INTONATION OF MODERN GREEK SENTENCES

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Abstract

This paper deals with the intonation of Modern Greek yes/no questions, wh-questions, and declarative-statements. In Greek there are questions which are introduced by a question word (wh-questions), but also questions which cannot be syntactically distinguished from their corresponding declarative-statements (yes/no questions). This implies that in Modern Greek yes/no questions and declarative-statements have equal syntactic structures. Intonation of the three types of sentences is described by means of two relatively new methods: the phonetic method of stylization, as presented in't Hart, Collier and Cohen (1990), and the phonological model of Pierrehumbert (1980), further developed in Hayes and Lahiri (1991). It is argued that three simple rules can describe the intonational structure of questions and declarative sentences in Modern Greek.

1 General introduction

Until recently Modern Greek intonation has been a comparatively neglected field of research. Few studies have paid attention to the intonational structure of Modern Greek and any *systematic* study on this subject is unknown to us. Until the appearance of the study of Setatos (1974), all existing studies on Greek intonation were restricted to subjective observations of different Greek dialects. Although Setatos (1974) is the first study that deals with 'standard Greek' and although it makes a lot of useful observations about the prosodic features in Modern Greek, it is again not based on measurements, but on subjective observations. Furthermore, it uses a quite complex descriptive apparatus.

The first one to publish a complete study on Greek intonation based on measurements was Waring (1976). Waring presents an extensive analysis based on the material of 4000 tone groups. Waring, like Setatos, merely concentrates on the attitudinal functions of intonation, and fails to find any one-to-one relationship between intonation contour and meaning. He nevertheless succeeds in making some broad correlations between intonation and meaning (Waring 1982, p. 25) :

> "rising: something incomplete or something which will be continued; to this case belong many non-final phrases, many questions, encouraging remarks, invitations, and some other imperative types;

falling-rising: as with rising, or to express 'doubt', 'uncertainty' or 'qualification' of what
is said;
rising-falling: 'contrast', such as that of insistently polar questions (in Greek) and
comments on the unexpected (in English);
falling: *no* special implication, but if it is 'marked' (e.g. by reaching very low pitch),
then 'conclusion', 'finality', 'definiteness'."

Recently Botinis (e.g. 1989, 1992) published several studies on Greek intonation and accent. He mainly deals with discourse intonation in Greek.

We studied Greek intonation in a smaller domain. We related acoustic measurements to perception and we described our findings within a phonological framework. We chose for a phonetic method based on the IPO-approach (Institute for Perception Research in Eindhoven, Holland), and for a phonological theory, first proposed in Pierrehumbert (1980) and further developed in Hayes and Lahiri (1991).

In the first part of this paper we give a short introduction to the phonetic method of stylization as developed at the IPO. Furthermore, the experimental design is given as well as an analysis of the intonation of the stimulus sentences. In the second part of this paper we present the phonological analysis.

2   Phonetic analysis of intonation

2.1   Introduction

Since the study of intonation is such a large topic, we chose to restrict ourselves to question intonation. In this paper we will investigate the intonational structure of two types of questions: (a) questions which are introduced by a question word (wh-questions) and (b) questions which are *not* introduced by a question word (yes/no questions, also called declarative questions). The intonational structure of these two types of questions will be compared to the intonational structure of declarative-statements. Yes-no questions probably rely on intonation alone to distinguish them from otherwise identical declarative-statements, as they have equal syntactic structure. The way in which the intonational structure of yes/no questions and declarative statements differs, is also subject of this paper. Especially the intonation of yes/no questions is difficult for Dutch learners of Modern Greek. One of the motivations for this investigation was to study the exact difference between Dutch and Modern Greek intonation in yes/no questions. In Dutch yes/no questions mostly have reversed order of subject and verb, next to a rising fundamental frequency at the end of the sentence.

We used the method of stylization that was developed at the Institute for Perception Research (IPO) in Eindhoven, Holland, by J. 't Hart, R. Collier and A. Cohen (1990).

The method of stylization reduces the fundamental frequency (F0) curves to the smallest number of movements, which still yield perceptual equality with the original F0-curve.

2.2   Experimental Design

2.2.1   Material

Meaningful sentences were constructed for the purpose of this experiment. The sentences were constructed according to the following criteria:
a) They had to be short and meaningful.

b) Lexical stress had to occur in all three possible positions in Greek (on the final, penultimate, and antepenultimate syllable) as we wanted to investigate the influence of lexical stress position on the intonational contour.

c) They had to have broad focus (i.e. with no specific element in focus and without expressing a certain psychological state of mind). To assure broad focus, all the sentences were accompanied by contextual information.

d) There had to be as few voiceless consonants as possible; this simplifies the interpretation of the F0-curves.

e) Since wh-questions had to be compared with yes/no questions and corresponding declarative-statements, every set of these three types of sentences was constructed with the same amount of syllables for every sentence-type and, whenever possible, the same syllable composition.

In this way, 45 sentences were constructed, 15 for every lexical stress-position (see Table 1).

Table 1. Composition of the sentence material.

	stress on the final syll.	stress on the penultimate syll.	stress on the antepenultimate syll.
yes/no question	5 sentences	5 sentences	5 sentences
wh-question	5 sentences	5 sentences	5 sentences
declarative statement	5 sentences	5 sentences	5 sentences

2.2.2 Speakers and procedure

The speakers of this speech material are two males, graduates of the school of music in Athens, and two females, graduates of the art school in Athens. The four speakers were raised in Athens. They speak nearly the same sociodialect. The subjects were provided with sheets on which the stimulus sentences were presented in random order. The contextual information was printed in normal format, the stimulus sentences were printed in bold.

The four speakers were asked to read out the stimulus sentences, after they had read the previous contextual information for themselves. They were asked to do this three times. The sentences were recorded on tape. The recordings took place in an apartment in a quiet neighbourhood of Athens, with a simple tape-recorder and a professional microphone and took about 20 minutes for each speaker.

The first author chose the realisation of a sentence (out of three repetitions) that was without back-ground noise or other possible deficiencies. This selected set of realisations of the sentences was judged by two Greek listeners. The best realisations of the intonation belonging to a sentence were established on a 7-point scale. These realisations were equally divided among the four speakers. Only these best 45 realisations were used for further investigation.

These 45 best realisations of the intonation were stored in a VAX 8530 computer under the operating system VMS. By means of a computer program the F0 contour of each sentence was established. After the establishment of the F0 contours, stylizations of all the contours were made (Spaai et al. (forthcoming)). The experimenter changed the fundamental frequency contour into the smallest amount of straight lines, which still

yielded perceptual equality with the original F0 contour. The original contour and the stylization could be resynthesized immediately after one another. In this way the experimenter could establish the perceptual equality. It was clear that sometimes small changes in the original contour had perceptual meaning, whereas for other instances large changes had no perceptual meaning at all. See figure 1 for an example of a stylization of the F0 contour. Although stylizations were made of the whole (short) sentence, we mainly concentrated on the final part, since this part is the most important one in relationship to the research question.
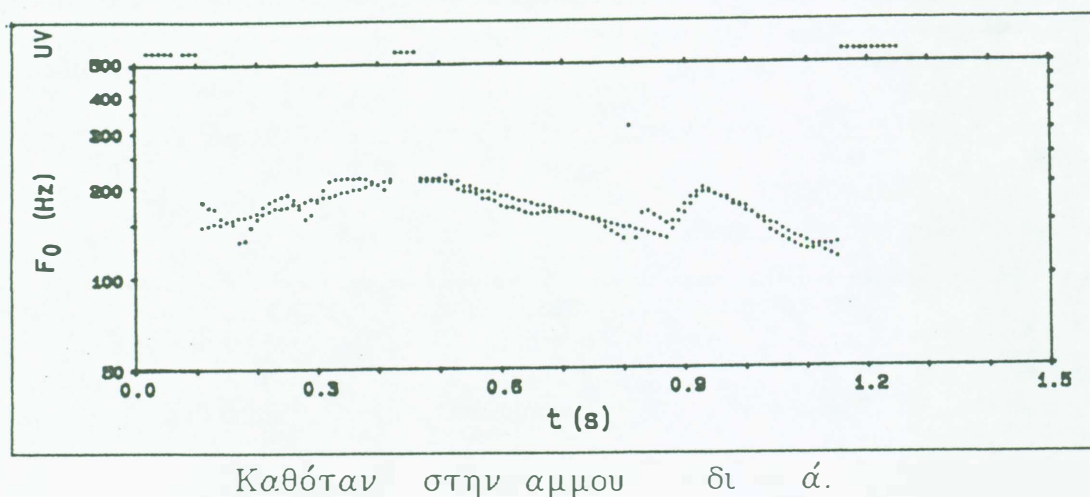

Καθόταν στην αμμου δι ά.

Figure 1: stylization and original contour of the sentence 'καθόταν στην αμμουδιά'. Ka´θotan stin ammu´δja. She sat on the sand.

After the stylizations were established, a perception test was performed: sentences with stylized contours and resynthesized sentences with original F0-curves were mixed and stored on a tape. Two Greek listeners were asked to judge each sentence on its acceptability and to put the right punctuation (i.e. question mark or period) for each sentence. All the sentences were judged to have normal Greek intonation and punctuation was always assigned correctly by both listeners.

2.3   Results

2.3.1   Yes/No-question (declarative question)

In the following section, figures of the stylized intonation contour are given for one sentence. Remember that there are five different examples per sentence type. Unless remarked otherwise, results hold for all of the five sentences. Underneath the figures the Greek sentences are presented. The stylizations and these sentences are more or less synchronized.

a) Stress on the final syllable of the sentence.

In this stress position we observe a rise-fall of the pitch in the area of the last syllable. The pitch rises smoothly and falls rather rapidly, as we can see in figure 2.
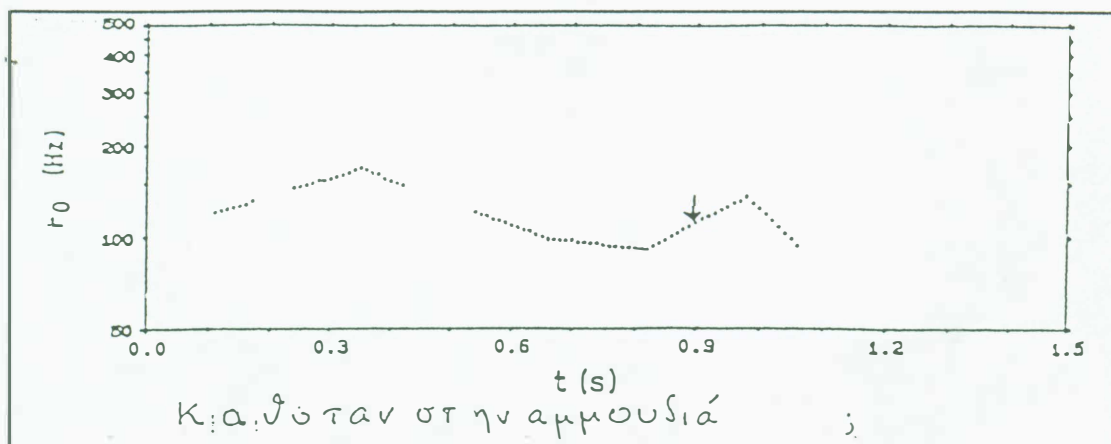
Figure 2: καθόταν στην αμμουδιά; Ka´θotan stin ammu´ðja? Did she sit on the sand? (The arrow marks the beginning of the stressed vowel).

b) Stress on the penultimate syllable of the sentence.

In this stress position we never observed any rise or fall associated with the syllable that bears stress. The rise-fall is observed only in the last (unstressed) syllable, as we can see in figure 3.
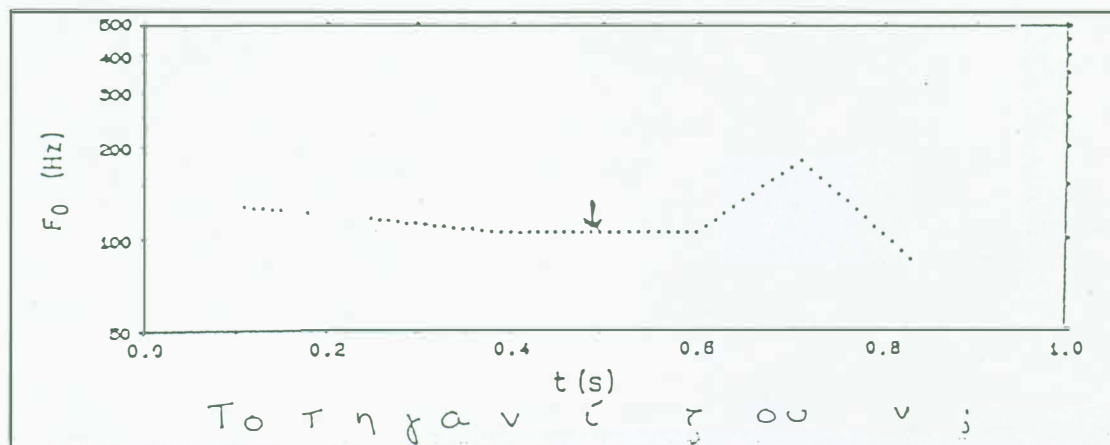

Figure 3: Το τηγανίζουν; To tiga´nizun? Do they fry it ?

c) Stress on the antepenultimate syllable of the sentence.

As in b) we never observed any rise or fall associated with the syllable that bears stress in the stress-position with stress on the antepenultimate syllable. The rise-fall takes place in the last one or two syllables of the sentence (see figure 4).
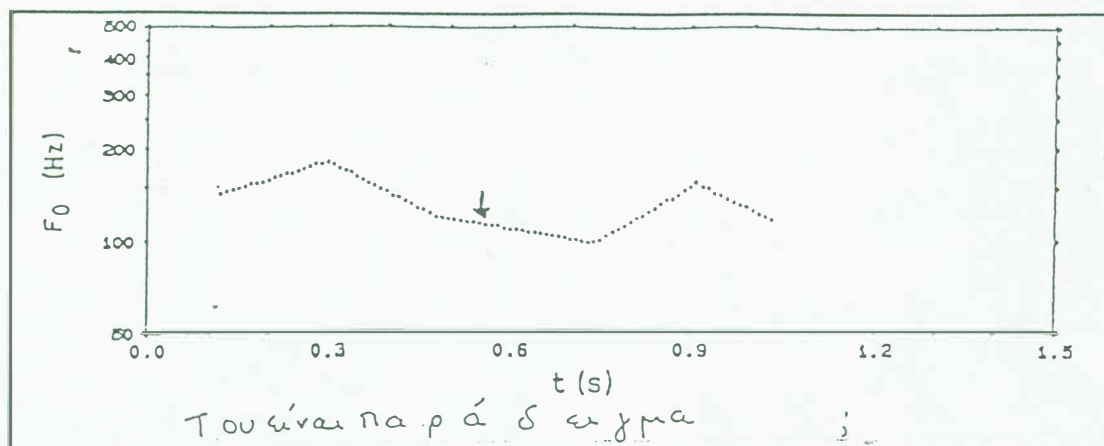
Figure 4: Του είναι παράδειγμα; Tu ´ine pa´raδigma? Is he an example to him ?

We observed one sentence with a different contour, in which the rise-fall is extended to the last four syllables, as illustrated in figure 5. The different contour of this sentence is due to the fact that it has narrow focus on the first word of the sentence. As the stimulus sentences had to have broad focus, the interpretation of this sentence lies outside of the scope of our investigation.
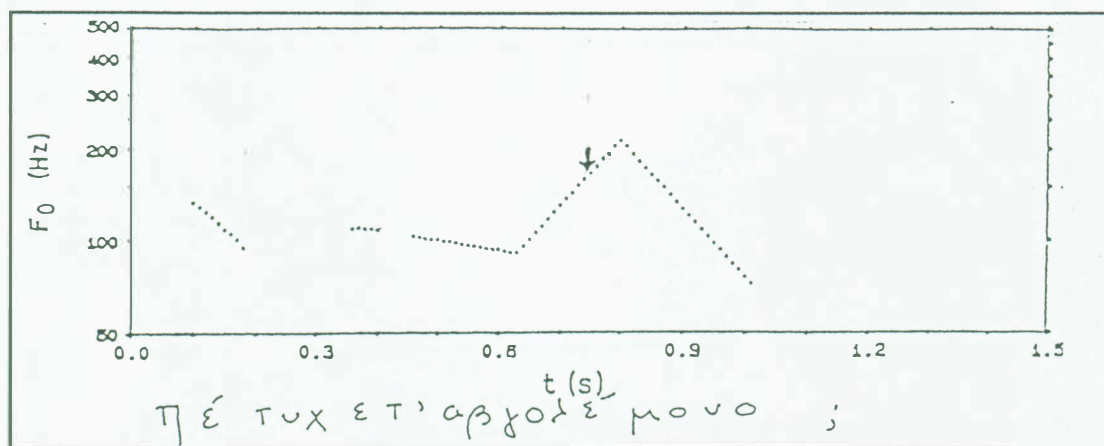
Figure 5: Πέτυχε τ 'αβγολέμονο; ´Petixe t avgo´lemono? Was the egg- and lemon sauce successful?

We conclude that the position of the lexical stress influences the shape of the intonational contour in yes/no questions: all of the yes/no questions show a rise-fall at the end of the utterance, but this rise-fall occurs - according to the lexical stress - in the last syllable or, in case of antepenultimate stress in the last word, on the last two syllables.

2.3.2   Wh-question

a) Stress on the final syllable of the sentence.

In the wh-questions with stress on the final syllable of the sentence, the pitch rises in the last (stressed) syllable, either before, after, or at the beginning of the vowel. We noticed considerable rises, in the range of a quint or an octave, as is shown in figure 6.
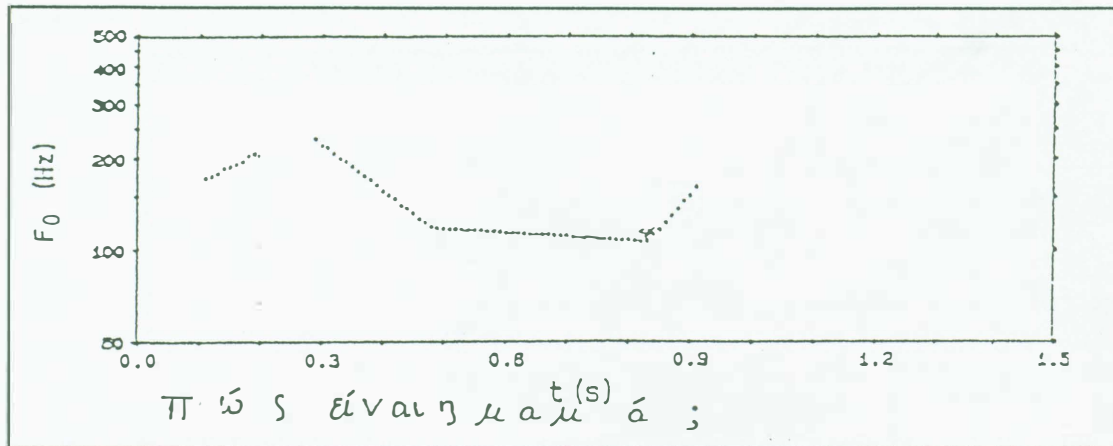
Figure 6: Πώς είναι η μαμά; ΄Pos ine i ma΄ma? How is mother?

b) Stress on the penultimate syllable of the sentence.

We observed that all sentences have the same intonational contour: an initial rise, followed by a fall, whereupon it remains level and finally rises at the end of the sentence. The final rise always appears in the last (unstressed) syllable, and we claim that the length of the sentence before the final rise influences the specific association of syllables on the contour (figures 7 and 8).

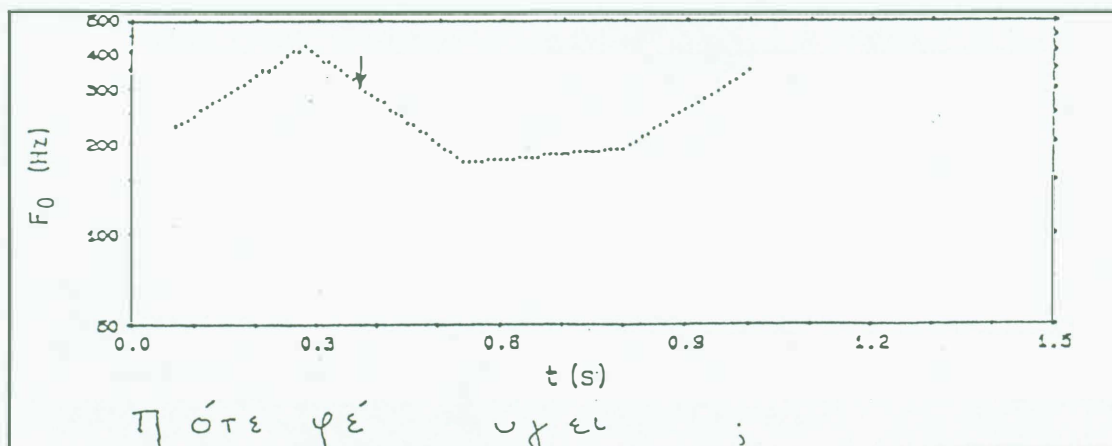Figure 7: Πότε φεύγει; ΄Pote ΄fevgi? When does he leave?
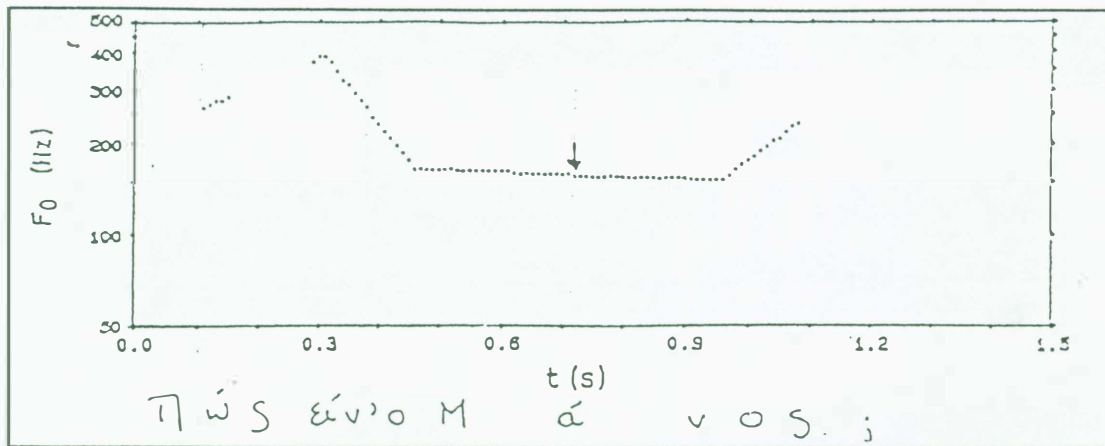
Figure 8: Πώς είναι ο Μάνος; Pos 'in o 'Manos? How is Manos (doing)?

c) Stress on the antepenultimate syllable of the sentence.

We found two almost identical shapes with a final rise of pitch either in the last or the last two syllables. The first shape (initial rise, followed by a fall, whereupon it remains level until the last syllable where pitch rises again) is shown in figure 9. The second shape (initial rise, followed by a fall, whereupon pitch rises over the last two syllables) is shown in figure 10.
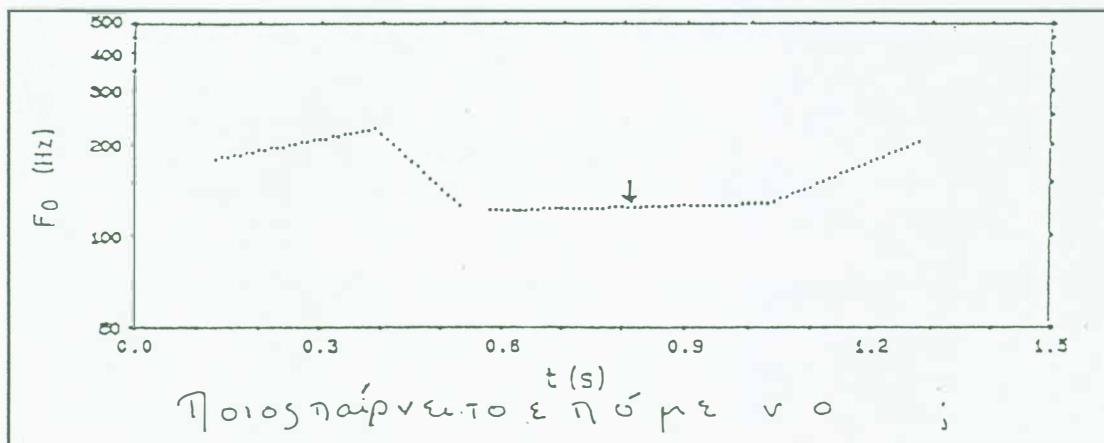
Figure 9: Ποιος παίρνει το επόμενο; Pjos 'perni to e'pomeno? Who will take the next one?

In wh-questions the lexical stress influences the final shape of the intonational contour. The intonational structure of the wh-question always shows a final rise, but the rise occurs, according to the lexical stress, either in the last syllable or in the last two syllables of the sentence.
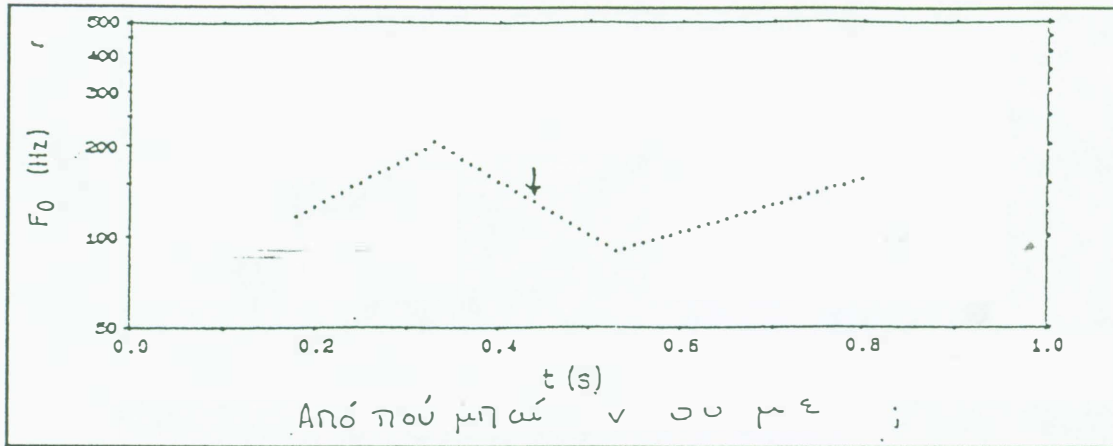
Figure 10: Από πού μπαίνουμε; A´po pu ˘benume? From which side do we enter?

2.3.3 Declarative-statement

a) Stress on the final syllable of the sentence.

In declarative-statements with stress on the final syllable at the end of the sentence we observed two different types of contours. The first consists of a rise-fall, which is extended over the last word of the sentence, as shown in figure 11. The rise starts at the beginning (the first syllable) of the last word, and not as in the corresponding yes/no questions in the last (stressed) syllable (compare the figures 11 and 12).
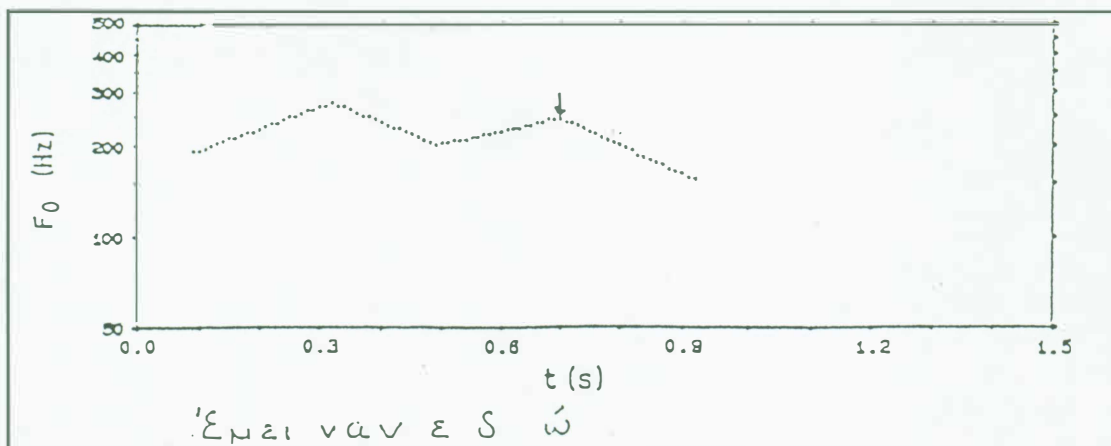
Figure 11:´Εμειναν εδώ. ´Eminan e´ðo. They lived here.
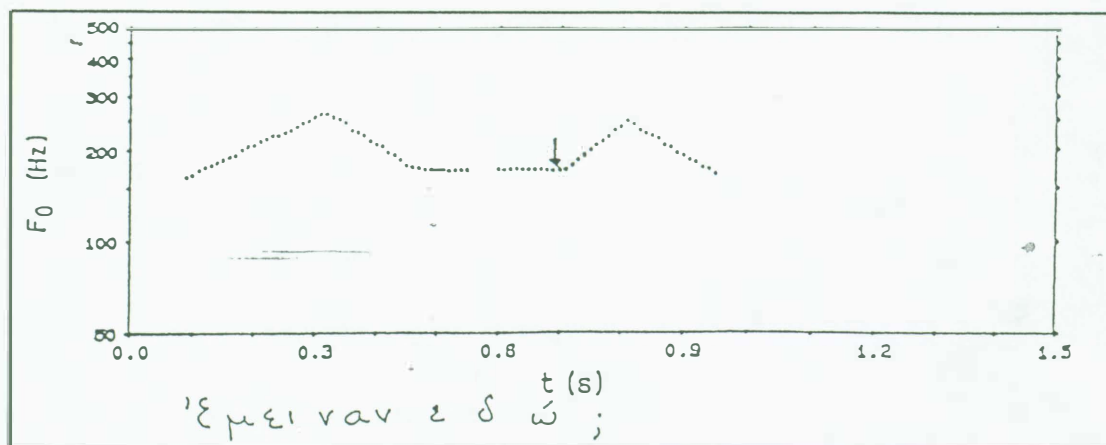
Figure 12:'Εμειναν εδώ; Eminan e'ðo? Did they live here?

The second type shows a quick rise, followed by a smooth fall in pitch, both in the last syllable, as shown in figure 13.
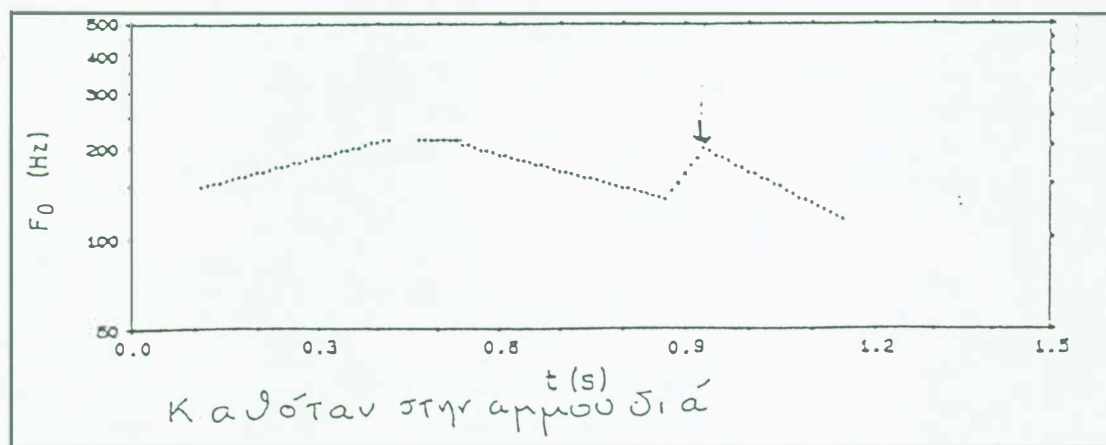
Figure 13: Καθόταν στην αμμουδιά. Ka'qotan stin ammu'ðja. She sat on the sand.

This type shows a great resemblance with the intonational contour of corresponding yes/no questions, as shown by comparing figures 13 and 2. The difference between those two sentences may be found in the exact timing of the pitch-peak. Early rise in the syllable is related to the stress, late rise in the syllable indicates the question.

b) Stress on the penultimate syllable of the sentence.

Stress is always realised by a rise-fall in the last stressed syllable. The rise-fall is followed by a level part. An example of this contour is shown in figure 14.
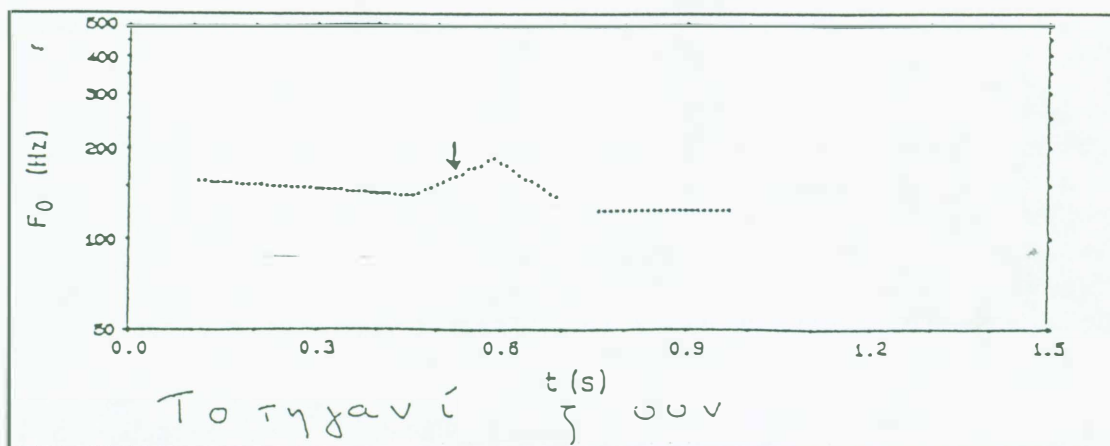
Figure 14: To τηγανίζουν. To tiga′nizun. They fry it.

c) Stress on the antepenultimate syllable sentence.

In the last stressed syllable we always noticed a rise, which is followed by a fall and a level part (or a slight rise). An example of this type of contour is shown in figure 15.
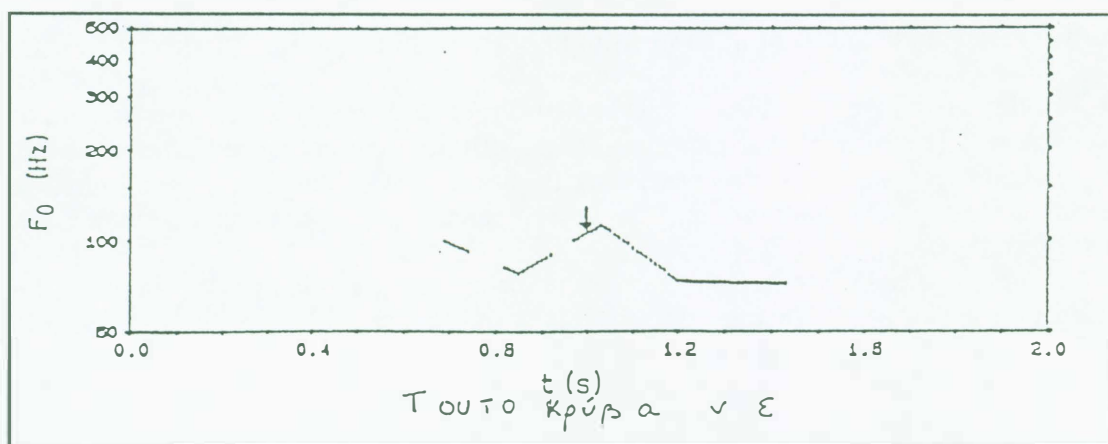
Figure 15: Του το κρύβανε. Tu to ′krivane. They kept it secret from him.

We found a clear distinction between the yes/no questions with stress on the penultimate syllable at the end of the sentence and the corresponding declarative-statements. The yes/no questions do not have a rise associated with the syllable that bears stress. The rise-fall takes place in the last or the last two syllables, while in the declarative-statements the rise takes place in the last stressed syllable. When we compare the intonation of the yes-no question in New Greek with the intonation of the yes-no question in Dutch, a clear difference may be observed. In Dutch, yes-no questions are mostly realised with a final rise, whereas in Greek intonation falls at the end of the sentence.

3 Phonological analysis

3.1 Theoretical framework - Generative intonation

The theory used for this analysis is that proposed in Pierrehumbert (1980) and developed further in Hayes and Lahiri (1991). Pierrehumbert developed a model for the representation of intonational patterns. This model provides us with a tool for the description of the tunes that characterize Modern Greek intonation and for their representation as a sequence of high (H) or low (L) tones. Tunes are comparable to intonational contours in the phonetic analysis. The model provides us with an internal structure of tunes, which consist of different types of tones:

Pitch accents: tones which get linked to stressed syllables. They can be realised by a single tone (marked L* and H*) or bitonally (marked L*+H, H*+L, L+H*, or H+L*).
Boundary tones: which, according to Hayes and Lahiri (1991), link more to a boundary than to a syllable, meaning that they get linked more to the beginning or end of a sentence rather than a particular syllable. The boundary tone is marked T%, where T means tone.

Hayes and Lahiri, drawing on the theory of Prosodic Hierarchy (cf. Selkirk 1980, Nespor and Vogel 1986), posit different levels of phonological constituents for the description of intonation patterns: the Intonational Phrase and the Phonological Phrase. This implicates that boundary tones may occur at **Phonological Phrase boundaries** (marked T_P) or at **Intonational Phrase boundaries** (marked T_I).

The model also gives us the possibility to develop a set of rules for tune-text association. The model of Pierrehumbert starts with the metrical representation of the text, indicating where stress is located, since the stressed syllables are the docking sites for pitch accents. The model then gives a representation of a tune as a sequence of (H)ighs and (L)ows.

When the internal structure of a tune is established, we are able to associate tunes to texts, by means of the following rules (cf. Hayes and Lahiri, 1991):

a. Pitch accents associate with stressed syllables within their phrasal domain.

b. Boundary tones associate with the boundary for which they are diacritically marked.

c. Given a choice of where to link a pitch accent, link it with the strongest stress of its phrasal domain.

3.2 Greek Stress

As we mentioned before, the docking sites for pitch accents are stressed syllables, so we must first locate the stress. Therefore, we will adopt the following rules for Greek stress:

a) Phonological Phrase (P-phrase) stress
Within the P-phrase, the rightmost word is the strongest.[2]

b) Intonational Phrase (I-phrase) stress
1. A P-phrase bearing narrow focus, receives the strongest stress of its I-phrase.
2. Under neutral focus, the rightmost P-phrase within the I-phrase is the strongest.

In structure (I) some examples of the application of the stress-rules are given. Example (Ia) illustrates the application of the rule of Phonological Phrase Stress. Example (Ib) illustrates the application of the rule of Intonational Phrase stress under neutral focus. Example (Ic) illustrates how P-phrases bearing narrow focus, receive the main stress.

(I a)
```
                          x
        x       x    x
        x       x    x
        x    x  x    x x x
[Μια   καλή   κοπέλα   ]P (broad focus)
Mja    ka´li   ko´pela.
A good girl.
```

(I b)
```
                                        x
        x                               x
        x                               x
        x                          x    x
        x x                   x    x x x
[[Πήγε            ]P    [στο σινεμά.   ]P]I
P´ige                    sto sine´ma ?   (broad focus)
Did she go to the cinema ?
```

(I c)
```
        x
        x                x
        x                x
        x          x     x
        x x x   x  x  x x x x
[[Πέτυχε]P[το αβγολέμονο;   ]P]I
´Petixe t avgo´lemono ?   (narrow focus on πέτυχε )
Was the egg- and lemonsauce successful ?
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3.3 Greek intonation

For the analysis of intonation a separation of the intonational contour into two parts was made (cf. Selkirk (1980; Nespor and Vogel (1986)):

Nucleus: the main stressed syllable plus everything after it.
Head: everything before the main stressed syllable.

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[2] We tend to agree with the assumption of Joseph and Philippaki-Warburton (1987, p. 244), that under normal circumstances the nucleus of the sentence in Greek is located in the last stressed syllable, instead of with Botinis' (1992) hypothesis of a left dominance in statements.

3.3.1 The nucleus in yes/no questions

Figure 16 (starting from the syllable Μά) illustrates the nucleus, which is most often used for Greek yes/no questions. This sentence has broad focus, so the rightmost phonological phrase gets the main stress of the sentence. In the yes/no nucleus the main stressed syllable (here Μά) gets a low pitch, after which pitch rises slowly until the last syllable, whereupon it falls again at the end of the utterance. The contour we propose to assign to the yes/no questions is L* Hp Lɪ, giving the nucleus of 16 the structure of (II). To show the stress pattern, we include a metrical grid.

(II)
```
                                          x
        x                                 x
        x                                 x
        x                                 x
        x   x   x                 x   x   x
  [[    Κέρδισε        ]ₚ   [     o Μάνος;        ]ₚ        ]ɪ   (broad focus)
                                 |               |         |
                                 L*              Hₚ        Lɪ
```
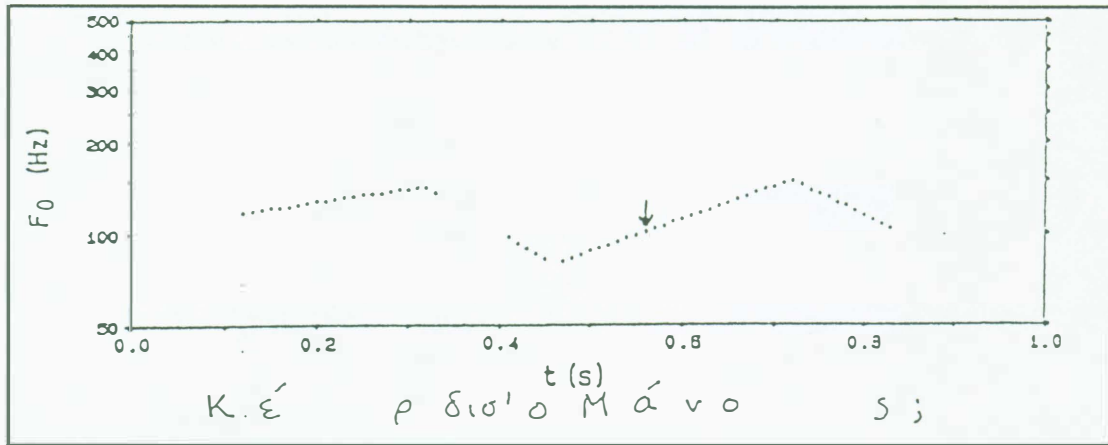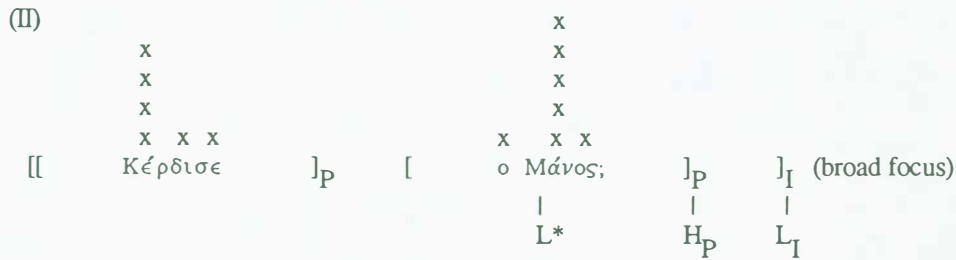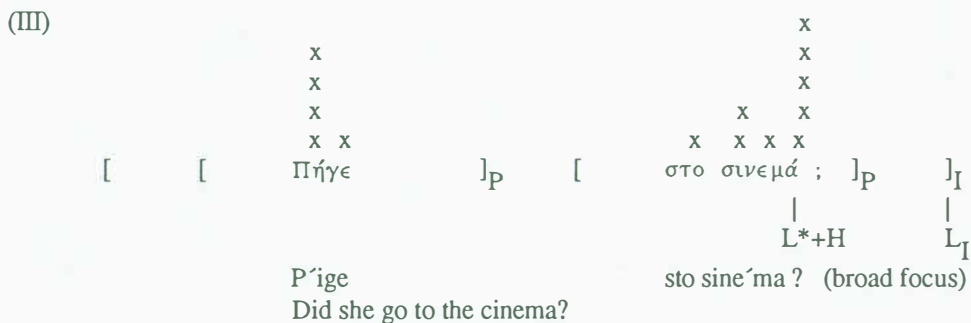

Figure 16: Κέρδισε o Μάνος; ´Cerðis o ´Manos? Did Manos win?

This nucleus is used for yes/no questions in all the stress positions. The intonational structure of the yes/no question nucleus with stress on the final syllable of the sentence, seems to be slightly different, but is in fact the same: L*+ H Lɪ, (see structure (III) and figure 17). The difference does not lie in the sequence of H and L tones (in both of the sequences the main stress is low, followed by H and L at the end of the utterance), but is due to the fact that one is bitonal and the other is not.

(III)
```
                                                  x
            x                                     x
            x                                     x
            x                             x   x
            x   x                     x   x   x   x
  [     [   Πήγε         ]ₚ   [       στο σινεμά ;  ]ₚ        ]ɪ
                                          |               |
                                          L*+H            Lɪ

            P´ige                         sto sine´ma ?   (broad focus)
            Did she go to the cinema?
```

We claim that the two nuclei, L* Hp L_I, and L*+ H L_I are in fact not two contrasting nuclei, but just one nucleus, which can be phonemized as L* Hp L_I . So we assume that the nucleus for all the types of yes/no questions we investigated is L* (+) Hp L_I
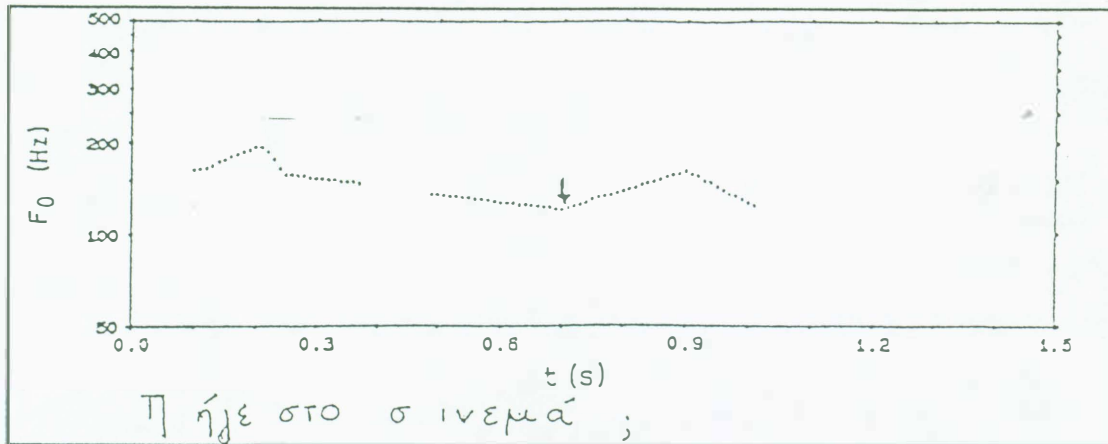

Figure 17: Πήγε στο σινεμά; P´ige sto sine´ma ? (broad focus) Did she go to the cinema?

3.3.2 The nucleus in wh-questions

Figure 18 shows the Greek nucleus most often used for wh-questions. The sentence has broad focus. The main stressed syllable gets a low pitch, after which pitch rises fast or remains level until the end of the phonological phrase, after which pitch rises again. The intonational contour of the wh-questions is phonemized as L* (L_P) H_I, giving the nucleus of 18 the structure of (IV).
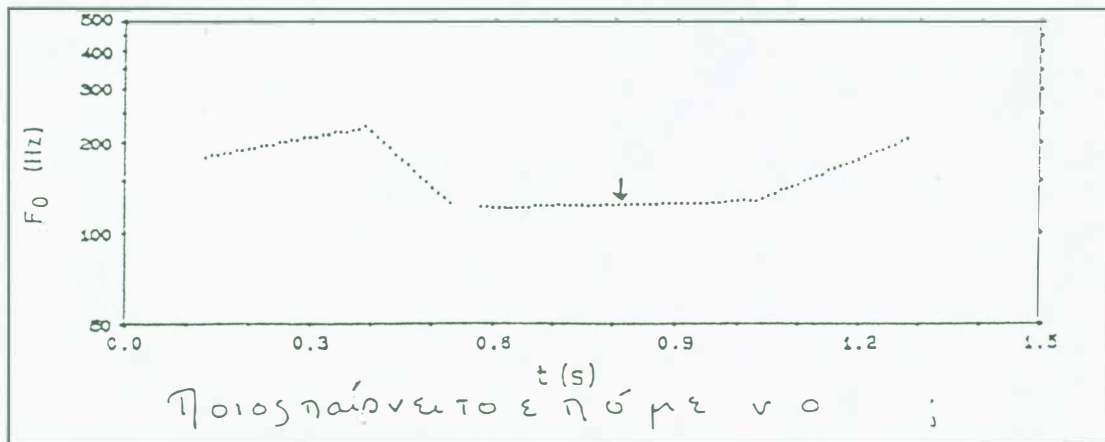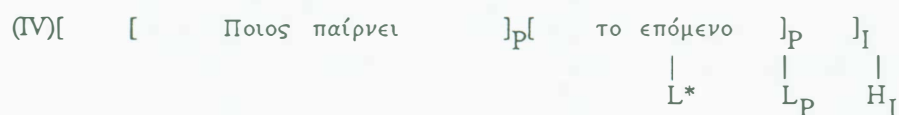

Figure 18: Ποιος παίρνει το επόμενο; Pjos ´perni to e´pomeno? Who will take the next one?

(IV)[[Ποιος παίρνει   ]_P[το επόμενο   ]_P   ]_I
                                | | |
                                L*   L_P   H_I

The lexical stress influences the existence of L_P, the level part: with stress on the penultimate syllable at the end, L_P always occurs (phonemized as $L^* L_P H_I$,); with stress on the antepenultimate syllable it may or may not occur (phonemized as $L^* (L_P)$ H_I,); with stress on the final syllable it never occurs (phonemized as $L^* H_I$).

3.3.3 The declarative-statement nucleus

Structure (V) and figure 19 illustrate the Greek nucleus most often used for declarative-statements.

(V)　　[　　　[Τον γνωρίζει]$_P$　　]$_I$
　　　　　　　　|　　|　　|
　　　　　　　L+H* L_P　L_I
　　　　　Τον γνωρίζει.
　　　　　Ton gno´rizi.
　　　　　She knows him.
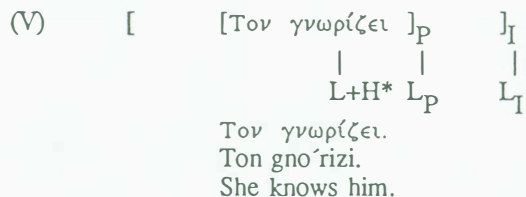
We will phonemize this declarative-statement nucleus as $L+H^* (L_P)L_I$. The level part (L_P) does not occur if stress occurs on the final syllable of the sentence, in the other cases it always exists.
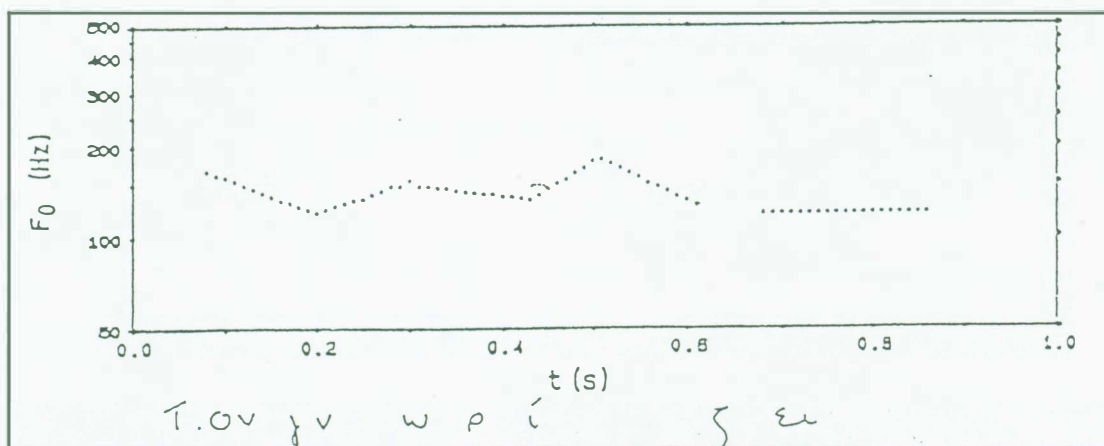

Figure 19: Τον γνωρίζει. Ton gno´rizi. She knows him.

3.3.4 The head

The 'head' in Greek intonation has a much simpler structure than the nucleus. Most of the heads we observed can be described as a rise, as can be seen in figure 2. We phonemize the head as $L^* H_P$. We have no evidence of how the head is phonologically generated when the head contains more phonological phrases, as our material consists of short sentences only.

If there are no other stressed syllables before the nucleus, the head can be described as starting with a high boundary tone (H_I), as illustrated in figure 20.
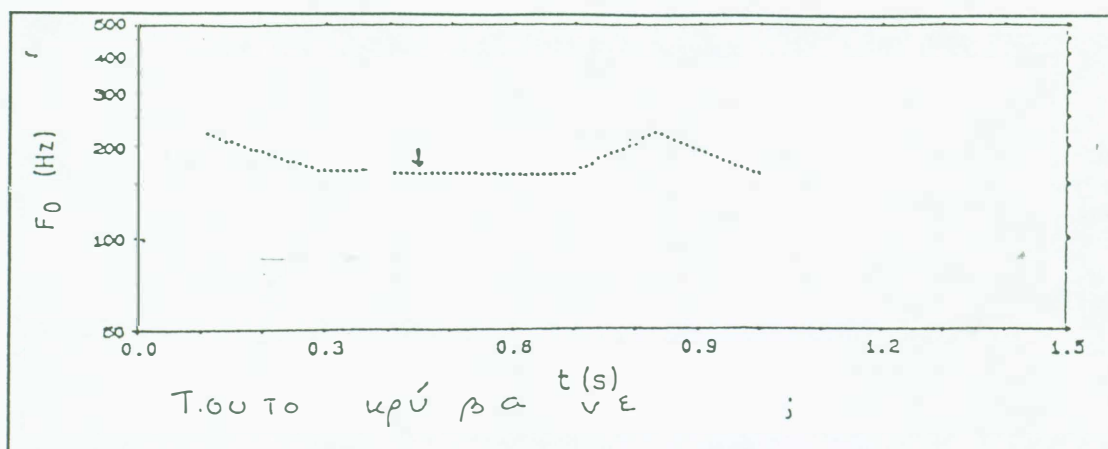
Figure 20: Του το κρύβανε; Tu to 'krivane? Did they keep it secret from him?

4 Summary and discussion

We distinguish the following tune structures in Greek:

(VI) a. $L^*(+)H_P L_I$ Yes/no question nucleus
  b. $L^* (L_p) H_I$ Wh-question nucleus
  c. $L+H^* (L_p)L_I$ Declarative-statement nucleus
  d. $L^* H_p$ Head

Concerning the existing sequences, the following observation can be made: identical tones can exist in sequence. For this reason we have to conclude that Greek does not obey the Obligatory Contour Principle (OCP), which prohibits sequences of two identical elements (cf. Leben, 1973; Yip, 1988). If Greek would obey the OCP, sequences like $L^* (L_p) H_I$ and $L+H^* (L_p)L_I$ would be prohibited.

Of course we based the above conclusions on material of limited extent, as the stimulus-sentences are short. Furthermore, we did not investigate other types of questions (e.g. complementary, alternative, or tag questions). Finally we restricted the investigation to the intonation in laboratory speech and did not investigate intonation in every day speech. An investigation of bigger extent is definitely desirable for a deeper understanding of the intonation of Modern Greek.

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