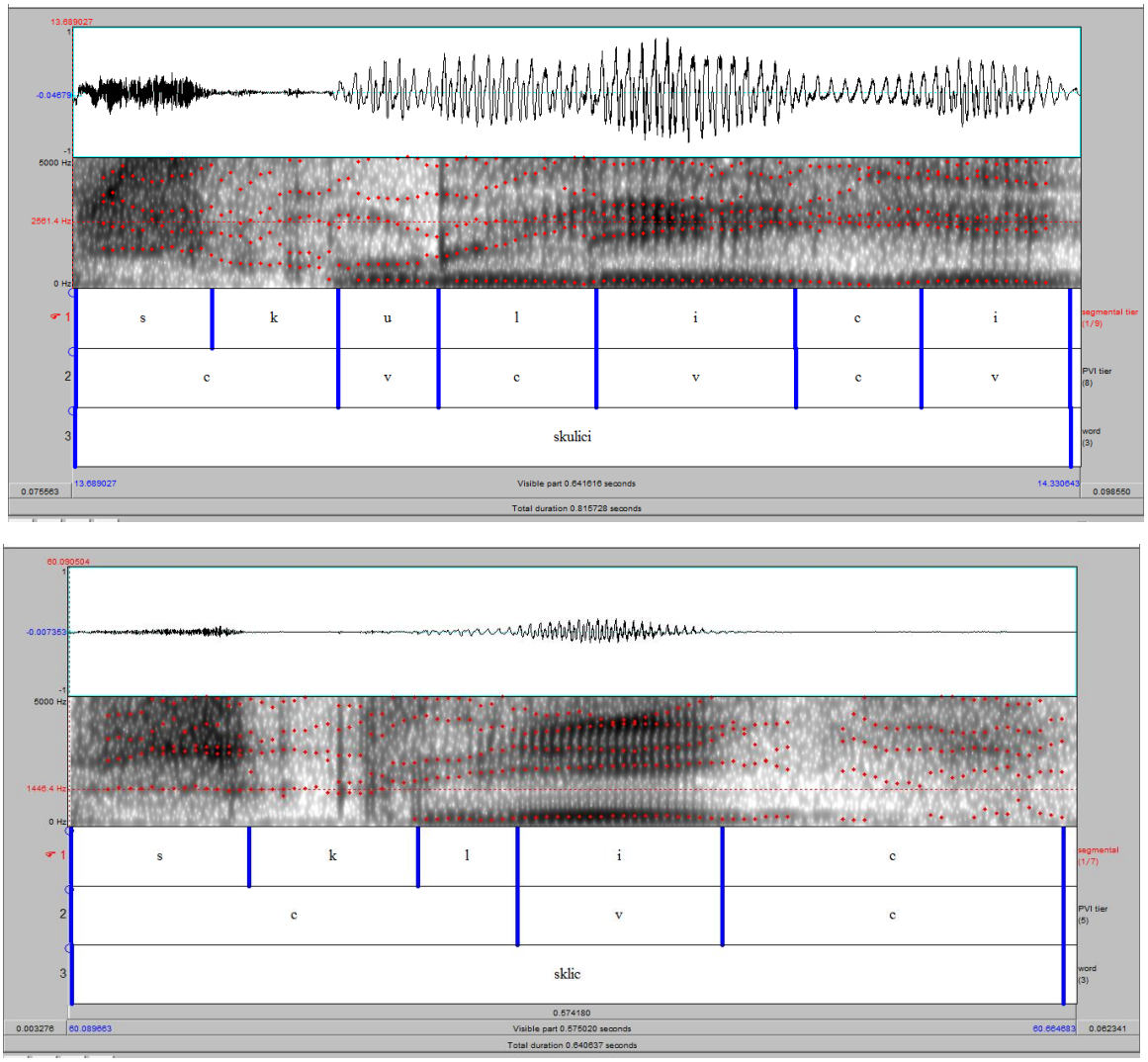


Figure 1: *Segmentation of the word /skuliki/ produced as [skulici] by the SMG speaker TT (above) and as [sklic] by the KG speaker TL (below).*
N.B: tier 1 = segmental tier, tier 2 = PVI tier, i.e. vocalic and consonantal intervals, tier 3 = word tier

The following segmentation principles were followed:
(a) Pauses and hesitation marks were excluded from measurement.
(b) Utterance-initial voiceless stops /p, t, k/ were included in the analysis. To determine their onset we estimated the average duration of all non-utterance initial and medial /p/, /t/, /k/ in the data. Thus, for each utterance initial stop, total duration was taken to correspond to the average duration of its non-utterance initial and medial counterparts.
(c) The alveolar /r/ in consonant clusters often included a vocoid having formant structure similar to that of a short vowel (see Arvaniti 2007, Baltazani 2005, 2009 for discussion). This part was included in the consonantal interval for phonetic/phonological reasons: since rhotics are considered to be consonants in most languages, the particular vocoid was considered as part of the articulation of the rhotic sound in the specific context. Figure 2 illustrates this realisation of /r/ in the word /traɣuðaɪ/ by the KG speaker TL.

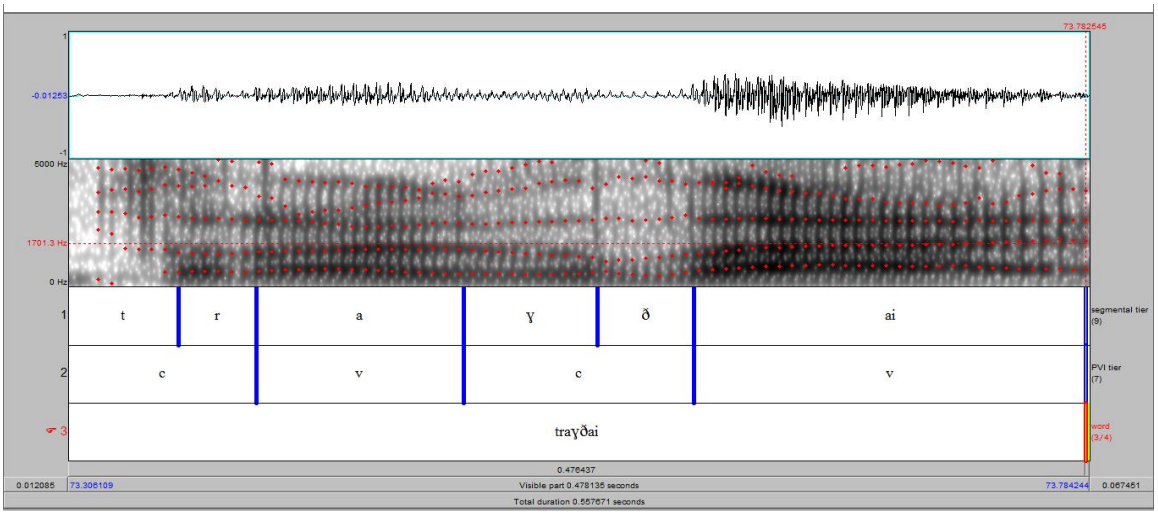
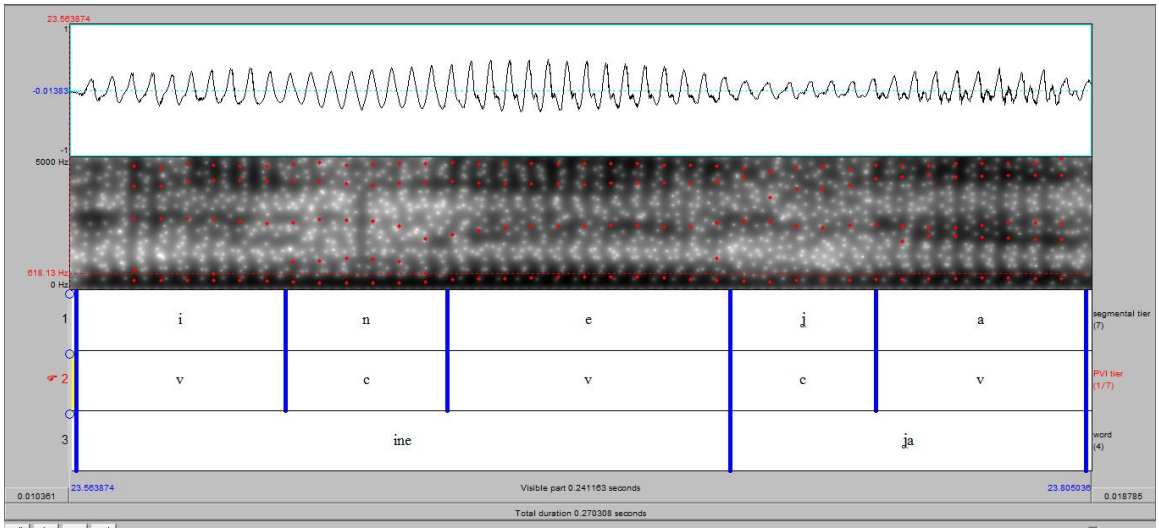


Figure 2*: Spectrogram of the word /traɤuðaɪ/ produced as [traɤðaɪ] by the KG speaker TL*.

(d) The voiced palatal fricative [j̟] was considered to be part of the consonantal portion when there were clearly observable changes in the formant structure or the amplitude of the signal (Figure 3 top). When reduced, i.e. articulated as an approximant, there were no clearly observable changes in the formant structure or the amplitude of the signal; in this case it was included in the vocalic portion (cf. Grabe and Low (2002) for the segmentation of glides and Malavakis 1984, Arvaniti 1999, 2007, Nicolaidis 2003, for the phonetics of Greek glides) (Figure 3 bottom).



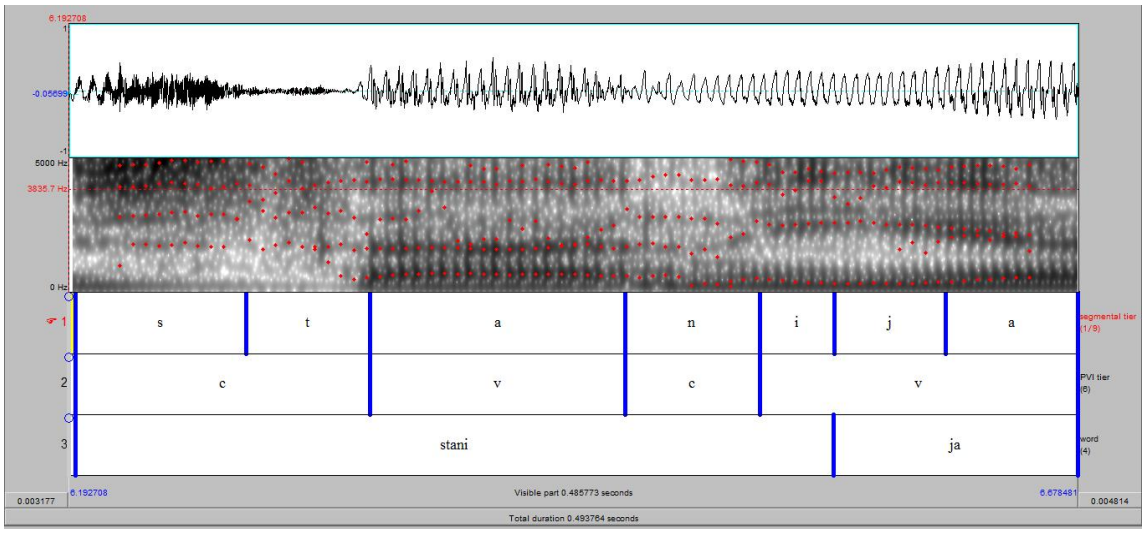


Figure 3*: Spectrograms of the words [ine ja] (top) and [stani ja] (bottom) produced by the SMG speaker BT*

(e) Reduced vowels were segmented as follows: those showing no evidence of voicing (i.e. no voice bar) were considered to be part of the consonantal interval (Figure 4, vowel /i/ in [astamatita]), whereas vowels with presence of voicing were considered to be part of the vocalic portion.

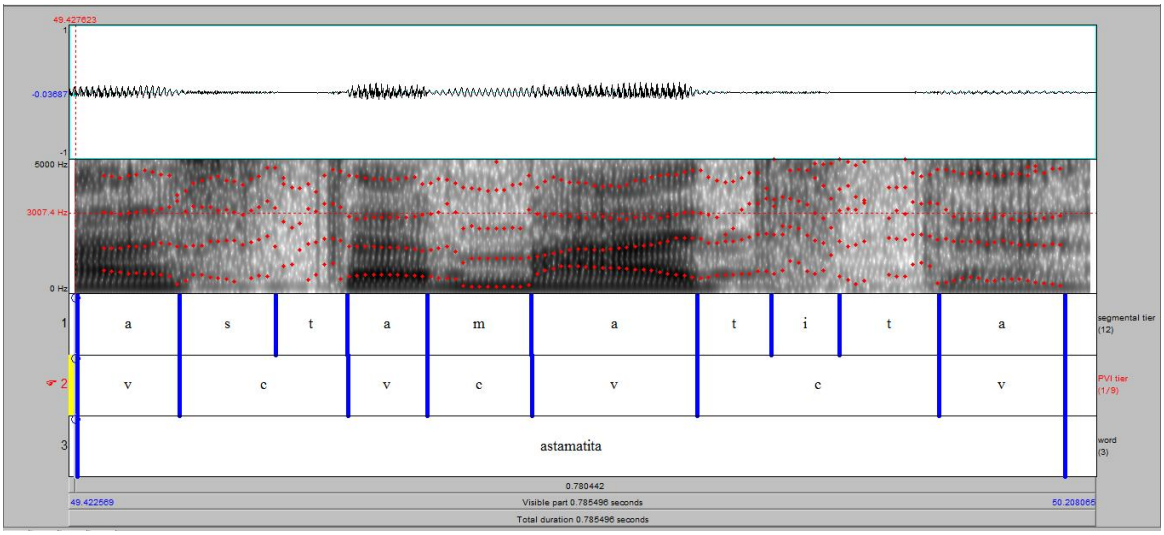


Figure 4: *Spectrogram of the word /astamatita/ produced by the KG speaker KS*.

An average of 129 vocalic and 126 consonantal intervals were measured for each speaker in the reading task and of 108 vocalic and 109 consonantal intervals in the quasi-spontaneous task. Subsequently a normalised version of the PVI was computed for the vocalic and consonantal intervals. The PVI is based on the mean difference in duration between successive vocalic and consonantal intervals divided by the sum of the same intervals. Normalised vocalic and intervocalic PVI were used, as normalisation adjusts for potential speaker rate variation due to the different types of the elicitation tasks (Bunta and Ingram 2007). For each passage, a PVI score for vocalic and a PVI score for consonantal intervals was computed (vocPVI and consPVI respectively). Statistical analyses were not conducted due to the small number of speakers. A detailed presentation of the results appears in section 3.1.

2.3.2. Inter-stress intervals (ISI)

The ISI approach adopted in this study is based on work by Asu and Nolan (2006) and Arvaniti (2009). Using data from Estonian and English, the former proposes that a language's rhythm is better captured by measuring the sPVI (syllable PVI) and fPVI (foot PVI) instead of vocalic and consonantal intervals. This account is more prosodic in nature since it draws on prosodic constituents (syllables, feet), instead of segmental material (consonants, vowels) that lacks prosodic constituency. On the other hand however, it remains a metrics approach and as such it has several limitations (see Section 1 and Arvaniti 2009 for detailed discussion). Unlike the metrics accounts, we instead endorse Arvaniti's (2009: 59) view that rhythm must be dissociated from timing and that durational variability – as in all metrics approaches – probably only plays a small role in rhythm. We thus assume that what gives a language its relevant rhythmic character is the spacing between the stressed syllables. This approach is further discussed in section 4.

For the computation of rhythm within the ISI account, the following procedure was used: all the speech material was phonetically transcribed, stressed syllables were identified and syllabification followed. Syllabification has not always been straightforward. For instance, BT pronounced the string *θα του πει* /θa tu pi/ as [θa tpi]. The [t] can be syllabified either as coda of the first syllable or as an onset of the second one. However, independently of which syllabication is adopted, the number of syllables – which is important for the ISI approach – is unaffected. For example, there were several cases of high vowel deletion or reduction as in /pefti/ produced as [peft] by the KG speaker KS. In such cases, we used acoustic criteria to decide on whether the vowel and hence a syllable was present. Similarly to the PVI segmentation principles described above, if voicing was evident during the vowel, it was considered present while absence of voicing was taken to indicate deletion.

Subsequently we counted the number of syllables intervening between any neighbouring stresses. While counting the inter-stress intervals, any unstressed syllables immediately following a pause were not included (i.e. the underlined syllables in the following example: 'pause' s s S s (S=stressed, s=unstressed)). The phrase *το σκυλί μόλις τον βλέπει, κουνά την ουρά, τρέχει και τον φιλά* /to ski'li 'molis ton 'vlepi ku'na tin 'ura 'trexi ke ton fi'la/ ('as soon as the dog sees him, it wags its tail, it runs and kisses him') in (1) illustrates this. Syllables in bold are stressed. The distances between the stresses are marked by a number ranging from 0 to 3. '0' indicates that stresses were adjacent (creating a stress-clash), whereas '3' denotes that three unstressed syllables intervened between two consecutive stresses. The first two unstressed syllables in (1) are ignored for calculation purposes since they follow a pause.

(1) *pause* to sci.**li mo**.lis ton **vle**.pi ku.**na** tn u.**ra treç** ce ton fi.**la**

s s S S σ σ S s s S s S S s s s S

0 2 2 1 0 3

Following this procedure for all data, we computed: (i) the average number of unstressed syllables for each speaker in each elicitation type, and (ii) the frequency occurrence of inter-stress intervals, i.e. how many 0σ, 1σ, 2σ, etc. intervals appeared. We counted the 0σ, 1σ, etc. intervals for each speaker in each elicitation type and divided each ISI (0σ, 1σ, etc) by the total number of ISIs for the particular speaker and elicitation type. The values were then expressed as percentages. The results are presented in section 3.2.

3. Results

3.1. PVI

Figure 5 presents the average PVI values for each group of speakers (KG versus SMG) and each type of elicitation task (text versus picture). The PVI scores for individual speakers are presented in Table 1.

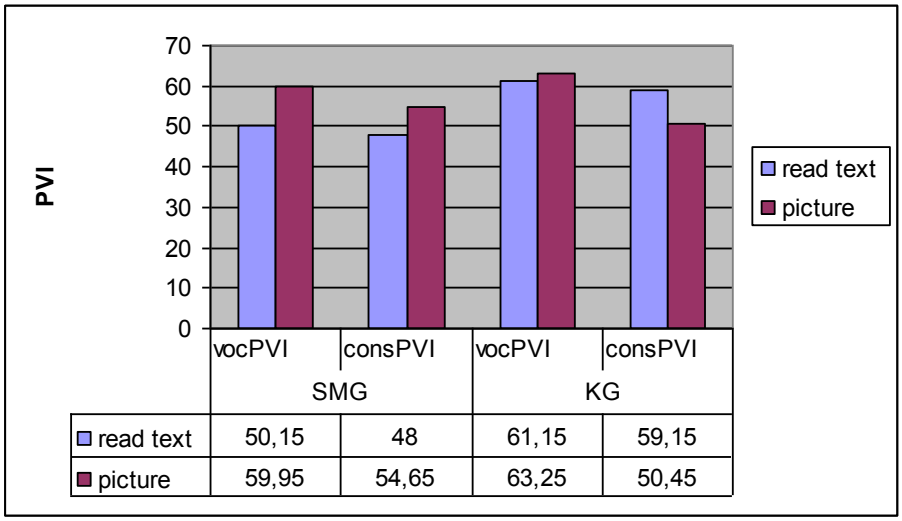


Figure 5: *Average vocalic and consonantal PVI values for SMG and KG*

Table 1: *Vocalic and consonantal PVI scores for individual speakers in the read text and picture elicitation tasks.*

STANDARD MODERN GREEK					**KOZANI GREEK**				
speaker	*gender*	*material*	*vocPVI*	*consPVI*	*speaker*	*gender*	*material*	*vocPVI*	*consPVI*
TT	male	text	48,4	46,3	TL	male	text	51,70	55,80
TT	male	picture	54,6	60,3	TL	male	picture	64,4	53,4
BT	female	text	51,9	49,7	KS	female	text	70,6	62,5
BT	female	picture	65,3	49	KS	female	picture	62,1	47,5

Figure 5 shows that KG has higher average PVI values than SMG, except for consPVI in the picture task. The high consPVI values for SMG in this task can be largely attributed to the high consonantal variability of the speaker TT (Table 1). Inter-speaker variability was also observed in the data. For example, there is a great difference in the vocPVI of the two KG speakers in the reading task and a great difference in the vocalic and consonantal PVI scores for the two SMG speakers in the picture task.

Variation due to elicitation type is also evident. For SMG, average PVI scores for the picture task are higher than those for text reading. KG shows the opposite pattern with generally higher scores for text reading than the picture task (with the exception of the voc PVI for speaker TL) (Table 1). It should be noted that the text used in this study was designed to include many words that could potentially undergo VD in KG. This is expected to result in the presence of many consonantal sequences and hence increased consonantal variability for the text-reading elicitation task. This is clearly illustrated in Figure 6 which plots consPVI against vocPVI. The KG read text appears on the right side of the graph as a result of the large consPVI. It should be noted that PVI scores closer to the upper-right side of the graph are indicative of more 'stress-timing', whereas scores closer to the lower-left side indicate lower variability and, thus, more 'syllable-timing'. For SMG quasi-spontaneous speech from the picture task shows greater PVI values than the read text indicating more variability in the former task.

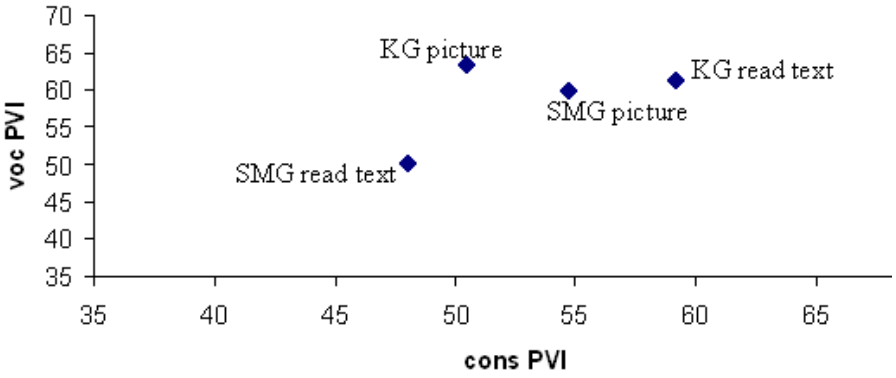


Figure 6: *The PVI profile of SMG and KG*.

3.2. Inter-stress intervals

Table 2 presents the average number of unstressed syllables between stresses for all speakers in the two elicitation tasks. On average, SMG tends to compress more unstressed syllables between stresses than KG in both text and picture, i.e. a larger number of unstressed syllables intervenes between stresses in SMG than KG. Speaker variability was however evident with KG speaker KS producing more unstressed syllables than the two SMG speakers in the picture task.

With reference to the influence of elicitation task, for SMG speakers, the averages for the read text are higher than those for the picture. This could be attributed to the presence of more instances of VD in quasi-spontaneous speech for the SMG speakers (see Dauer 1983, Baltazani 2007). Text reading may be assumed to involve a more careful style of production thus not favouring as many instances for VD as more free types of speech.

While, on these grounds, similar results may be expected for KG, i.e. more unstressed syllables in the read text than quasi-spontaneous speech, interesting speaker variation is evident in the data. Speaker TL shows a similar pattern to SMG speakers while speaker KS produces slightly fewer unstressed syllables in the read text. Overall, KS has the largest number of unstressed syllables of all speakers in the picture task. It is interesting to note that in the read text there is no large inter-speaker variation within SMG or KG indicating relatively similar speaker behaviour in the more formal style of speech. For SMG, inter-speaker variation is consistent between elicitation types, i.e. BT consistently produces fewer unstressed syllables than TT in both tasks; this can be interpreted as more instances of VD by this speaker. For KG, speaker KS consistently produces more unstressed syllables than TL in both elicitation types indicating less VD by this speaker. Evidence of more unstressed syllables in the picture task than the read text may relate to individual/idiolectal preferences during the production of freer speech, i.e. relatively careful production, or to possible planning/execution strategies, for example prolongation of unstressed vowels or other dysfluencies, which may affect the number of unstressed syllables between stresses.

Table 2: *Average number of unstressed syllables between stresses per speaker across dialects and elicitation tasks*

	SMG		KG	
	BT	TT	KS	TL
Read text	1.71	1.83	1.56	1.44
Picture	1.39	1.49	1.65	1.14

To investigate the regularity of prominences / beats, we examined the frequency of occurrence of unstressed syllables, i.e. how many 0σ, 1σ, 2σ, etc. intervals appeared

between stresses, for each speaker and text type. In figures 7 and 8, percentage data are pooled for both speakers in SMG and KG, so that dialectal differences are shown.

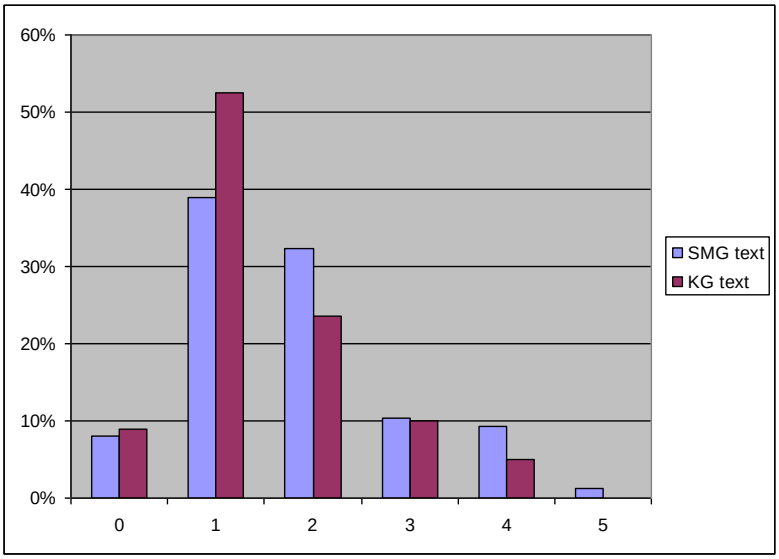


Figure 7: *Percentages of unstressed syllables between stresses cross-dialectally in 'read text'*

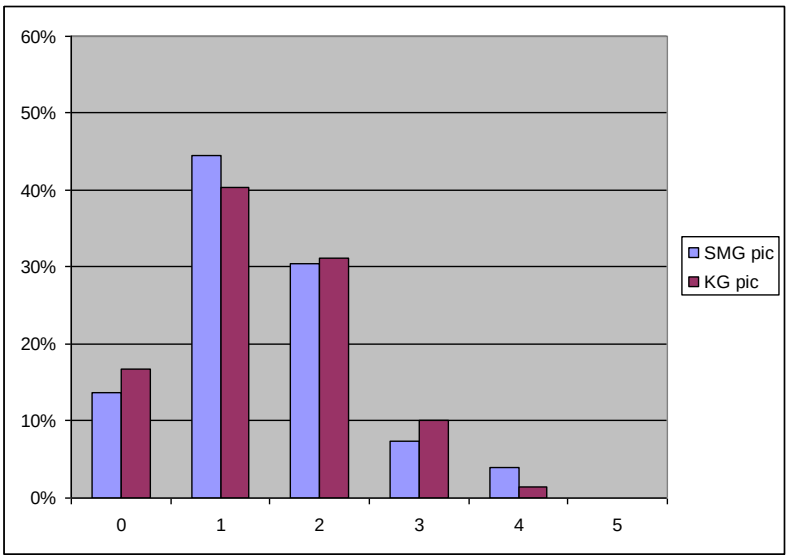


Figure 8: *Percentages of unstressed syllables between stresses cross-dialectally in 'picture'*

With reference to the read text, the preferred ISI is 1σ for KG; this appears over 50% of the time. The 2σ ISI shows relatively high frequency, but compared to the 1σ ISI, it appears less frequently at approximately 25%. The remaining intervals appear much less frequently, i.e. less than 10%. For SMG speakers the 1 and 2σ intervals are also preferred, but their percentages are much more balanced, i.e. 39% vs. 32% respectively. The remaining ISIs appear less frequently, less than 10%, but intervals longer than 3σ, emerge slightly more frequently in this dialect compared to KG. In fact, a single instance of a 5σ interval, the longest present in the data, is found in the read text of SMG.

With reference to the picture task, preference for 1σ and 2σ ISIs is evident in both dialects. Larger ISIs (3σ and 4σ) appear less frequently, i.e. less than 10%, in both dialects. Comparing the two elicitation types (Figures 7 and 8), an interesting increase in the 0σ ISIs is evident in the picture task for both dialects. For KG, a decrease is evident in the 1σ ISIs and an increase in the 2σ ISIs in the picture task compared to the read text.

Interesting speaker variability especially between the KG speakers was also evident in the data (Figures 9 and 10). For the read text, relatively large differences between the two KG speakers are evident for the 2σ ISIs followed by the 0σ and 3σ ISIs.

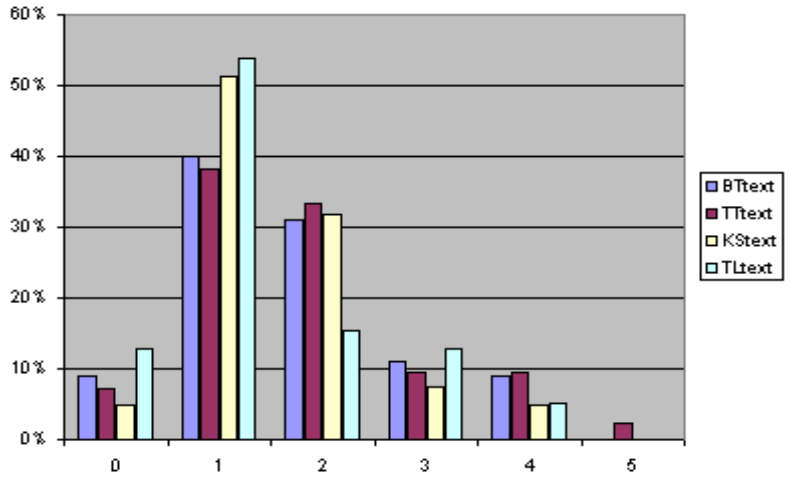


Figure 9: *Percentages of unstressed syllables between stresses for each speaker in 'read text'*

For the picture task, there is a very large difference between the KG speakers for the 1σ ISI which is lower by 20% for speaker KS compared to TL. Relatively large differences between the KG speakers are also evident for the 3σ ISI. In addition, KS is different from the other SMG and KG speakers in that she has a higher percentage for the 2σ than the 1σ ISI.

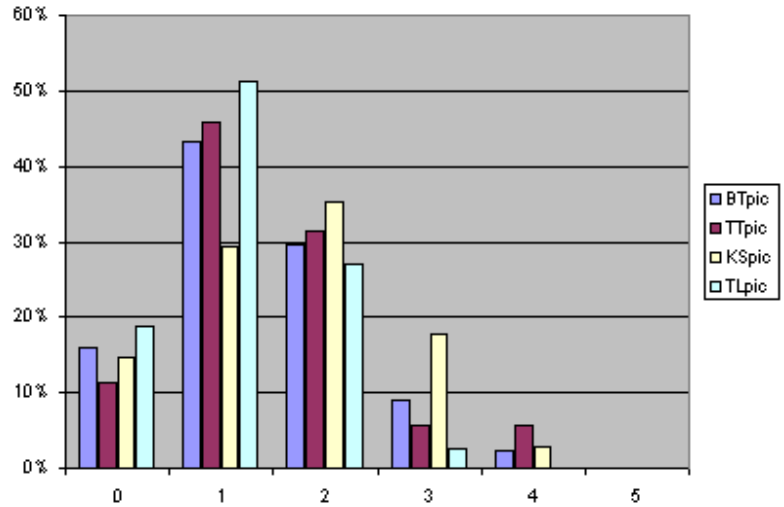


Figure 10: *Percentages of unstressed syllables between stresses for each speaker in 'picture'*

4. Discussion

The aim of this study has been to investigate potential differences in speech rhythm between SMG and KG. KG typically includes processes such as VD of unstressed high vowels (/i/ and /u/) and as such it is expected to present a more complex syllable structure due to the creation of consonantal sequences after the application of VD. Complex syllable structure and vowel reduction may affect its rhythmic classification differentiating it from SMG.

The results of the PVI analysis for the read text indicated that KG had more consonantal and vocalic variability and was thus more stress-timed compared to SMG. Since the text used in the current study included many potential instances of VD in KG, it

can be argued that these findings support Arvaniti's (2009) findings on the influence of type of material on metric scores. As a result of VD, the text included more instances of consonantal sequences which together with variability in the vocalic intervals resulted in the more stress-timed classification of KG.

Such influence is not expected in the quasi-spontaneous speech from the picture task. The PVI results showed larger vocPVI for KG which suggests greater vocalic variability in this dialect. This is in line with the results of Topintzi and Baltazani (to appear) who argue that VD is gradient and variable in KG. It is gradient in the sense that outputs of the process range from truly elided vowels to fully voiced ones along with various intermediate realisations, such as completely or partly devoiced. It is also variable, because tokens of the same word may sometimes undergo vowel deletion and sometimes not. While gradient and variable effects have been reported for VD in SMG by Dauer (1980) and Baltazani (2007), these results suggest greater variability in KG that SMG.

On the other hand, the consPVI was greater for SMG than KG indicating more consonantal variability in SMG. Although both SMG speakers showed this tendency, there was inter-speaker variability as one of the speakers (TT) had a very high consPVI and thus a large difference from the KG speakers. The other speaker had relatively similar consPVI with the KG speakers. Taken together, these results for the quasi-spontaneous speech (for which there is no expected imbalance towards more instances of VD for the SMG dialect) show different tendencies for KG and SMG which do not clearly differentiate the two dialects in the more or less stress- timed continuum.

The results of the ISI approach have shown that on average there are more unstressed syllables between stresses in SMG than KG. This is the case for both speakers in the read text. Such a finding may relate to the text used; many instances of VD by the KG speakers may be expected to result in fewer unstressed syllables between stresses. The results for the picture task may thus be expected to show more representative cross-dialectal differences. Speaker variation was however evident in the data. Similarly to the results for the read text, one of the speakers produced fewer unstressed syllables compared to the SMG speakers. The other speaker though produced more unstressed syllables than the SMG speakers. The results do not therefore provide conclusive evidence as to possible differences in the spacing of prominences in the two dialects. Following Arvaniti (2009), prominences may be expected to be sparser in SMG if this is assumed to be less stress-timed than KG due to simpler syllable structure and less VD effects.

In terms of the frequency of occurrence of unstressed syllables, both SMG and KG show a higher frequency of occurrence of 1σ and 2σ ISIs over less (0σ) or more (3σ, 4σ, 5σ) unstressed syllables. The highest percentages are evident for the 1σ ISIs in both dialects. Variation was evident due to elicitation type. In the read text KG speakers showed a strong tendency for the 1σ ISIs over the 2σ ISIs (twice as many 1σ ISIs), while SMG speakers had smaller differences between the 1σ and 2σ ISIs. Such a finding may relate to the read text used (see above). In the picture task, the results show similar tendencies between SMG and KG, i.e. overall highest percentage for 1σ ISIs followed by 2σ ISIs. There was however important speaker variability especially for the KG speakers. One KG speaker showed a slightly higher percentage for the 2σ ISI over the 1σ ISI. The other KG speaker showed a strong preference for the 1σ ISI over the 2σ ISI similarly to the read text. For both dialects, an interesting increase in the 0σ ISI was also evident indicating more instances of adjacent stresses (i.e. stress clashes) in the quasi-spontaneous speech.

To sum up, the above findings have provided important information regarding consonantal and vocalic variability as well as the interstress intervals in SMG and KG. Variation due to speaker and elicitation type has clearly shown that more speakers and different types of material are necessary before any conclusive evidence is provided regarding possible rhythmic differentiation between the two dialects.

Overall, we believe that the ISI approach adopted in this study may provide a promising line of research in the study of rhythm in line with Arvaniti's (2009) suggestion

that rhythm should be dissociated from timing following a distinction used in psychology, namely that "timing is concerned with the durational characteristics of events, while rhythm has to do with the pattern of periodicities that is extracted from these durations" (2009: 59). This approach also offers a tentative interpretation – by means of interstress intervals – of Arvaniti's statement that rhythm is created on the basis of grouping and prominence patterns. In particular, we have set aside reference to consonantal and vocalic variability and speculate that rhythm primarily relies on two dimensions:

(a) Beat Frequency
(b) ISI distribution

Beat frequency refers to the preferable spacing between beats expressed as the mean value of the ISIs. The higher this number, the more syllables are clustered between stresses or, alternatively, the longer the ISI in terms of syllables. ISI distribution refers to the distributional pattern of unstressed syllables, i.e. whether most ISIs are clustered together in a certain area, e.g. that of 1-2σ, or they are more evenly distributed among various syllables, e.g. roughly equally spread between 0-4σ.

Several aspects of this approach need to be fine–tuned and evaluated in future work, e.g. methodological issues such as the exclusion of unstressed syllables following a pause and theoretical issues such as the influence of vowel/consonant length and mora structure on overall rhythm. While the results of the current study have not been conclusive for the two dialects of Greek (SMG and KG) – possibly because they are not very different – it will be interesting to test the ISI account in other languages, especially those that are traditionally termed stress-timed (English, Dutch) and syllable-timed (Spanish, French). Another testing ground is languages with fixed primary stress and no secondary stress even in polysyllabic words of 5 or 6 syllables, e.g. Mohawk (Michelson 1989, see also Heinz 2007), especially if they lack processes of vowel reduction/deletion while speaking rate is not very high. The ISI approach predicts that ISI distribution should be quite scattered, because in the absence of secondary stress, the spacing between fixed stresses will be relatively variable, thus creating the percept of less 'canonical' rhythm.

Appendix

A) *Text*

Κάθε μέρα με το που χαράζει ο Νίκος, νυσταγμένος, βγαίνει από το σπίτι. Περπατά αργά ως τη στάνη για να ταίσει τα γουρούνια. Πάντα χαζεύει γύρω του. Χαζεύει το πουλί που τσιμπολογά το σκουλήκι, το χιόνι που πέφτει στα βουνά ασταμάτητα, το σκυλί που το κόκκαλο χώνει βαθιά στη γη. Το σκυλί μόλις τον βλέπει, κουνά την ουρά, τρέχει και τον φιλά. Είναι λες και του τραγουδά. Μέχρι να γυρίσει πίσω είναι για τα καλά ξύπνιος. Κάθε μέρα η ίδια δουλειά**.**

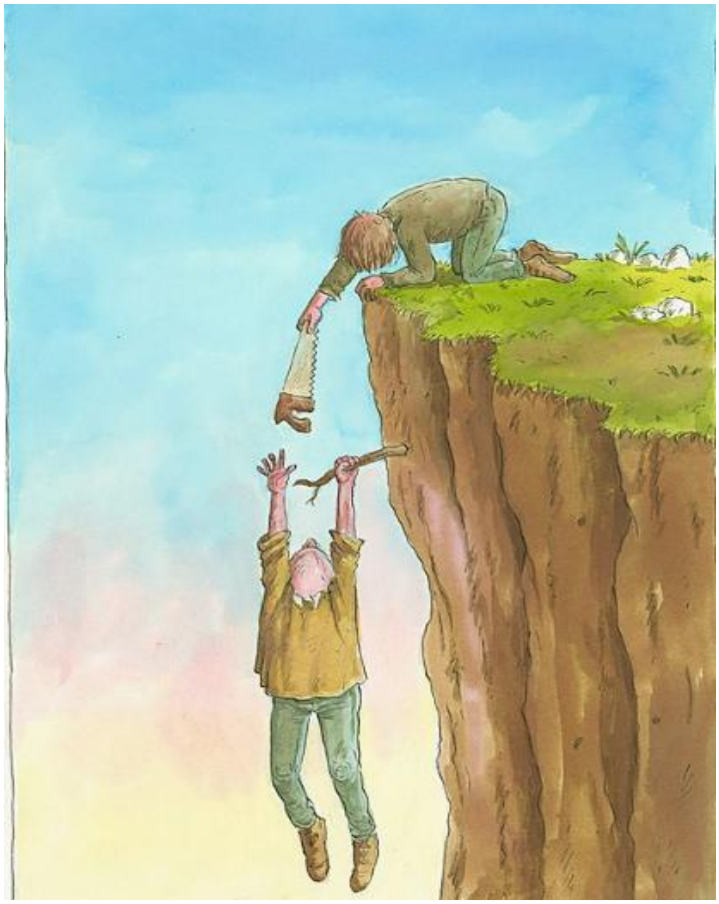
IPA Transcription *(assuming SMG careful speech)*

‖ ˈkaθe ˈmeɾa me to pu xaˈɾazi | o ˈnikos | nistaɣˈmenos | ˈvʝeni apo to ˈspiti ‖ peɾpaˈta aɾˈɣa os ti ˈstani ʝa na taˈɪsi ta ɣuˈɾuɲa ‖ ˈpaⁿda xaˈzevi ˈʝiɾo tu ‖ xaˈzevi to puˈli pu tsiᵐbolˈɣa to skuˈlici | to ˈçoni pu ˈpefti sta vuˈna astaˈmatita | to sciˈli pu to ˈkokalo ˈxoni vaˈθça sti ʝi ‖ to sciˈli ˈmolis ton ˈvlepi | kuˈna tin uˈɾa | ˈtɾeçi | ce ton fiˈla ‖ ˈine les ce tu tɾaɣuˈða ‖ ˈmexɾi na ʝiˈɾisi ˈpiso | ˈine ʝa ta kaˈla ˈksipɲos ‖ ˈkaθe ˈmeɾa i ˈiðʝa ðuˈʎa‖

Translation

Every day as soon as it dawns, sleepy Nikos gets out of the house. He walks slowly to the pen to feed the pigs. He always looks around. He stares at the bird that pecks a worm, the snow that endlessly falls on the mountains, the dog that buries a bone deep in the ground. The dog, as soon as it sees him, wags its tail, runs towards him and kisses him. It's as if it sings to him. Until he (Nikos) comes back is wide awake. Every day the same thing goes on.

B) *Picture* (from: http://www.humor-kamensky.sk/indexuk.htm)



References

Asu E. L. & Nolan F. (2006). Estonian and English rhythm: a two-dimensional quantification based on syllables and feet. In Proceedings of Speech Prosody 2006, Dresden, Germany

Abercombie D. (1967). *Elements of General Phonetics.* Edinburgh: Edinburgh University Press.

Arvaniti A. (1999). Illustrations of the IPA: Modern Greek. *Journal of the International Phonetic Association* 19: 167-172.

Arvaniti A. (2007). Greek phonetics: State of the art. *Journal of Greek Linguistics* 8: 97-208.

Arvaniti A. (2009). Rhythm, timing and the timing of rhythm. *Phonetica* 66: 46-63.

Baltazani M. (2005). Phonetic variability of the Greek rhotic sound. Poster presented at the *Phonetics and Phonology in Iberia (PaPi 05),* Barcelona, Spain.

Baltazani M. (2007). Prosodic rhythm and the status of vowel reduction in Greek. *Selected Papers on Theoretical and Applied Linguistics from the 17th International Symposium of Theoretical and Applied Linguistics,* Thessaloniki, 31-43.

Baltazani M. (2009). Acoustic characterization of the Greek [ɾ] in clusters. *Proceedings of the 18th International Symposium on Theoretical and Applied Linguistics, Salonica 4-6 May 2007*, Volume 1: 87-95

Barry W. & Andreeva B. (2001). Cross-Language similarities and differences in spontaneous speech patterns. *Journal of International Phonetics Association* 31: 51–66.

Barry W. J., Andreeva B., Russo M., Dimitrova S. & Kostadinova T. (2003). Do rhythm measures tell us anything about language type? *Proceedings 15th ICPhS*, Barcelona, pp. 471-474.

Boersma P. & Weenink D. (2007). Praat. Doing phonetics by computer (version 4.6.01), http://www.praat.org/

Bolinger D.L. (1965). *Form of English: Accent, Morpheme, Order*. Cambridge Mass: Harvard University Press.

Bunta F. & Ingram D. (2007). The acquisition of speech rhythm by bilinguals Spanish- and English-speaking 4- and 5-year-old children. *Journal of Speech, Language and Hearing Research* 50: 999-1014

Dauer R. M. (1980). The reduction of unstressed high vowels in Modern Greek. *Journal of the International Phonetics Association* 10: 11-27

Dauer R. M. (1983). Stress–timing and syllable–timing reanalyzed. *Journal of Phonetics* 11: 51-62.
Dauer R. M. (1987). Phonetic and Phonological components of language rhythm. *Proceedings of the 11th International Congress of Phonetic Sciences* 5: 447-450.
Dinas K. (2005) *The dialect of Kozani* [*Το γλωσσικό ιδίωμα της Κοζάνης*]. Kozani: Institute of Book and Reading.
Ferjan N., Ross T. & Arvaniti A. (2008). L2 speech and rhythm metrics. Paper presented at *ASA '08*, Paris, June 29- July 4 2008.
Frota S. & Vigario M. (2001). On the correlates of linguistic rhythmic distinctions: The European/Brazilian Portuguese case. *Probus* 13: 247-275.
Ghazali S., Hamdi R. & Barkat M. (2002). Speech rhythm variation in Arabic dialects. *Speech Prosody*, Aix-en-Provence, France, 331-334.
Grabe E. & Low E. L. (2002). Durational variability in speech and the rhythm class hypothesis. *Papers in Laboratory Phonology 7*, Berlin: Mouton de Gruyter, 515-546.
Heinz J. N. (2007). *Inductive learning of phonotactic patterns*. PhD Dissertation, UCLA.
Jianm H.-L. (2004). On the syllable timing in Taiwan English. *Speech Prosody*, Narra, Japan, 247-250.
Johnson K. & Sinabaugh B. (1985). The simplification of the Greek vowel system. *CLS* 21/1: 189-198.
Ladefoged P. (1975). *A Course in Phonetics*. New York: Harcourt Brace Jovanovich.
Lehiste I. (1977). Isochrony reconsidered. *Journal of Phonetics* 5: 253-263.
Ling L. E., Grabe E. & Nolan F. (2000). Quantitative characterizations of speech rhythm: Syllable timing in Singapore English. *Language and Speech* 44/3: 377-401.
Malavakis T. I. (1984). Φωνηεντικές Συνέχειες: Διφθογγοποίηση, Ουρανικοποίηση και Φωνηματική Κατάταξή τους [Vowel Sequences: Diphthongization, Palatalization and Phonemic Classification]. *Studies in Greek Linguistics* 4: 1-16
Michelson K. (1989). Invisibility: Vowels without a timing slot in Mohawk. In D.B. Gerdts & K. Michelson (eds.), *Theoretical Perspectives on Native American Languages*. New York: SUNY Press, 38-69.
Mok P. P. K. & Dellwo V. (2008). Comparing native and non-native speech rhythm using acoustic rhythmic measures: Cantonese, Beijing Mandarin and English. *Speech Prosody 2008*, Campinas Brazil, 423-426.
Nicolaidis K. (2003). Μια Ηλεκτροπαλατογραφική Μελέτη των Ουρανικών Συμφώνων της Ελληνικής [An Electropalatographic Study of the Palatal Consonants of Greek]. *Σύγχρονες Τάσεις στην Ελληνική Γλωσσολογία* [Contemporary Trends in Greek Linguistics], D. Theophanopoulou-Kontou, C. Lascaratou, M. Sifianou, M. Georgiafentis & V. Spyropoulos (eds.), Athens: Patakis, 108-127
O' Rourke E. (2008). Speech rhythm variation in dialects of Spanish: Applying the pairwise variability index and variation coefficients to Peruvian Spanish. *Speech Prosody 2008*, Campinas Brazil, 431-434.
Pike K. (1945). *The Intonation of American English*. University of Michigan: Ann Arbor Press.
Ramus F., Nespor M. & Mehler J. (1999). Correlates of linguistic rhythm in the speech signal. *Cognition* 73: 265-292.
Ross T., Ferjan N. & Arvaniti A. (2008a). Speech rhythm and its quantification in L1. Poster presented at the *1st Southern California Workshop on Phonetics / Phonology (SCOPHO),* November 1, 2008.
Ross T., Ferjan N. & Arvaniti A. (2008b). On quantifying speech rhythm. Poster presented at the *Workshop on Empirical Approaches to Rhythm*, 28 March 2008, UCL, London.
Topintzi N. & Baltazani A. (to appear). The acoustics of high-vowel loss in a Northern Greek dialect and typological implications. P. Hoole, L. Bombien, M. Pouplier, C. Mooshammer, and B. Kühnert (eds) *Clusters and Structural Complexity*. Interface Explorations Series, Berlin: Mouton de Gruyter.
Tsiartsioni E. (2008). A PVI analysis of Greek speech rhythm among children, teenagers and adults. *Proceedings of the 29th Annual Meeting of the Department of Linguistics,* Aristotle University of Thessaloniki 10-11/5/2008, 541-552.
White L. & Mattys S. (2007). Calibrating rhythm: first and second language studies. *Journal of Phonetics* 35 / 4: 501-522.