INTONATION RESEARCH AND THE AUTOSEGMENTAL-METRICAL MODEL OF INTONATIONAL PHONOLOGY

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This workshop covers theoretical and practical aspects of doing intonation research
It explains the fundamental tenets of the autosegmental-metrical theory of intonational phonology (*AM*)

Part I:
- Challenging features of intonation
- How they are addressed in different models
- How AM comes closer to addressing them

Part II:
- AM and phonetics
- Practical aspects of
  - doing research on intonation
 - using AM principles for intonation analysis

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F0, pitch, intonation, and prosody
θεμελιώδης συχνότητα, τονικό ύψος, επιτονισμός, προσωδία

- These four terms should not be used interchangeably

- F0 (fundamental frequency) is the main exponent of intonation but it is not intonation per se

- F0 is an acoustic property of the speech signal determined by the rate of vibration of the vocal folds

- Vocal fold vibration rates are determined by physiology (sex, age), as well as social factors (e.g. gender and related social norms)

- F0 is measured in Hz (cycles per second)

- F0 gives rise to the percept of pitch (measured in mel, bark, ERB)

- All languages use and modulate F0; however, intonation is only of the numerous functions of F0; i.e. **not all F0 modulations are intonation**

- Intonation is a component of a language's prosody (which also includes metrical structure)

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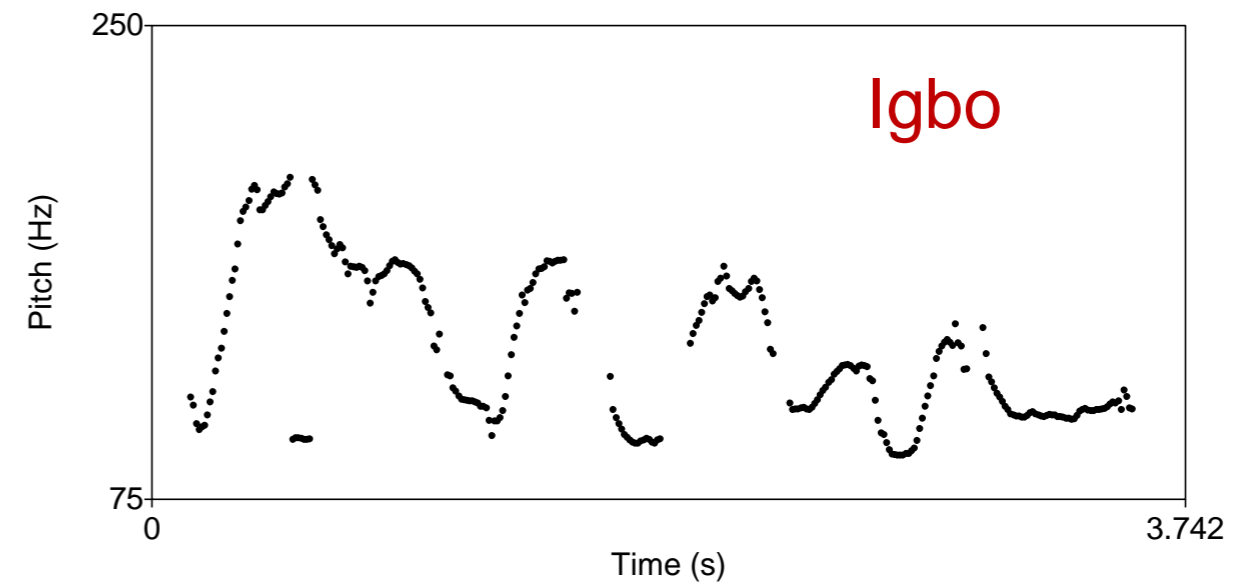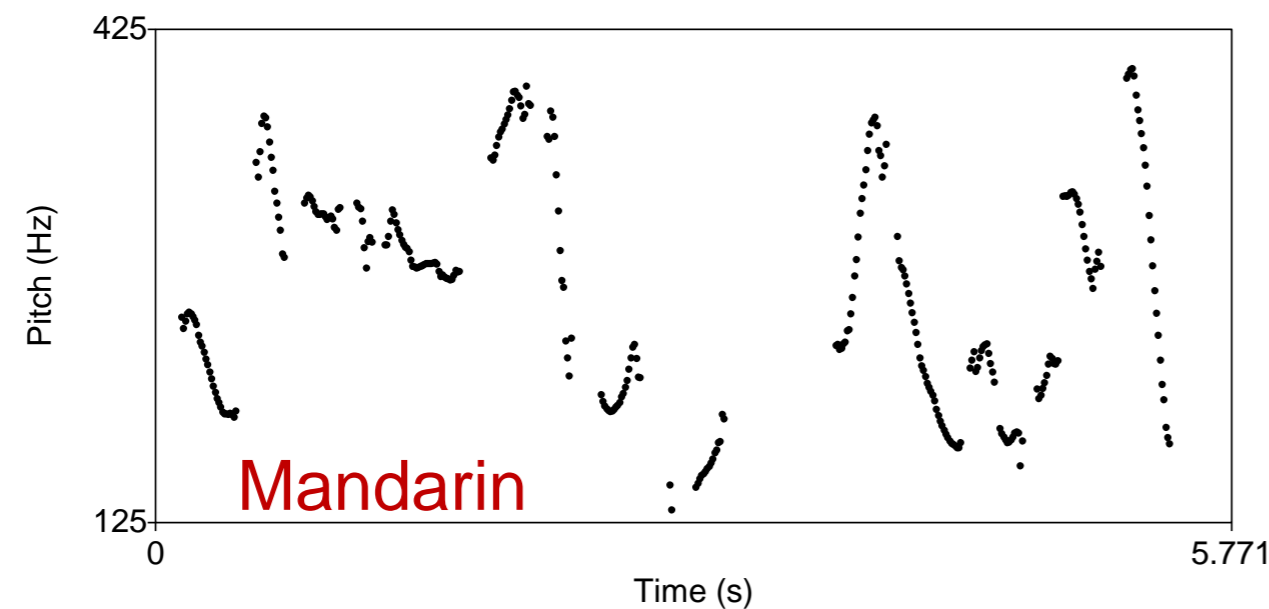**Radboud University**
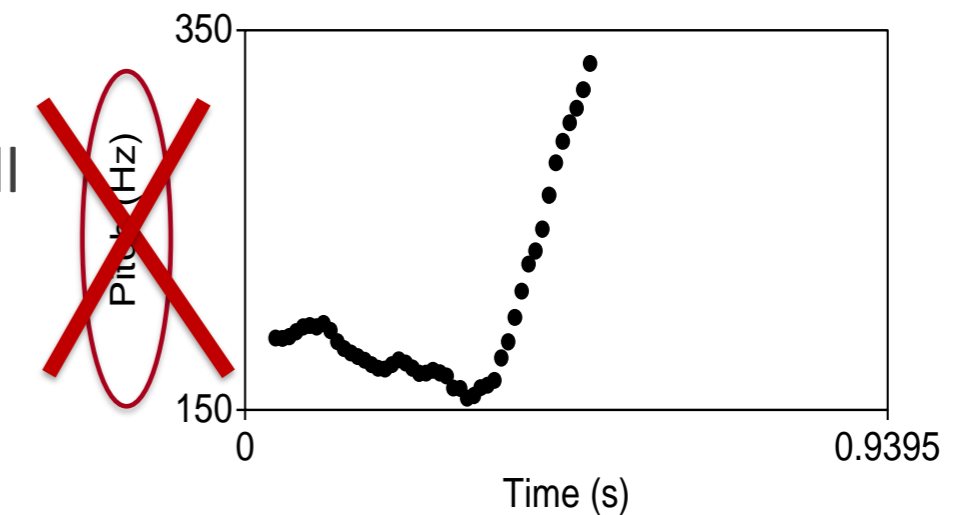
Uses of F0: lexical uses

- Languages use F0 lexically, post-lexically, para-linguistically and for sociolinguistic purposes

- Lexical uses of pitch are referred to as tone and pitch accent

- They are changes of F0 that change the meaning of words

Pinyin	Chinese Character	Meaning	Sound Clip
mā	媽 (trad) / 妈 (simp)	mother	audio ◀))
má	麻	hemp	audio ◀))
maˇ	馬 / 马	horse	audio ◀))
mà	罵 / 骂	scold	audio ◀))

Lexical uses of F0: tone & lexical pitch accent

- Lexical uses of F0 refer to changes of F0 that change lexical meaning
- We typically talk of
  - lexical tone when tonal specifications are frequent (e.g. on practically every syllable as in Cantonese)
  - lexical pitch accent when at most one syllable in (at least part of a language's vocabulary) bears tonal specification (e.g. Japanese)
- Languages that use F0 to encode lexical contrasts also use F0 for intonation purposes

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Non-lexical uses of F0

- Languages use F0 lexically, post-lexically, para-linguistically and for sociolinguistic purposes

- Lexical uses of pitch are referred to as tone and pitch accent

- Post-lexical grammatical uses of pitch are referred as intonation

- Para-linguistic uses refers to changes in pitch to show anger, boredom, surprise, excitement and the like; these uses are sometimes referred to as "emotional prosody".
  - I prefer to use the term prosody for linguistic purposes only

- Changes in **pitch range**, **pitch span** and **dynamism** may also serve sociolinguistic functions, such as performing gender

- All these uses are not mutually exclusive: e.g. languages that use F0 for lexical purposes also have intonation, one can be bored in a tone language, etc.

What is intonation?

- Intonation refers to language-specific and systematic modulations of F0 that
  - span entire utterances (i.e. have utterance, not the word, as their domain)
  - have grammatical function (other than lexical semantics)
    - marking phrasal boundaries
    - encoding pragmatic information (modality, focus, implicatures)

Intonation is not tone

- F0 changes related to intonation are NOT associated with lexical meaning, but with the syntax and pragmatics of the utterance; cf. *my ex / (τ)o(ν) πρώην μου* as a response to
  - (i) *who's that? ποιος είναι αυτός;*
  - (ii) being surprised that your new partner has invited their ex to your birthday party

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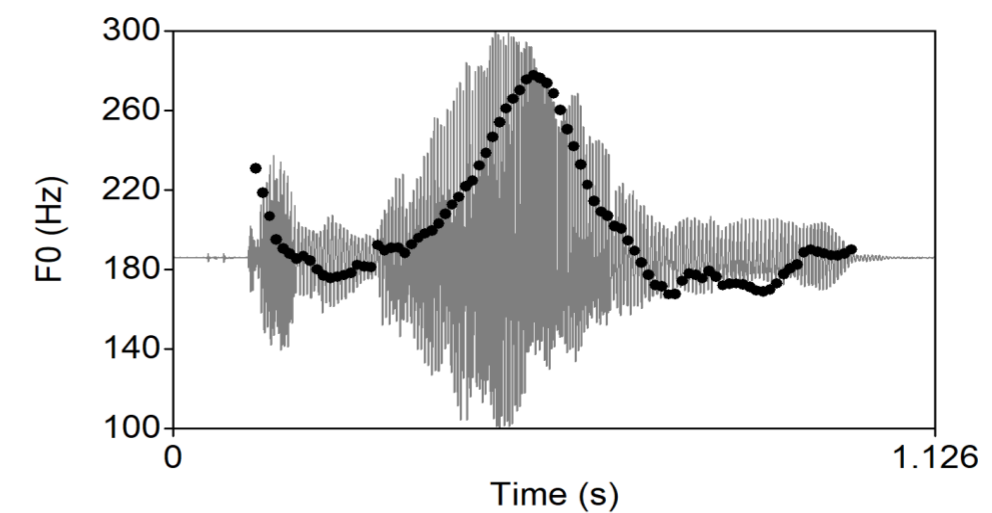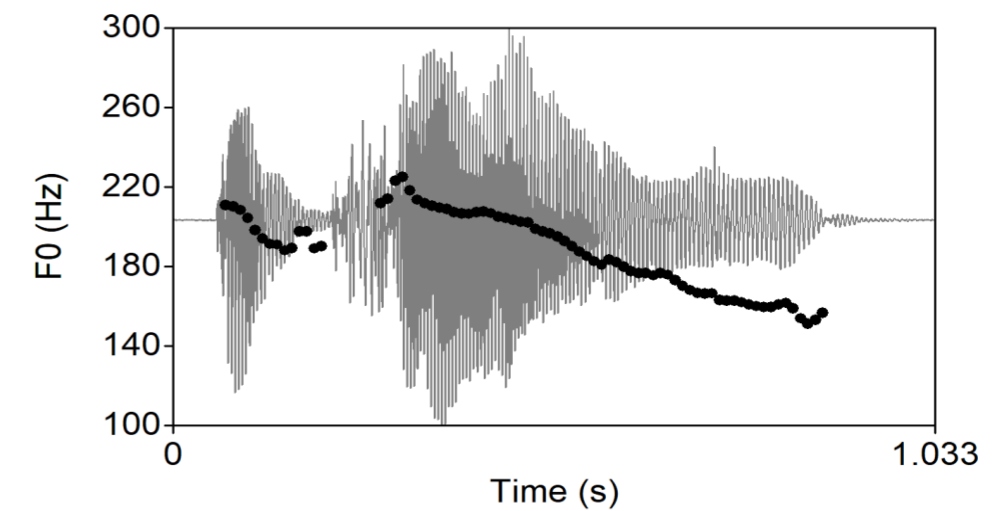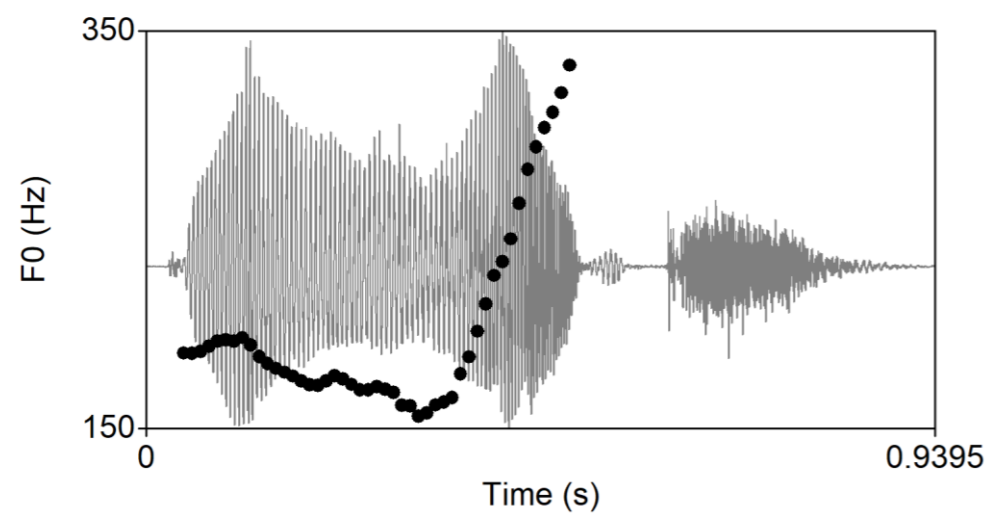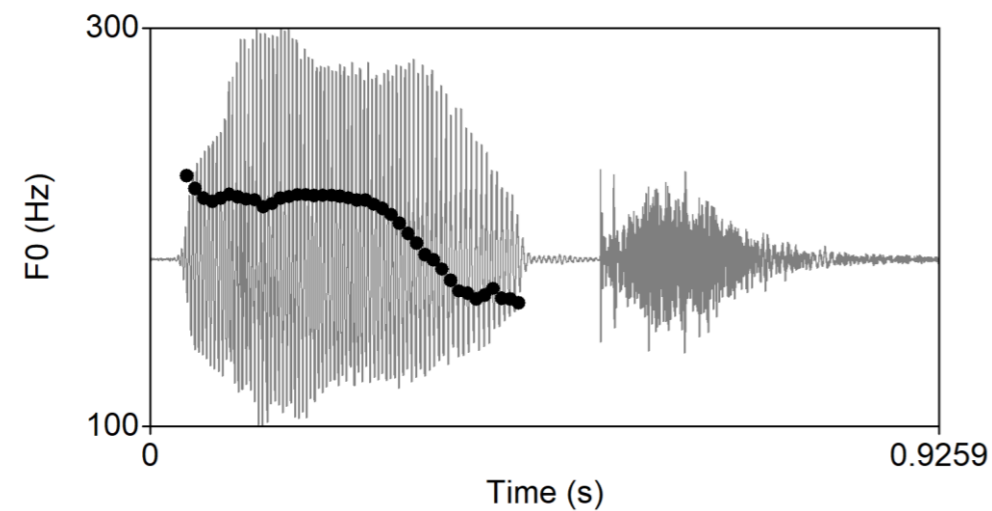
Some myths and misconceptions about intonation

- Intonation is difficult or unsystematic

- Intonation shares patterns across languages based on biological characteristics (cf. Ohala, 1983; cf. the frequency code of Gussenhoven, 2004)
- Intonation has to do with affect or emotion
- Intonation can be switched on and off; cf. researchers who "instruct participants to speak without intonation"

- Particular tunes have particular meanings; e.g. "question intonation"

- Intonation is as systematic as the rest of speech; many difficulties derive from confusing intonation and F0
- We do not have sufficiently detailed studies of the intonation systems of enough languages to be certain there are such trends
- Confuses intonation and paralinguistic F0 uses
- It is impossible to speak without intonation

- The relationship between tune and meaning is many to many (because pragmatics)

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# A main challenge in intonation research

- How to determine the number and nature of a tune's components
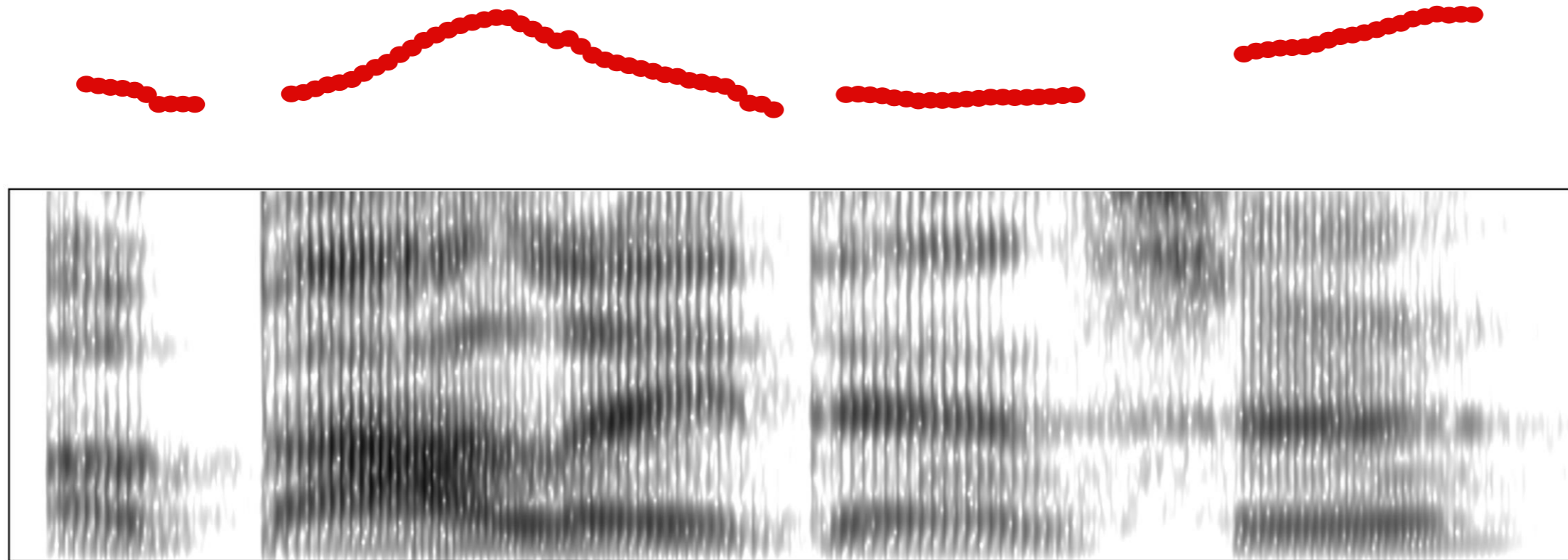
- One option is to assume there are no components, i.e. to assume tunes are configurations

Why pitch contours are not configurations?

- Pitch contours can vary substantially even when listeners recognize them as instances of the same tune
- Differences are systematic and due to linguistic context: **lawful variability** (Arvaniti & Ladd, 2009; Arvaniti, 2016)
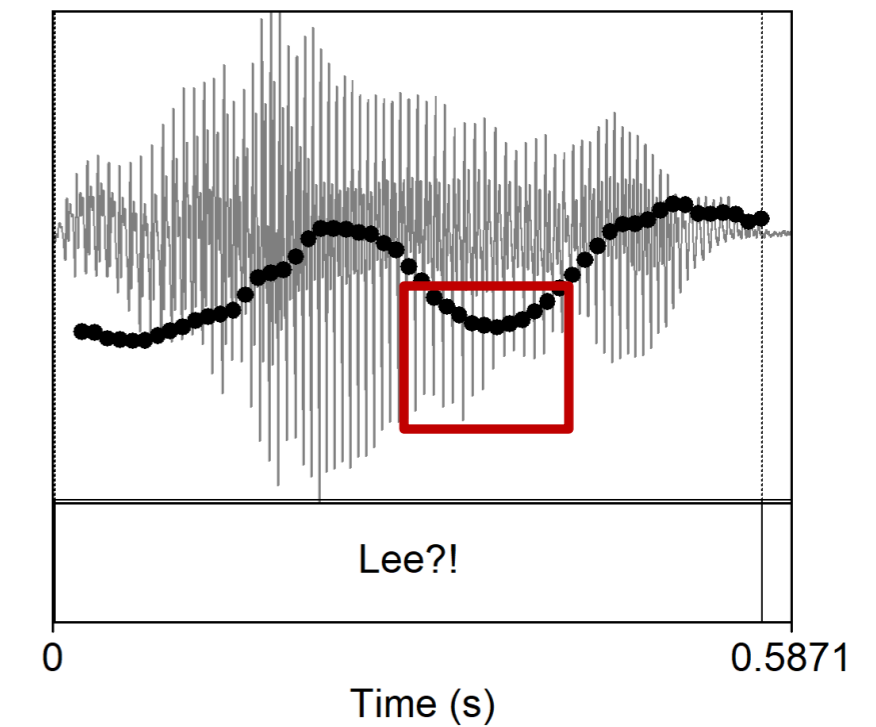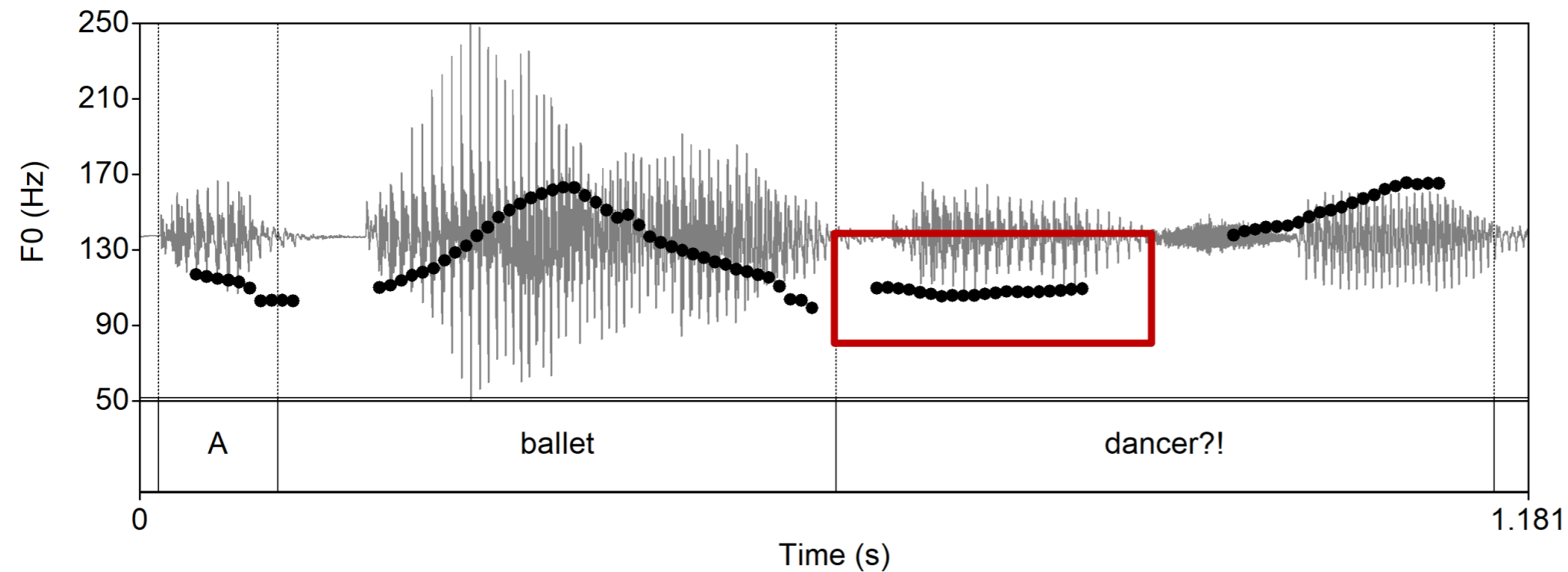
Contours do not behave like an accordion

- Contours do not shrink or stretch to fit the segments of an utterance but display systematic changes that can be explained by parameters such as utterance length and the position of stressed syllables

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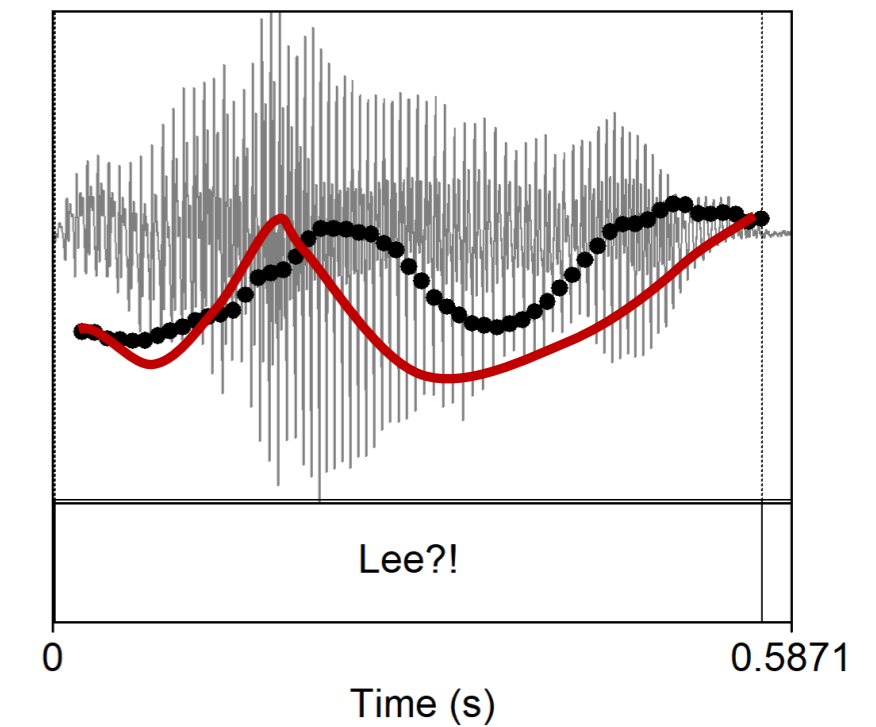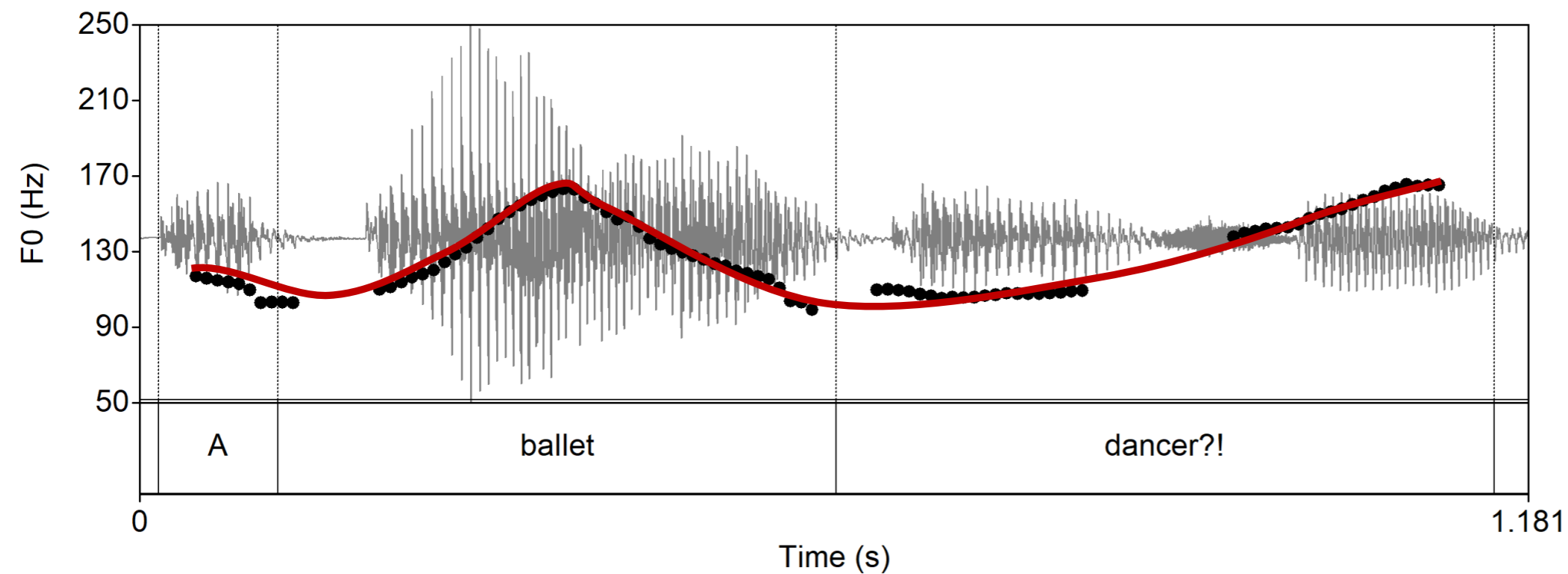**Radboud University**

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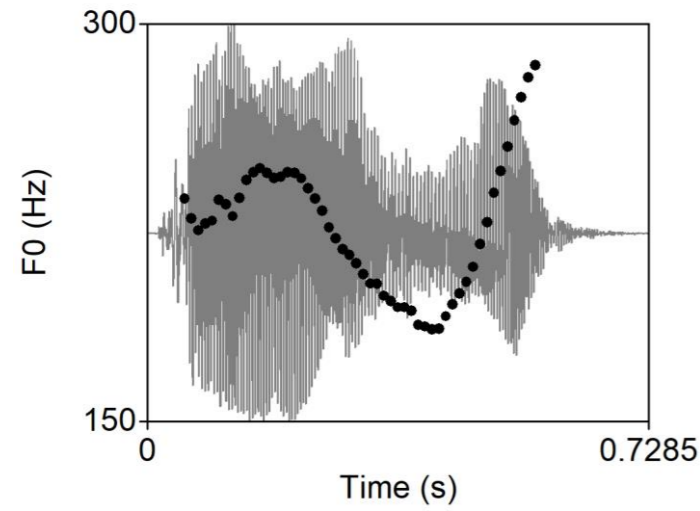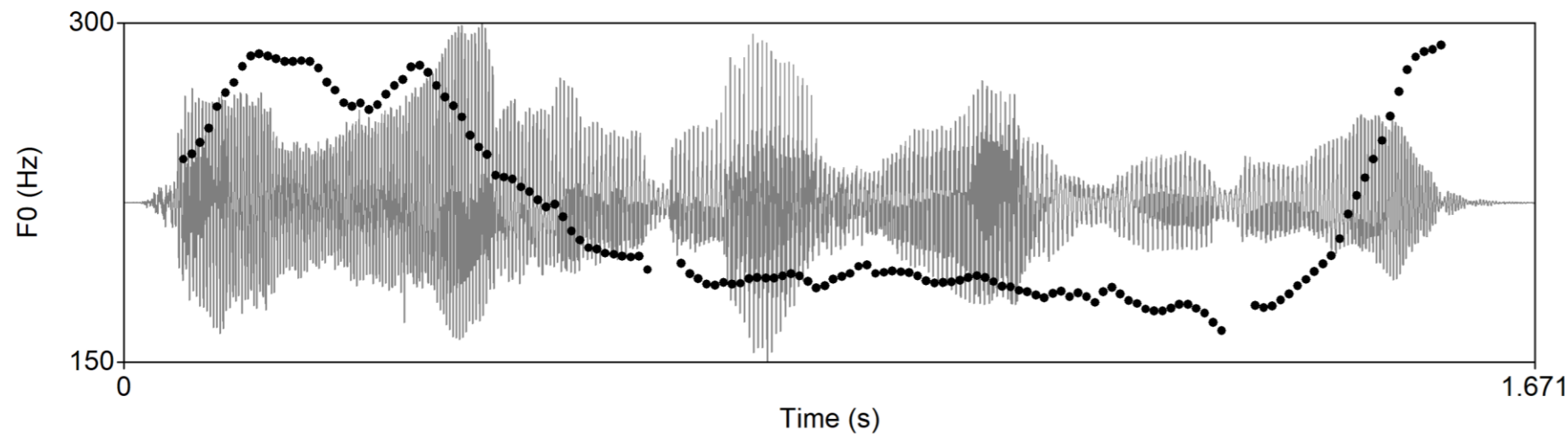Radboud University
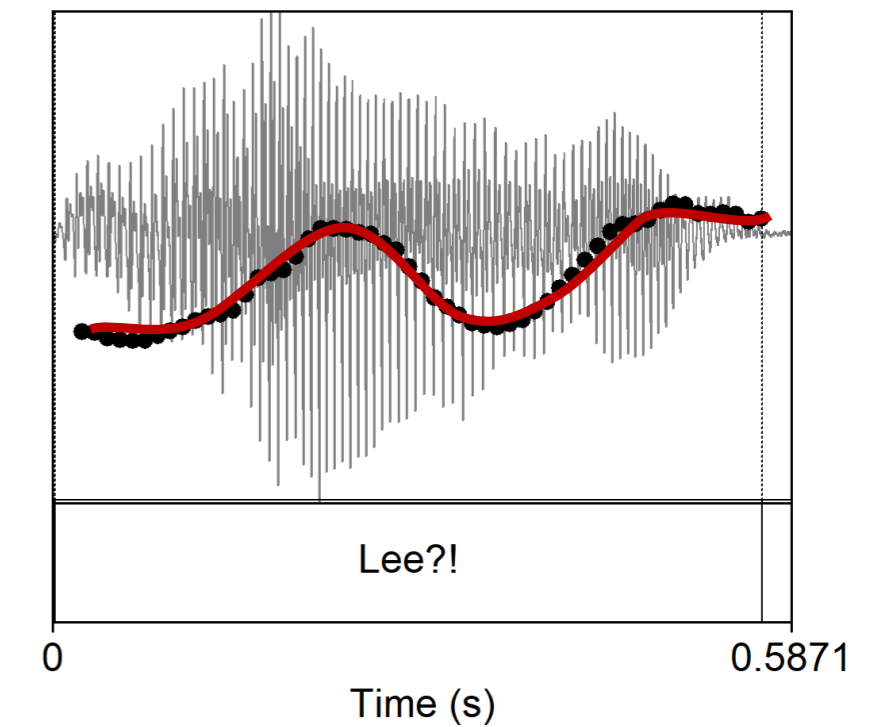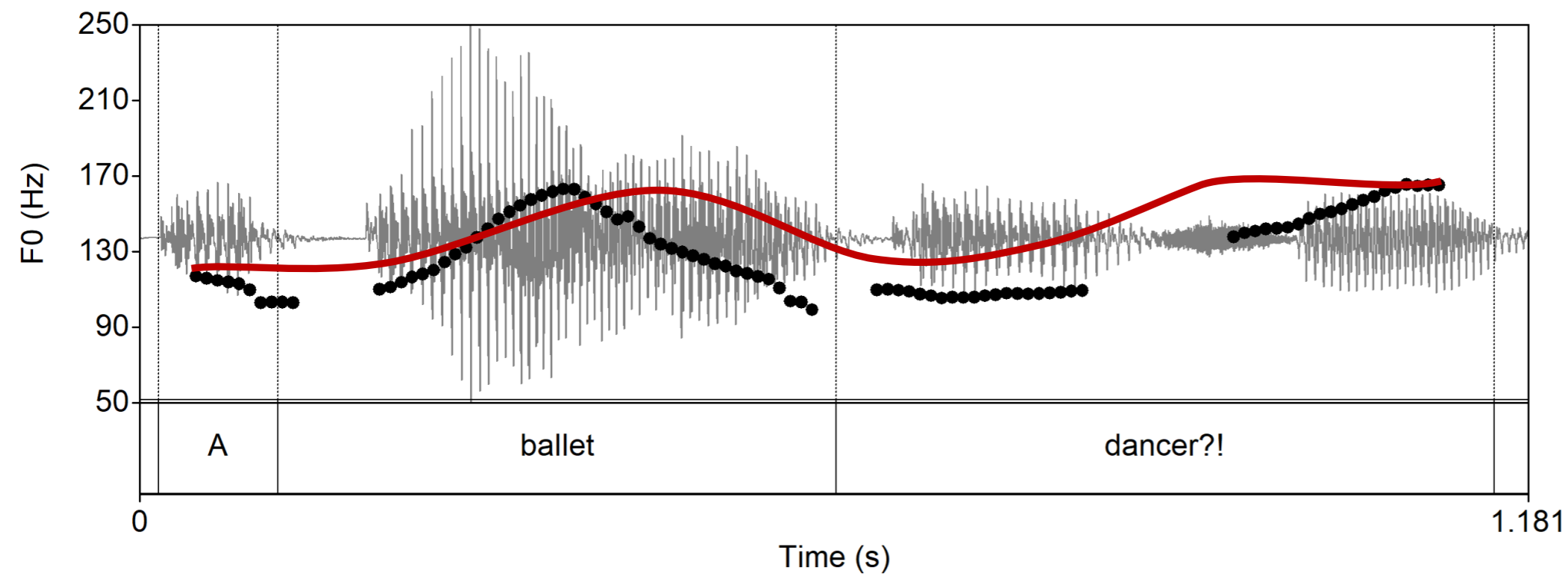
This applies to Greek too: the case of wh-questions

Πού;

Πού ζούνε οι λαγόγυροι;

manipulated version

Arvaniti & Ladd, 2009, in *Phonology*

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Essential research questions in intonation

- Our first aim should be to uncover this systematicity in the variation among tunes
- Given the variability in contour shape,
  - how do speakers of a language determine which contours are instances of the same tune?
  - how do they learn how to produce tunes with segmental material of varying lengths and structures?
- How can we capture the above and in a way that will help us understand the structure and meaning of intonation (see Arvaniti, 2019, ICPhS)?
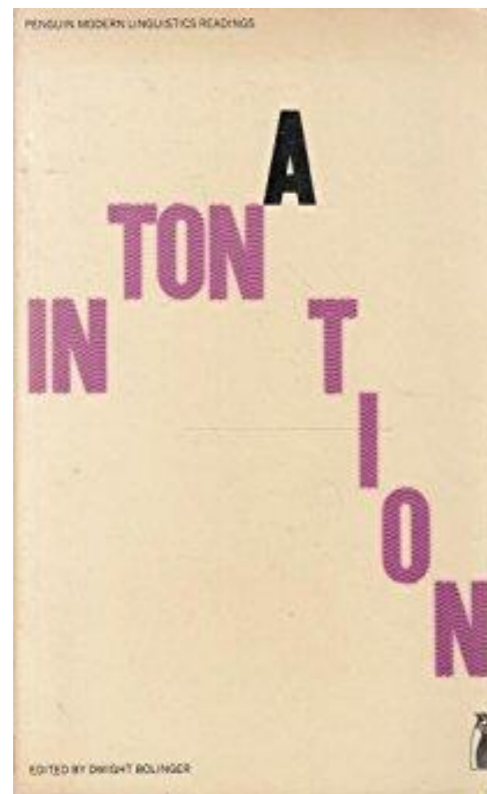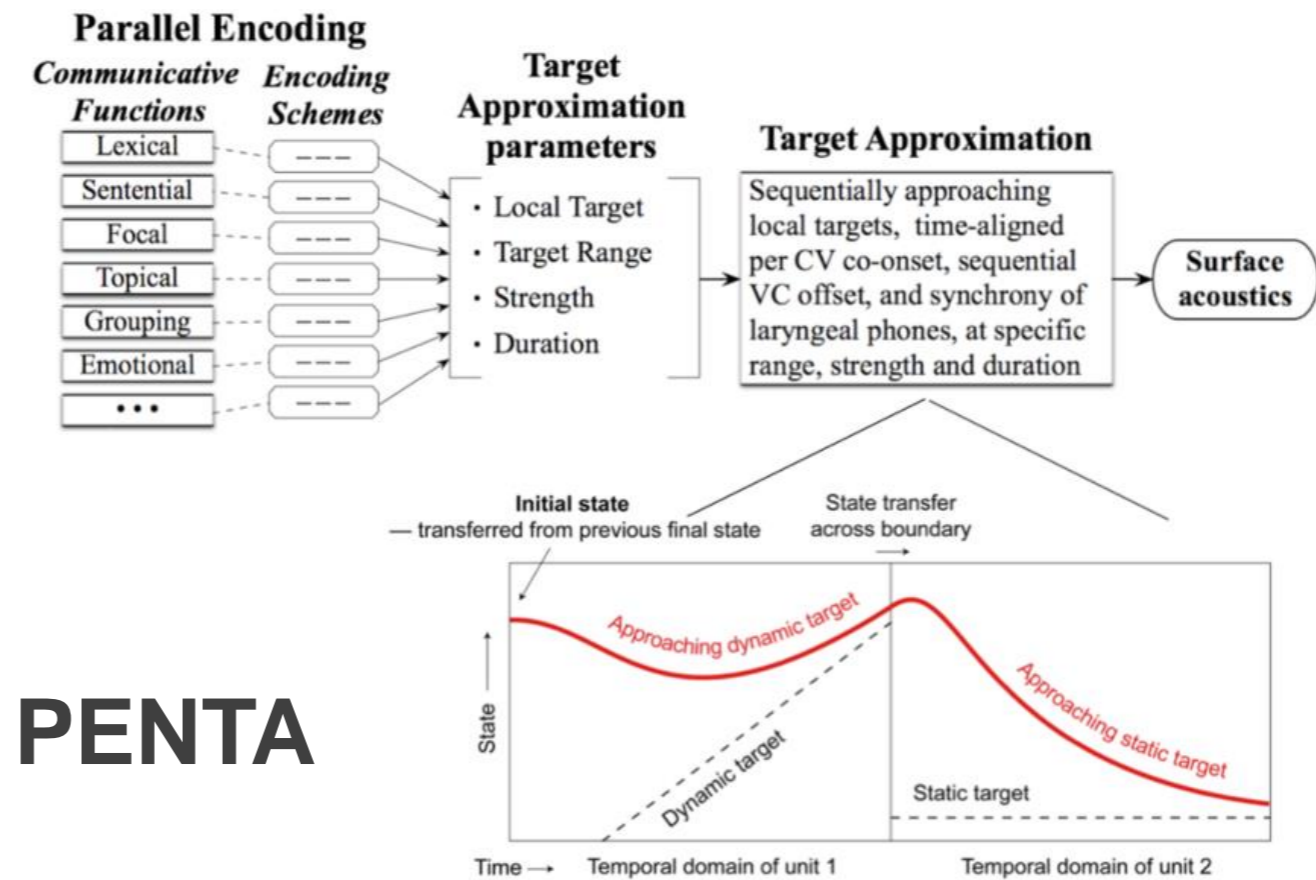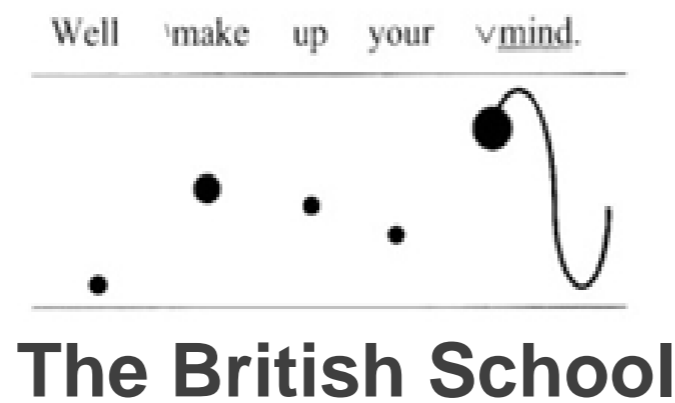
Approaches to intonation

Pitch contours are idealized: detail is removed   Focus on phonetic detail, so abstraction is difficult

Both types of models are primarily preoccupied with modelling F0, not intonation

Bolinger

The British School

PENTA

Autosegmental-Metrical Theory of Intonational Phonology (AM)

- Janet Pierrehumbert's thesis (1980): **The phonetics and phonology of English intonation**

- Bob Ladd (1996) dubbed the theory *autosegmental metrical theory of intonational phonology*

- Why this mouthful of a term?

- Intonation involves the discrete elements called tones, L(ow) and H(igh), which are concatenated in various ways and associated with metrical structure

- **Autosegmental**
  - Tones are autosegments

- **Metrical**
  - Tones associate with structural positions in the metrical structure: heads and boundaries of constituents

What AM is and is not

- AM is a phonological theory of intonational structure which also addresses how its phonological representations can be phonetically realized

- The aim of AM is NOT to faithfully present F0 contours – that's what pitch tracks are for

- AM is **not** a transcription system for intonation

- AM is not the same as ToBI, which is a family of systems for prosodic annotation; ToBI requires an existing AM analysis
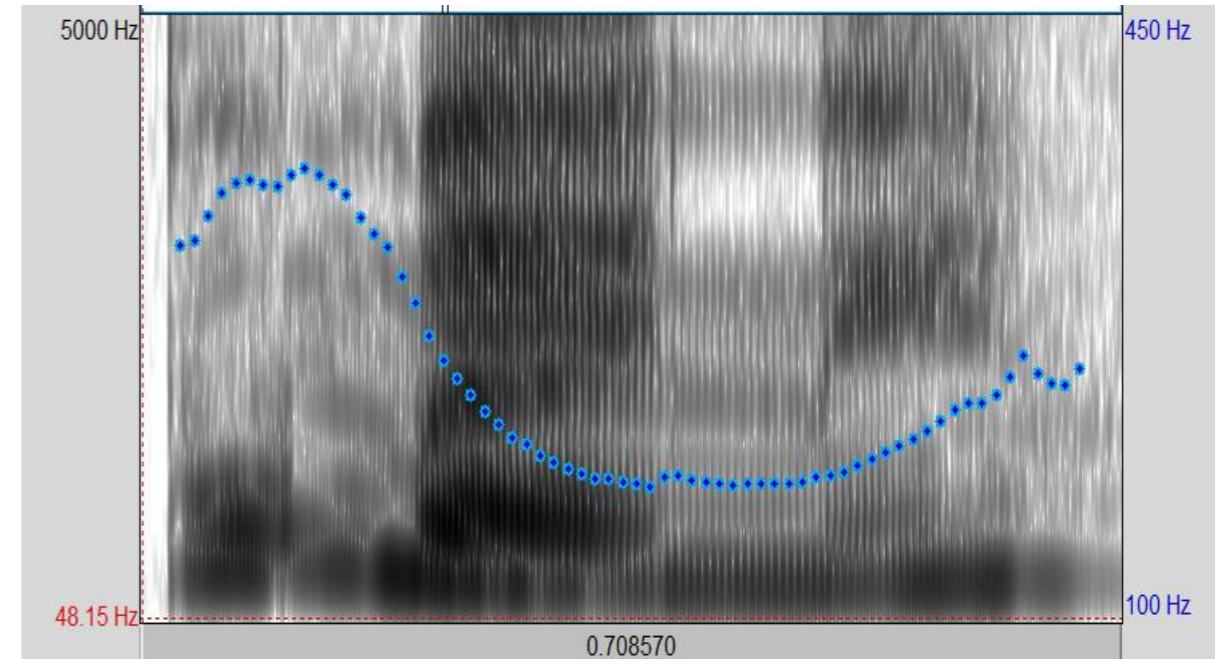
Tones as autosegments

- The primitives of intonation are **tones**: low (L) and high (H)
- Tones are represented as a string of **autosegments**: LHLHLH
  - They are independent of vowels and consonants (though they have to co-occur with them to be realized)
  - They are independent of each other
  - They may form bitonal (or even tritonal) groups, e.g. L+H* is a bitonal pitch accent

- Some consequences of viewing tones as autosegments
- The relationship between tones and segments (Tone Bearing Units or TBUs) is NOT one-to-one
- The number of TBUs and tones may match
  - We can have more tones than TBUs
  - We can have more TBUs than tones

Tones as autosegments: an example

- *Etung*

édìmbá	bìsóŋé	ékúé	òbô
pot	*wife*	*forest*	*arm*

(from Gussenhoven & Jacobs 1998)

- How can we account for these patterns, especially the fact that in some words every syllable has a different tone, in others they all have the same tone, and in yet others, some syllables have a complex tone (e.g. last syllable of *arm*)?

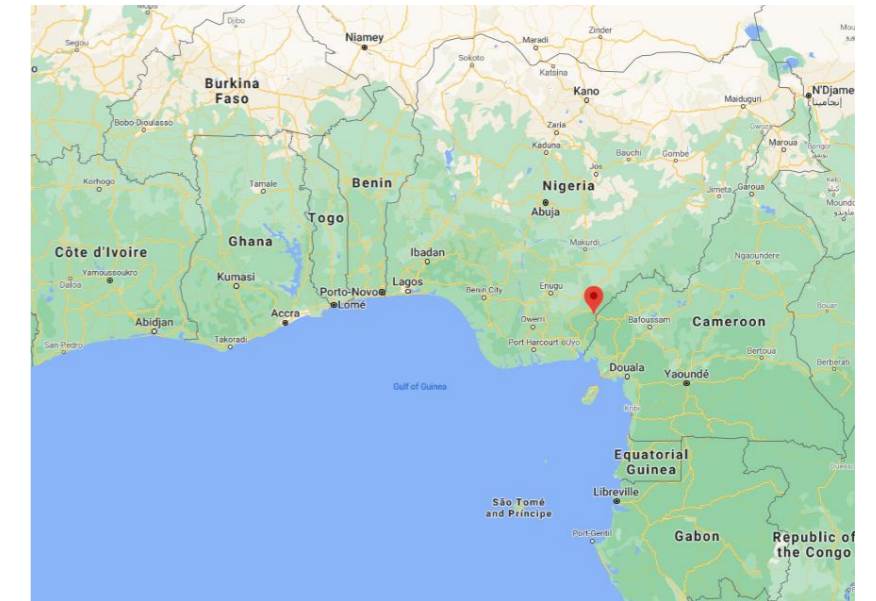| édìmbá	bìsóŋé	ékúé	òbô
| | |	| \/	\/	| /\
H L H	L H	H	L HL

Intonation, tones and metrical structure

- Tones create melodies, many of which are very frequent; e.g. **H* L-L%** is the most common melody for English declaratives (what may be described as a fall)
- The autosegmental representation of melodies also includes information as to how the tones associate with the segmental string: this is known as the **tune-text association**
- AM assumes the existence of a metrical structure that is independent of a language's melodies
- This structure provides the necessary information:
  - prominence relations among constituents (*heads*, informally *stresses*)
  - position of phrasal (and other constituent) boundaries
- Tones associate with the **heads** and **edges** of metrical constituents
- Whether tones associate with both heads and edges is language specific;
  - e.g. languages that do not have stress, such as Korean, only show tone associations with phrasal boundaries
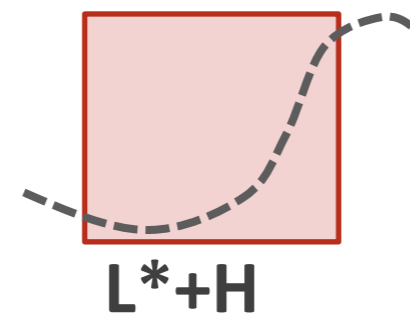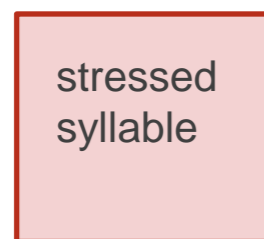
Association by tone type

- Tones may associate with the heads of metrical constituents (roughly, stressed syllables):
  - pitch accents, e.g. L*, L+H*, L*+H

- Tones may associated with boundaries:
  - phrase accents, e.g. L-, H-, LH-, associate with the boundaries of **intermediate phrases (ip)**
    - not all AM analyses involve this level of phrasing
    - phrase accents are also used to demarcate the edges of the Accentual Phrase (e.g. in analyses of Korean and French), a constituent larger than the prosodic word but smaller than the ip

  - boundary tones, e.g. L%, HL%, associate with **Intonational Phrase (IP)** boundaries
    - typically found in the right boundary (but left boundaries may also associate with boundary tones)
    - analyses with complex BTs have been proposed for Korean, e.g. LHLH% and HLHL% (among other complex boundary tones)
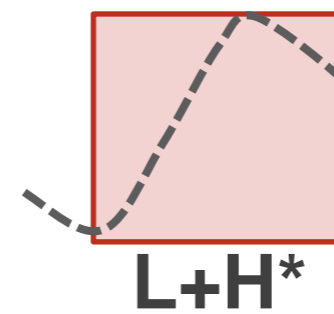
* % + and other AM esoterica

- *, - and % are diacritics that indicate the association of tone with metrical structure
- In bitonal accents the ***** indicates the **metrically stronger** tone and typically the one that co-occurs with the stressed vowel (but it does not have to be; this is a matter of analysis not phonetics alone)
- When tonal events consist of two (or more) tones, a + may be used to indicate their connection: L+H% or LH%
- Jun & Fletcher (2014) have suggested that + be used only if the tones are independent of each other:
  - L+H* is a weak L tone followed by a strong H tone
  - LH* is a rise
- This practice is not yet widely accepted however
- Brackets are meant to show that the * is related to the unit rather than a particular tone, e.g. (L+H)*
- In some analyses left-associating boundary tones are represented with the symbol before the tone, e.g. %H

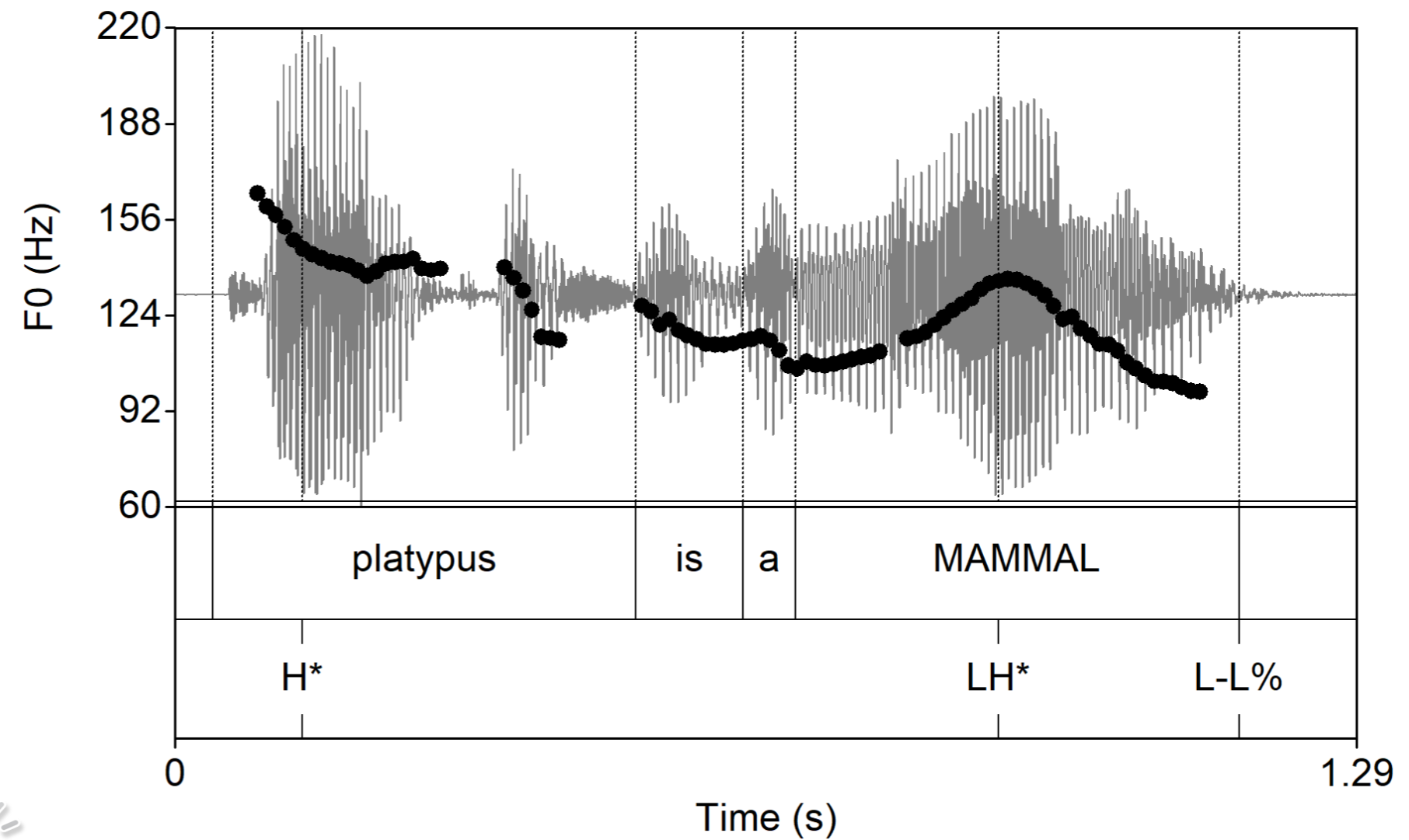stressed syllable

L*+H   and   **L+H***   in English

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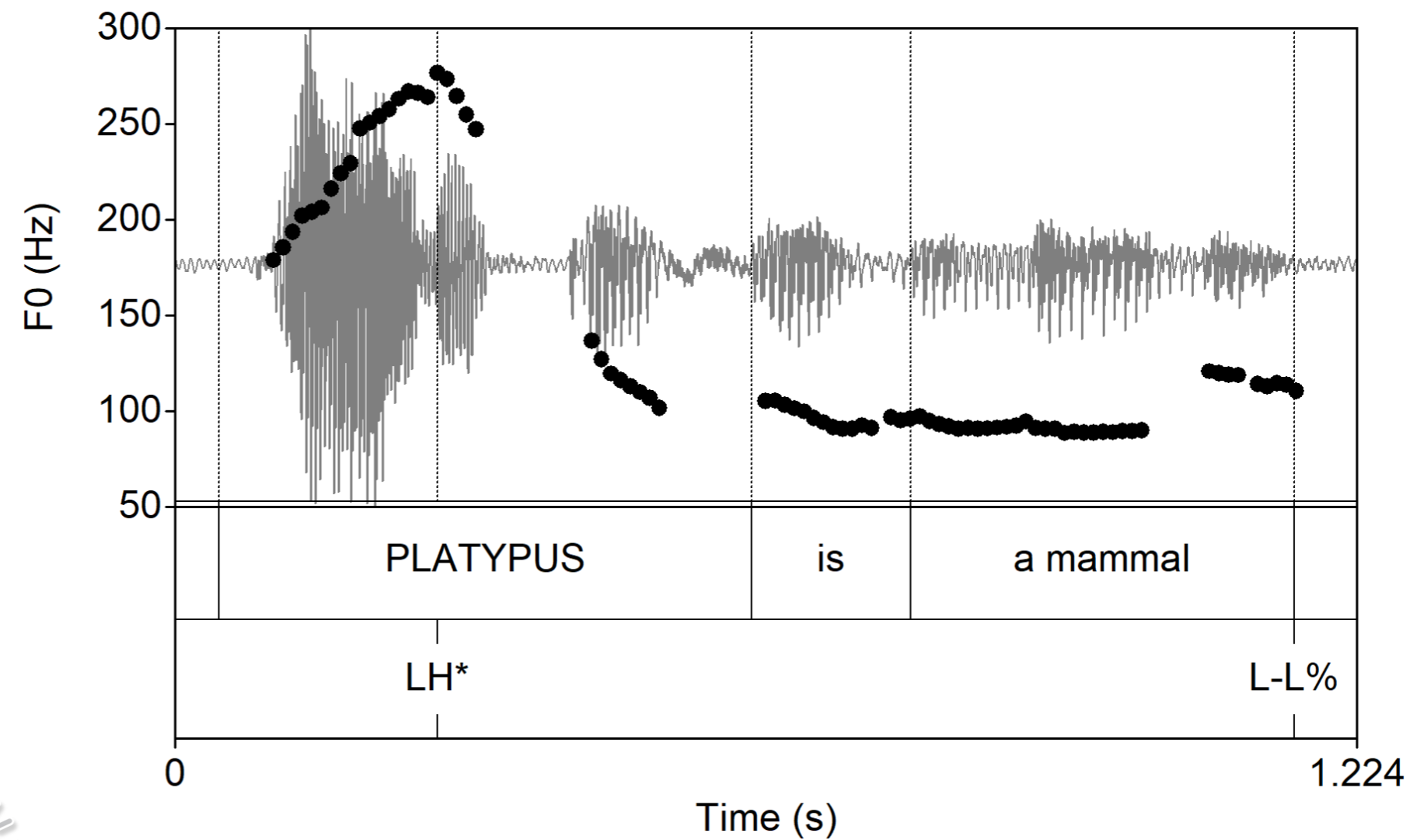# Text-tune association i

-Is platypus a bird?
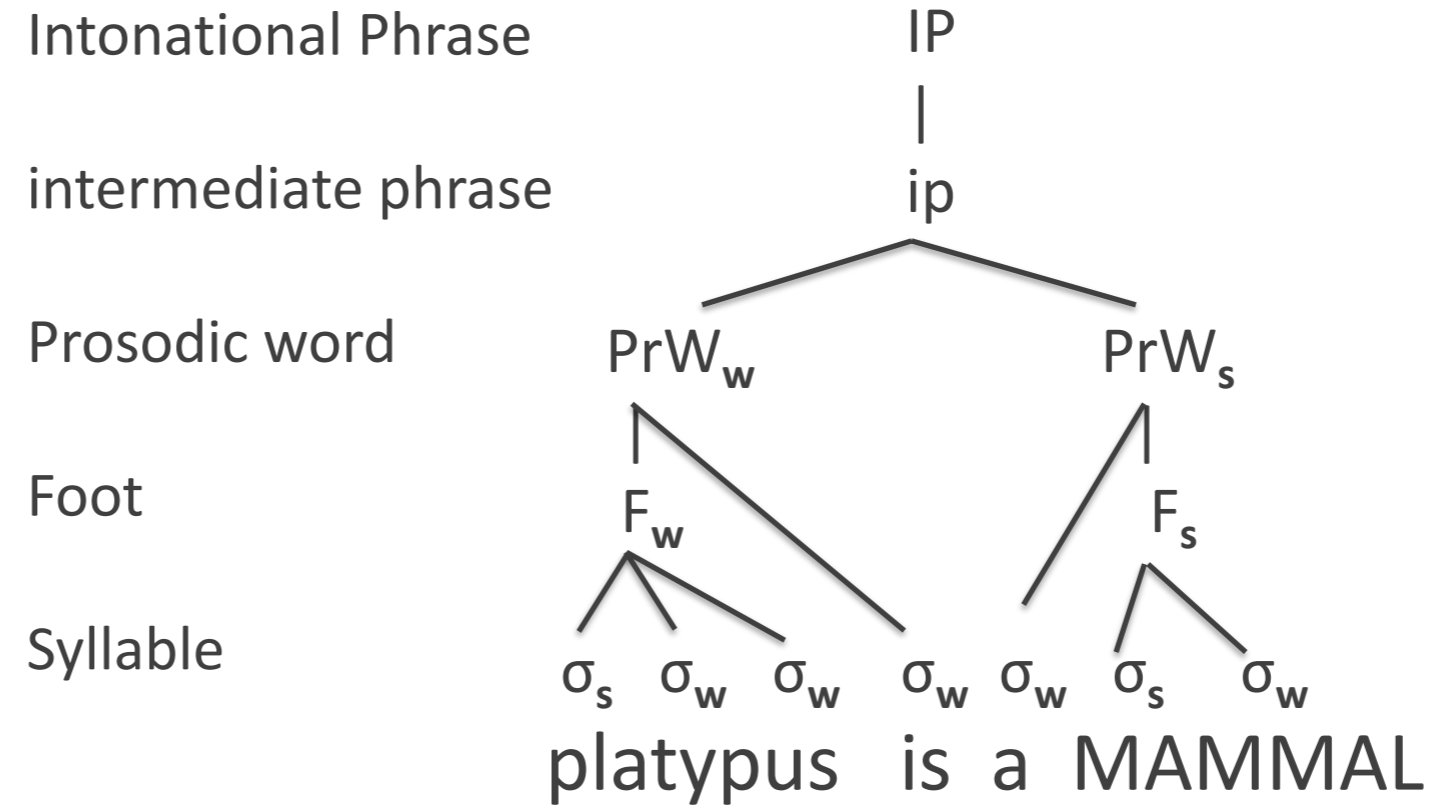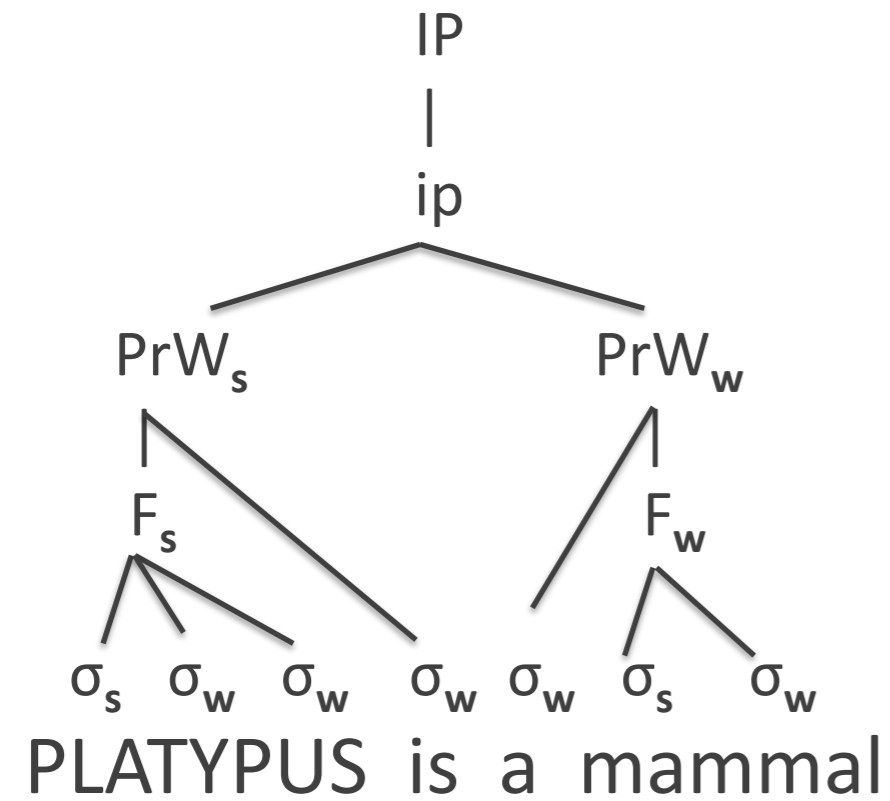-Platypus is a MAMMAL

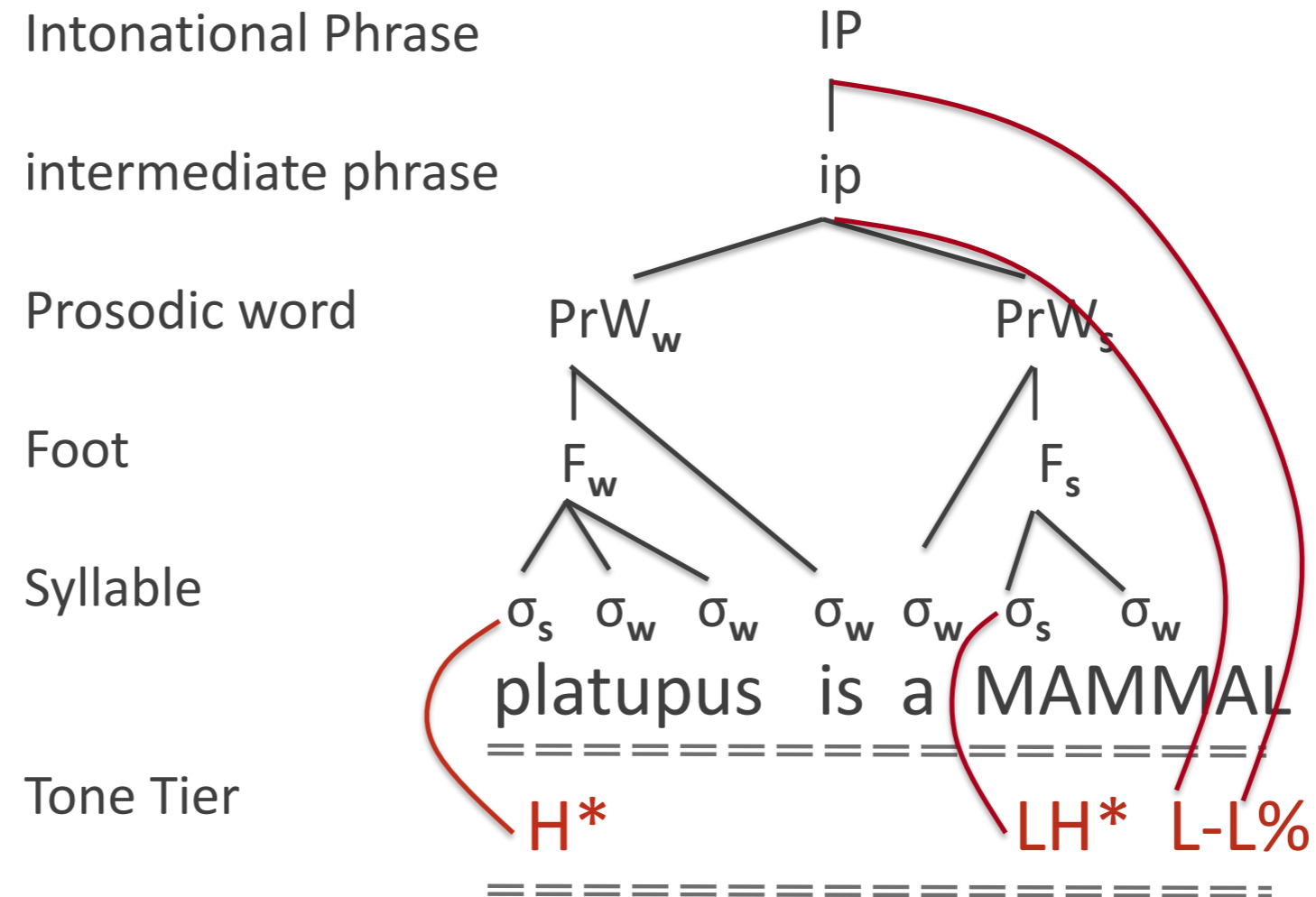CLS | Centre for Language Studies
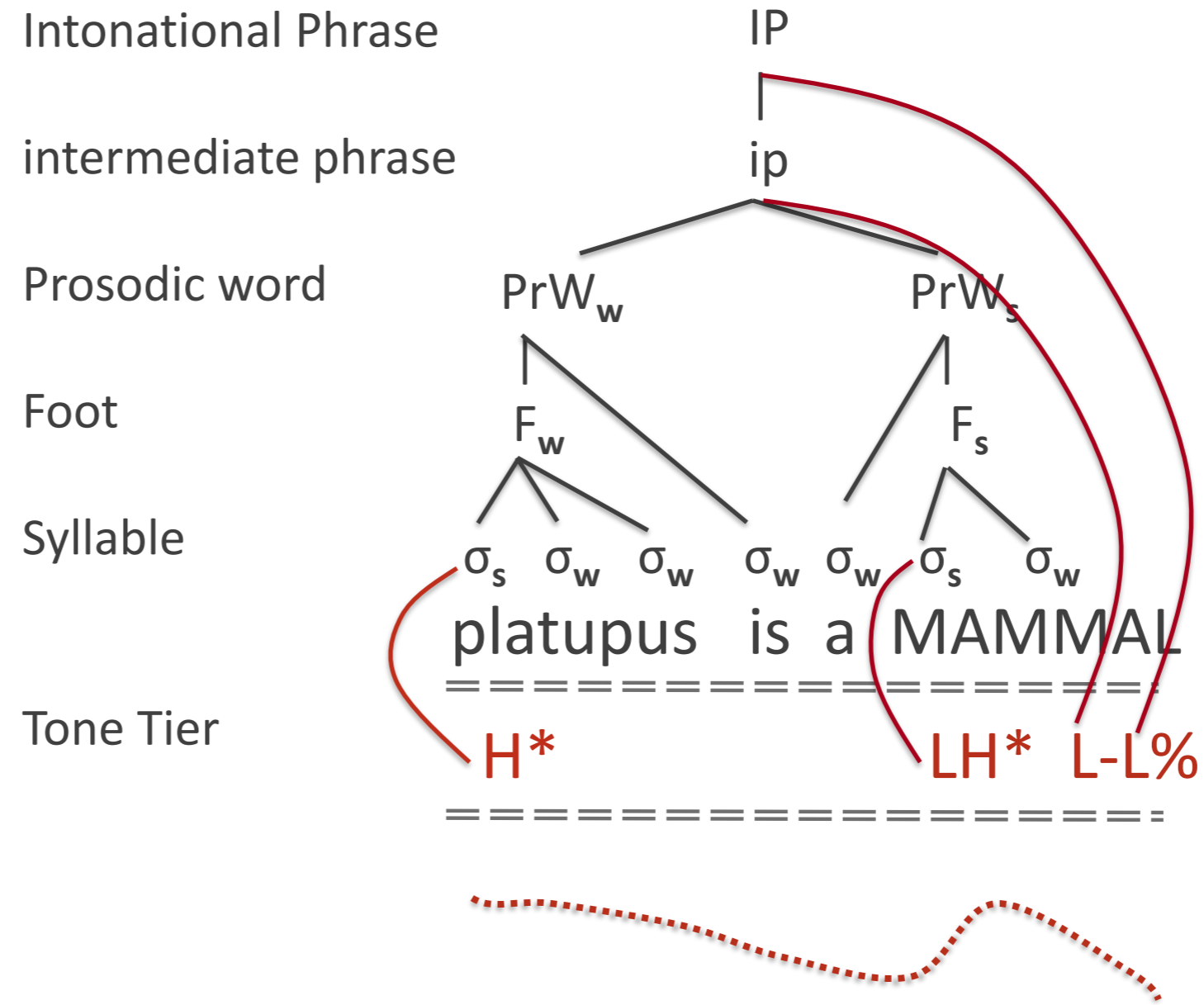Radboud University

Text-tune association ii

-Name a mammal
-PLATYPUS is a mammal

Metrical structures

Intonational Phrase

intermediate phrase

Prosodic word

Foot

Syllable

PLATYPUS is a mammal

platypus is a MAMMAL

Structures based on Pierrehumbert & Beckman (1988)

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Metrical structure and association to tones

IP	Intonational Phrase
ip	intermediate phrase
PrW	Prosodic word
F	Foot
σ	Syllable

Left structure:

IP → ip → PrW$_s$, PrW$_w$

PrW$_s$ → F$_s$ → σ$_s$ σ$_w$ σ$_w$

PrW$_w$ → F$_w$ → σ$_w$ σ$_w$ σ$_s$ σ$_w$

PLATYPUS is a mammal

Tone Tier: LH*   L-L%

Right structure:

IP → ip → PrW$_w$, PrW$_s$

PrW$_w$ → F$_w$ → σ$_s$ σ$_w$ σ$_w$

PrW$_s$ → F$_s$ → σ$_w$ σ$_w$ σ$_s$ σ$_w$

platupus is a MAMMAL

Tone Tier: H*   LH* L-L%

Structures based on Pierrehumbert & Beckman (1988)

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Metrical structure and association to tones

IP	Intonational Phrase	IP
ip	intermediate phrase	ip
PrW$_s$ PrW$_w$	Prosodic word	PrW$_w$ PrW$_s$
F$_s$ F$_w$	Foot	F$_w$ F$_s$
σ$_s$ σ$_w$ σ$_w$ σ$_w$ σ$_w$ σ$_s$ σ$_w$	Syllable	σ$_s$ σ$_w$ σ$_w$ σ$_w$ σ$_w$ σ$_s$ σ$_w$
PLATYPUS is a mammal		platupus is a MAMMAL
============================		============================
LH* L-L%	Tone Tier	H* LH* L-L%
============================		============================

Structures based on Pierrehumbert & Beckman (1988)

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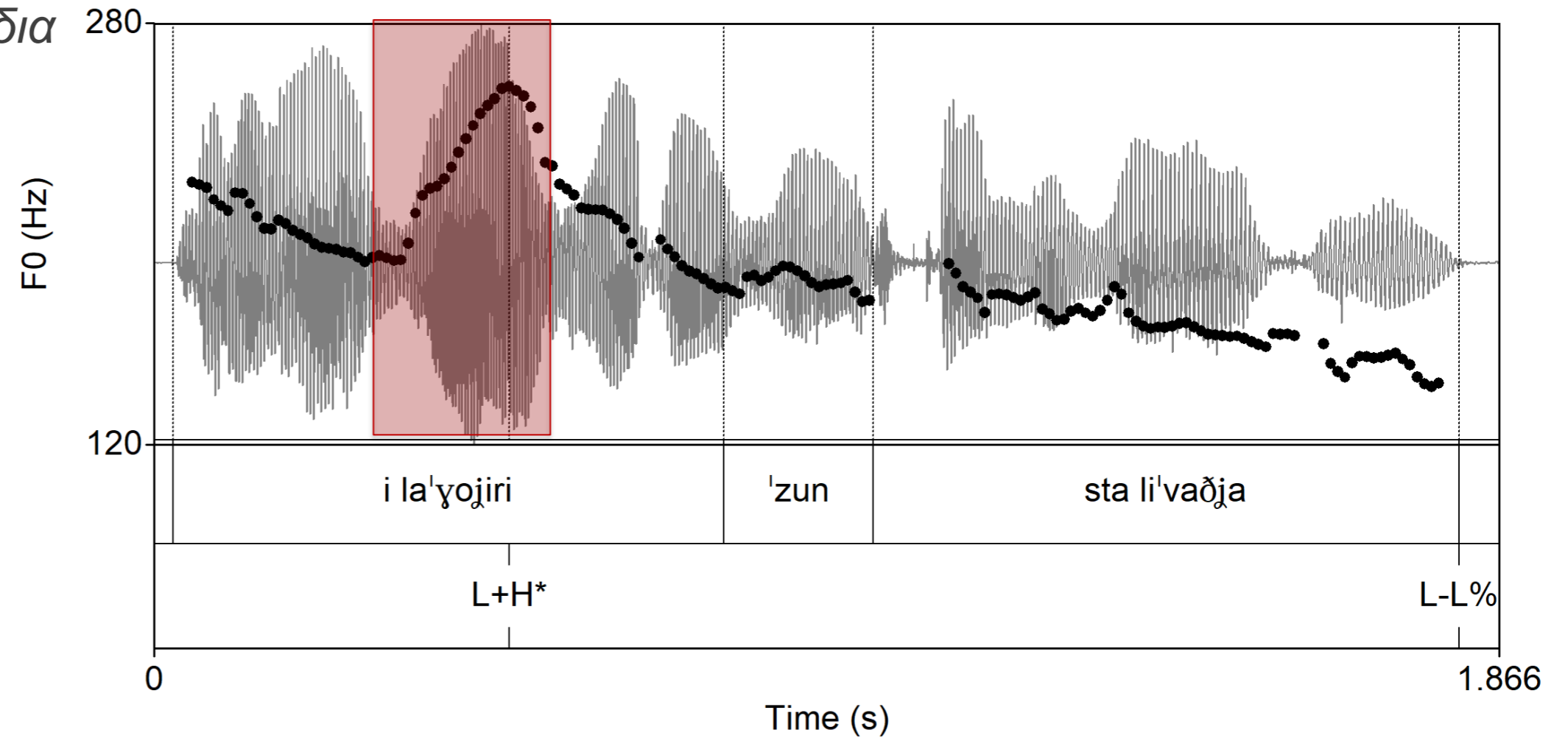**Radboud University**

Text-tune association in Greek i
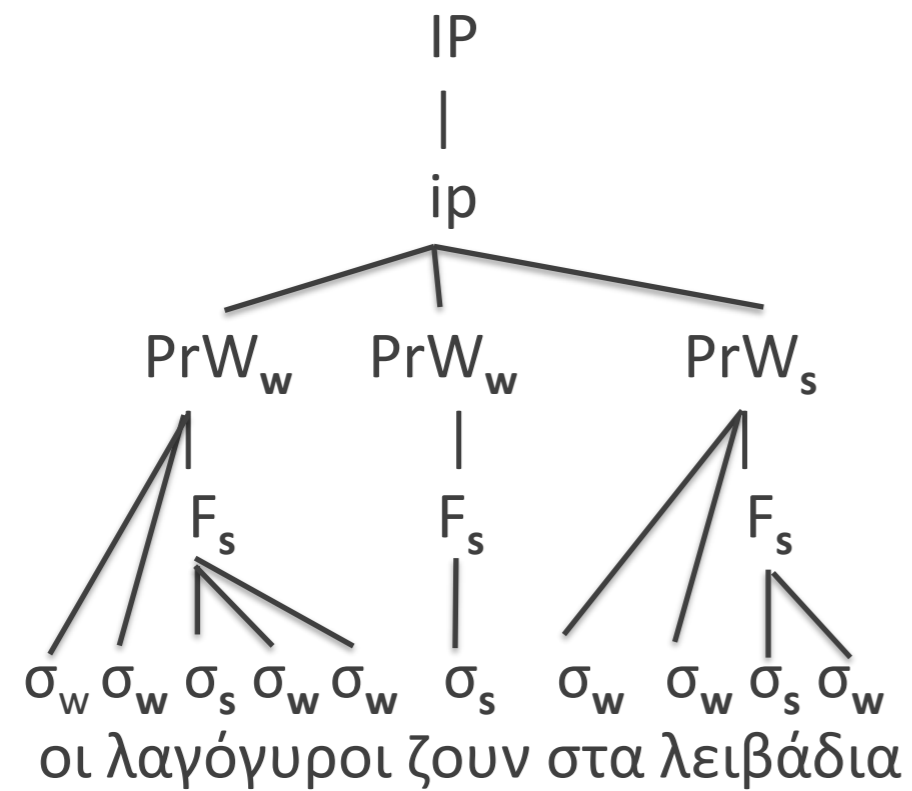
-Πού ζουν οι λαγόγυροι;
-Οι λαγόγυροι ζουν στα λειβάδια
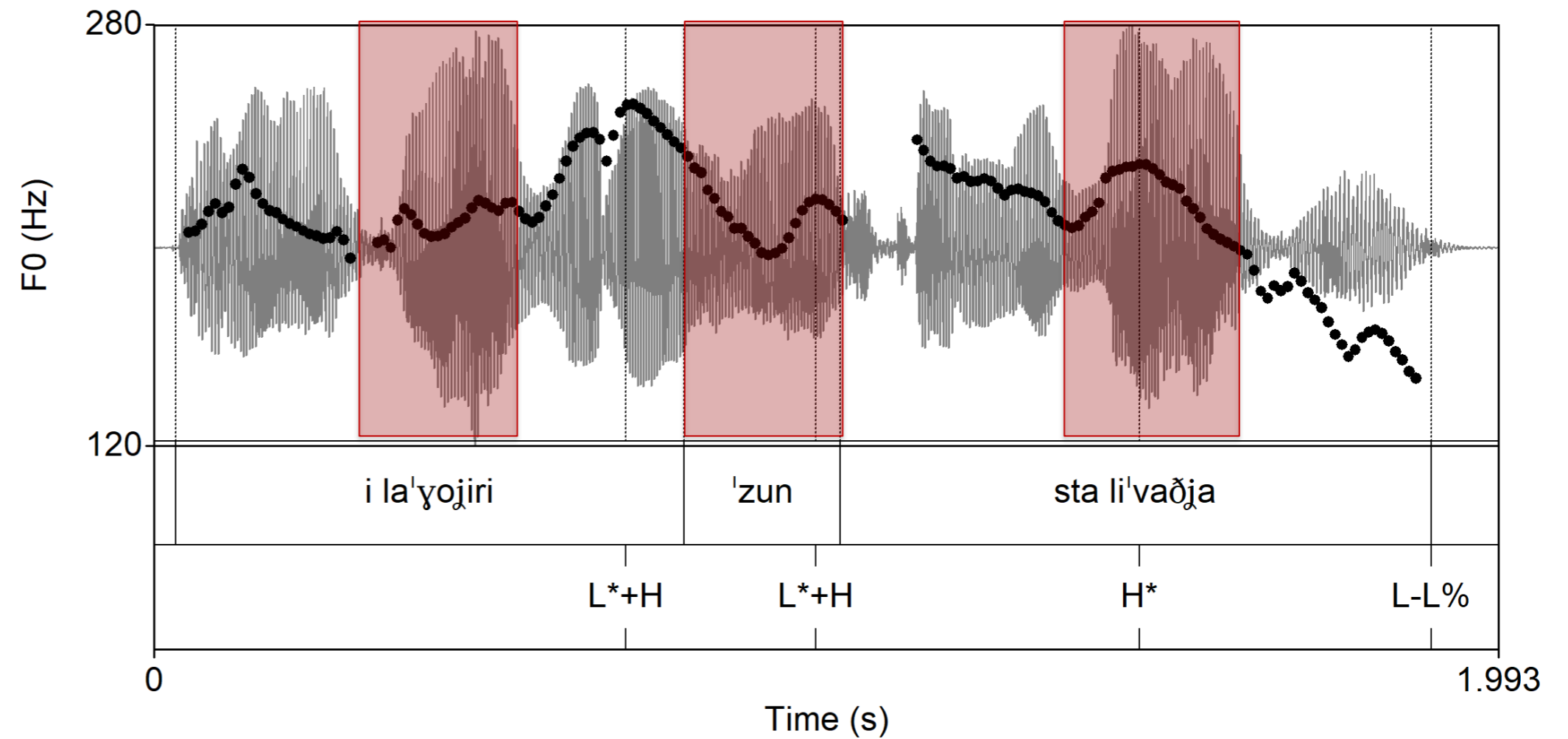
Text-tune association in Greek ii

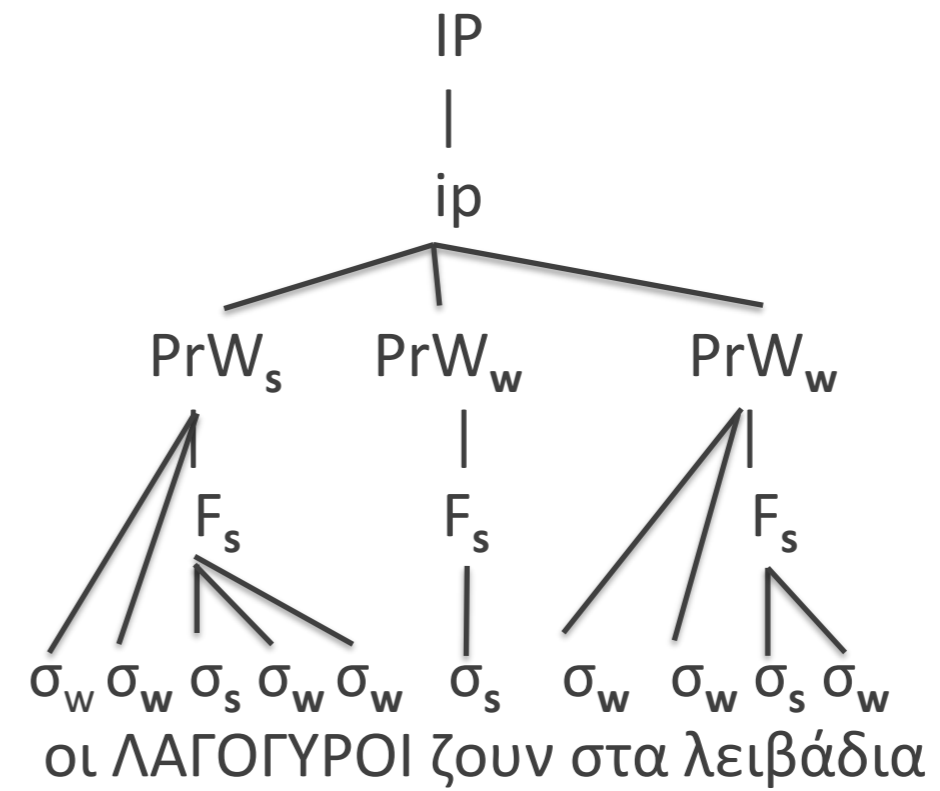-Οι σκίουροι ζουν στα λειβάδια
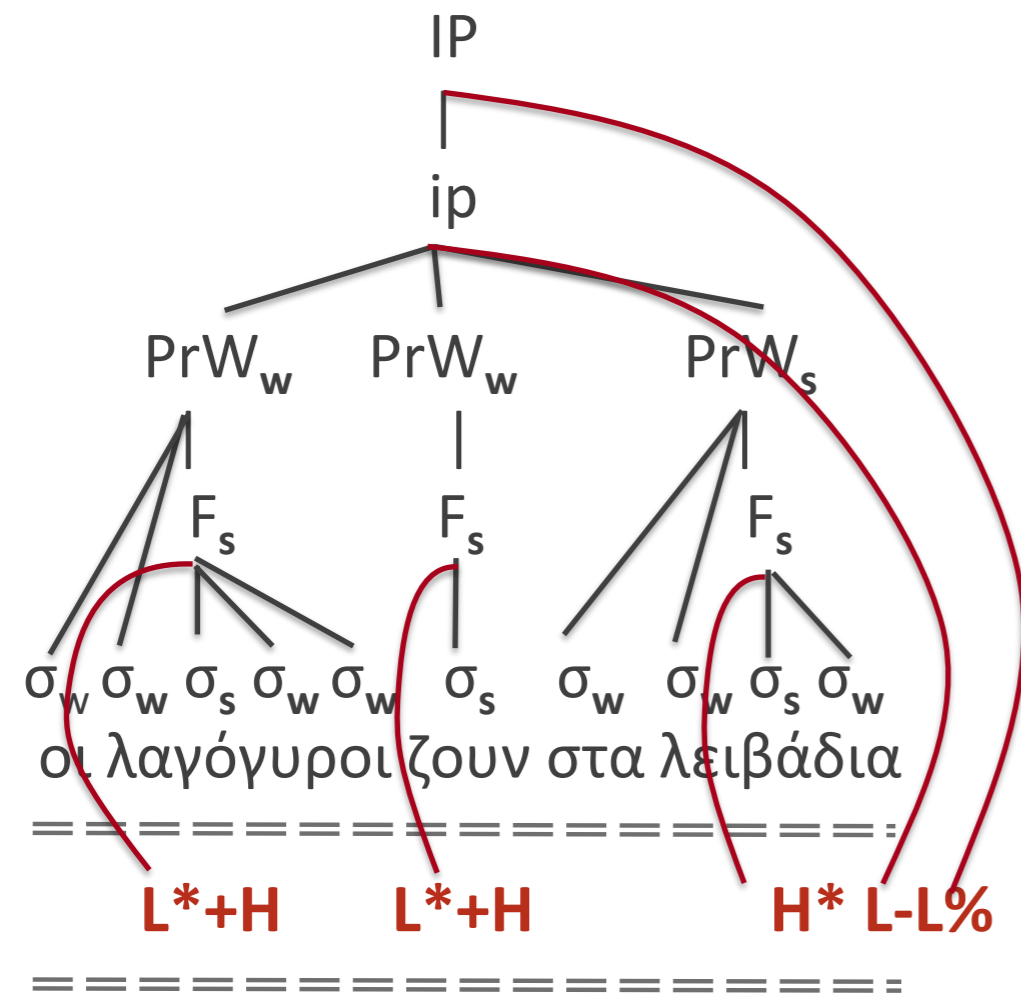-ΟΙ ΛΑΓΟΓΥΡΟΙ ζουν στα λειβάδια

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Metrical/prosodic structures

Intonational Phrase

intermediate phrase

Prosodic word

Foot

Syllable

Structures based on Pierrehumbert & Beckman (1988)

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Metrical/prosodic structures and association to tones

Intonational Phrase

intermediate phrase

Prosodic word

Foot

Syllable

Structures based on Pierrehumbert & Beckman (1988)
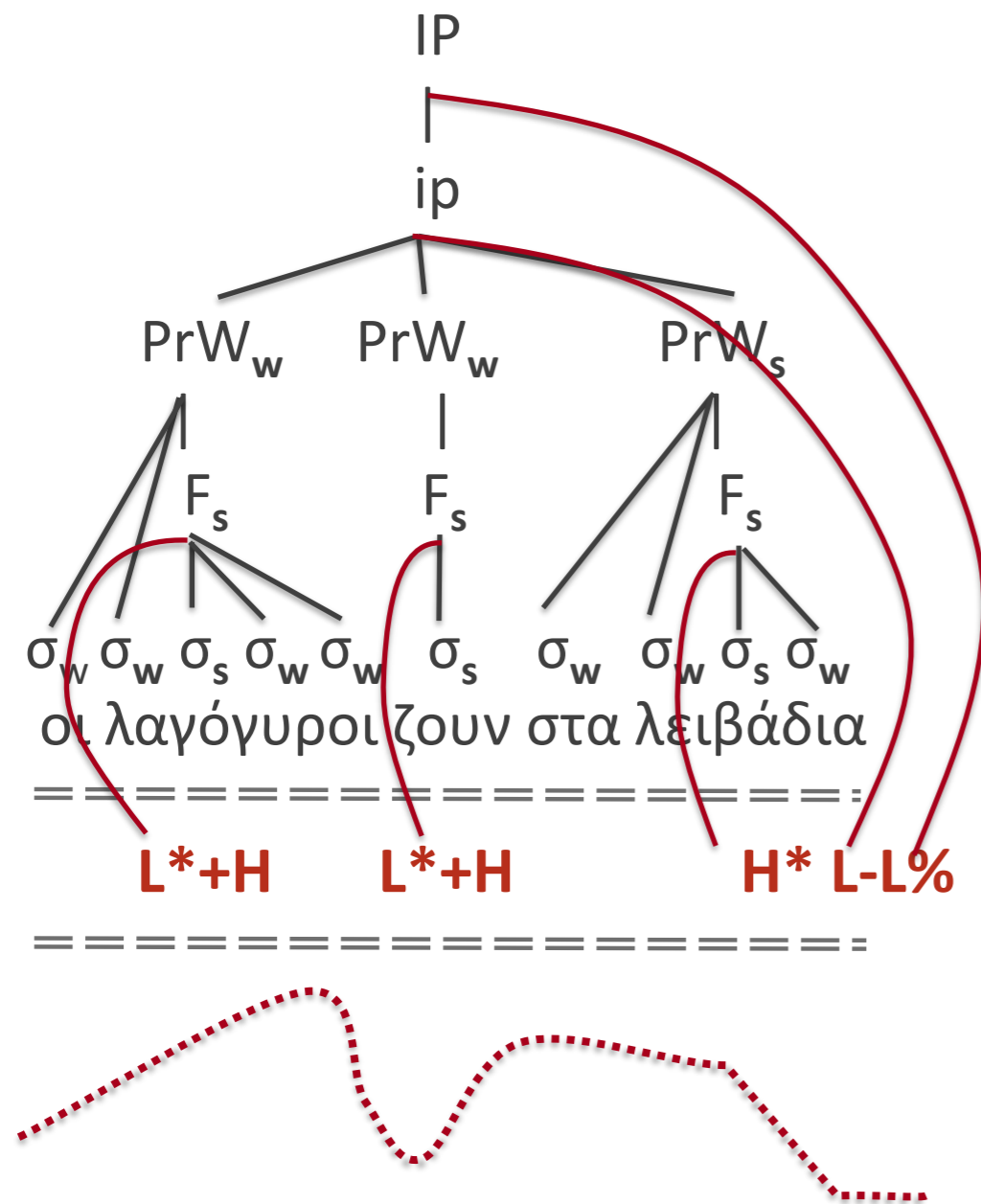
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Metrical/prosodic structures and association to tones

Intonational Phrase

intermediate phrase

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Structures based on Pierrehumbert & Beckman (1988)

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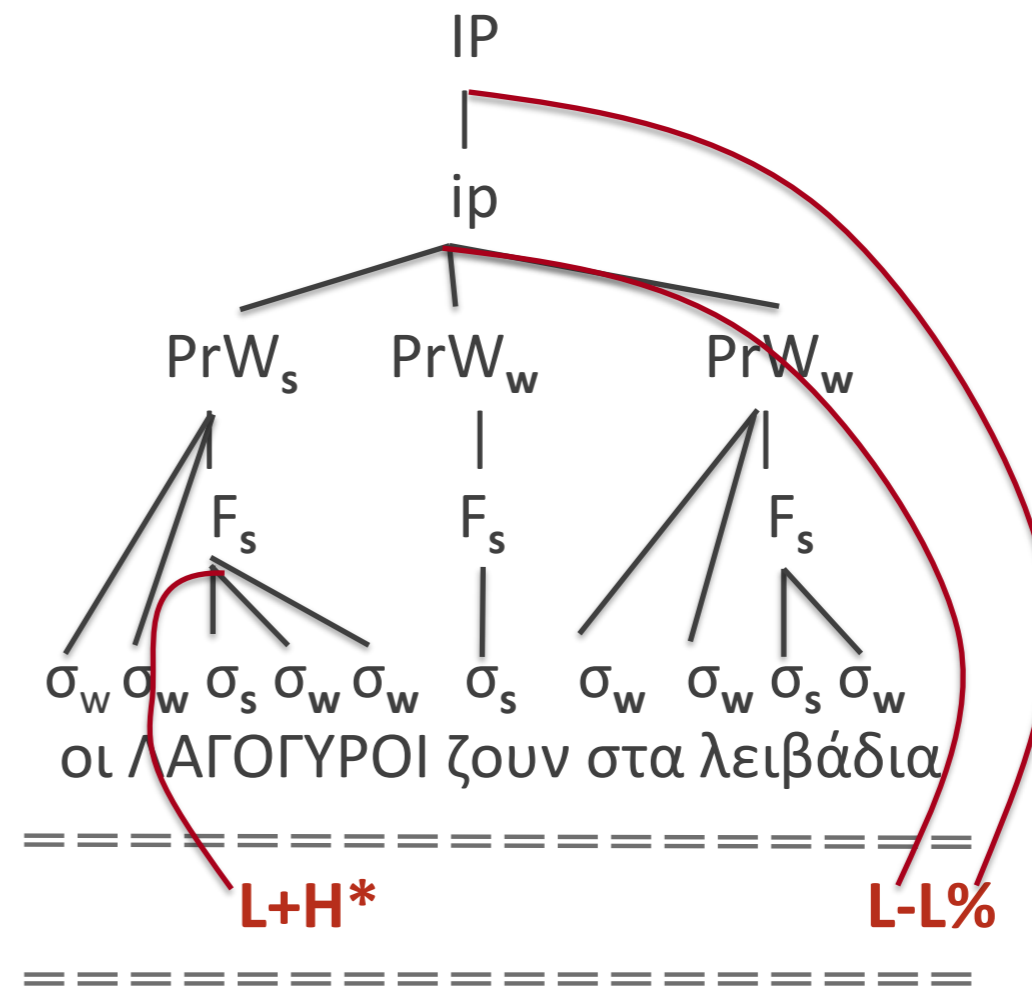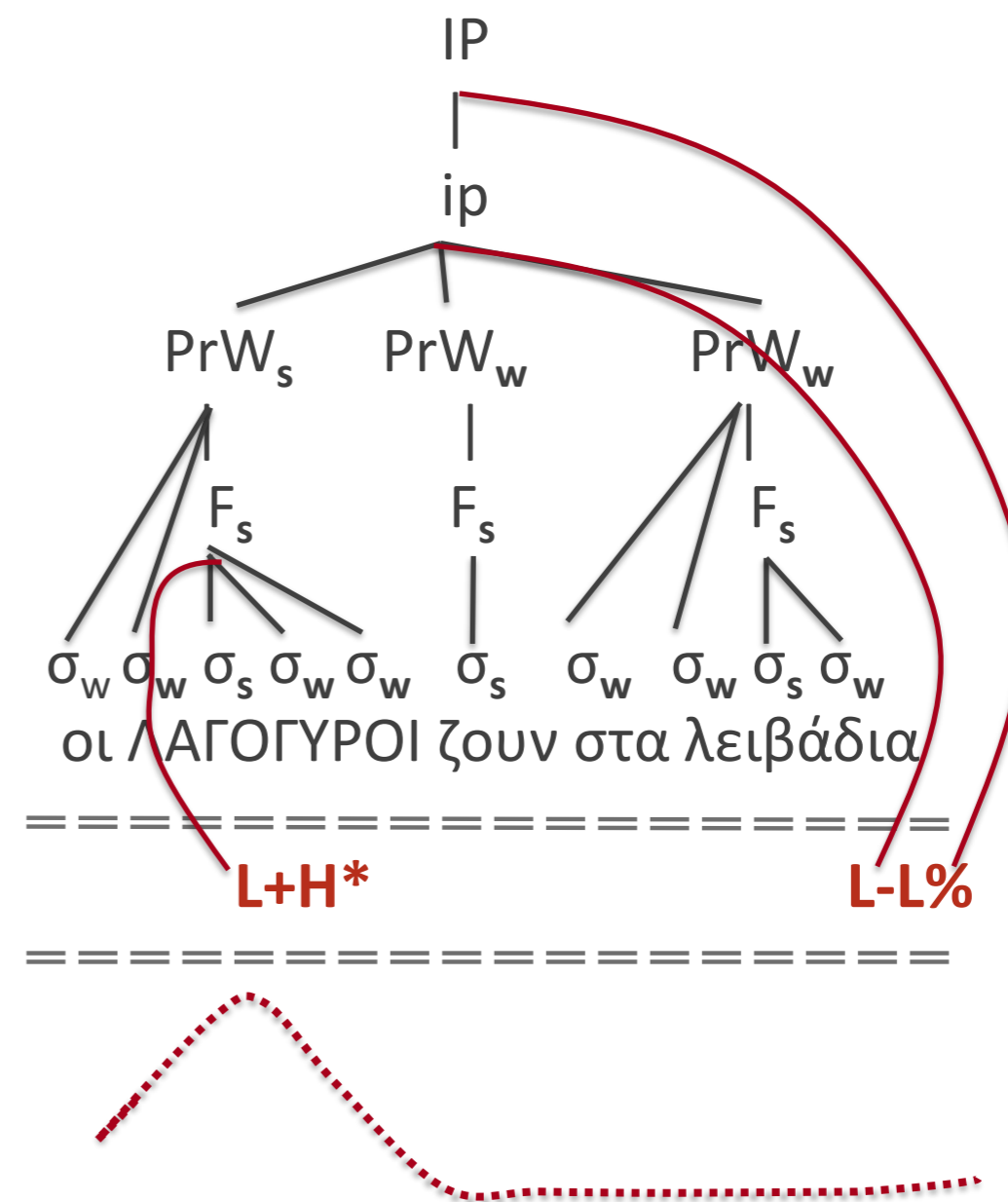
RECAP

- AM is a theory of intonational phonology
- Its aim is to represent the contrastive elements of an intonational system
- These elements are tones, which are considered to form a string of autosegments
- Tones associate with structural positions in metrical structure:
  - heads of constituents (informally stresses)
  - phrasal boundaries
- The overall representation of intonation is seen as part of a language's phonology
- AM is not meant to provide a transcription of actual F0 contours

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ΤΕΛΟΣ ΤΟΥ ΠΡΩΤΟΥ ΜΕΡΟΥΣ