

PHRASE ACCENTS REVISITED: COMPARATIVE EVIDENCE FROM STANDARD AND CYPROT GREEK

Amalia Arvaniti

University of Cyprus

ABSTRACT

Phrase accents, one of the three tonal categories assumed by much recent research on intonation, are expected to associate with a prosodic boundary (e.g. the end of the utterance) but not to phonetically align with a specific tone-bearing unit (TBU), such as a stressed syllable. This paper presents experimental evidence on the intonation of Cypriot Greek polar questions suggesting that phrase accents prefer to associate with specific TBUs. Concretely, it is shown that in Cypriot Greek polar question intonation, autosegmentally described as $L^* H L\%$, the H phrase accent does not align with the final stressed vowel as in Standard Greek, but instead it aligns approximately 30ms from the onset of either the penultimate or the final vowel of the utterance. The data provide evidence that phrase accents, like other tonal categories, exhibit stable phonetic alignment and support Ladd, Arvaniti and Mennen's [1] typology of stress-seeking and non-stress-seeking phrase accents.

1. INTRODUCTION

In much recent research based on the autosegmental/metrical approach to the study of intonation (e.g. [2], [3]), three categories of intonational events are distinguished: on the one hand *pitch accents*, i.e. distinctive pitch movements associated with stressed (or otherwise prominent) syllables, and on the other, *phrase accents* and *boundary tones* both of which are considered peripheral elements. That is, phrase accents and boundary tones are said to associate phonologically with some prosodic boundary, such as the end of an utterance, but they are not expected to show phonetic alignment with a specific tone-bearing unit (TBU), such as a stressed syllable (e.g. [4], [5]). The most controversial and least understood of these three tonal categories appears to be that of phrase accent (see e.g. [2], [4], [5], [6]). Generally, there is disagreement on the phonological status and association of phrase accents and in particular on their phonetic alignment with the segmental string.

An attempt to classify phrase accents on the basis on their preferred mode of alignment was presented in Ladd, Arvaniti and Mennen [1]. Specifically, Ladd *et al.* present evidence that some phrase accents do associate with specific TBUs and that they can be classified as stress-seeking and non-stress-seeking. Their claim is based on data from polar questions (PQs) in Standard Greek and Hungarian. Both languages use the same tonal configuration for PQs, autosegmentally described as a sequence of a L^* pitch accent, a H phrase accent and a $L\%$ boundary tone. Yet, in Greek the H phrase accent aligns with the lexically stressed syllable of the utterance-final word (see also

[7]), while in Hungarian it aligns with the penultimate syllable irrespective of stress location. In both languages, if the phrase accent's "preferred" syllable is already associated with the nuclear L^* (i.e. if the nucleus is on the final word of the utterance), the H occurs on the utterance-final syllable.

This paper extends the line of inquiry into phrase accents sketched above by examining the phonetics of the PQ contour used in Cypriot Greek, the variety of Greek spoken in Cyprus.

From a phonological point of view, Cypriot Greek PQs have the same intonational structure as Standard Greek (and Hungarian) PQs: as can be seen in Figure 1, they exhibit a dip on the nuclear syllable and a rise-fall movement that occurs towards the end of the utterance. As in the other two languages, this contour can be autosegmentally described as $L^* H L\%$, i.e. as consisting of a L^* pitch accent reflected in the $F0$ dip, and a sequence of a H phrase accent followed by a $L\%$ boundary tone, which together form the final rise-fall. Despite the overall similarity between the Greek and Cypriot contours, however, auditory impressions suggest that the tones must be aligned differently. It will be shown here that the differences are due primarily to the way the H phrase accent associates in the two varieties (due to space limitations, other less striking realisational differences will not be discussed here). The original hypothesis, based on the observation of data from an unrelated experiment, was that the H phrase accent is Cypriot Greek associates in the same way as that of Hungarian, i.e. it seeks the penultimate syllable. The following experiment was conducted in order to test this hypothesis.

2. METHOD

2.1. Materials

The materials were constructed with the help of two native speakers of Cypriot Greek, SJ and TC, both students at the University of Cyprus, whose assistance is gratefully acknowledged. The materials consisted of 20 short PQs containing two content words, a verb and a noun. Since in the other languages examined, nucleus location proved crucial for the alignment of the H phrase accent ([1], [3], [7]), the sentences in this experiment were constructed so that they could be uttered with focus on either of their two content words. Focus placement resulted in the main experimental condition, nucleus location: the test sentences were either nucleus-final (NF), i.e. had focus on the second content word, or nucleus-non-final (NNF), i.e. had focus on the first content word.

Table 1: Sample test sentences with word-for-word translation and separate glosses for the NF reading (nucleus on the word with dotted-underlining) and the NNF reading (nucleus on the word with single underlining).

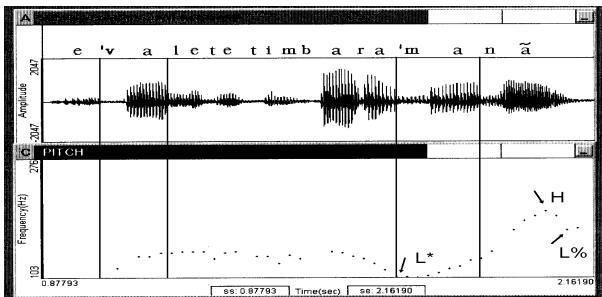


Figure 1: Waveform and *F0* contour of the test sentence [ℳ ⓘ ♦ ℬ ℬ ♦ ℬ ♦ ⓘ ⓘ ⓘ ⓘ ⓘ ⓘ] ‘Put-past-pl. the-safety-pin’ “Did you put the SAFETY-PIN?” by speaker KR. The vertical lines delimit the two stressed syllables of the utterance.

In addition, the test sentences were designed so that the position of the final stressed syllable varied relative to the end of the utterance. The aim of this manipulation was to see whether H alignment would be affected by the position of the final stressed syllable as it is in Greek [7]. Thus the test sentences were divided into four sets of five sentences each; in the first set the final stress was on the utterance-final syllable, in the second it was on the penult, in the third on the antepenult, and in the fourth on the *ante*-antepenult (a pattern permitted in Cypriot Greek but not in Standard Greek). Finally, care was taken to avoid voiceless stops and fricatives in the materials so as to obtain smooth F0 contours. Sample sentences in two of the four stress conditions are given in Table 1, together with word-for-word translations and glosses for the NF and NNF readings.

2.2. Procedure

The materials were read by three native speakers, SJ and TC, who had acted as informants, and KR. SJ and TC are females in their early twenties and KR a male in his thirties. None of the speakers has any known speech or hearing problems. Although SJ and TC helped construct the materials they did not know what specific hypotheses were being tested, so all speakers can be considered naïve as to the purpose of the experiment.

For the recording the speakers read the sentences twice in random order from cards written in the semi-official Cypriot Greek orthography. Each of the test sentences appeared on two cards, once with the first and once with the second word underlined to indicate nucleus location. The speakers read the sentences with correct nucleus placement without difficulty. The

materials were recorded directly onto a PC equipped with an AWE64 Sound Blaster multimedia card, at a sampling rate of 22,050 Hz and using the recording facilities of Kay's Multispeech program and a SONY ECM-909 stereo microphone. The recording took place in quite conditions though not in a sound-treated room.

2.3. Measurements

Three tokens of each test sentence were selected for measurement, one from each speaker. The tokens selected were the most natural-sounding ones according to the author's judgement. The measurements were made using Multispeech and involved measuring the *scaling* of particular *F0* points and their *alignment* with specific segmental landmarks. The measured *F0* points were considered to be the reflexes of the tones in the phonological structure of Cypriot PQ intonation. The measurements of interest here are the following:

- H: the highest *F0* point in the vicinity of the right boundary of the utterance
- VStoH: the distance between the onset of the final stressed vowel and the H
- VPtoH: the distance between the onset of the utterance's penultimate vowel and the H
- VFtoH: the distance between the onset of the utterance's final vowel and the H

Measurements of $F0$ scaling were obtained from pitch tracks, using the Multispeech pitch tracking facility which extracts $F0$ information directly from the waveform by calculating the time intervals between dominant waveform peaks. Alignment measurements were obtained using a combination of pitch tracks, waveforms and wide-band spectrograms.

3. RESULTS

Overall, the experimental results support the original observation that the phonological structure of the Cypriot Greek PQ contour is the same as that of Standard Greek (and Hungarian) though the H phrase accent is aligned differently. All results reported below are based on three-way analyses of variance with nucleus location (NF, NNF), final stress location (final, penultimate, antepenultimate, *ante*-antepenultimate stress) and speaker (SJ, TC, KR) as the independent variables.

3.1. Scaling of the H phrase accent

The statistical analysis shows that the H is scaled lower in the NF condition (where the nucleus is on the final word) than in the NNF condition (where the nucleus appears earlier) [$F(1,96)=7.78, p<0.006$]. The difference, which averages 7 Hz across speakers, is not surprising: in the NF condition all three tones of the PQ contour are crammed in a *maximum* of four syllables (from the *ante-antepenult* to the final syllable), while in the NNF condition they are more spread out. This *undershooting* of tonal targets under *tonal crowding* is well-attested (e.g. [8], [9], [10]).

In addition, the results showed that final stress location had no effect on the scaling of the H, while speaker did affect it [$F(2,96)=275.06, p<0.0001$]. Planned comparisons showed that this effect was not the result of differences in patterning, but was simply due to mixing data from male and female speakers and to individual differences of range among speakers.

3.2. Alignment of the H phrase accent

The results on the distance of the H from the final stressed vowel (VStoH) confirmed the original impression that in Cypriot Greek the H does not align with respect to the final stressed vowel as it does in Standard Greek. For all speakers, final stress location did affect the distance of H from VS [$F(3,96)=313.65, p<0.0001$], but the observed effect suggests that the H is independent of the final stressed vowel: as Figure 2 shows, the further from the end of the utterance the final stressed vowel is located the further away from it the H aligns. Moreover, this result is independent of nucleus location; yet, if the H were meant to align with the final stressed vowel, the NF and NNF patterns would be very different from one another due to the tonal crowding in NF. This difference is indeed observed in Standard Greek PQs [7]. Instead, as Figure 2 shows, the H in Cypriot Greek aligns closer to the final stressed vowel in the NNF than in the NF condition [$F(1,96)=185.35, p<0.0001$] irrespective of final stress location. This effect of nucleus location, which tallies with the results on scaling, was expected, since in the NF condition the proximity of the nuclear L* to the end of the utterance creates tonal crowding triggering the displacement of H to the right (for similar results on Standard Greek PQs see [7]). In short, the effects of nucleus location and final stress location together show that the H phrase accent in Cypriot Greek is not stress-seeking. On the other hand, the progressively longer distance between the H and the final stressed syllable as the latter moves away from the end of the utterance suggests that the H must align relative to a segmental landmark close to the end of the utterance. A natural candidate is the penultimate vowel to which I now turn.

The statistical analysis of the distance between the H and the penultimate vowel (VPtoH) shows again that H alignment is earlier in the NNF condition [$F(1,96)=237.04, p<0.00001$] and that it is also affected by final stress location [$F(3,96)=20.50, p<0.00001$]. In this case, however, there is interaction between the two factors [$F(3,96)=19.91, p<0.00001$]. *Post-hoc* Scheffé tests show that this is due to the different effect of final stress location on the two nucleus location conditions. As can be seen in Figure 3, VPtoH remains stable in the NNF condition

independently of the location of final stress [all *post-hoc* tests are statistically non-significant]. In the NF condition, however, VPtoH is much shorter in words with final and penultimate stress than it is in words with antepenultimate and *ante-antepenultimate* stress [for all *post-hoc* comparisons $p<0.001$, except for final vs. penultimate and antepenultimate vs. *ante-antepenultimate* which are statistically non-significant].

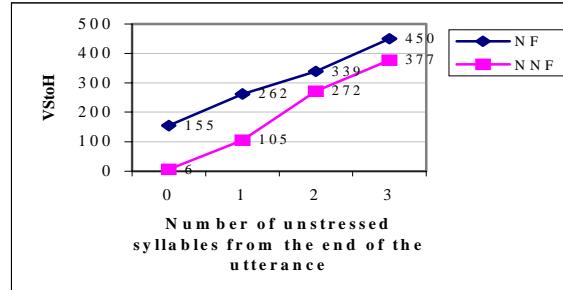


Figure 2: Distance of the H phrase accent from the final stressed vowel (VStoH) in the NF and NNF conditions, according to the location of the final stressed syllable; data for all speakers together.

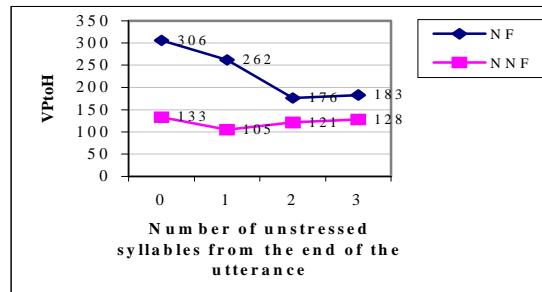


Figure 3: Distance of the H phrase accent from the penultimate vowel (VPtoH) in the NF and NNF conditions, according to the location of the final stressed syllable; data for all speakers together.

The stability of VPtoH in NNF but not in NF suggests that in NNF the H is canonically aligned. However, the average distance between the penultimate vowel and H in NNF also implies that the H is aligned *after* the penultimate vowel. This unexpected outcome is due to the interaction between nucleus location and speaker [$F(2,96)=13.47, p<0.00001$]. As can be seen in Figure 4, the interaction is the result of the difference between SJ on the one hand and TC and KR on the other. Specifically, for all speakers H is aligned closer to VP in the NNF than in the NF condition [according to Scheffé tests $p<0.00001$ in all cases], but in both conditions SJ aligns the H much closer to VP than TC and KR do [in NF, for SJ vs. TC $p<0.0008$, for SJ vs. KR $p<0.0001$; in NNF, $p<0.00001$ for both comparisons; there were no differences between TC and KR]. In fact in the NNF condition SJ aligns the H 26ms from the penultimate vowel's onset. It appears then that, when the nucleus is not final to put pressure on the H, SJ aligns the H early in the penultimate vowel thereby confirming the initial hypothesis. However, this is not the case with the other two speakers. Nevertheless, the stability of VPtoH in the NNF

condition in the data of all speakers, suggests that even if TC and KR do not align the H within the penultimate vowel, they do align it in an unvaried manner. Furthermore, the fact that H alignment in the NF position is affected primarily when the nucleus is on one of the last two syllables implies that these speakers may align the H with the final vowel.

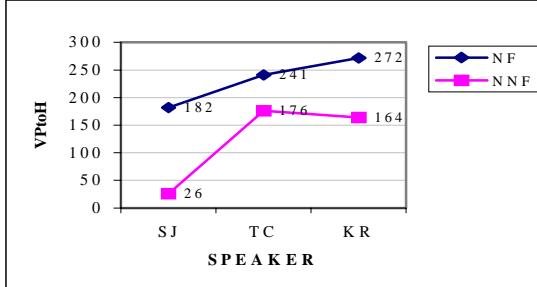


Figure 4: Distance of the H phrase accent from the penultimate vowel (VPtoH) in the NF and NNF conditions, for each speaker separately.

This is indeed the case: when the distance of the H from the final vowel (VFtoH) was examined, it was found that TC and KR aligned the H on average 29ms into the final vowel, a value comparable to that of SJ for the penultimate vowel. An example of H alignment with the final vowel in NNF is shown in Figure 5 (which can also be compared with Figure 1 that presents the NF reading of the same sentence by the same speaker). As expected, the results also show earlier alignment of the H in NNF [$F(1,96)=191.71, p<0.00001$], and interaction between nucleus location and speaker [$F(2,96)=31.65, p<0.00001$]. Scheffé tests show that the interaction is due to the substantially earlier alignment of H in SJ's data, reconfirming that the speakers use two different patterns of alignment for the H phrase accent.

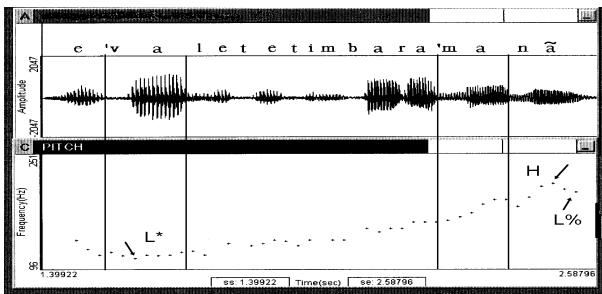


Figure 5: Waveform and F0 contour of the test sentence [Πύθησες τη σφραγίδα] ‘Put-past-pl. the-safety-pin’ ‘Did you PUT the safety-pin?’ by speaker KR. The vertical lines delimit the two stressed syllables of the utterance.

4. DISCUSSION AND CONCLUSION

In short, the data on the H phrase accent in Cypriot Greek PQs show that while the phrase accent is scaled in a relatively stable manner among speakers, it exhibits two distinct patterns of alignment. Concretely, when there was no tonal crowding, one of the three speakers in the present study aligned the H phrase

accent with the penultimate vowel of the utterance (as did one more speaker in data gathered for a different experiment), while the other two speakers aligned it with the final vowel. It is clear that this difference in pattern demands a more thorough investigation with a larger group of speakers. One possible explanation is that the two patterns represent legitimate variation. It is also conceivable that the speakers are influenced by different local varieties of the dialect, even though they are supposed to speak educated Cypriot Greek as spoken in Nicosia.

Nevertheless it must be stressed that the observed variation is regular. Under canonical conditions, the Cypriot Greek H phrase accent associates with a specific TBU in a stable manner, on average 30ms into the penultimate or the final vowel of the utterance. In this respect the data support the distinction proposed by Ladd *et al.* [1] that phrase accents despite their phonological association with boundaries are phonetically aligned in the same precise way pitch accents have been shown to align [10]. Despite the limitations posed by the observed variation among speakers in the present study, these are encouraging results in the effort to classify phrase accents and explain their alignment in a principled manner.

5. REFERENCES

1. Ladd, D.R., Arvaniti, A., and Mennen, I., “• • ward a typology of phrase tones,” *Linguistics Association of Great Britain Spring Meeting*, 1997.
2. Pierrehumbert, J., *The Phonology and Phonetics of English Intonation*, PhD dissertation, MIT.
3. Ladd, D.R., *Intonational Phonology*, Cambridge University Press, Cambridge, 1996.
4. Pierrehumbert, J., and Beckman, M., *Japanese Tone Structure*, The MIT Press, Cambridge: MA, 1988.
5. Gussenhoven, C., “The boundary tones are coming: on the nonperipheral realisation of boundary tones,” in M. Broe and J. Pierrehumbert (eds), *Papers in Laboratory Phonology V*, Cambridge University Press, in press.
6. Ladd, D.R., “Phonological features of intonational peaks,” *Language* 59: 721-759, 1983.
7. Arvaniti, A., Ladd, D.R., and Mennen, I., “Acoustic properties of tonal targets in Greek polar question intonation,” forthcoming.
8. Silverman, K., and Pierrehumbert, J., “The timing of prenuclear high accents in English,” in J. Kingston and M.E. Beckman (eds), *Papers in Laboratory Phonology I: Between the grammar and physics of speech*, pp.71-106, Cambridge University Press, 1990.
9. Prieto, P., van Santen, J., and Hirschberg, J., “Tonal alignment patterns in Spanish,” *Journal of Phonetics* 23: 429-451, 1995.
10. Arvaniti, A., Ladd, D.R., and Mennen, I., “Stability of tonal alignment: the case of Greek prenuclear accents,” *Journal of Phonetics* 26: 3-25, 1998.