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GREEK INTONATION AND THE PHONOLOGY OF PROSODY: POLAR QUESTIONS REVISITED

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Abstract

This paper briefly reviews the literature on Greek prosody and uses the default intonation of Greek polar questions to illustrate the relevance of research on Greek for our understanding of prosody at large. In particular, the paper compares several competing phonological representations of the Greek polar question intonation and presents new data from multi-word questions which show that in these longer utterances, the F0 stretch between the low F0 of the word in focus and the final rise-fall is not always flat, as in short questions, but may show optional and reduced F0 movements associated with stressed syllables; these movements can plausibly be analyzed as the reflex of postnuclear accents. Thus, the Greek data show that the notions of phrase accent and postnuclear accent, which have been argued to be one and the same, can co-exist in a linguistic system and thus should be considered distinct phenomena.

1. Introduction

Phonetics and phonology have always been the poor relatives in the field of Greek linguistics. Prosody in particular has long been neglected perhaps because it is often confused with non-linguistic (or paralinguistic) expression (e.g. speaker attitude, emotion and the like). Here, however, I use the term *prosody* to refer not to these paralinguistic aspects but to a group of interacting and interdependent *linguistic* phenomena, namely stress, rhythm, sandhi, prosodic phrasing and intonation. I briefly review the existing literature on these phenomena (for a full discussion, see Arvaniti 2007b) and focus on the intonation of polar questions. I discuss alternative analysis of this melody and present new data from Greek polar questions that bear on our understanding of intonational entities at large.

2. Brief review of research on Greek prosody

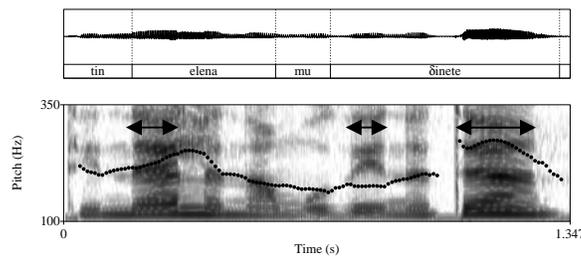
2.1 Stress

Several studies have shown that in Greek stress is manifested as increased duration and/or increased average amplitude of the stressed vowel and, to an extent, of the consonant(s) of the

stressed syllable (Dauer 1980; Botinis 1989; Arvaniti 2000; Nicolaidis & Rispoli 2005). In addition, Fourakis, Botinis & Katsaiti (1999), Barry & Andreeva (2001) and Baltazani (2007a) have shown that unstressed vowels are more centralized than stressed vowels in Greek. Taken together, these acoustic correlates suggest that stress in Greek is realized as *localized hyperarticulation* (de Jong 1995).

In addition to the above parameters, F0 has often been taken to be a correlate of stress both in Greek (e.g. Botinis 1989, Papazachariou & Politis in press) and in other languages (Fry 1958). Although it is clearly the case that in Greek stressed syllables are often associated with pitch movements (*pitch accents*) that make them prominent, it is also the case that stressed syllables may not co-occur with some pitch movement, while unstressed syllables may do so. Figure 1, which shows the F0 contour of a polar question, is an illustration of the orthogonality of stress and intonation: while the stressed syllable of the first word [ˈelena] does show a pitch rise, the stressed syllable of the focused word [ˈðinete] “give, 2PL” has low F0 and is followed by a pitch rise on the last syllable [te], which is unstressed. Given data like these, it is fair to conclude that stress and intonation are independent of one other.

Figure 1: Spectrogram and F0 contour of the question [tiˈnelena mu ˈðinete] “Could I speak to Elena please”, in which the focus is on the verb [ˈðinete] “give, 2PL”. The two stressed vowels and the final (unstressed) vowel are indicated by arrows.



In addition to the traditional distinction between unstressed and unstressed syllables, phonological accounts posit a secondary level of stress, invariably referred to as *secondary stress* or *rhythmic stress* (e.g. Malikouti-Drachman & Drachman 1981; Nespor & Vogel 1989). One such type of secondary stress is the demoted lexical stress of a host followed by an enclitic: e.g., in [to pa,raθiˈro mu] “my window”, the enclitically stressed [ro] becomes the primary stress of the sequence, while the lexically stressed [ra] becomes a secondary stress. In addition, polysyllabic words are said to have rhythmic stresses that are added to remedy *stress lapses*, that is, sequences of more than two unstressed syllables, which violate *eurhythm*; e.g., under this view a word like

[kalimera] “good morning” is produced not only with primary lexical stress on [me] but also with an additional post-lexical rhythmic stress on [ka].

Empirical research has found no production or perception evidence for different levels of stress. First, it has been shown that syllables with enclitic stress are not different from phrase-final syllables with lexical stress, while demoted lexical stresses are not different from other non-phrase-final stresses (Botinis 1989, Arvaniti 1992, Papazachariou in press). In addition, studies have shown that syllables with rhythmic stress are not different from unstressed syllables (Arvaniti 1994), but substantially different from lexically stressed syllables both in production and in perception (Arvaniti 1992, 1994; Kastrinaki 2003). Thus sequences such as [i simvuli tu] which could either have lexical stress on [sim] (i.e. “his councilors”) or on [li] (i.e. “his advice”) are acoustically distinct and clearly distinguished by speakers (Arvaniti 1992); their metrical patterns are [i ˌsimvuˈli tu] and [i simvuˈli tu] respectively; by contrast, phonological accounts predict they are metrically the same, i.e. [i ˌsimvuˈli tu] (Malikouti-Drachman & Drachman 1981).

Given the lack of empirical evidence for multiple degrees of stress in Greek, it is best to assume a simple two-way distinction between stressed and unstressed syllables (where stressed syllables may be accented or unaccented), at least until evidence to the contrary is procured.

2.2 Rhythm

Languages are said to fall into two rhythmic categories, stress-timing (e.g. English) and syllable-timing (e.g. French), that exhibit isochrony of interstress intervals and syllables respectively. The lack of empirical evidence for this popular dichotomy lead Dauer (1983) to propose a continuum from more to least stressed-based rhythm (often misrepresented as a continuum from stress- to syllable-timing). Whether we assume a dichotomy or a continuum, Greek has not been conclusively classified: Dauer (1983) places it in the middle of her continuum but somewhat closer to the stress-based end; Johnson & Sinsabaugh (1985) assume that Greek is stress-timed (because it has stress); Grabe & Low (2002) treat Greek as unclassified and conclude that it is unclassifiable. Barry & Andreeva (2001), on the other hand, examine Greek and other “syllable-timed” languages and show that they all present similar reduction patterns to stress-timed languages, casting doubt (like many other studies) on the stress-/syllable-timing distinction.

More recently, Tsiartsioni (2003), Baltazani (2007a) and Ross Ferjan & Arvaniti (2008) have looked into the possibility of using rhythm metrics that is, ways of quantifying consonantal and vocalic variability that purportedly classify languages according to rhythmic type (Ramus, Nespors & Mehler 1999; Grabe & Low 2002). The results of these studies also fail to rhythmically classify Greek conclusively: Baltazani’s scores show low vocalic but high consonantal variability

(higher than that reported in Grabe & Low (2002) for Greek). These results are the exact opposite of the scores reported in Ross et al. (2008), and different from the low scores reported in Tsiartsioni (2003) which strongly suggest that Greek is syllable-timed.

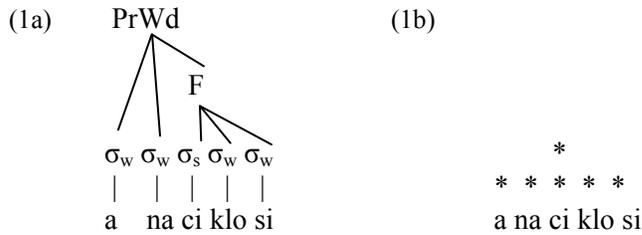
In my view, the above body of work indicates that the stress-/syllable-timing distinction applies only to a limited number of languages, those typically used as examples of each category. Most other languages, however, cannot be classified by any type of quantification of rhythm, including metrics (for a review see Arvaniti 2007b; for a critique of metrics see Arvaniti 2008).

An alternative view of rhythm is based on metrical phonology and the phonological insight that rhythm is based on the alternation of strong and weak (or more and less prominent) metrical constituents. This view, explored in Arvaniti (1994), has the advantage of being both phonetically and phonologically plausible and in line with the psychological understanding of rhythm (e.g. Fraise 1982). It is also supported by the findings of Dauer (1983) and works well with the simpler distinction of only two levels of stress advocated above. In this view, Greek has sparse prominences and limited possibilities for repairs of non-eurhythmic sequences (Arvaniti 1994): stress lapses do not appear to be remedied at all, while the repair of stress clashes is optional, and can only be realized as a lengthening of the first syllable in the clash. This rhythmic behavior of Greek is most parsimoniously explained if we assume that only the stressed syllable of each content word and the syllables to its right are grouped into a trochee that can have up to one extrametrical syllable; the syllables to the left of the lexical stress are not metrified but attach directly to the prosodic word node. This structure is illustrated in (1a); (1b) shows the corresponding metrical grid (after Arvaniti 1998). This structure accounts for the absence of a rule similar to the *Rhythm Rule* of English (which allows English speakers to switch the strength of multiple prominences in a word in order to create a more even alternation of strong and weak metrical constituents; e.g. *Japanese* has secondary stress on its first syllable and primary stress on its ultima in *I am Jàpanése*, but the prominence is reversed in *Jàpanése lantern*). Greek prosodic words do not have multiple heads of feet the relative prominence of which can be switched under conditions of stress clash. At the same time, an additional stress does appear in Greek words with enclitics, if there are more than two unstressed syllables after the lexical stress, since that part of the word is fully metrified. These effects are difficult to explain if we assume that all syllables in a polysyllabic Greek word are parsed into feet.

2.3. Prosodic phrasing

Several researchers have presented phonological rules to account for sandhi in Greek (Theophanopoulou-Kontou 1973; Kaisse 1985; Nespor & Vogel 2007; Malikouti-Drachman &

Drachman 1992). Unfortunately, these descriptions often disagree on two main points, the conditioning environment of the rules, and their outcome.



As we begin to better understand speech production, it is becoming clear that the reason for these disagreements could well be that not all sandhi phenomena are categorical (Nicolaidis 2001, Arvaniti & Pelekanou 2002, Tserdanelis 2005, Baltazani 2006a, 2006b). Instead, many of the phenomena that have been described as the output of categorical rules (that is, as deletions, insertions or feature changes) are best seen as the result of variable degrees of overlap between articulatory gestures; this is now the consensus about vowel deletion (Arvaniti & Pelekanou 2002; Baltazani 2006a) and /s/-voicing in Greek (Arvaniti & Pelekanou 2002; Baltazani 2006b).

These Greek data add to an increasing set of similar cross-linguistic cases, and suggest that it is necessary to empirically investigate each type of sandhi using a large number of speakers, a variety of speaking styles, and acoustic or articulatory data, rather than impressionistic transcriptions, before a conclusion can be reached that the phenomenon under investigation is more likely to be gradient or categorical in nature. Further, the Greek data cast doubt on the assumption that sandhi phenomena provide all or the most important cues to prosodic phrasing.

2.4 Intonation

Greek uses intonation, that is it systematically manipulates fundamental frequency (F0) to encode pragmatic meaning, but does not use F0 to encode lexical distinctions. Reviewing the research on intonation is difficult due to the variety of frameworks and perspectives adopted in the existing studies many of which are interdisciplinary in nature (e.g. Georgiafendis & Sfakianaki 2004, Baltazani 2007b). Due to lack of space, in the next section I present a brief overview of the most widely used framework for intonational research, the autosegmental-metrical (AM) framework of intonational phonology and focus on the phonetics and phonology of Greek polar questions and the repercussions the empirical data on this melody have both for our understanding of Greek intonation and of the structure of intonation at large.

3. The intonation of Greek polar questions

According to the basic principles of AM, intonation is phonologically represented as a string of Low (L) and High (H) tones and combinations thereof (Pierrehumbert 1980, Beckman & Pierrehumbert 1986, Ladd 1996). Tones are seen as autosegments that are phonologically associated to structural positions in the metrical representation of an utterance, in particular, phrasal boundaries and heads of feet (informally, stressed syllables). Tones that associate with stressed syllables are called *pitch accents* and their role is to enhance the prominence of these syllables. Tones that associate with boundaries are of two types, *boundary tones* and *phrase accents*, and their main role is to demarcate phrasal boundaries. Phonetically, tones are realized as *tonal targets*, that is as specific points in the F0 contour that have stable scaling, i.e. F0 value (e.g. Arvaniti, Ladd & Mennen 1998) and alignment, i.e. position relative to specific tone-bearing units or TBUs (e.g. Arvaniti et al. 1998; Arvaniti, Ladd & Mennen 2006a, 2006b; Arvaniti & Ladd 2009). Typically, pitch accents co-occur with stressed syllables, while phrasal tones co-occur with phrase-final TBUs (in Greek, syllables) independently of stress.

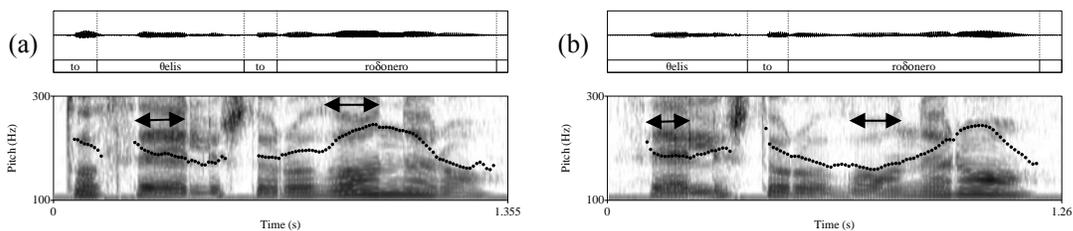
Pitch accents and boundary tones are tonal categories that are well established and relatively uncontroversial, in that these types of elements are assumed in several unrelated frameworks. Phrase accents, on the other hand, are a category the existence of which has been hotly disputed in the literature (see Ladd 1996, and Grice, Ladd & Arvaniti 2000 for reviews). The most widely adopted view among those who accept the phrase accent is that proposed by Beckman & Pierrehumbert (1986), namely that phrase accents are distinct from pitch accents and boundary tones and phonologically associate with the right boundary of *intermediate phrases* (a constituent in the prosodic hierarchy similar to, but not identical with, the phonological phrase of models such as that of Nespor & Vogel [2007]). The main arguments against positing phrase accents as a separate category include the following: (a) the domain of realization of phrase accents tends to be fuzzy (Ladd 1996), (b) phrase accents often follow immediately after the last (or *nuclear*) pitch accent of the utterance and thus could be more parsimoniously analyzed as part of that accent (e.g. Frota 2002, Gussenhoven 2004), and (c) phrase accents often co-occur with postnuclear stressed syllables and thus can be analyzed as postnuclear pitch accents (Ladd 1996).

Grice et al. (2000) present data from German, English, Dutch Standard and Cypriot Greek, and Standard and Transylvanian Hungarian and Romanian that lend support to the view that phrase accents are tonal entities distinct from pitch accents and boundary tones. Further, Grice et al. argue that the common feature of phrase accents is that they have a primary association to a phrasal boundary, but also an additional *secondary* association to a non-peripheral TBU which may or may not be metrically prominent.

Among the melodic patterns used to support this analysis is that of Greek polar questions. Specifically, Greek polar questions have two superficially different melodies that depend on the position of the word in focus. If the focused word is not utterance-final, then it has low F0 that extends all the way to the last *stressed* syllable in the question; this last stressed syllable shows an abrupt rise to a high peak, after which F0 falls reaching the bottom of the speaker’s range at the very end of the question. If the focused word is final, however, the low F0 plateau is localized on the stressed syllable of the focused word and the rise-fall co-occurs with the utterance-final syllable. These two patterns are illustrated in Figure 2; extensive quantitative data are presented in Arvaniti et al. (2006a; 2006b).

Grice et al. (2000) analyze this melody as L* H- L%, where L* is the pitch accent associated with the focused word, L% is the final low F0, and H- is a phrase accent with dual association: the primary association of the H- phrase accent is to the phrasal boundary and its secondary association is to the last stressed syllable in the question. If this syllable is associated with the focal L* pitch accent, the secondary association is not phonetically realized and the H- co-occurs with the last syllable of the question (see Figure 2b). If, however, the last stressed syllable is not associated with another tone (i.e. when the focused word is not utterance-final) then the secondary association of the H- phrase accent takes effect and the H- is realized as a peak on the last *stressed* syllable of the question (see Figure 2a).

Figure 2: On the left, waveform, spectrogram and F0 contour of the question [to 'θelis to ro'ðonero] “Do you want the rose-water?” with focus on the verb ['θelis] “want, 2s”. On the right, waveform, spectrogram and F0 contour of the same question with focus on [ro'ðonero] “rose-water”. The stressed syllables are indicated by arrows.



3.1 Non-AM analyses

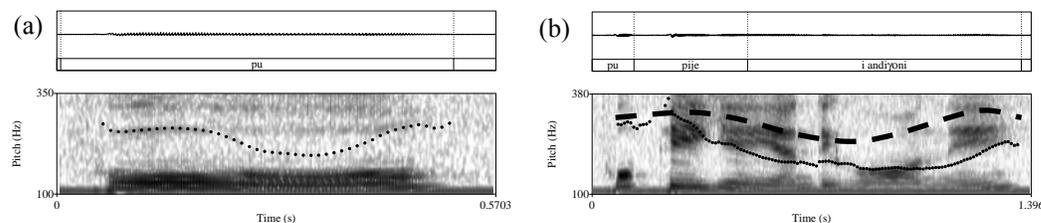
The analysis of Grice et al. (2000) for Greek polar questions is not accepted by everyone. Papazachariou in a series of papers (e.g. 1994, 2000, 2004) takes exception to this analysis, arguing that other melodies are possible and that the choice of melody reflects changes in epistemic modality. In addition, Papazachariou proposes an analysis of the question tune that is based on the “British school” notion of the nucleus, which Papazachariou breaks down into two

elements, a rise and a fall; he further argues that the pitch range of the two elements (low rising vs. high rising, low falling vs. high falling) is distinctive.

It is of course correct that the AM analysis presented in §3 does not cover all possible melodies used with polar questions in Greek. The AM analysis covers the tune that is used as a default by speakers of Standard Greek when they are asked to produce a sentence as a polar question. This does not preclude the existence of other melodies used with polar questions to encode changes in epistemic modality as argued by Papazachariou (2004) – a point discussed in some detail in Arvaniti (2007b). Further, as with all other elements of speech, it is quite possible that the tune used for questions is not the same in all varieties of Greek.

More importantly, however, some of Papazachariou’s objections stem from two major assumptions of the British school of intonation. One is that it is possible, indeed desirable, to analyze a melody on the basis of one-word utterances (because this provides an “unadulterated” view of the nucleus). However, research has shown that intonational tunes are not gestalts; if they were, one would expect them to shrink or stretch, accordion-like, to fit the length of the utterance they co-occur with. This is clearly not the case, as I have extensively argued elsewhere (Arvaniti et al. 2006a, Arvaniti 2007a; Arvaniti 2007b; Arvaniti & Ladd 2009). An illustration of this point is provided in Figure 3 which shows two wh-questions, one containing just the wh-word, the other being much longer: as can be seen, the stretched out contour of the monosyllabic question (thick broken line in Figure 3(b)) is not the same as the actual contour of the longer question. Thus, it is important to test melodies in a variety of contexts in order to figure out what the elements of each melody are, which of them form units and which are independent of each other.

Figure 3: On the left, waveform, spectrogram and F0 contour of the question [ˈpu] “Where?”; on the right, waveform, spectrogram and F0 contour of the question [ˈpu ˈpije i andiˈɣoni] “Where did Andigoni go?”. The thick broken in (b) is a stretched out version of the F0 contour in (a).



Papazachariou’s second assumption is that the intonational primitives are movements the scaling of which (e.g., high rise vs. low rise) is contrastive. In AM, by contrast, the primitives are L and H tones, the scaling of which is partly determined with respect to surrounding tones and is not expected (simplifying somewhat) to be contrastive. This different perspective means that contours analyzed by Papazachariou as showing the same rise-fall movement but with different

scaling, are analyzed as sequences of different tones in AM. These differences are not trivial, as the two analyses make different predictions, about the alignment of the various elements of the tune, but the data support only the predictions of AM (for extensive argumentation on this point, and some illustrations see Arvaniti 2007b).

3.2 Alternative AM analyses

In addition to the AM analysis of Grice et al. (2000), alternative analyses have been proposed in Baltazani & Jun (1999), Baltazani (2006d) and Arvaniti et al. (2006a). Baltazani & Jun (1999) and Baltazani (2006d) propose that the boundary tone of Greek polar questions is a bitonal H+L%. For Baltazani & Jun (1999) there is no phrase accent in this tune, but Baltazani (2006d) proposes instead that the melody includes a L- phrase accent. Arvaniti et al. (2006a) – noting that the L target, which they had expected to be localized on the stressed syllable of the focused word, in fact spreads from that syllable to the last stressed syllable in the question – propose that the phrase accent is bitonal, i.e. L+H- (instead of H-, as in Grice et al.), in order to account for the resulting low plateau. The four competing analysis are presented in (2)-(5) below:

- (2) L* H- L% (Grice et al. 2000)
- (3) L* H+L% (Baltazani & Jun 1999)
- (4) L* L- H+L% (Baltazani 2006d)
- (5) L* L+H- L% (Arvaniti et al. 2006a)

As can be seen, all analyses agree that the focal accent is a L*. Further, (4) and (5), the newer analyses which are based on more extensive data, agree that there is a low plateau between the focal L* and the final peak that has to be accounted for, and analyze it as the reflex of a phrase accent. Where the analyses disagree is in the treatment of the final rise-fall: while Baltazani treats it as a unit, a bitonal L+H% boundary tone, Arvaniti et al. break it into two separate and independent components, a phrase accent, L+H*, and a boundary tone, L%.

I see two problems with the bitonal H+L% boundary tone analysis. First, the H and L tone of the putative H+L% are not temporally coordinated in any way. If the H and L tones were a unit, we would expect either one of them to align with respect to the other, or for both of them to occur close to each other and to align with respect to specific and related segmental landmarks. For example, in the Greek L*+H pitch accent, the L aligns with the onset of the stressed syllable and the H with the onset of the first vowel after the stressed syllable; in contrast, in Portuguese, one type of nuclear fall shows consistent slope, a pattern plausibly analyzed as the reflex of a H*+L pitch accent in which the L aligns with respect to the H (Frota 2002). In Greek polar questions, however, the L tone is consistently aligned at the very end of the utterance, while the H

varies: it may align with the last syllable as well, but it can also occur one or two syllables earlier. This dual patterning is difficult to reconcile with the idea of the two tones being a unit.

An argument advanced in Baltazani (2006d) is that in her analysis all intermediate phrases (ips) that form one intonational phrase (IP) in a long question are right-demarcated by L-; e.g. a question like [epi'teθice ston ane'momilo | 'eçi ipo'komo me 'ɣajðaro | ce ro'tas 'pos ton 'lene] “He attacked a windmill, has a squire with a donkey, and yet you ask what his name is?” is typically broken down into three ips, as indicated, and the non-final ips can be right-demarcated by L- (example from Baltazani 2006d). However, the non-final ips of this question can also be produced with a H- phrase accent, so the uniformity holds only for some melody variations. In addition, the stipulation that all ips within an IP should end with the same phrasal tone is rather *ad hoc*. Indeed, from a functional perspective, it would be advantageous not to do so, so that the choice of phrase accent can alert the hearer that the utterance is not yet over. This is exactly what is suggested by the results of Baltazani & Jun (1999) who found that in both statements and questions of various types, non-IP-final ips were demarcated with a phrasal tone that was the opposite of that used with the IP-final ip (e.g. “continuation rises”, i.e. H- phrase accents, were found in the non-final ips of declaratives that ended in a final fall, i.e. L- L%).

Finally, Baltazani (2006d) suggests that her analyses dispenses both with the atypical bitonal phrase accent proposed by Arvaniti et al. (2006a) *and* with the need for secondary association. However, the bitonal L+H- phrase accent of Arvaniti et al. is not more atypical in Greek than the bitonal H+L% boundary tone proposed by Baltazani. In addition, the two distinct types of association found for the H still need to be accounted for, whether the H is seen as a part of a phrase accent or of a boundary tone, since the H shows two clearly distinct patterns of alignment (Arvaniti et al. 2006a). In this respect, an analysis in which the H tone is part of the phrase accent fits the typological pattern uncovered by Grice et al. (2000).

Thus, we can conclude that the analysis of Arvaniti et al. (2006a) appears to be the one that makes the predictions that are most consistent with the data and at the same time it is consistent with typological findings and with AM-internal principles regarding tonal composition.

4. Phrase accents and postnuclear pitch accents

As mentioned, it has been argued that phrase accents could be reanalyzed as *postnuclear* pitch accents, given their propensity to associate with metrically strong syllables (see Ladd 1996 for a review). As discussed above, however, Grice et al. (2000) show that not all phrase accents exhibit “stress-seeking” behavior and that they are best seen as a distinct tonal entity. However, the data of Grice et al. (2000) cannot address the issue of whether phrase accents with dual association can

replace the notion of postnuclear pitch accents altogether. Greek polar questions are a good case for testing a putative distinction between the two. First, it is already established that their intonation is best analyzed as involving a phrase accent. Second, Greek polar-questions can be very long, while the focus can remain on the first word. In such cases, if there are no postnuclear pitch accents, one would expect a low plateau stretching from the nuclear syllable to the final rise-fall; any pitch movement realized on metrically strong syllables and occurring between the focal pitch accent and the phrase accent can plausibly be analyzed as the reflex of a postnuclear accent. This is the hypothesis that the data presented here were designed to explore.

4.1 Method

The materials were two sets of increasingly long questions (one is shown in Table 1). The shortest question contained two prosodic words, the first associated with the nuclear L* and the second with the L+H- phrase accent; the longest contained seven prosodic words, with the first word carrying the L* pitch accent and the last the L+H- phrase accent. All questions could be uttered with focus on any of their words, but the default is to put the focus on the verb which was always the first content word (Baltazani 2007b). In addition, the questions were part of mini-dialogues that made this focusing option more likely. Care was taken to create sentences that sounded as natural as possible (given their length), and contained as few voiceless consonants as was feasible without compromising naturalness.

Table 1: One set of test materials; the underlined word is the word in focus.

PrWds	Sentence and gloss
2	[θa 'p <u>aris</u> ti'lefono] “Will you call?”
3	[θa 'p <u>aris</u> ti'lefono ti 'mina] “Will you call Mina?”
4	[θa 'p <u>aris</u> ti'lefono ti 'mina sti 'mia] “Will you call Mina at one?”
5	[θa 'p <u>aris</u> ti'lefono ti 'mina sti 'mia na 'vɣume] “Will you call Mina at one to go out?”
6	[θa 'p <u>aris</u> ti'lefono ti 'mina sti 'mia na 'vɣume ja 'volta] “Will you call Mina at one to go out for a walk?”
7	[θa 'p <u>aris</u> ti'lefono ti 'mina sti 'mia na 'vɣume ja 'volta sti 'limni] “Will you call Mina at one to go out for a walk at the lake?”

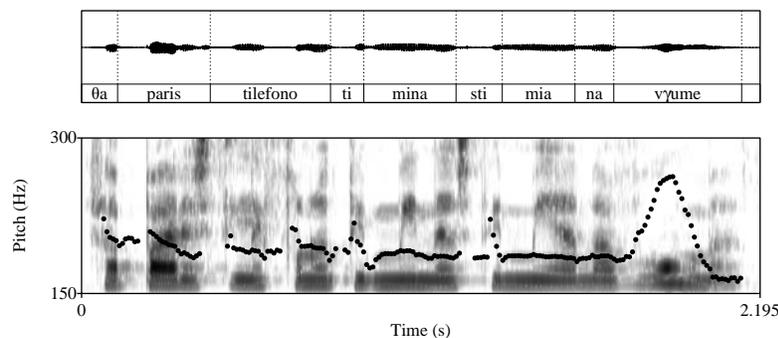
Eleven female and four male speakers were recorded in Greece. They were all educated, monolingual speakers of Standard (Athenian) Greek with no known speech or hearing problems, ranging in age from late thirties to early fifties. All the speakers were naïve as to the purposes of the experiment. As the materials for the present study were recorded at the same time as materials for unrelated work, in order to keep the recording time reasonable, the speakers were given the option to either read the entire dialogues or only the questions; they were asked to choose the option that would make them read most naturally, and most of them chose to read the entire dialogues. No special instructions were given as to the intonation to be used, but the speakers

were told to avoid “inserting commas”. In addition, if a speaker’s production showed fluctuations in the position of the nucleus or in phrasing the author provided a couple of illustrations, and gave additional contextual information to help the speaker adopt the desired contour.

4.2 Results

Here only a subset of the data, based on the set of materials in Table 1 and the data from four female speakers is discussed. Qualitative analysis of these data suggests that F0 is often flat between the nucleus and the final rise-fall; this is illustrated in Figure 4. In many cases, however, additional tonal events are evident between the two. Two such contours are illustrated in Figure 5.

Figure 4. Waveform, spectrogram and F0 of the question [θa 'paris ti'lefono ti 'mina sti 'mia na 'vɥume] “Will you call Mina at one to go out?” from the data of speaker MP.

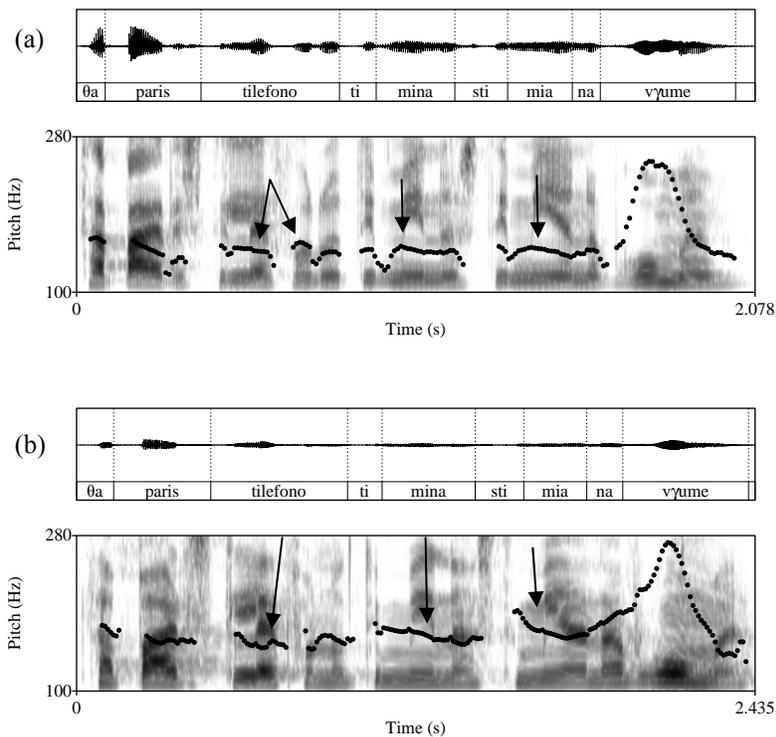


These tonal events are reduced in scale (6-15 Hz or roughly ~10% of the final rise). They are typically realized as falls from a peak (e.g. the accents on [mia] and [mina] in Figures 5a and 5b) or as delayed rises (e.g. the accents on [telefono] in Figures 5a and 5b). Their forms suggest that they are not copies of the phrase accent or of the nuclear accent. Since the nuclear accent is L*, the presence of postnuclear copies should either result in localized dips on postnuclear stressed syllables or in a strongly declining plateau. However, it is clear from Figures 4 and 5 that such localized dips were not present, while the analysis of the slope of the low plateau in the same data (Colavin 2007) suggest that the plateau is not declining (or rising) substantially. On the other hand, if these reduced tonal events were the result of copies of the phrase accent, one would expect them to show a rise on the stressed syllable with the peak being reached roughly 2/3 into the stressed syllable’s vowel, as happens with the phrase accent (Arvaniti et al. 2006b). Neither of these patterns obtained however. Thus, it is more plausible that these reduced tonal events are postnuclear accents of some sort.

The variability in the form of these accents is intriguing and clearly requires further investigation. There is clearly some connection between these accents and the observation of

Baltazani (2006c) that the prenuclear accents of questions and statements may not be identical in form. In particular, Baltazani observes that the prenuclear accents in polar questions show a longer low plateau and later peak alignment. The data presented here suggest that such accents may also appear, albeit reduced in scale, in postnuclear position as well. The falling accents are more similar to the H*+L nuclear pitch accent discussed in Arvaniti & Baltazani (2005).

Figure 5. Waveform, spectrogram and F0 of the question [θa 'paris ti'lefono ti 'mina sti 'mia na 'vɣume] “Will you call Mina at one to go out?” from the data of speaker AL (top) and ET (bottom). The arrows show the location of potential postnuclear accents.



These accents are optional in several ways. First, they are not present on all words even in the longer questions. Second, the postnuclear accents are not found in all the repetitions of a question, not even those produced by the same speaker. Third, postnuclear accents are not equally frequent in the data of all speakers: typically slower talkers are more likely to use postnuclear accents. Finally, postnuclear accents are more frequent in longer questions.

5. Conclusion

The presence of these accents suggests that Greek has a weak preference for retaining some extra prominence on lexically stressed syllables even after the focused item, at least in polar questions. It is worth investigating whether this applies to other melodies as well, such as declaratives with early narrow focus and long wh-questions. More generally, the presence of these postnuclear

accents in the Greek intonational system suggests that intonational phonology needs both phrase accents and postnuclear pitch accents as distinct tonal entities in order to fully account for attested intonational phenomena.

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