

Prosodic phrasing and syntactic structure in Greek

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Abstract

This is a study of prosodic phrasing in relation to syntactic structure as a function of female and male speaker's gender as well as normal and fast speech tempo in Greek. The results indicate: (1) prosodic phrasing has a 95% identification rate; (2) prosodic phrasing has a major effect on final tonal boundaries; (3) speech tempo has a major effect on pause productions but only a marginal effect on tonal productions; (4) speaker's gender has a major effect on both tonal and pause productions.

Introduction

This study is within a multifactor research context in sentence structure linguistics. We examine the relation between sound and meaning as a function of lexical, syntactic, semantic and prosodic interactions in an integrated experimental phonetics, theoretical linguistics and computational linguistics framework (see Botinis 2003, Botinis, Gawronska and Haida 2003, Botinis, Baltazani and Haida 2004).

Phrasing continuous speech into a variety of meaningful linguistic units is one of the basic functions of prosody, which is assumed to be characterized by distinctive functions and related phonetic forms. In this study, one perception experiment was set to examine the identification of phrasing and one production experiment to investigate its phonetic form as a function of normal and fast speech tempo as well as female and male speaker's gender.

Our primary interest in this research paradigm is the production of basic experimental knowledge in order to develop powerful linguistic models, which may be used in a variety of applications in language technology, language education and language pathology.

Experimental methodology

The speech material of both perception and production experiments consists of a compound sentence with three distinctive phrasings, which define the syntactic boundaries of a main and a subordinate clause, indicated by a comma in Greek orthography (Table 1).

Table 1. Prosodic phrasing and syntactic boundaries of test sentence productions.

a	Ótan bíkame, mésa sto jípeðo jinótane xamós. When we got in, inside the stadium a riot broke out.
b	Ótan bíkame mesa, sto jípeðo jinótane xamós. When we got inside, in the stadium a riot broke out.
c	Ótan bíkame mésa sto jípeðo, jinótane xamós. When we got inside the stadium, a riot broke out.

In the perception experiment, the three distinctive sentence productions were organised in consecutive stimuli, in a random order of ten repetitions, separated by a two seconds interval. Ten students of the Linguistics Department at Athens University were asked to tick on one of the three alternative test sentence options for each stimuli, in accordance with the perceived phrasing distinction.

In the production experiment, five female and five male students of the Linguistics Department at Athens University produced the speech material in ten repetitions at normal and fast speech tempo. The speech material was directly recorded in to a computer disc and analysed with the Waveserfer software package.

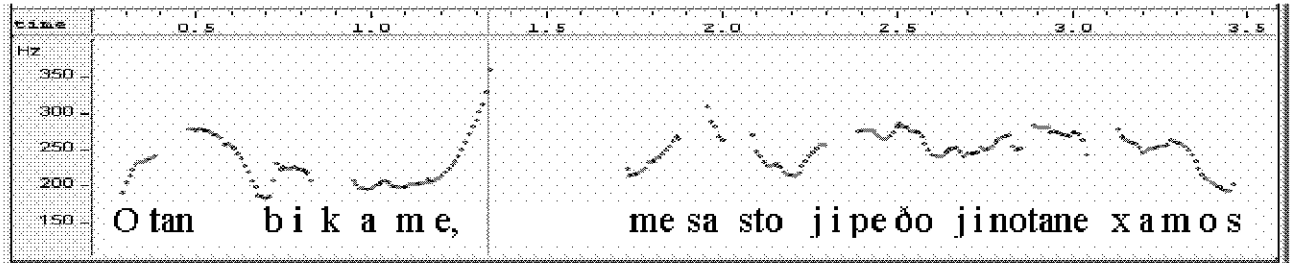
Tonal measurements were taken at onset and offset of sentence productions as well as left and right boundaries of the speech material corresponding to all three phrasing productions. Temporal measurements of silent pause productions were also taken at the latter points.

Results

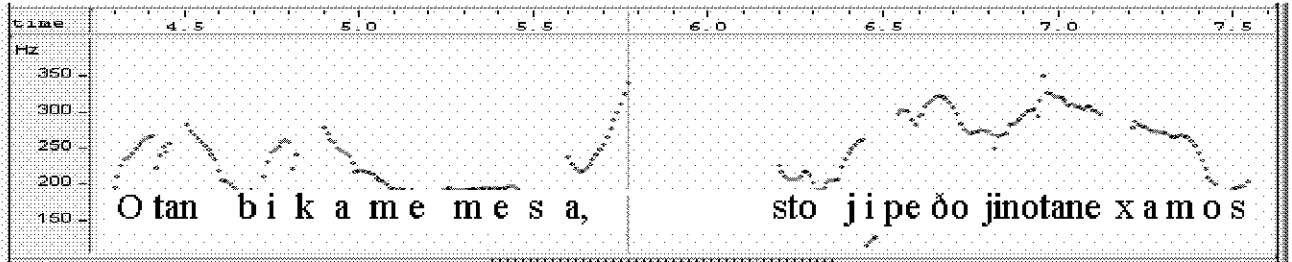
Table 2 shows the results of the perception experiment. Figure 1 shows prosodic analysis of a female speaker, the normal tempo of which was used for the perception experiment. Figure 2 shows the production experiment results.

Table 2. Results of the perception experiment.

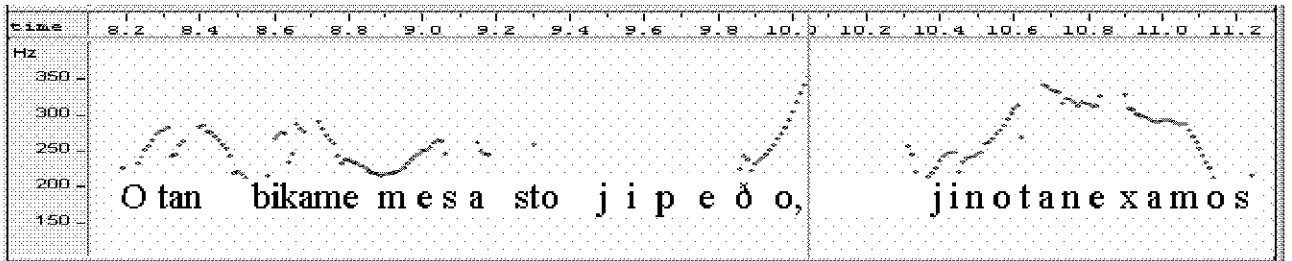
Produced	Perceived					
	Fast			Normal		
	a	b	c	a	b	c
a	95	3	2	95	2	3
b	2	95	3	3	95	2
c	3	2	95	2	3	95



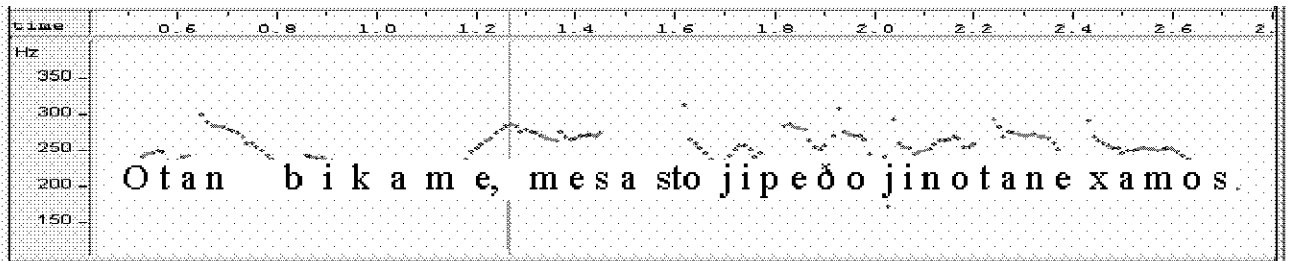
(a) normal tempo.



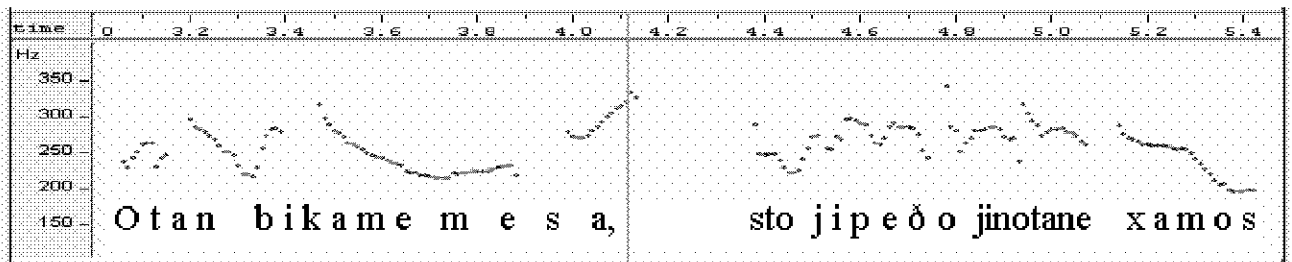
(b) normal tempo.



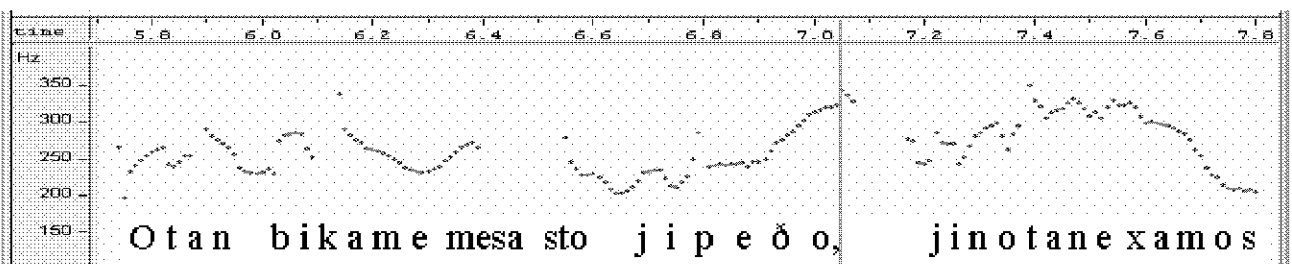
(c) normal tempo.



(a) fast tempo



(b) fast tempo



(c) fast tempo.

Figure 1. Distinctive phrasing productions at normal and fast tempo by a female speaker.

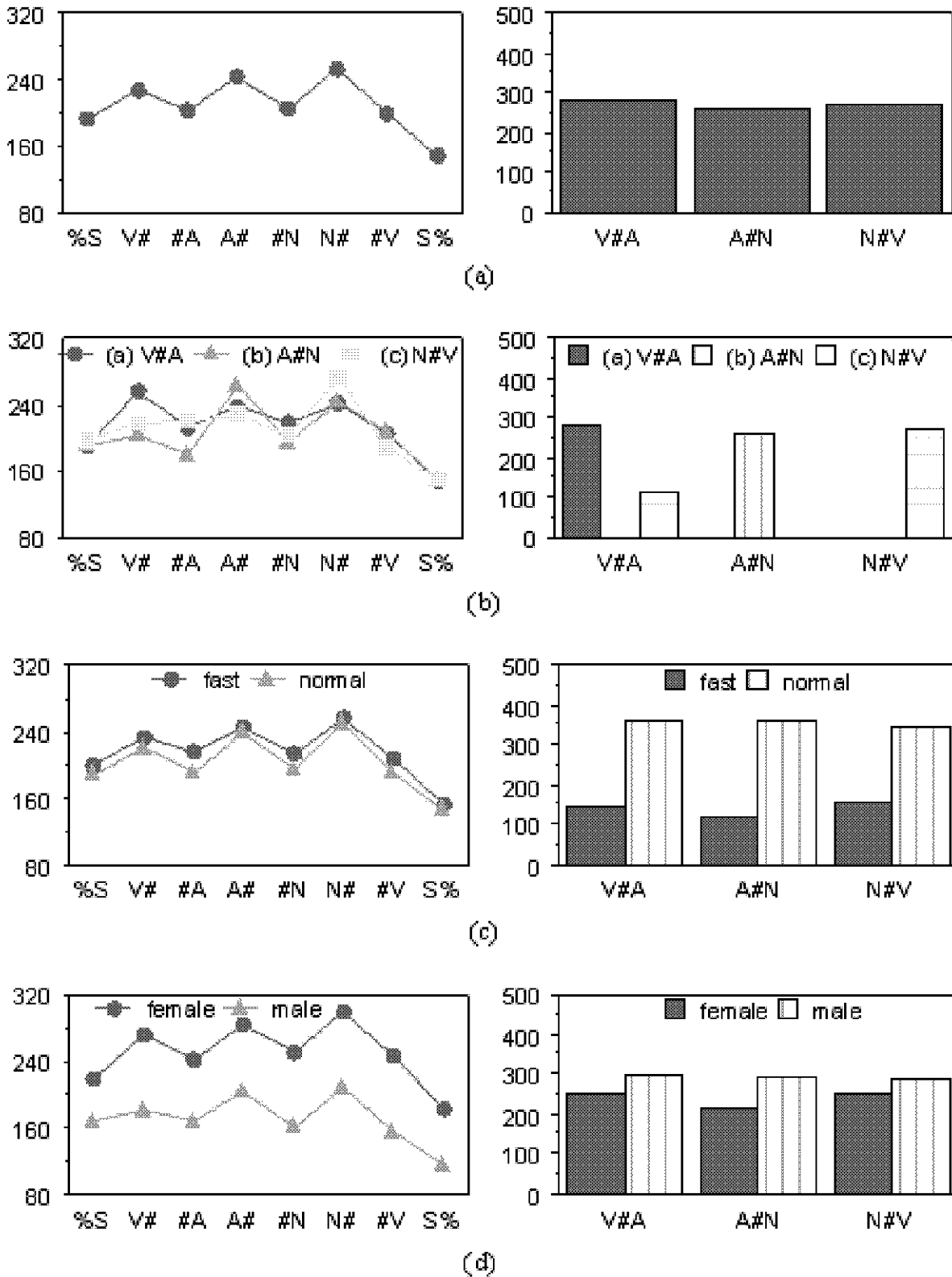


Figure 2. Tonal (left) and temporal (right) results of (a) phrasing productions as a function of (b) each distinctive phrasing, (c) normal and fast speech tempo and (d) female and male speaker's gender. Sentence boundaries are indicated by %, and lexical boundaries by #.

In Table 2, the three distinctive phrasing productions (a, b, c) were identified by 95% across both normal and fast speech tempo.

In Figure 1, the test sentence was produced with two prosodic phrases in all three distinctive phrasing productions (a, b, c).

The final tonal boundary of the preceding prosodic phrase is a major tonal rise, which is the most prominent one across the prosodic phrase. There are tonal variations aligned with lexical stress distinctions except for the final one of the corresponding prosodic phrase.

In Figure 2(a) (left), the analysis of the total speech material shows a tonal rise production on the final edge of each lexical boundary, which is the effect of the three distinctive phrasing productions. The left edge of the lexical boundaries shows a lowered tonal pattern, which is the effect of a phrasing tonal resetting. In Figure 2.1 (right), however, pause productions do not show any variation with reference to the syntactic constituency boundaries.

In Figure 2(b, left), the distinctive phrasing productions have a significant effect (at least 0.05 level) across all tonal measurement points except for the initial and final sentence boundary ones. In Figure 2(b, right), the main effect of the phrasing productions is mostly confined to the respective phrasing boundaries except for one prosodic production (c), which may have a double pause distribution effect.

In Figure 2 (c, left) the main tonal effect of speaker's speech tempo is a minor one, confined to the left edge of the lexical boundaries associated with the prosodic phrasing productions, and this effect is significant (at 0.05 level). The main temporal effect of speech tempo, on the other hand, is highly significant (at 0.0001 level) as normal speech tempo has over double pause durations than fast speech tempo (Figure 2c, right).

In Figure 2 (d, left), the main effect of speaker's gender is highly significant (at 0.0001 level), as the tonal production of female speakers is on the average about 60% higher than that of male ones. In Figure 2 (d, right), the main effect of speaker's gender is highly significant, as male pauses at prosodic phrasing boundaries are on the average about 20% longer than male ones. The total sentence durations, however, do not have any significant differences as shown in Table 3.

Table 3. Test sentence durations as a function of speech tempo and speaker's gender.

Tempo	Female	SD	Male	SD	
Normal	2987	351	2964	279	NS
Fast	2154	165	2141	190	NS
	p<0.0001		p<0.0001		

Discussion and conclusions

The results of the present study indicate that, on the one hand, prosodic phrasing is a distinctive linguistic category with identification rate at 95% and, on the other hand, all investigated factors of prosodic phrasing, speech tempo and speaker's gender have a significant effect on both tonal and temporal productions of the analysed speech material.

Prosodic phrasing has both a tonal production effect and a pause production effect correlated with prosodic boundaries. Pause production is most evident at normal tempo. The effect of prosodic phrasing has both local and global effects and may cause deaccentuation of lexical stress productions.

Speech tempo has a major pause production effect and a minor tonal production effect. At normal speech tempo, prosodic phrasing may have an optional pause production effect. Fast speech tempo, on the other hand, may be correlated with higher tonal production and this has been observed in earlier research on Greek (Fourakis, Botinis and Katsaiti 1999).

Speaker's gender has a major effect on tonal production, which is about 60% higher for female speakers than male one. The effect of speaker's gender on temporal production has hardly drawn particular attention in international research. In this study, male speakers produce longer pauses than female speakers whereas the results of recent research indicate that female speakers may produce segmental vowels significantly longer than male ones.

References

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