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Phrase-final words in Greek storytelling speech: a study on the effect of a  
culturally-specific prosodic feature on short-term memory

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## **Abstract**

Prosodic patterns of speech appear to make a critical contribution to memory-related processing. We considered the case of a previously unexplored prosodic feature of Greek storytelling and its effect on free recall in thirty typically developing children between the ages of 10 and 12 years, using short ecologically valid auditory stimuli. The combination of a falling pitch contour and, more notably, extensive final-syllable vowel lengthening, which gives rise to the prosodic feature in question, led to statistically significantly higher performance in comparison to neutral phrase-final prosody. Number of syllables in target words did not reveal substantial difference in performance. The current study presents a previously undocumented culturally-specific prosodic pattern and its effect on short-term memory.

Keywords: prosody, storytelling, short-term memory, pitch, duration

## **1 Introduction**

Prosodic information in the acoustic signal plays a pivotal role in word recognition and retrieval (Lindfield et al. 1999), forms part of the listener's memory representation of an utterance (Cutler et al. 1997), and has been shown to have an effect on speech processing at a very young age (Fernald and Mazzie, 1991; Grassmann and Tomasello, 2007; Sakkalou and Gattis, 2012). Lists of items presented in serial recall tasks are often retrieved more easily when they are organised in rhythmic groups (Reeves et al. 2000). Interestingly, the facilitatory effect of prosodic cues on short-term memory can be independent of syntax, enhancing performance even in the case of nonsense syllables and digit

sequences (Gilbert and Boucher, 2007). The interaction of prosodic features will sometimes also facilitate recall. In a study of digit series recall, participants scored higher when grouping was combined with pitch contours in the stimuli (Savino et al. 2013).

Prosody does not, however, seem to always have a processing advantage over prosodically neutral speech. Emotional prosody, which reflects the affective state of the speaker (Grandjean, et al. 2006; Thompson et al. 2012), has been demonstrated to have an effect on short-term memory in some studies, but this evidence is not conclusive. Emotionally coloured words have been found to be more easily recalled in comparison to neutral words (Brierley et al. 2007) and this effect has been also shown in neurological patients (Nieuwenhuis-Mark et al. 2009). However, older adults, as suggested in Fairfield et al. (2016), can do better on word recall tasks for prosodically neutral rather than emotionally charged words. One possible reason for this inconsistency is that different emotions correspond to a variety of different acoustic realizations (Johnstone and Scherer, 1999; Wiethoff et al. 2008), which can lead to different effects on performance across studies.

Prosody can extend beyond the study of established linguistic and emotional prosodic categories. Prosodic marking in speech suggests that speaker variance is not captured in predictable phonological rules stemming from syntactic structure and emotional state. Theune et al. (2006) compared the output of storytellers and newsreaders and found that pitch and intensity variation was more pronounced in storytellers. Storytellers were also found to speak slower, take longer pauses among sentences, and place more emphasis on adjectives and adverbs through

increased pitch differences and duration patterns. Similar differences between storytelling and radio news speaking style speech were also found in Doukhan et al. (2011). Although storytelling is often studied in relation to emotion labels (Alm and Sproat, 2005; Sarkar et al. 2014), prosodic devices employed during storytelling can differ substantially from the acoustic features pertaining to specific emotions (Montano and Alias, 2016). It should be noted that such additional devices point to further directions allowing for the study of prosody beyond syntactic well-formedness and emotion.

In the present study, we consider the case of an unexplored characteristic of Greek prosody which, according to a survey that we conducted as part of our study, is identified by Greek native speakers as a characteristic of storytelling speech and is a prosodic pattern that needs to be examined further. The prosodic pattern in question arises from the combination of a falling pitch contour in relation to the preceding word and, more notably, extensive final-syllable vowel lengthening regardless of whether the syllable is stressed. In order to better appreciate this feature, it is worth looking briefly at vowel duration patterns in Greek. Vowel duration in Greek is determined by the presence of word stress, word length, and position of a given vowel relative to word stress, with post-stress vowels being shorter (Baltazani, 2007). Secondary stress does not normally occur in Greek, except for cases where stress falls on the antepenult or penult of a word that is followed by an enclitic (Arvaniti, 1999). The storytelling prosodic pattern we examine here is not in line with the vowel duration rule stated above, while at the same time raising questions on aspects of syllable prominence. The rule of shorter post-stress vowel does not seem to apply to this

particular case. On the contrary, the last vowel of a word in storytelling can be much longer than the stressed vowel even when it is a post-stress vowel (see Figure 1 in section 2.4). As this feature would rarely occur in everyday speech, we do not consider it as an example of secondary stress. We, however, suggest that it alters -to some extent- perception of syllable prominence due to the extensive lengthening of the last syllable irrespective of stress position.

Previous studies that have been conducted in different languages and used storytelling speech show that prosodic patterns happening to occur in storytelling enhance memory-related tasks in children (Goldman et al. 2006; Mira and Schwanenflugel, 2013). Rather than using generic storytelling speech, we here focus on a specific phrase-final prosodic feature of Greek storytelling, adopting a free recall paradigm. To our knowledge, this phonological feature has not been reported before and, hence, we conducted a preliminary survey, as mentioned above, that allowed us to determine whether native speakers of Greek identify the feature in question as a storytelling characteristic. In our main study, we report on a free recall experiment using stimuli differing in prosodic realization in three conditions, controlling for the effect of number of syllables in target words.

The aims of the present work are threefold: to introduce an unexplored prosodic feature of Greek storytelling, to study the effect of storytelling on short-term memory in close relation to a specific phonological pattern rather than a type of discourse, and to discuss whether this pattern could contribute to the field of teaching. As this feature is not in line with the phonological rules of Greek, appearing to be idiosyncratic to storytelling, it is of interest to examine whether a

feature standing out of the phonological norms can enhance processing. The fact that this prosodic property applies only to the last word of an utterance makes it a good candidate for assessing its effect without confounding effects stemming from preceding parts of the sentence. This affords us the opportunity to study the cognitive underpinnings of an unexplored acoustic feature in relation to short-term memory processing, shifting away from the dichotomy of linguistic and emotional prosody. Taking into account that some children manifest literacy impairments in the presence of preserved prosodic processing abilities (Anderson et al. 2013; Männel et al. 2017; Marshall et al. 2009), this study can pave the way for future educational interventions based on this storytelling prosodic pattern.

## **2 Materials and Methods**

### **2.1 Preliminary survey**

In order to assess the ecological validity of our stimuli and evaluate Greek native speakers' familiarity with the prosodic pattern in question, we conducted a survey with a group of 30 native speakers of Greek (20 of them between the ages of 10 and 12 years and another 10 between the ages of 20 and 50 years).

Participants were exposed to utterances recorded for our main study with final words bearing this prosodic pattern. Examples corresponded to the Greek equivalents of simple sentences such as 'Everyone wanted to win the prize' and 'The cat knocked down the vase'. At the end of each session, participants were asked whether they had heard a similar pattern of speaking before. It was made clear to them that the question did not refer to the semantic content of the utterances, but rather the way the speaker pronounced them. All participants

reported that the stimuli reminded them of a familial adult individual narrating a story. Hence, as our initial assumption was confirmed, we proceeded to examine recall of phrase-final words using the same sets of stimuli.

## 2.2 Pilot study

Eight children (mean age= 11.68, SD= 0.24) participated in a pilot study. The pilot sessions afforded us the opportunity to examine whether serial or free recall would be more appropriate for the purposes of the study. Starting with a serial recall paradigm, we observed that children were not able to recall target words in the middle of the list, which limited the variability in our pool of stimuli. We, therefore, modified our methods and used a free recall paradigm for the experimental portion of the study.

## 2.3 Participants

Thirty children, 17 girls and 13 boys between the ages of 10-12 years ( $M=11.28$ ,  $SD=0.58$ ) participated in the study (see Table 1). The children were recruited from two public primary schools in North Thessaloniki, Greece. All participants were native speakers of Greek and shared similar socio-economic status. None of the children had a history of learning difficulties, speech and language problems, or hearing impairments, nor did they have extracurricular music training. Fitness for participation in the study was evaluated in collaboration with parents and teachers that provided us with information necessary to rule out bilingualism and formal music education. Informed consent was obtained from all participants and the experimental procedure was carried out according to the Declaration of Helsinki.



Variables	Participants
Number (N)	30
Mean age	11.28
Age SD	0.58
Age range	10.3-12
Girls (%)	56.7
Boys (%)	43.3

Table 1. Summary characteristics of study participants

## 2.4 Material

A total of 18 short sentences were spoken by a female Greek native speaker in a soundproof room and were recorded using Audacity software. The speaker was provided with some practice items bearing the target prosodic realization. The two acoustic features making up the prosodic pattern in question, namely the falling pitch contour on the sentence-final word and, more notably, the lengthening of the final-syllable vowel, were pointed out to the speaker. In addition, the speaker was instructed to utter the sentences in an emotionally neutral tone. More importantly, the speaker was encouraged to recall her own storytelling experience as a listener. Due to its considerable cultural relevance, the speaker immediately picked up on the feature in question and her output faithfully imitated our examples.

Half of the sentences contained final words that were prosodically neutral and half included final words bearing the storytelling prosodic pattern which, as described above, consists of a combination of falling pitch contour in relation to the preceding word and conspicuous phrase-final syllable lengthening. Sentences with phrase-final prosodic features randomly alternated with those of neutral prosody. As noted in the introduction, post-stress vowels in Greek are shorter than stressed ones, but this rule does not seem to hold true in this particular prosodic pattern (Figure 1 visually clarifies an example of this pattern along with other features and Table 2 provides additional details). The two prosodic realizations were compared in terms of the duration difference between the target vowel and the preceding vowel and the F0 difference between the target vowel and the last vowel of the preceding word using Independent Samples t-tests. Statistically significant differences were found both in terms of duration ( $t(16)=8.843, p=0.000$ ) and F0 ( $t(16)=4.693, p=0.001$ ).

The material was divided into three conditions of six sentences each, depending on phrase-final syllable number. Designing these three syllable conditions aimed at controlling for the effect of number of syllables on free recall in our tasks. Each sentence was 2.5-3.5 seconds long and there was a 1.5 second pause between stimuli.

Condition	Prosodic realization	Mean Duration (sec)-target vowel	Duration on SD-target vowel	Mean Duration (sec)-preceding vowel	Duration SD-preceding vowel	Mean F <sub>0</sub> (Hz)-target vowel	F <sub>0</sub> SD-target vowel	Mean F <sub>0</sub> (Hz)- last vowel of preceding word	F <sub>0</sub> SD-last vowel of preceding word
2-syllable	storytelling	0.82	0.10	0.26	0.06	185.34	4.80	196.28	6.42
2-syllable	neutral	0.08	0.03	0.13	0.06	204.56	1.15	206.62	2.03
3-syllable	storytelling	0.89	0.14	0.15	0.13	176.58	5.62	204.82	9.3
3-syllable	neutral	0.15	0.05	0.10	0.06	194.06	9.26	200.08	7.99
4-syllable	storytelling	0.80	0.16	0.13	0.07	183.25	5.61	213.61	5.02
4-syllable	neutral	0.13	0.03	0.09	0.04	199.88	3.20	205.76	3.14

Table 2. Acoustic analysis of target vowels in relation to other vowels in the stimuli. The analysis presents prosodic realization in terms of duration and  $F_0$  for storytelling prosody and neutral prosody.

Simple SVO sentences with emotionally neutral words (e.g., Greek equivalents of the words ‘house’, ‘table’, ‘vase’, ‘teacher’, ‘customer’) were used. The material originated from short stories and some unpublished stories containing age-appropriate vocabulary. Special care was taken not to include derivatives of a word (e.g., ‘driver’ and ‘driving’) in the same sentence or combinations of semantically (e.g., ‘table’ and ‘chair’) or phonologically (e.g., /'spi.ti/ ‘house’, /'mi.ti/ ‘nose’) similar words. This was done to exclude a possible confounding priming effect on short-term memory processing.

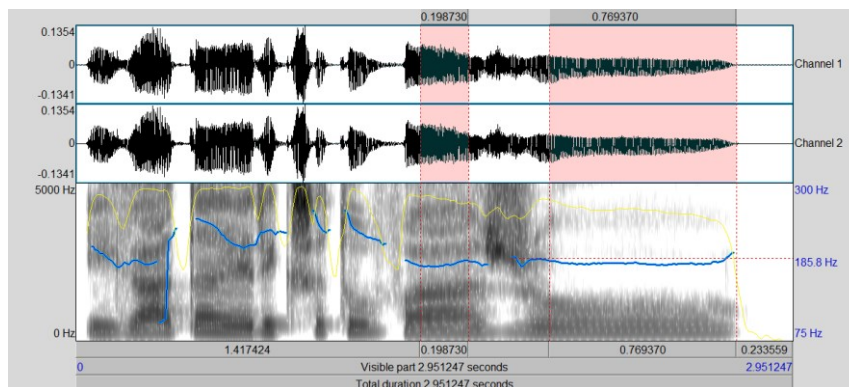


Figure 1. Representative waveform and spectrogram of an utterance bearing the Greek storytelling prosodic feature in question. The blue-coloured line shows the pitch contour and the yellow-coloured line shows intensity. Time selections indicate the duration of the vowels /a/ and /o/ in the two-syllable word /'va.zo/. Note that, although the vowel /a/ (the first selection) is a stressed vowel, its duration (0.20 seconds) is far shorter than the final-syllable unstressed vowel /o/ (0.77 seconds).

## 2.5 Procedure

Each participant was tested individually in a quiet room with no distractions, isolated from the rest of the school. Sessions lasted approximately fifteen minutes. Sessions were kept short to ensure that fatigue would not set in and there would be no confounding issues regarding attention to the tasks. Participants were informed that they could take breaks between different conditions if they wished but they all chose to complete all three conditions in a single sitting. They were asked to sit comfortably in a chair and, as no headphones were used, sound volume was adjusted to be clearly audible. To verify previously obtained information, a brief interview was conducted covering personal information, music education, and linguistic background. Practice stimuli were given at the beginning of each session.

Participants were instructed to attend to the stimuli and recall the last word of each sentence in random order for each of the conditions. It was made clear to them that they only needed to retrieve the last word rather than the whole sentence. Note that Greek has grammatical number, three genders, and four cases which are morphologically signaled. Thus, participants were required to retrieve words exactly as they appeared in an utterance, that is, without changing their morphological inflection.

Upon completion of all conditions, an additional interview similar to that of our preliminary data collection survey was conducted. Participants from the main study were encouraged to describe differences they perceived between the

prosodically neutral stimuli and those bearing the storytelling pitch and duration patterns.

### **3 Results**

During the debriefing, participants reported that some of the sentences reminded them of storytelling, which validated findings from the preliminary survey. When asked to elaborate, they mentioned that, in some cases, words sounded longer at the end of the sentence. None of the participants mentioned differences in pitch. Yet this does not necessarily rule out the effect of pitch on their judgments overall.

The maximum possible score for each syllable condition was 6. Successfully recalled words were divided into two categories depending on prosodic realization. The measurement scale for each category ranged from 0 to 3. If participants recalled the word in a morphologically different form (e.g., different grammatical number, case, or gender), their score was marked down by 0.5 point.

Statistical analysis was performed using SPSS software, version 23 for Windows. Using Paired Samples t-tests, we compared the mean difference in the performance of participants on storytelling versus neutral prosody for each condition and across all three conditions. We also conducted an Independent Samples t-test to compare the performance of girls and boys. Finally, we used One-way ANOVA to compare performance of all participants across the three

conditions in order to examine the effect of number of syllables on short-term memory.

Results showed that words bearing storytelling prosody were more often recalled in comparison to prosodically neutral words. The mean score for storytelling prosody was 5.35 (SD=1.40), whereas for neutral prosody it was 3.77 (SD=1.55). The Paired-Samples *t*-test showed that the difference was statistically significant;  $t(29)=4.568$ ,  $p=0.000$ . Table 3 displays overall results and scores broken down by syllable condition. Note that in order for the reader to appreciate the difference in performance in relation to prosodic realization, the scores for every syllable condition have been divided into separate columns. That is, the mean and SD for every score refer to the prosodic realization categories (prosodic vs. neutral) rather than the whole syllable condition. The maximum score per syllable condition is 6 but the maximum score per prosodic category reported in the table below is 3.

Syllable Condition	Mean (prosody)	Max. possible score per category	SD (prosody)	Mean (neutral)	Max. possible score per category	SD (neutral)	t-value	p-value
Total	5.35	9	1.40	3.77	9	1.55	4.568	0.000
Cond. 1	1.68	3	0.89	1.23	3	0.83	2.121	0.043
Cond. 2	1.86	3	0.68	1.33	3	0.75	2.605	0.014
Cond. 3	1.81	3	0.7	1.21	3	0.72	3.674	0.001

Table 3. Overall results and performance on the three syllable conditions. Note that scores are reported for each prosodic realization category (prosodic vs. neutral) rather than for all stimuli of each syllable condition.

Analysis of Independent Samples *t*-test comparing the performance of boys and girls did not reveal statistically significant differences;  $t(28)=0.069$ ,  $p=0.946$ . One-way ANOVA was used to determine whether the number of syllables had an effect on performance. Analysis showed no significant differences across conditions [ $F(2, 58)= 0.633$ ,  $p= 0.535$ ]. Our results show that gender and number of syllables in target words did not have a statistically significant effect on free recall performance.

#### **4. Discussion**

The present study explored the effect of a previously unexplored and undocumented culturally-specific storytelling prosodic feature on free recall in typically developing children aged 10-12 years. To ensure that our stimuli were ecologically valid, we conducted a preliminary survey which confirmed the familiarity of native speakers of Greek with this prosodic aspect of storytelling.

The prosodic feature under investigation results from the combination of a falling pitch contour on the sentence-final word and, more notably, considerable lengthening of the final-syllable vowel. The pattern in question, to our knowledge, shows that the Greek phonological rule of the post-stress vowel being shorter than the stressed one does not hold true. Building on earlier research investigating the effect of other types of prosody on recall, we found that the presence of this prosodic feature resulted in enhanced recall compared to prosodically neutral words. Three experimental conditions were designed in order to control for the effect of number of syllables. Depending on the

condition, sentences contained two-syllable, three-syllable, and four-syllable target words in sentence-final position. In all syllable conditions, the recall difference in comparison to prosodically neutral words was statistically significant, being particularly pronounced in the third syllable condition.

Our findings are in line with other studies pointing to the critical effect of prosody on short-term memory both in serial recall (Gilbert and Boucher, 2007; Reeves et al. 2000; Savino et al. 2013) and free recall (Nieuwenhuis-Mark et al. 2009; Sober et al. 2016). Although the feature we studied does not fall under the established prosodic categories, it is proposed that its acoustic realization is simple and relatively similar to the linguistic prosody stimuli of the above studies. It is less similar to the complex combinations of acoustic cues in stimuli in emotional prosody studies (Brierley et al. 2007; Fairfield et al. 2016; Nieuwenhuis-Mark et al. 2009) in which the effect of prosody on recall is not always shown to be positive. We are not aware of other controlled experiments focusing on specific, isolated prosodic features of storytelling and their effect on recall. Hence, direct comparisons with findings in other studies in Greek or other languages may be a topic to investigate in the future. However, it is worth turning to two studies that highlight the role of prosody in global content comprehension. Working with children of the same age group as participants in the present study, Goldman et al. (2006) found that recall of stories with richer prosody was better than that of story versions containing less prosodic information. In a more recent study with younger children, exposure to story recordings with larger pitch variation led to significantly higher performance on cued recall questions in comparison to versions of stories with limited pitch



variation (Mira and Schwanenflugel, 2013). Despite our focus on the local rather than the global level, our results concur with these studies in showing the positive effect of prosody on children's cognitive performance in a storytelling context.

Recall performance was not here found to correlate with variation in number of syllables. Comparisons of total scores across the three conditions did not reveal any statistically significant differences. Although previous research has pointed to a link between number of syllables and recall performance, known as the 'word-length effect' (Baddeley et al. 1975; Campoy, 2011; Cowan et al. 1992), this correlation can be alternatively attributed to differences in experimental conditions and methodological design across studies (Jalbert et al. 2011; Katkov et al. 2014).

Our findings can have implications for educational interventions based on memory enhancement stemming from prosodic organisation. As prosody draws attention to salient information, prosodic structure can be considerably effective in highlighting information that the reader of a story wishes to convey (Mira and Schwanenflugel, 2013). Studies with infants and young children suggest that prosody can facilitate speech processing (Fernald and Mazzei, 1991; Grassmann and Tomasello, 2007) and understanding of intentions and mental states (Sakkalou and Gattis, 2012). As prosodic processing appears to be part of early linguistic development and has been also found to be intact in the presence of literacy impairments (Anderson et al. 2013; Männel et al. 2017; Marshall et al. 2009) the feature we studied can be used as a tool capitalising on this ability in order to facilitate short-term memory for speech as well as other linguistic tasks.

Given that young speakers of Greek have been here shown to be familiar with this prosodic dimension and their memory performance was found to correlate positively with it, we suggest that it can be used for teaching new vocabulary and introducing new concepts. A link between phonological memory and vocabulary acquisition has been demonstrated in a number of studies (e.g., Gathercole et al. 1999; Michas et al. 1994; Verhagen and Leseman 2016) and it can be argued that storytelling can provide a useful educational construct that can be easily integrated into teaching. Employing vocabulary activities using target words bearing the prosodic feature we report in this study can play a critical role in enriching vocabulary acquisition activities in early grades.

We cannot completely rule out the effect of word frequency in our stimuli, as we did not have access to a corpus including Greek word frequency lists tailored to the age of children we studied. Nevertheless, we ensured that the vocabulary used was taken from age-appropriate material in order to control for word familiarity.

This work can be the starting point for additional research using separate groups and exposing participants to either stimuli of neutral prosody or stimuli containing the storytelling prosodic feature we studied, as suggested by an anonymous reviewer. It would be also of interest to investigate perception of this feature in speakers of other languages in order to further explore its culturally-specific dimension.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

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