

# Intermediate Phonology

## Part 8: Tones and intonation

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# Tones and intonation

The fundamental frequency ( $f_0$ ) is the acoustic signal produced by the vibration rate of our vocal chords (more vibrations = higher pitch). In speech, our voice modulates  $f_0$  and produce rises and falls in tonal contours, “pitch” being the term for what we perceive.

When talking about tones and intonation, a primary distinction is made between

- **local pitch changes** corresponding to accentuation or prominence at the word level, i.e. **pitch accent**
- **global  $f_0$  melodies**, i.e., melodic contours with rising and/or falling  $f_0$  pattern.

Lexical tone exists in “**tone languages**”, where minimal pairs are distinguished not only by their segmental composition but also by their tonal component. Asian languages such as Mandarin Chinese, Vietnamese, and African languages such as Yoruba, Tagbana, etc. are tone languages.

Both English and Greek are “**intonation languages:**” intonational grammar takes place at the phrasal level only. The tonal configuration of words is not part of their meaning.

# Tones and intonation

In most intonation languages such as English and Greek, words have lexical accents. Some intonation languages, such as French, have no lexical accent.

In both Greek and English, Culminativity is active at every prosodic level. Prosodic phrases and intonation phrases also have prominent syllables that can be represented on a metrical grid structure.

Moreover, syntax plays a major role in the elaboration of prosodic constituents. Pragmatics, information structure, and semantics also play a role in defining prosodic phrasing.

The basics of the **tone sequence model of intonation** is introduced for English. Concrete examples are illustrated for Greek.

# English intonation

**Pierrehumbert's tone sequence model of intonation** (adapted from Bruce 1977 for Swedish, Pierrehumbert 1980 for English + many others) also sometimes called autosegmental-metrical model (Ladd 1996/2004) because English heavily relies on prominent syllables on a metrical grid for the distribution of pitch accents.

However the other tones are not metrical, and some languages do not have any 'accents.'

Tones can be high (H) or low (L).

Pitch accents are monotonal, and written H\* and L\*, or bitonal, and written L\*H, LH\*, H\*L, HL\* (and also HH\*). In L\*H the unstarred tone is a trailing tone, in HL\* it is a leading tone.

Phrasal tones are H<sup>-</sup> and L<sup>-</sup>. Boundary tones are H% and L%

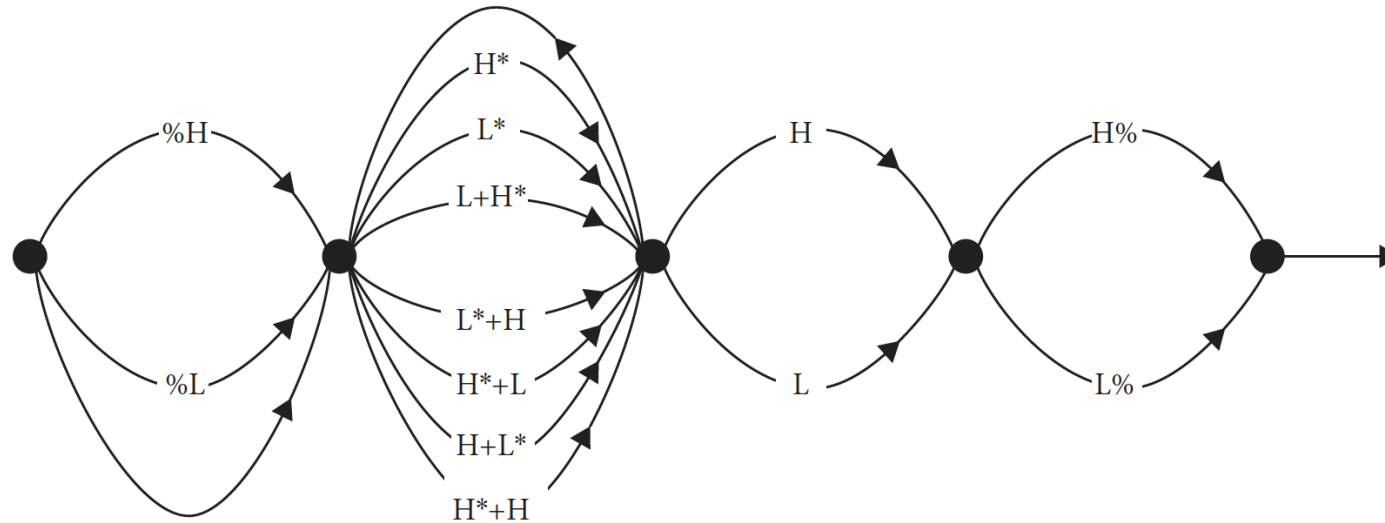
Pitch accents are associated with/realized on prominent syllables in their domain (prosodic word  $\omega$ , prosodic phrase  $\varphi$  and intonation phrase  $\iota$ ).

Phrasal tones are assigned at the level of  $\varphi$  after the last pitch accent.

Boundary tones are assigned at the level of  $\iota$  and are the last tone of the intonation phrase.

Last pitch accent + phrasal tone + boundary tone are the ingredients of the **nuclear contour** of the British school (where tonal melodies are described in terms of contours rather than as sequences of discrete tones).

# English intonation



Finite state grammar of tone sequences (from Pierrehumbert 1980:29, revised by Dainora 2006)

Pierrehumbert proposed that the possible tone sequences appearing in an English  $\iota$ -phrase are best accounted for by a finite state grammar (1980:29).

An intonation phrase ( $\iota$ -phrase) starts with an optional boundary tone. It is followed by one or more pitch accents (see the arrow leading back) and it ends with an obligatory phrasal tone (or phrase accent in her terminology) and an obligatory boundary tone.

# English intonation

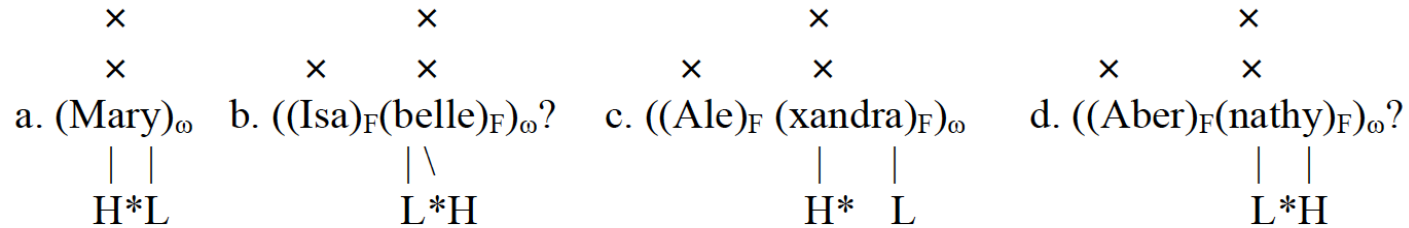
## Text-tone association

### Phonological rules for text-to-tune association

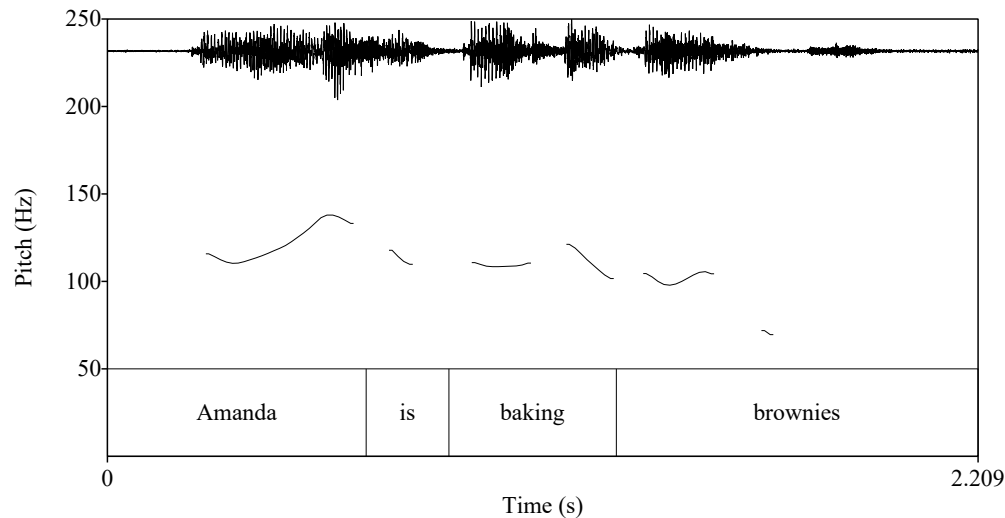
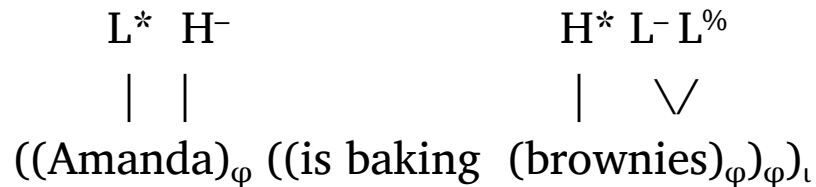
- a. Pitch accents associate with (the strongest) stressed syllables within their prosodic domain (prosodic word  $\omega$ , prosodic phrase  $\varphi$  and intonation phrase  $\iota$ ).
- b. Phrasal tones associate after the last pitch accent of prosodic phrase  $\varphi$ , for which they are diacritically marked with  $\bar{\cdot}$ .
- b. Boundary tones associate with the boundary of intonation phrase  $\iota$ , for which they are diacritically marked with  $\%$ .

# English intonation

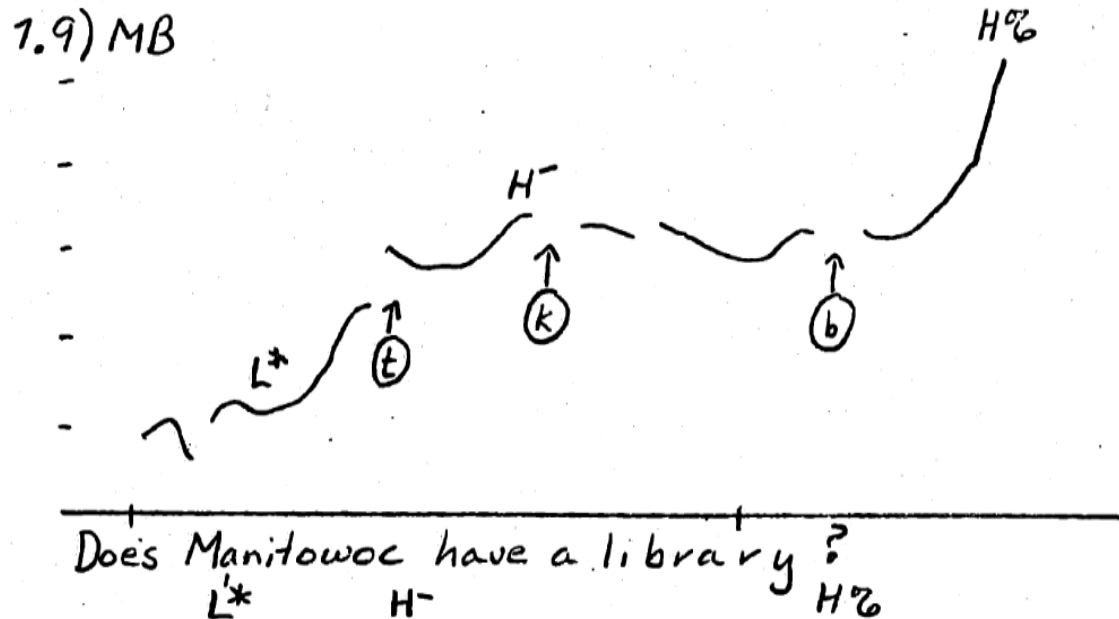
a. Pitch accents associate with (the strongest) stressed syllables within their prosodic domain.



b. Boundary tones and phrasal tones associate with the boundary of the prosodic domain for which they are diacritically marked.



# English intonation



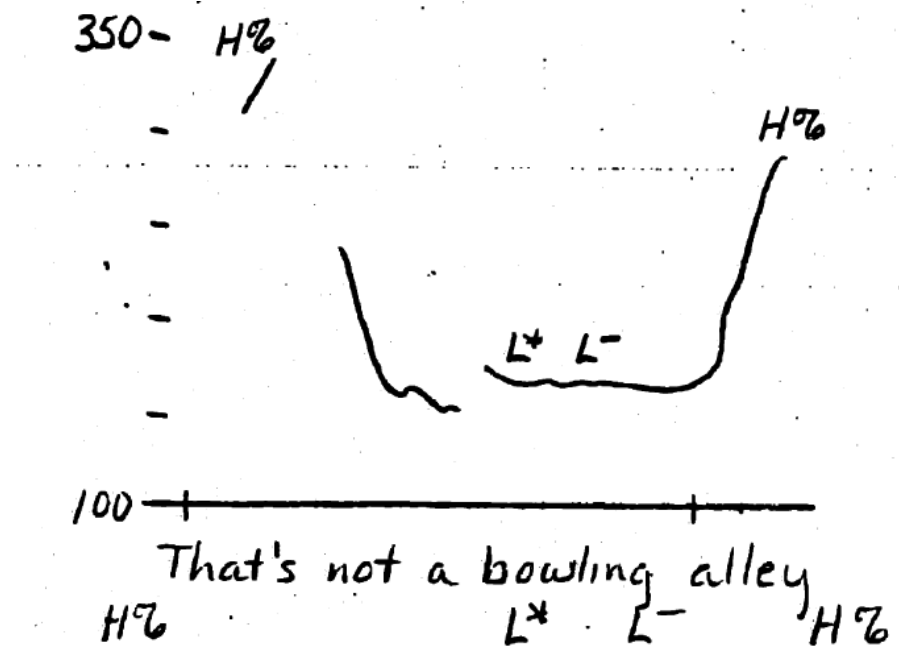
*Does MANITOWOC have a library?*:  $L^*$   $H^-$   $H\%$  (from Pierrehumbert 1980:265)

The starred tone  $L^*$  (nuclear tone) is associated with the stressed syllable of *Mánitowoc*. The final boundary tone is high, and the phrase accent between  $L^*$  and  $H\%$  defines a high ( $H^-$ ) plateau.

The accent structures of the examples shown with capital letters in the legend are not always the default accent structure associated with an all-new utterance.



# English intonation



*That's not a BOWLING alley.* H% L\* L- H% (from Pierrehumbert 1980:385)

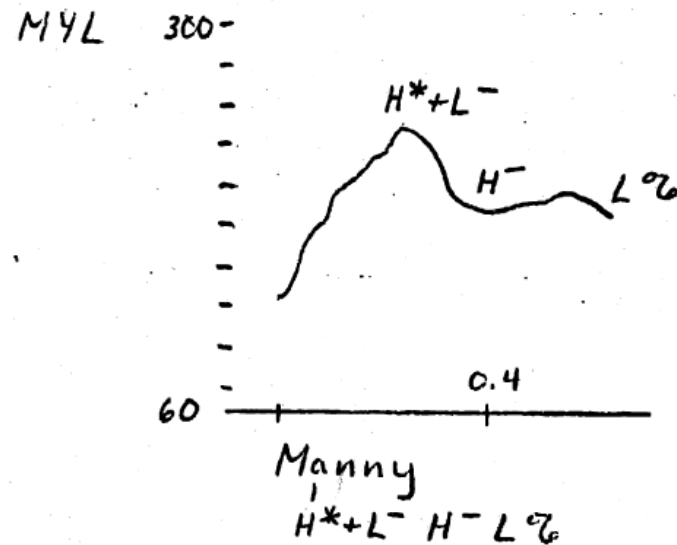
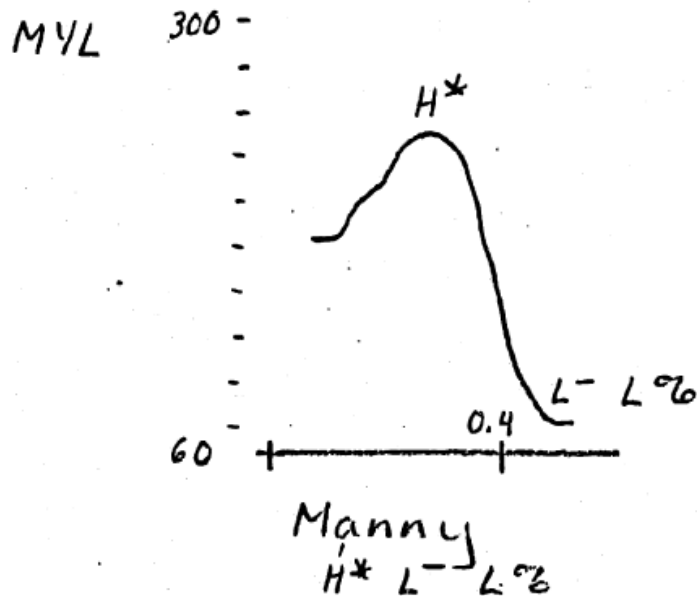
The utterance begins high, and the initial high target on an unstressed syllable is analysed as a high boundary tone.

The starred tone L\* is associated with the stressed syllable of *bówling*. Final boundary tone is high, and the phrase accent between L\* and H% defines a low (L-) plateau.

# English intonation

Leftward illustration: the high pitch accent  $H^*$  on the stressed syllable of the word *Mánnny* is followed by a low phrase accent and a low boundary tone, defining a steep fall on the second syllable of *Mánnny*. The fall is typical for a declarative intonation as it reaches the bottom of the speaker's register.

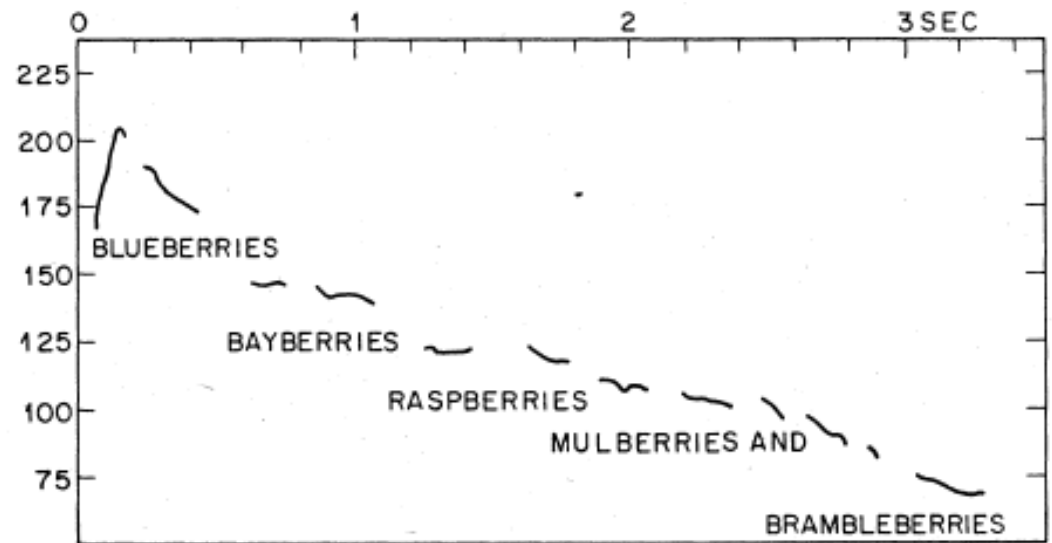
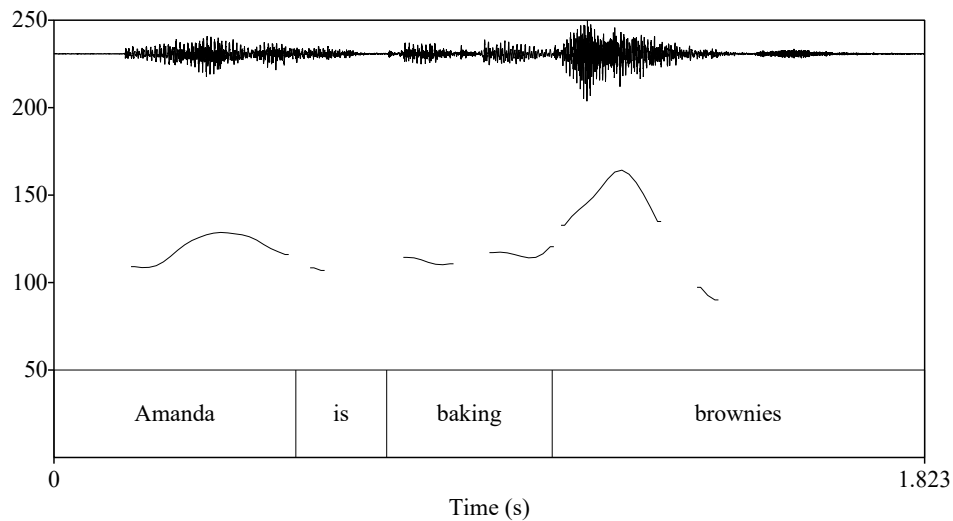
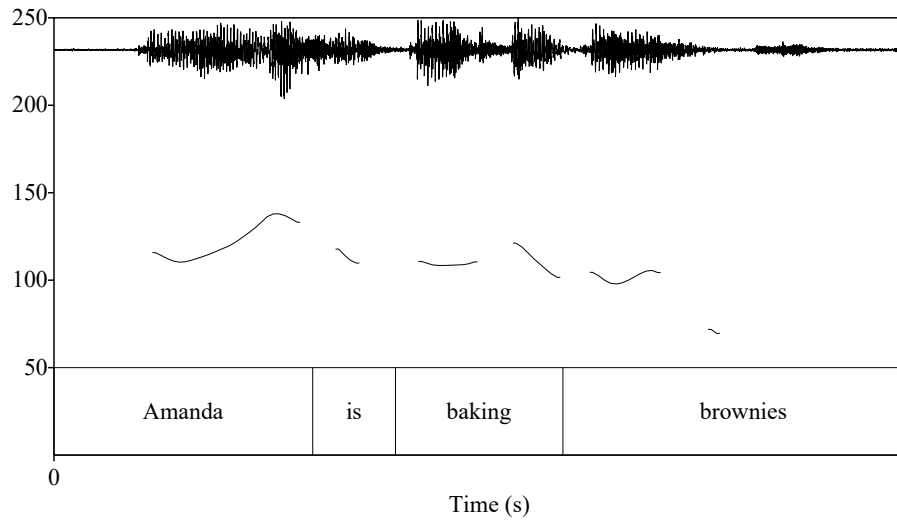
Rightward illustration: a vocative contour. It also has a peak on the stressed syllable, but this time the falling contour is accounted for by a bitonal tone  $H^* + L^-$ . At the end of the phrase, the lowest value only reaches mid-register:  $H^-$  is lower than  $H^*$  and  $L\%$  is higher than in the leftward illustration.  $L\%$  is upstepped by  $H^-$ .



*MANNY* in two tone sequences,  $H^* L^- L\%$  and  $H^* + L^- H^- L\%$  (from Pierrehumbert 1980:273)<sup>10</sup>

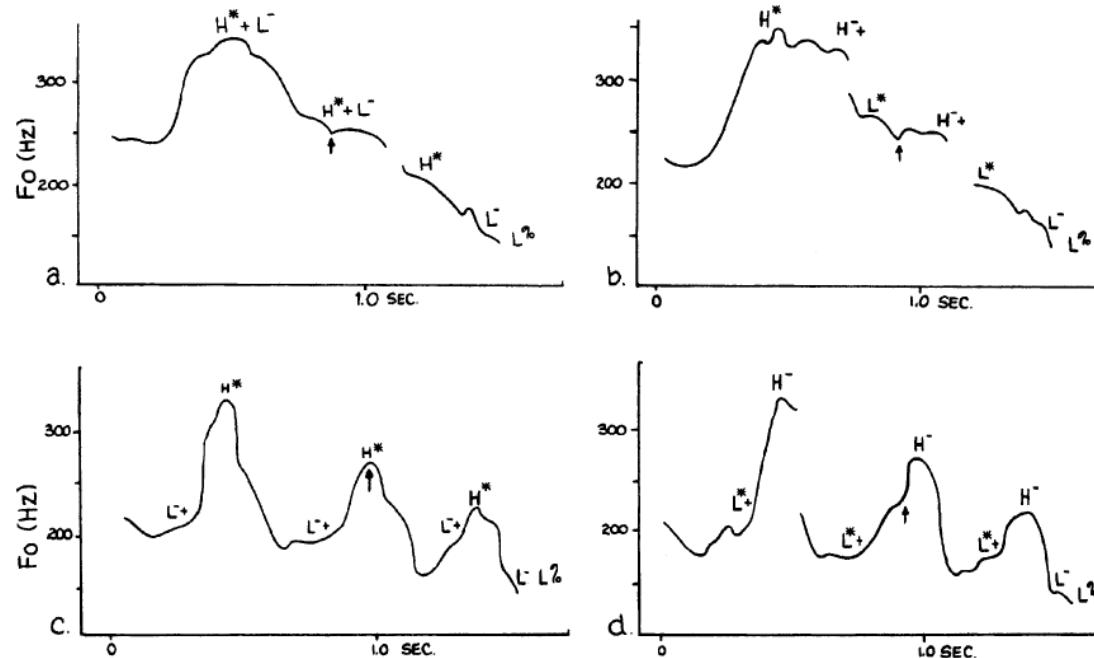
# English intonation

## Downstep and upstep



Lieberman & Pierrehumbert 1984:171

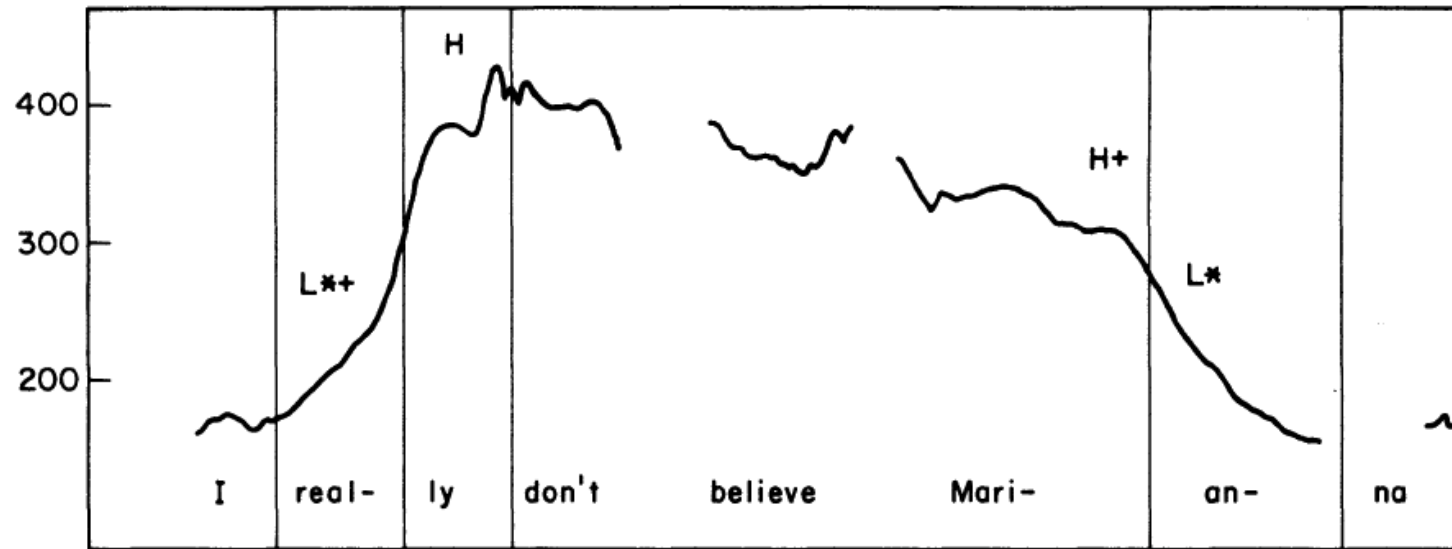
# English intonation



From Ladd (1983a) reproducing four pitch tracks from Pierrehumbert (1980): *There are MANY INTERMEDIATE LEVELS* in four variants with downstep. The arrows show the location of [d] of *intermediate*.

Downstep between two Hs is triggered by an intervening L. This L tone must be part of a bitonal pitch accent, like H\* + L-, H- + L\*, L- + H\* or L\* + H-, i.e. in any combination of a bitonal tone containing an H and an L.

# English intonation



*I REALLY don't believe MARIANNA*: downstep of H after L\* + H (Beckman & Pierrehumbert 1986:276)

In Beckman & Pierrehumbert (1986), downstep applies to all high tones after any bitonal pitch accent, also those in which the L part is not between the two H tones.

The leading tone H of H+L\* on *Marianna* can be downstepped relative to an immediately preceding H, itself part of a bitonal L\* + H on *really*.

# English intonation

## Continuous phonetic melody: spreading and interpolation

In **interpolation**, the melodic contour between two syllables specified for tones is just smoothly going from the first tonal value to the second one, across all syllables in-between that are unspecified for tone, i.e. not associated with any tone.

In **spreading**, a specific tone is associated not only with the syllable from which it originates, but to all following syllables up to the next specified tone. See *I REALLY don't believe MARIANNA* and *Does MANITOWOC have a library?*

# English intonation

The role of intonation differs from the other grammatical modules, without being completely separated from them. Rather the part played by an intonation contour interacts with other grammatical components to produce specific nuances.

However, as we saw, intonation has a grammar on its own. The choice of specific tones and the way they combine is essential in communication.

In intonation languages, **meanings and illocutionary roles** influence the tonal patterns of sentences, and conversely, the choice of tones has an influence on the pragmatic interpretation of sentences. Relationship between intonation on the one hand and pragmatics, semantics and information structure on the other.

The **information structure** roles (focus, givenness, topic) influence the prosodic phrasing and the tonal pattern of sentences by assigning special tones or tonal sequences to bearers of the information structural roles.

# English intonation

The melodic pattern conveys additional information as to the modality of the sentence, its declarative or interrogative status, and as to the speaker's attitude.

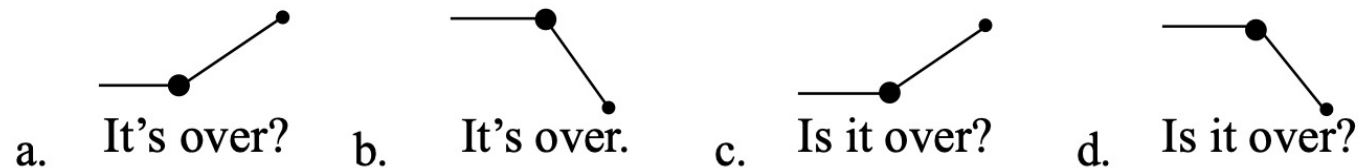
The melody emerging from the concatenation of tones is associated with specific pragmatic meanings. The semantic effect of tones is thus mediated through the prosodic categories they appear in. In other words, it is not a 'rising tune' that is meaningful, but rather the pragmatic interpretation of a sentence is determined by specific tones in a prosodic domain, for instance a low pitch accent  $L^*$  followed by a high  $\phi$ -phrase boundary tone  $H$ -. In sum, meanings result from the association of individual tones to specific prosodic domains and of the way these tones are concatenated in a particular text.

Moreover, intonation also provides additional information on the mood and emotional state of the speaker, like cheerfulness, anger, joy, fear or sadness



# English intonation

Gunlogson (2003) compares declarative syntax (a, b) vs. interrogative syntax (c, d) combined with rising intonation (a, c) vs. falling intonation (b, d).



a. is the interesting case, rising declarative questions cannot be used 'out of the blue', without any relevant preceding context, as interrogatives can be, see (1).

(1) [to coworker eating a piece of fruit]

- a. Is that a persimmon?
- b. #That's a persimmon?
- c. #That's a persimmon.

(2) can only be uttered in a context in which the speaker already has evidence that it is raining, for instance upon seeing somebody entering the room with a wet umbrella.

(2) It's raining?

# Greek intonation

Baltazani & Jun (1999) and Arvaniti & Baltazani (2005) propose a tone sequence model for Greek and they identify the following tones:

Two monotonal pitch accents :  $H^*$  and  $L^*$

Three bitonal pitch accents :  $L^* + H$ ,  $L + H^*$  and  $H^* + L$ .

The most frequently used pitch accent is  $L^* + H$ , which is the predominant choice for pre-nuclear accented syllables. It is also frequently attested in nuclear position, in calls, imperatives, negative declaratives, and wh-questions.

$H^*$  and  $H^*L$  are not easy to distinguished, especially when  $H^*$  is followed by  $L^-$ .

Phrasal tones:  $H^-$ ,  $L^-$  and  $!H^-$  (used for representing downstep)

Boundary tones  $L\%$ ,  $H\%$  and  $!H\%$  (used for representing mid-level, recall the vocative contour in English)

Baltazani, M., & Jun, S.-A. 1999. Focus and topic intonation in Greek. *Proceedings of the XIVth International Congress of Phonetic Sciences*. University of California, Berkeley.

Arvaniti, Amalia & Mary Baltazani. 2005. Intonational analysis and prosodic annotation of Greek spoken corpora. In Jun, Sun-Ah. 2005. *Prosodic Typology*. Cambridge University Press. 84-117.

# Greek intonation

## Possible combinations of phrasal tone and boundary tone and their usage

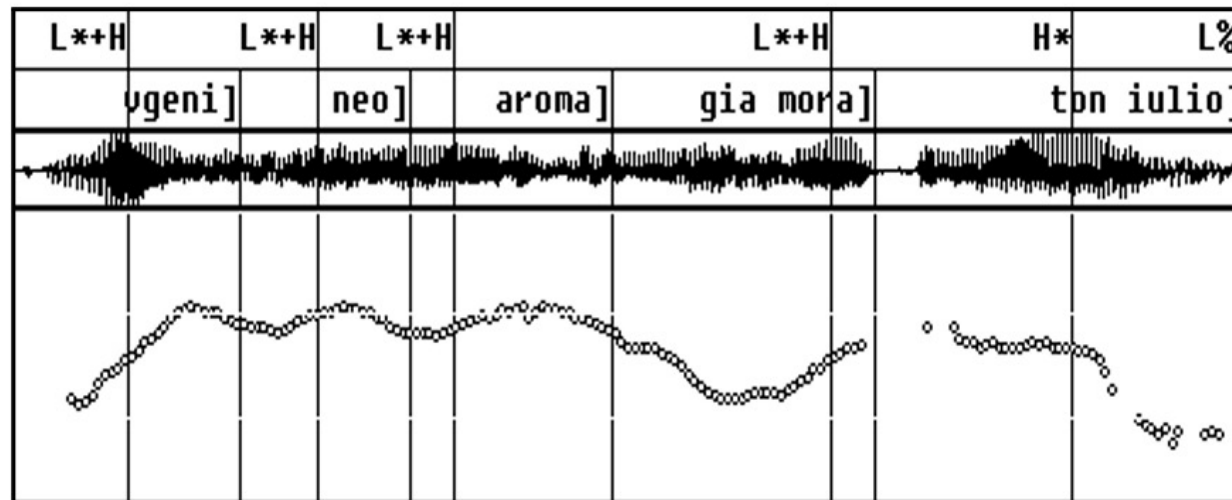
| Configuration | Schematic representation | Usage  |
|---------------|--------------------------|--|
| L-L%          | —                        | declaratives, negative declaratives, imperatives, wh-questions                             |
| L-H%          | ↘↗                       | ‘involved’ continuation rise, ‘suspicious’ calls   |
| H-L%          | ↗↘                       | yes-no questions, requesting calling contour   |
| H-H%          | ↗                        | continuation rise, questioning calling contour   |
| L-!H%         | —↗                       | ‘involved’ wh-questions, negative declaratives showing reservation, requesting imperatives |
| H-!H%         | ↗—                       | stylized continuation rise   |
| !H-!H%        | ↘—                       | stylized call, incredulous questions   |
| !H-H%         | —↗                       | polite stylized call   |

Arvaniti, Amalia & Mary Baltazani. 2005. Intonational analysis and prosodic annotation of Greek spoken corpora. In Jun, Sun-Ah. 2005. *Prosodic Typology*. Cambridge University Press. 84-117.

# Greek declarative intonation

Neutral declarative sentence

|  |            |              |                 |                  |
|--|------------|--------------|-----------------|------------------|
| <i>vgeni</i>                                     | <i>neo</i> | <i>aroma</i> | <i>gia mora</i> | <i>ton iúlio</i> |
| comes  | new        | perfume      | for babies      | in July          |
| 'A new perfume for babies is coming out in July' |            |              |                 |                  |



Prenuclear pitch accents: L\* + H (continuation rises); Nuclear accent: (final) H\* (nuclear fall, a L phrase accent is missing); Boundary tone: L%

Based on the tonal structure, the following phrasing is the most plausible one.

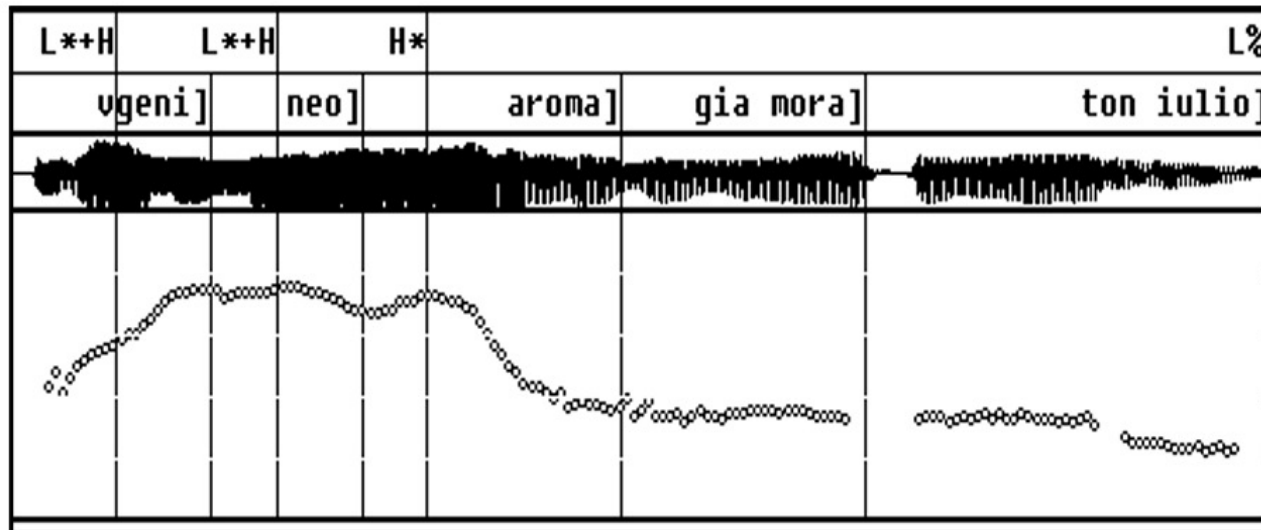
((Vegni neo aroma gia mora)<sub>φ</sub> (ton iúlio)<sub>φ</sub>)<sub>ι</sub>

Baltazani, M., & Jun, S.-A. 1999. Focus and topic intonation in Greek. *Proceedings of the XIVth International Congress of Phonetic Sciences*. University of California, Berkeley.

# Greek declarative intonation

Declarative focus sentence, focus is on ‘aroma

|  |            |              |                 |                  |
|--|------------|--------------|-----------------|------------------|
| <i>vgeni</i>                                     | <i>neo</i> | <i>aroma</i> | <i>gia mora</i> | <i>ton iúlio</i> |
| comes  | new        | perfume      | for babies      | in July          |
| ‘A new perfume for babies is coming out in July’ |            |              |                 |                  |



Prenuclear pitch accents: L\*H; Nuclear accent on the focused word H\* (a L phrase accent directly after the nuclear H\* is missing); Boundary tone: L%

Deaccenting of the postnuclear material induces a recursive  $\varphi$ -phrasing:

$((Vegni\ neo\ aroma)_\varphi\ gia\ mora\ ton\ iúlio)_\varphi$

Baltazani, M., & Jun, S.-A. 1999. Focus and topic intonation in Greek. Proceedings of the XIVth International Congress of Phonetic Sciences. University of California, Berkeley.

# Greek intonation and information structure

Information structure: focus induced by a wh-question:

Q: *Ta marulia poios ta efage?*  
 the lettuces-acc who them ate-3s  
 “Who ate the lettuce?”

A: [*o MANOLIS*]<sub>FOCUS</sub> [*ta efage ta marulia*]<sub>TAIL</sub> S clitic-V O  
 the Manolis them ate the lettuces-acc

B: [*ta marulia*]<sub>TOPIC</sub> [*o MANOLIS*]<sub>FOCUS</sub> [*ta efage*]<sub>TAIL</sub> O S clitic-V  
 the lettuces-acc the Manolis them ate

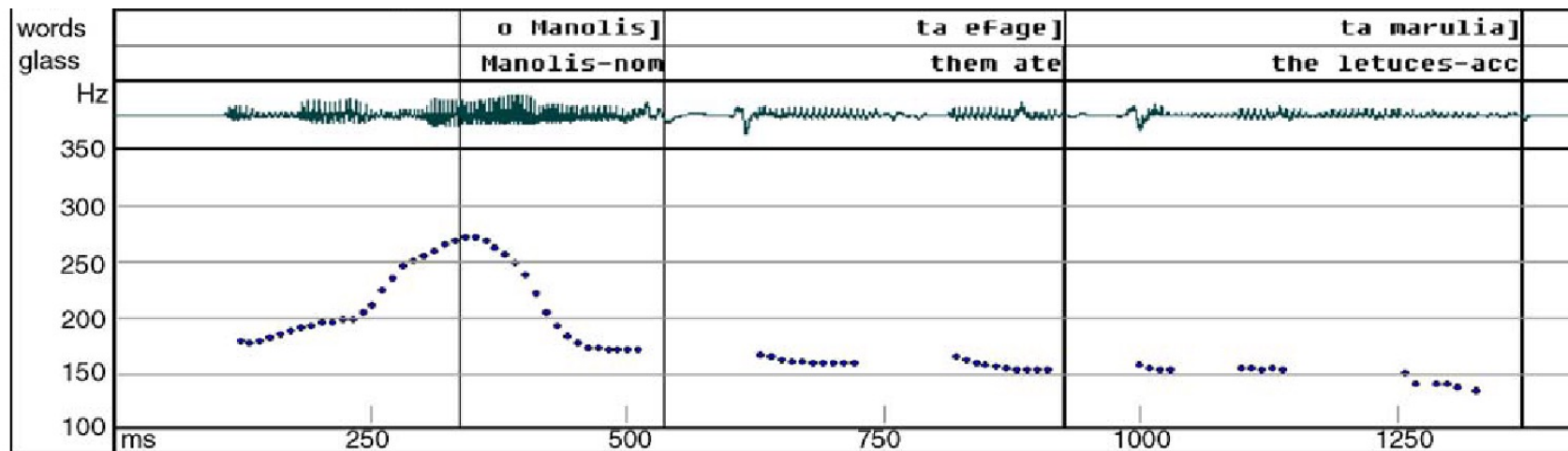
C: [*ta efage*]<sub>TOPIC</sub> [*o MANOLIS*]<sub>FOCUS</sub> [*ta marulia*]<sub>TAIL</sub> clitic-V S O  
 them ate the Manolis the lettuces-acc

Three possible word orders and tonal contours with narrow focus on the subject *o Manolis*. The given subject *ta marulia* ‘the lettuce’ can be part of the given VP, as in A, or it can be a topic, as in B. If the verb is a topic, as in C, the focused subject is postverbal and nuclear and the given object is extraposed.

A topic always forms its own  $\varphi$ -phrase.

# Greek intonation and information structure

Information structure: S clitic-V O answer



H\* L-

L%

((([o MANOLIS]<sub>Focus</sub>)<sub>φ</sub> [ta efage ta marulia]<sub>Given</sub>)<sub>φ</sub>)<sub>ι</sub> S clitic-V O

the Manolis them ate the letuces-ACC

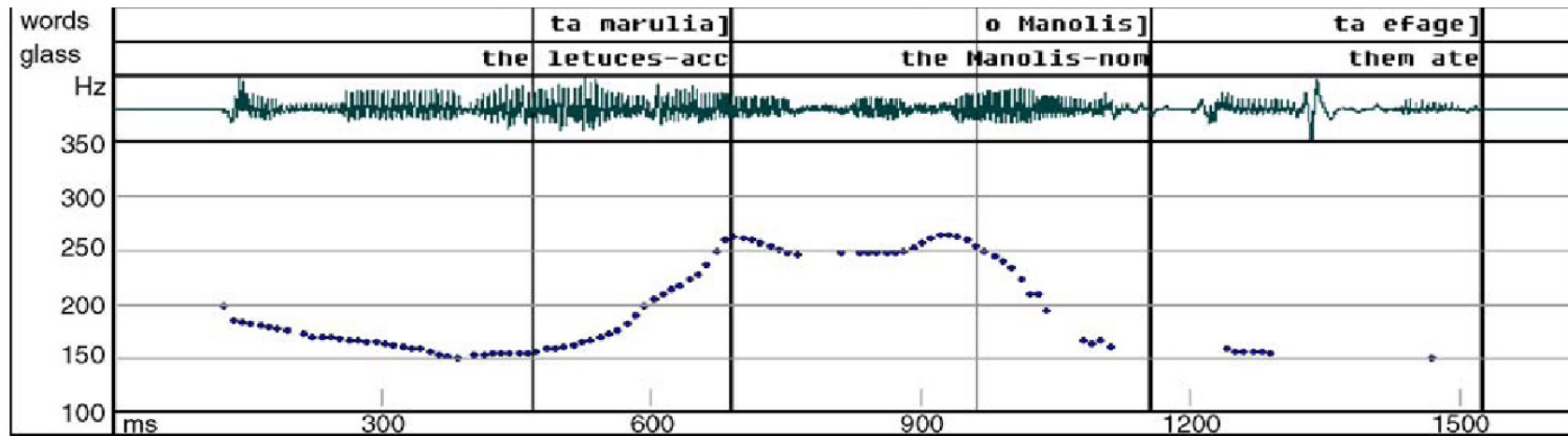
*O Manolis* carries the falling nuclear accent, the remaining sentence is low and unstressed.

The φ-phrasing is recursive.

Pitch track from Baltazani, Mary. 2006. Intonation and pragmatic interpretation of negation in Greek. *Journal of Pragmatics* 38. 1658–1676. Tones and phrasing are mine.

# Greek intonation and information structure

Information structure: O S clitic-V answer



When *ta marulia* is the topic, a clitic referring to it is obligatory

L\*H-                          H\* L-                          L%

((([ta marulia]<sub>Topic</sub>)<sub>φ</sub> (([o MANOLIS]<sub>Focus</sub>)<sub>φ</sub> [ta efage]<sub>Given</sub>)<sub>φ</sub>)<sub>ι</sub>                          O S clitic-V

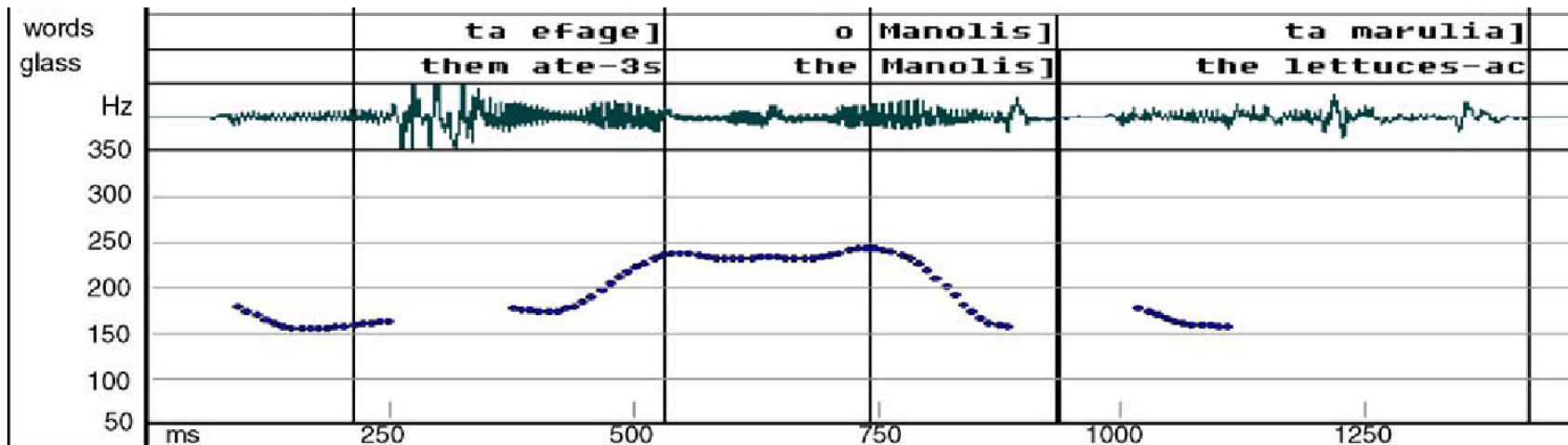
the lettuces-ACC        the Manolis                          them ate

Pitch track from Baltazani, Mary. 2006. Intonation and pragmatic interpretation of negation in Greek. *Journal of Pragmatics* 38. 1658–1676. Tones and phrasing are mine.



# Greek intonation and information structure

Information structure: Clitic-V S O answer



Since the verb, a topic, and the full object are separated by the focused subject, a preverbal clitic coreferent with the object is needed.

L\*H-                      H\* L-                      L%

(([ta e fage]<sub>Topic</sub>)<sub>φ</sub>) ([o MANOLIS]<sub>Focus</sub>)<sub>φ</sub> ([ta marulia]<sub>Given</sub>)<sub>φ</sub> )<sub>t</sub>      Clitic-V S O answer  
 them ate                      the Manolis                      the lettuces-ACC

# Greek intonation and information structure

Freedom of word order has its limits. Compare narrow focus on the object in (1) and focus on the entire VP in (2).

(1) ‘Who did Eleni praise in the meeting?’

- a. Epénese [to VÍRONA]<sub>F</sub>  
praised-3s the Vironas-acc
- b. [to VÍRONA]<sub>F</sub> epénese

(2) ‘What did Eleni do in the meeting?’

- a. [Epénese to VÍRONA]<sub>F</sub>
- b. # [to VÍRONA]<sub>F</sub> epénese  
‘She praised Vironas.’

# Greek intonation and information structure

## Information structure

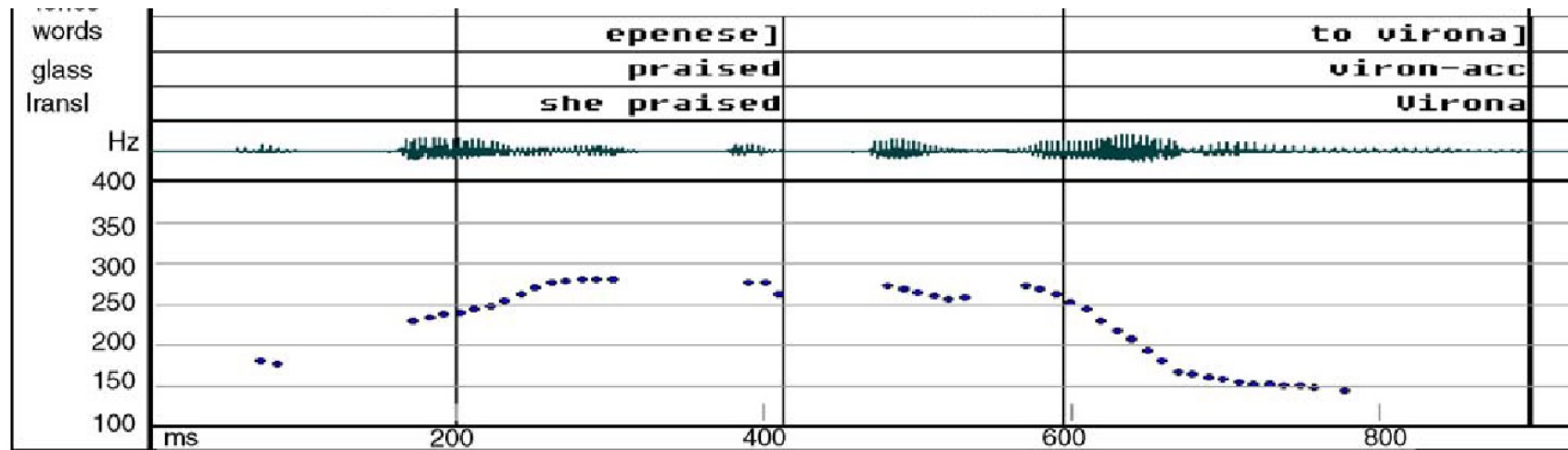


Fig. 1. Verb-Object answer: *Epénese to Vírona* 'She praised Virona'.

VO: Possible word order and intonation in both answers, i.e. with narrow focus on the object *Vironas* and with focus on the VP.

Baltazani, Mary. 2006. Intonation and pragmatic interpretation of negation in Greek. *Journal of Pragmatics* 38. 1658–1676.

# Greek intonation and information structure

## Information structure

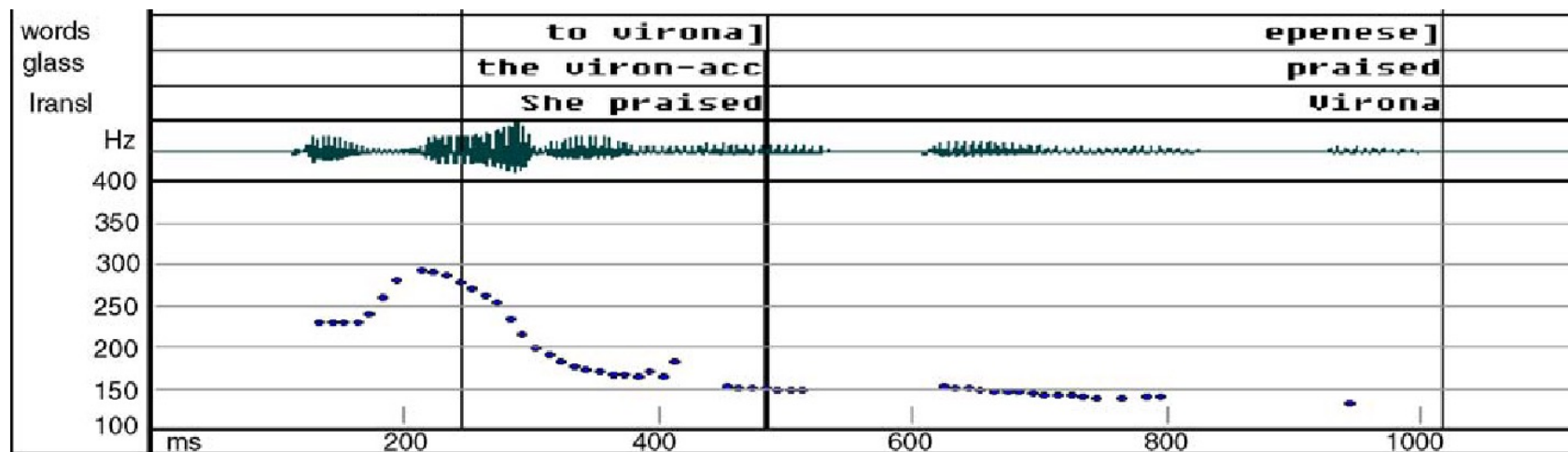


Fig. 2. Object-Verb answer: *to Virona epénese* 'She praised Virona'.

OV: This word order is only possible as the answer with narrow focus on *Vironas*, not with focus on the VP, because the verb is (obligatorily) deaccented.

Baltazani, Mary. 2006. Intonation and pragmatic interpretation of negation in Greek. *Journal of Pragmatics* 38. 1658–1676.

# Greek question intonation

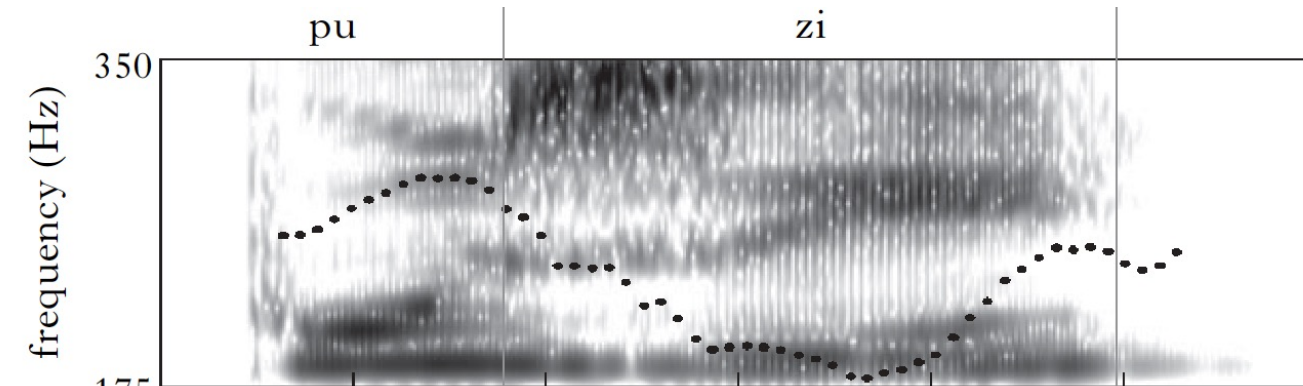
In wh-questions, it is the wh-word that carries the nuclear pitch accent.

Greek wh-question melody: L\*H L- H%

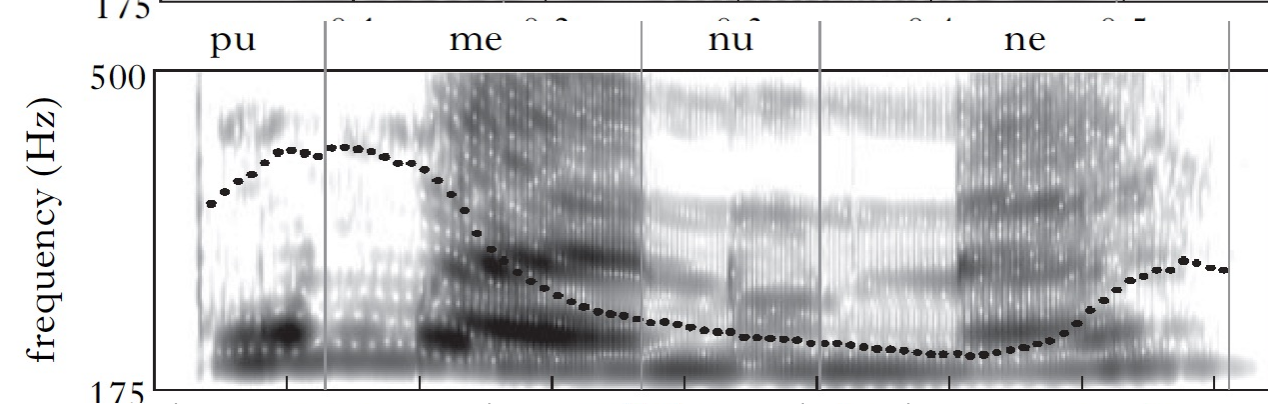
- (1) a. ['pu 'zi]    b. ['pu 'menune]  
    where live.3SG                                        where stay.3PL  
    ‘Where does s/he live?’                         ‘Where are they staying?’
- c. [apo'pu 'milaje 'tu menelu]  
    from where speak.3SG.PAST the Menelos.GEN  
    ‘Where was s/he speaking to Menelos from?’
- (3) [apo'pu na mu mi'layane]  
    from where to me speak.3PL.PAST.SUBJ  
    ‘Where could they have been talking to me from?’

Arvaniti, Amalia & O . Robert Ladd. 2009. Greek wh-questions and the phonology of intonation.  
Phonology 26. 43-74 .

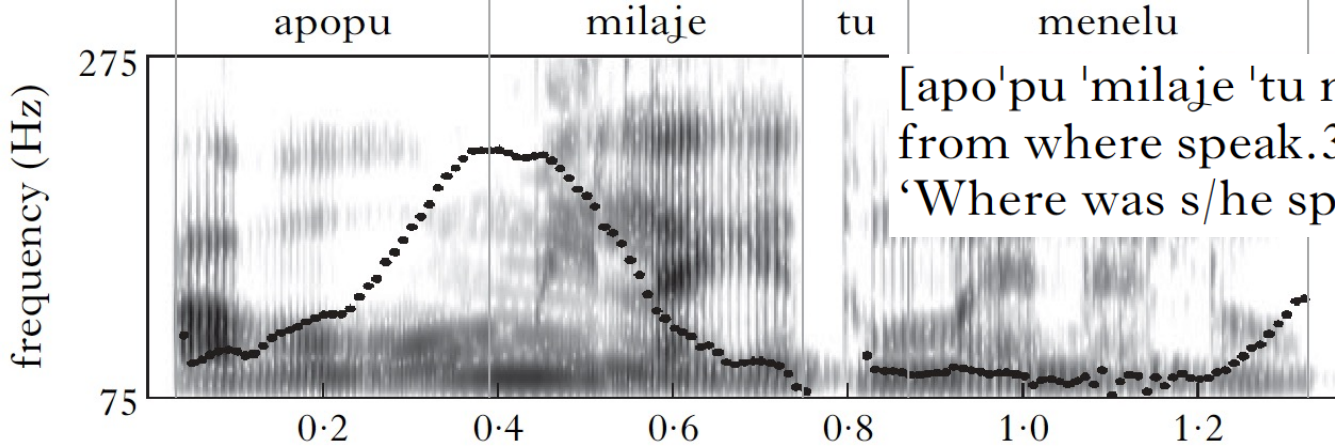
# Greek wh-question intonation



[*'pu 'zi*]  
 where live.3SG  
 'Where does s/he live?'



[*'pu 'menune*]  
 where stay.3PL  
 'Where are they staying?'



[*apo'pu 'milaje 'tu menelu*]  
 from where speak.3SG.PAST the Menelos.GEN  
 'Where was s/he speaking to Menelos from?'

# Greek question intonation

The Greek wh-question melody is  $L^* + H L^- !H\%$

The rise at the very end of all three examples is the most typical pattern, though wh-questions may also end low (Arvaniti & Baltazani 2005).

Arvaniti & Ladd (2009) investigated the Greek wh-question melody in sentences with variable length

Experiment with four native speakers uttering sentences

Four parameters of variations in the sentences

- (i) The numbers of words in the sentences
- (ii) The number of unstressed syllables between the accented wh-word and the first postnuclear stressed syllable.
- (iii) The distance of the last stressed syllable from the end of the question.
- (iv) The length of the wh-word: *pu* or *apo'pu*

# Greek question intonation

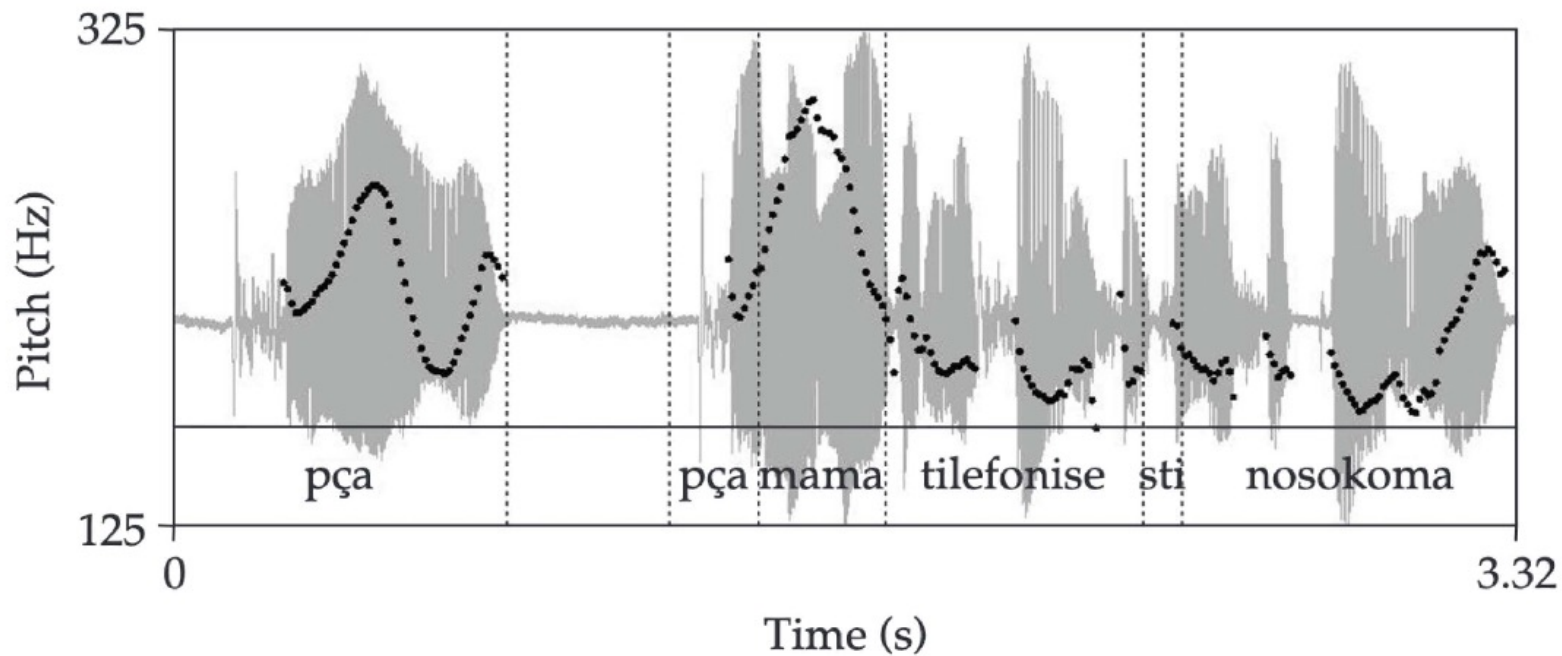
1. When the wh-word is monosyllabic, the contour starts with a shallow rise; if it consists of more syllables, the contour starts with a rise from a low F0 point.
2. The peak roughly coincides in time with the stressed vowel of the wh-word.
3. The fall induced by L<sup>-</sup> comes immediately after the H of the pitch accent.
4. While the contour of the shortest question (a) shows a rather brief low region, in the longer questions the early peak is followed by a long low plateau.
4. Given enough segmental material after the nuclear accent, the phrase accent L<sup>-</sup> seeks to associate with a lexically stressed syllable

Arvaniti, Amalia & O. Robert Ladd. 2009. Greek wh-questions and the phonology of intonation. *Phonology* 26. 43-74 .



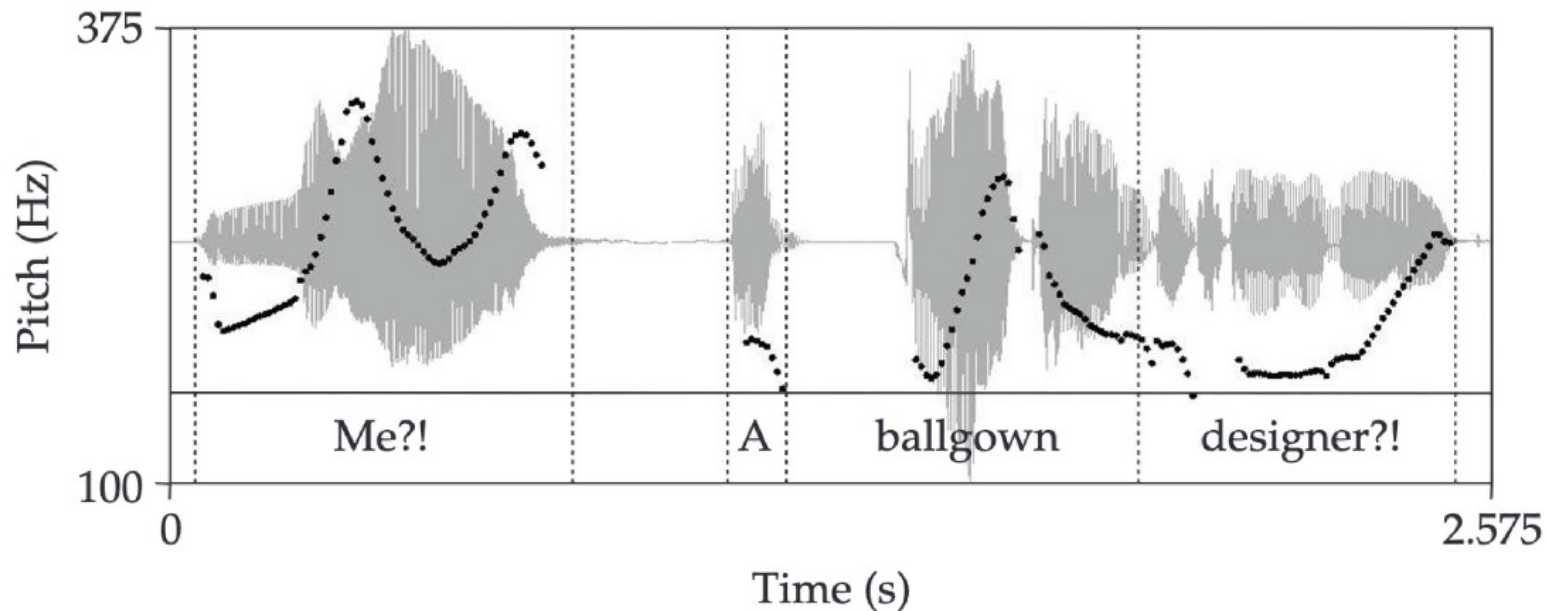
# Greek question intonation

The same contour can be realized on a single syllable, compare the two contours:



Waveforms, transcriptions, and F0 contours of two Greek wh-questions, on the left, [‘pça] 'which (FEM)', on the right, [‘pça ma'ma tile'fonise sti noso'koma] 'which mom called the nurse?'

# English intonation



L<sup>-</sup> L\* + H\* L<sup>-</sup> H%

A ball gown designer

Waveforms and F0 contours of two English utterances illustrating the “incredulity contour” (Hirschberg and Ward 1992): Tonal sequences are twice L\* + H L<sup>-</sup> H%

- L\* + H is associated with *me* and *ball*, the metrically strongest syllables in the i-phrases.
- The phrase tone L<sup>-</sup> spreads between the L\* + H and H%, accounting for the fall and low-level stretch of F0.

# Greek question intonation

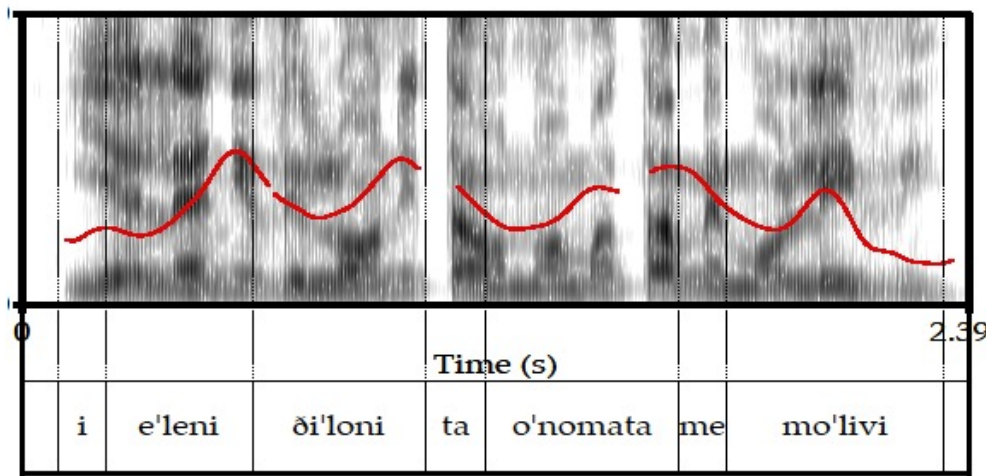
String identical neutral declarative sentence

and interrogative sentence

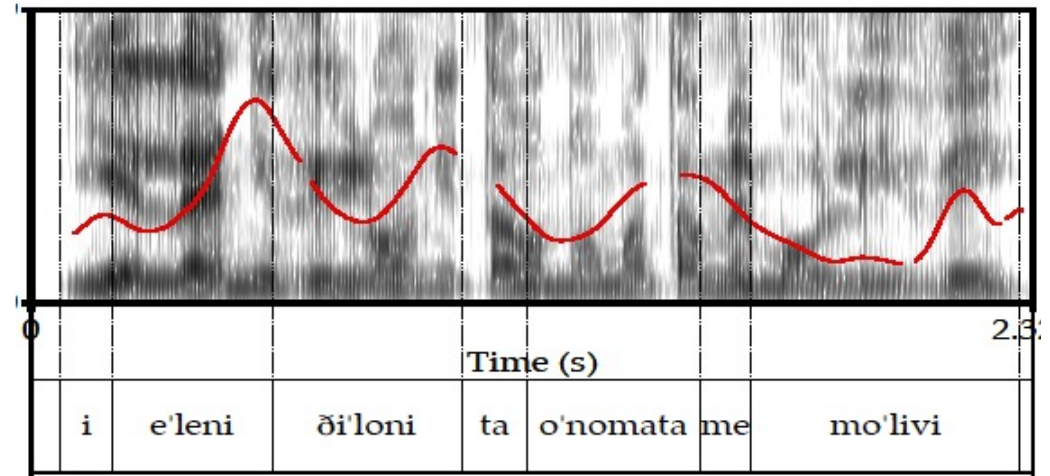
[i eléni ðilóni ta onómata me molívi]

(a) *Eleni registers the names with a pencil.*

(b) *Does Eleni register the names with a pencil?*



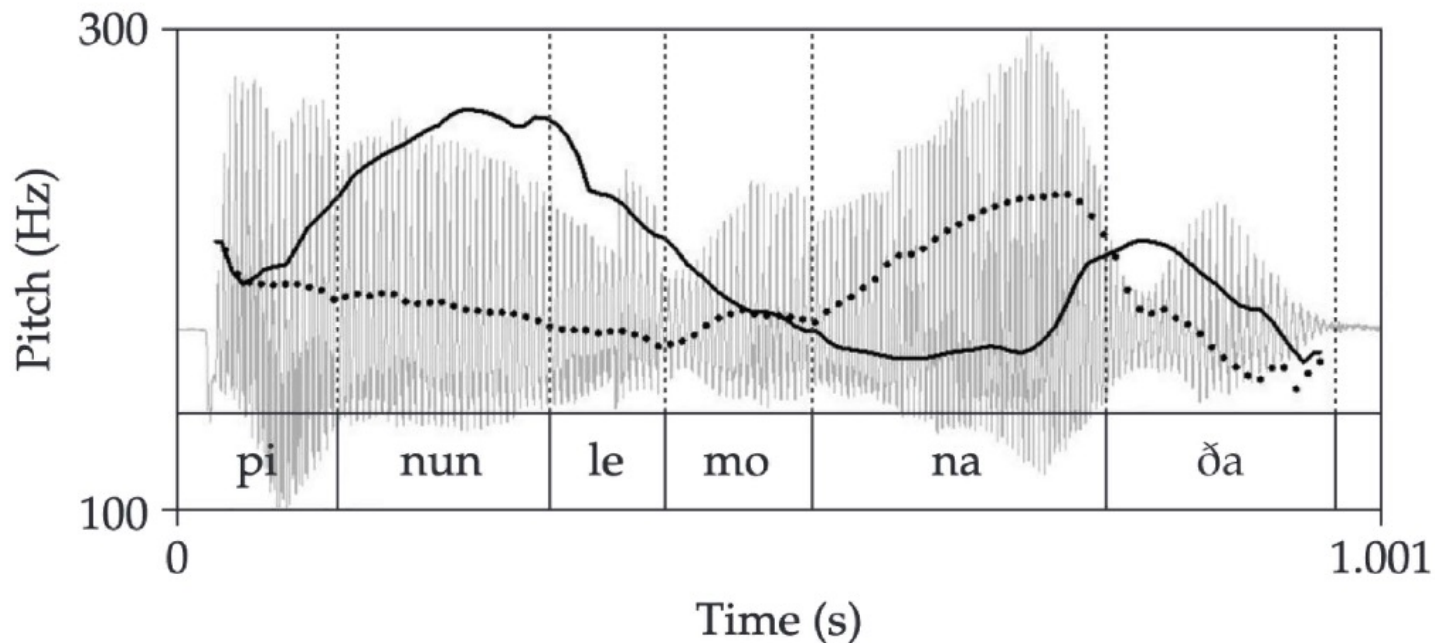
[mo'liv] carries a H\* nucleus  
followed by L- L% edge tones



[mo'liv] carries a L\* + H nucleus  
followed by L- H%

Baltazani, M, Kainada, A. Lengeris, & K. Nicolaidis. 2015. *The Prenuclear Field Matters: Questions And Statements In Standard Modern Greek*. Proceedings of the 18th ICPHS.

# Greek question intonation



[pínun lemonáða] 'they drink lemonade?' uttered as a question with focus on the verb (dotted line) or the noun (solid line). This contour illustrates a falling contour on a question.

# Summary of tones and intonation

Greek and English both use the same tones for their intonation, i.e. monotonal or bitonal pitch accents, phrase tones H<sup>-</sup> and L<sup>-</sup> and boundary tones H<sup>0</sup> and L<sup>0</sup>. The tones are distributed in a similar way in the two languages: pitch accents are associated with prominent syllables, phrasal tones in each  $\varphi$ -phrase accounting for the contour between pitch accent and boundary tone, and boundary tones located at the very end of the  $\iota$ -phrase defining the general orientation of the whole contour.

Both languages also react to information structure in the same way: a topic forms a separate  $\varphi$ -phrase, a narrow focus is accented and postnuclear given constituents are unstressed and tonally flat.

The main differences may lie in the “meaning” of special intonational contours, such as the question contour in Greek. More research is needed on the pragmatic interpretation of tonal contours.

# Summary of the class

We found differences between the phonology of Greek and English at most prosodic levels. Properties of a specific prosodic level often have an impact for phenomena at another level, showing that it is crucial to apprehend the phonological system of a language as a whole.

Segments and allophonies: nothing spectacular here, except for the lack of contrast between short/lax and long/tense vowels.

Syllables and moras: Greek syllables maximize onsets (but with variation in syllabification), and allow sonority plateaus plus other clusters that English rejects. Phonotactic principles only allow vowels as syllable peak. Codas are exceptional: only [s] and [n] word-finally (usually from suffixes). Moreover, because of the contrast between lax and tense vowels, one or two vowel positions appear in the rime in English vs. only one in Greek. Syllabification often takes place across words in Greek, but not in English.

Foot and lexical stress: In Greek, stress assignment is lexical and grammatical, whereas in English, stress assignment is phonological: moraic trochees play a decisive role, albeit with numerous exceptions and many loanstresses.

# Summary of the class

Prosodic words: In English inflection is always nonmoraic and unstressed. Derivational affixation is variable: affixes are stressed or unstressed, stress-shifting or stress-neutral, induce resyllabification or not, etc. In Greek, inflectional and derivational affixes behave very much alike. They always resyllabify, and always form a non-maximal  $\omega$ -word with the stem or root. Clitics form a maximal  $\omega$ -word with their stem: some of the many sandhi rules applying in the non-maximal  $\omega$ -word are blocked and secondary stress appears when needed for the three-syllable-window.

Prosodic Phrases:  $\varphi$ -phrases may be formed by Align or Match constraints. Align delivers a better solution to the asymmetry problem: the right edge is more prominent and perceptible in both languages. Word order is more flexible in Greek than in English and different word orders elicit different phrasings. Information structure has an important impact on phrasing and tonal structure.

Tonal structure: Pierrehumbert's tone sequence model defines pitch accents, phrasal tones and boundaries for both languages. In a declarative sentence, prenuclear contours are systematically rising in Greek and nuclear pitch accents are falling. The influence of information structure is evident. The only striking difference concerns the question intonation which is more complex in Greek than in English.

See also Féry, Caroline. 2017. *Intonation and prosodic structure*. Cambridge: Cambridge University Press.

Thanks also to the organizers and the participants of the CreteLing23 school, especially the students who attended the class,

to my informants Jim Kotopulis and Christiana Chaidaridou

and to my friends and colleagues Anthi Revithiadou, Nina Topintzi, Ioanna Kappa and Stavros Skopeteas who took the time to answer all my questions.