Accentual phrases in Slovak and Hungarian – more data and some French

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Outline

1. Hierarchy and definition of prosodic phrases
2. Relevance of accentual phrases in French, Slovak and Hungarian?
3. Linear and parabolic stylization of F0 within accent groups
4. Comparison of stylized accent group and intonational phrase

Prosodic phrasing

- Important aspect of prosodic structure.
- Participates in/co-creates cognitive contrasts, e.g. syntactic parsing (PP-attachment)
  - e.g. *She saw a man with a telescope.*
- But sometimes might be susceptible to "low" effects such as the number of syllables).

The hierarchy of prosodic phrases

Beckman & Pierrehumbert (1986)

( )	**intonational phrase (IP)**
( )( )	intermediate phrase (ip)
( )( )( )	accentual phrase (AP)
( )( )( )( )( )( )	prosodic word (PW)
()( )( )()( )()( )()( )()( )	**syllable/mora**

Prosodic phrases

- Largest prosodic unit: intonational phrase. Smallest prosodic unit: syllable/mora. Smallest intonation-based prosodic unit: prosodic word.
- These units are universal and appear in all languages.
- There is a general agreement on their definition.
- Phrases between the IP and the syllable/mora are not clearly defined.

Jun & Fletcher (2014: 12):
For duration, [the AP] can have minor or no phrase-final lengthening. An ip typically includes a few words or APs and is the domain of pitch reset, though not always marked by a boundary tone, and has a medium degree of phrase-final lengthening (i.e., weaker than IP-final lengthening).

Accentual phrase

Jun & Fletcher 2014

- **Accentual phrase (AP)**: phrasal stress at the beginning or end of the phrase. It is often found in languages with fixed stress, but seldom in languages with lexical stress (e.g. Farsi).
- In an AP, pitch contours show a regular pattern $\rightarrow$ rising, falling or rising-falling.
- There is often an additional boundary tone marking the other edge of the prosodic unit.
- Pitch accents can mark prominence (English), demarcate a prosodic boundary (Japanese) or both (French).

APs in French

Jun & Fougeron (2002) on French APs:

- a sequence of rising pitch movements demarcating phrase boundaries,
- lexical stress has no distinctive function,
- stress is word-final, but only if the word is phrase-final,
- optional initial (secondary) rising pitch movement.

Slovak and Hungarian

- Slovak and Hungarian: initial stress fixed to the left-most syllable of a prosodic word.
- Hungarian: stress is word-initial, Slovak: stress can be shifted to the preposition preceding the lexical word, e.g. *HOry* 'hills', *DO hory* 'to the woods'.
- Slovak: "no lower prosodic level than intermediate phrase" (Rusko, Sabo & Dzúr 2007).
- Hungarian: assumptions that an accent starts a new prosodic unit:
  - character contours (Varga 2002),
  - phonological phrase (Hunyadi 2002).

A bottom-up approach

- Guidelines how to identify intermediate and accentual phrases are tentative and rely on intuition.
- Our approach: to investigate accent groups (AG).
  - The AG is a rhythmic unit that stretches from an accented syllable until the last unaccented syllable before the next accent or the end of the IP.
- Our goal: to test whether accent groups form an independent prosodic unit in Slovak and Hungarian.
- AG – ? – AP

Speech data

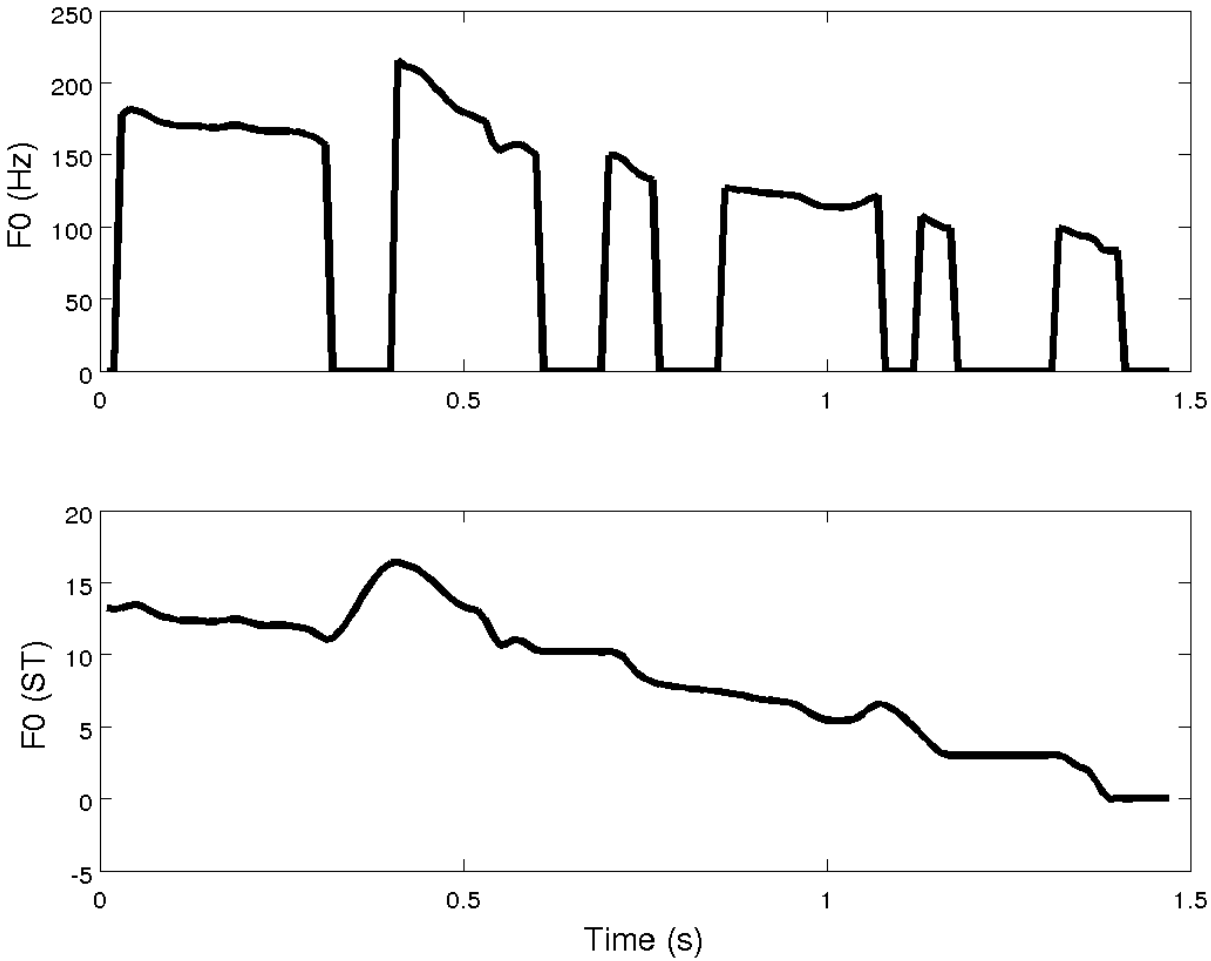
150 French, Hungarian and Slovak spontaneous utterances, around 440 AGs in each language

- forming a single intonational phrase (IP),
- with at least two pitch accents (manual labelling),
- 15 utterances of 10 speakers in each language.

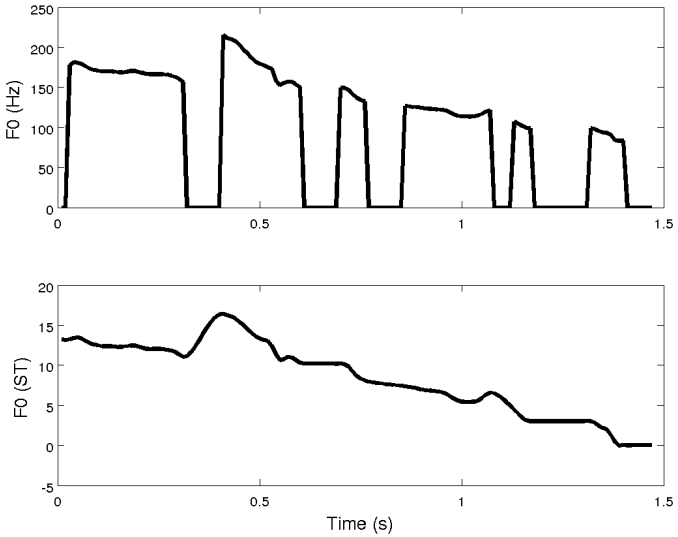
F0 stylization

- **linear stylization:** deviation of the accent groups from the intonation phrase
- **parabolic stylization:** F0 shape of the accent groups

F0 extraction and preprocessing



F0 extraction and preprocessing



- F0 extraction by autocorrelation
- cubic spline interpolation over voiceless utterance parts and F0 outliers
- smoothing by Savitzky Golay filtering
- **normalization, semitone transform**
  $F0_{ST} = 12 \cdot \log_2 \frac{F0_{Hz}}{b}$
- base value b: F0 median below the 5th percentile of an utterance
- **normalization:** removes effect of overall F0 level
- **semitones:** perceptually more adequate than linear Hz scale

AG-IP deviation: Overview

Motivation

acoustic correlates for the presence of accentual phrases are

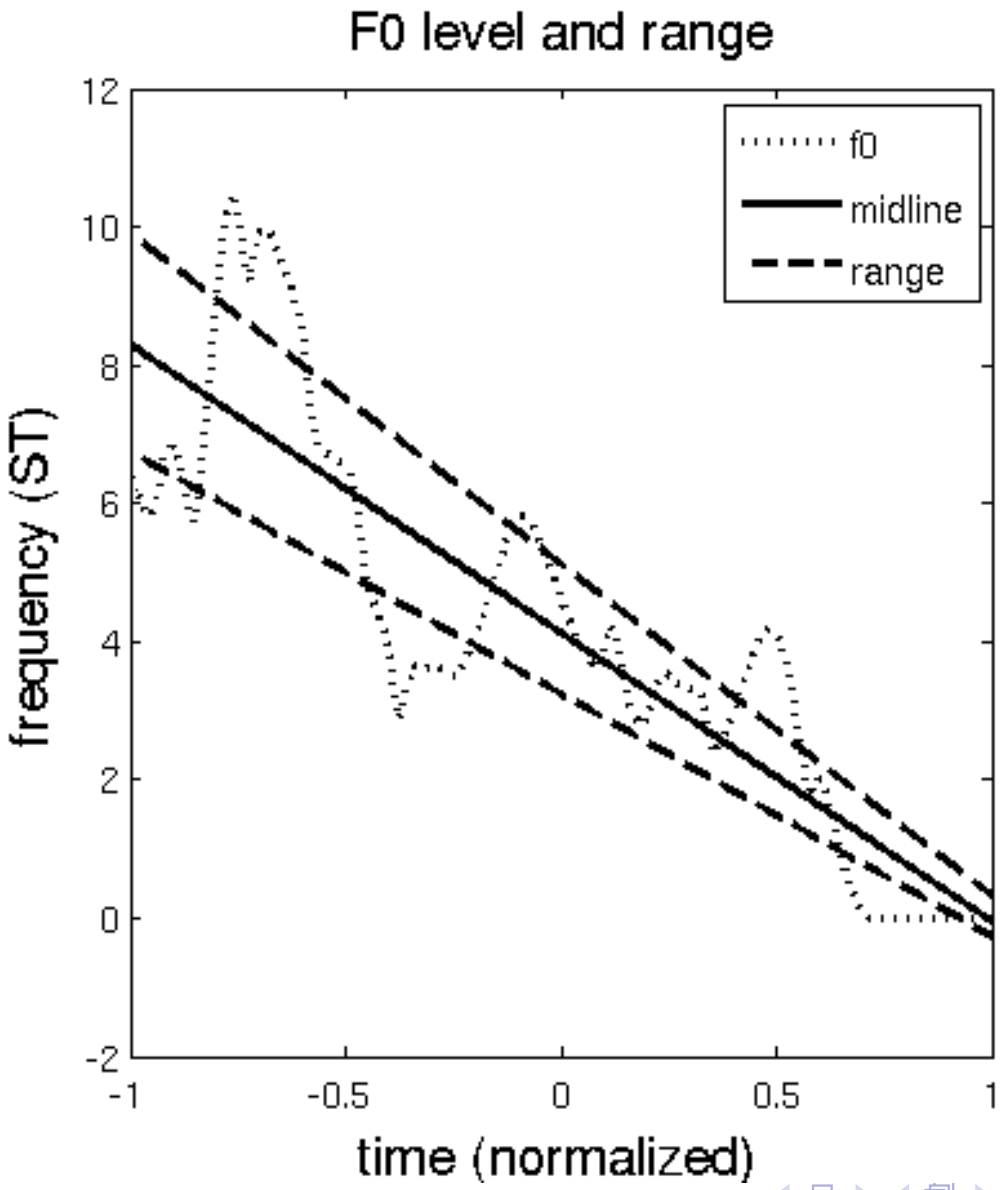
- local **level deviations** between the AG and the IP
- prominent F0 movements (**high AG range**)

Processing steps

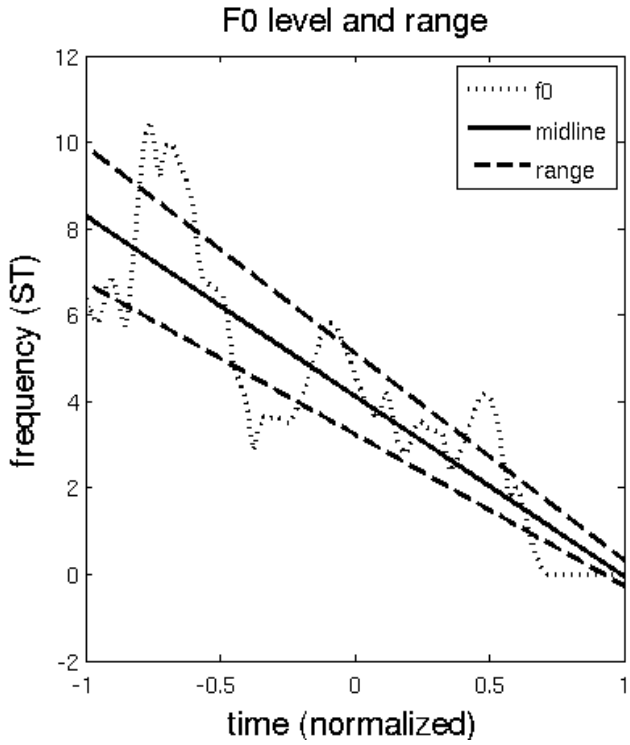
1. **level and range stylization** within IPs and AGs
2. **distance calculation** between AG and IP stylization parameters

$\longrightarrow$ **the more distant the higher the AG-IP deviation**

AG-IP deviation: Register stylization



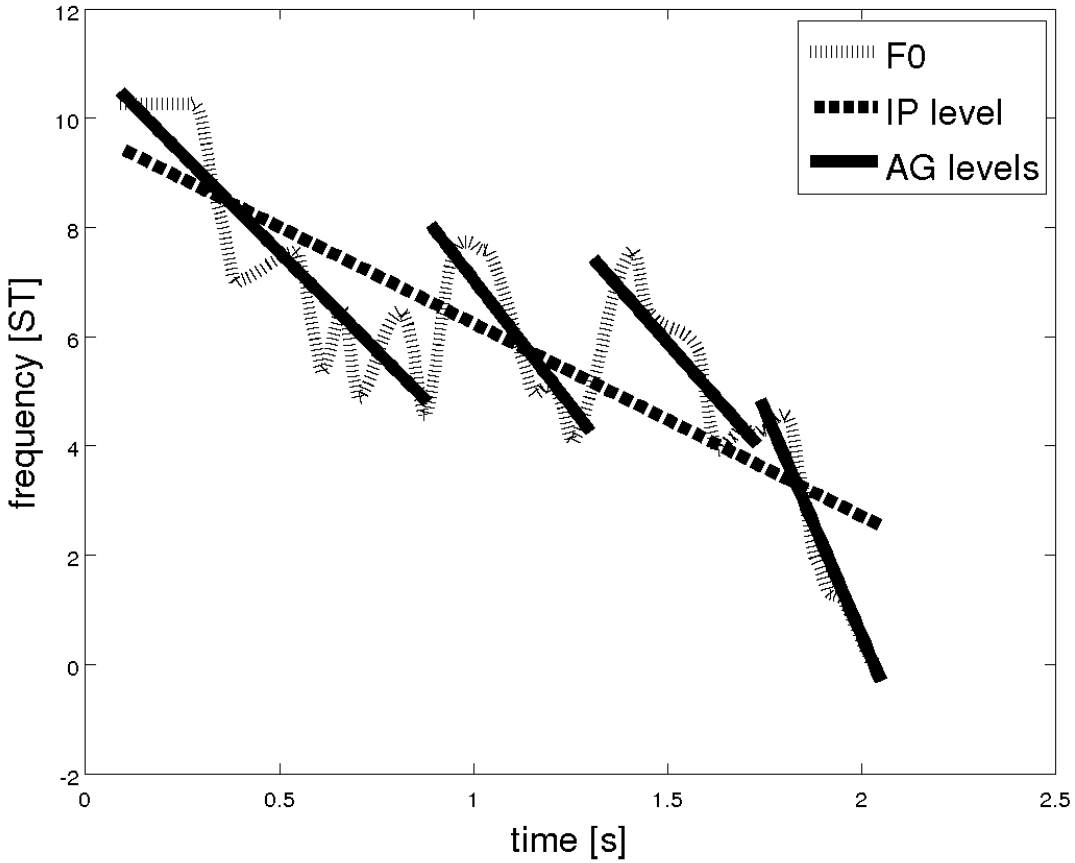
AG-IP deviation: Register stylization



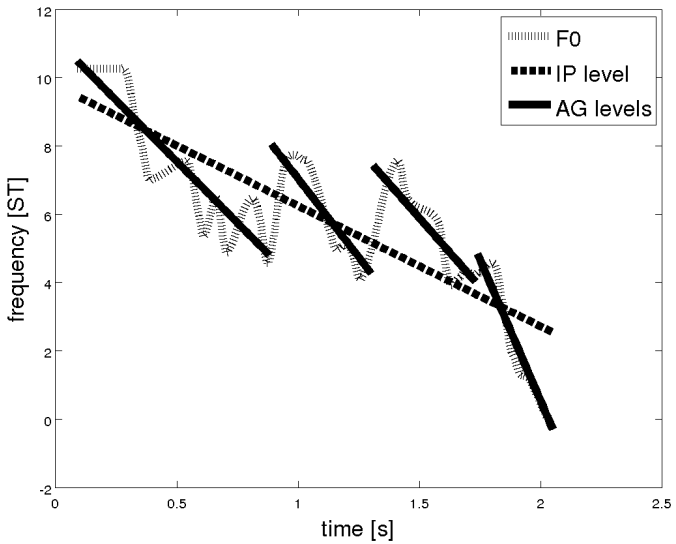
- F0 medians calculated within windows (length 200 ms, window shift 10 ms)
  - of the values $<$ 10th percentile for the baseline,
  - of the values $>$ 90th percentile for the topline, and
  - of all values for the midline.
- time normalization to remove phrase length effects
- fit line to each of the three median sequences

AG-IP deviation: Distance Measures

AG and IP level



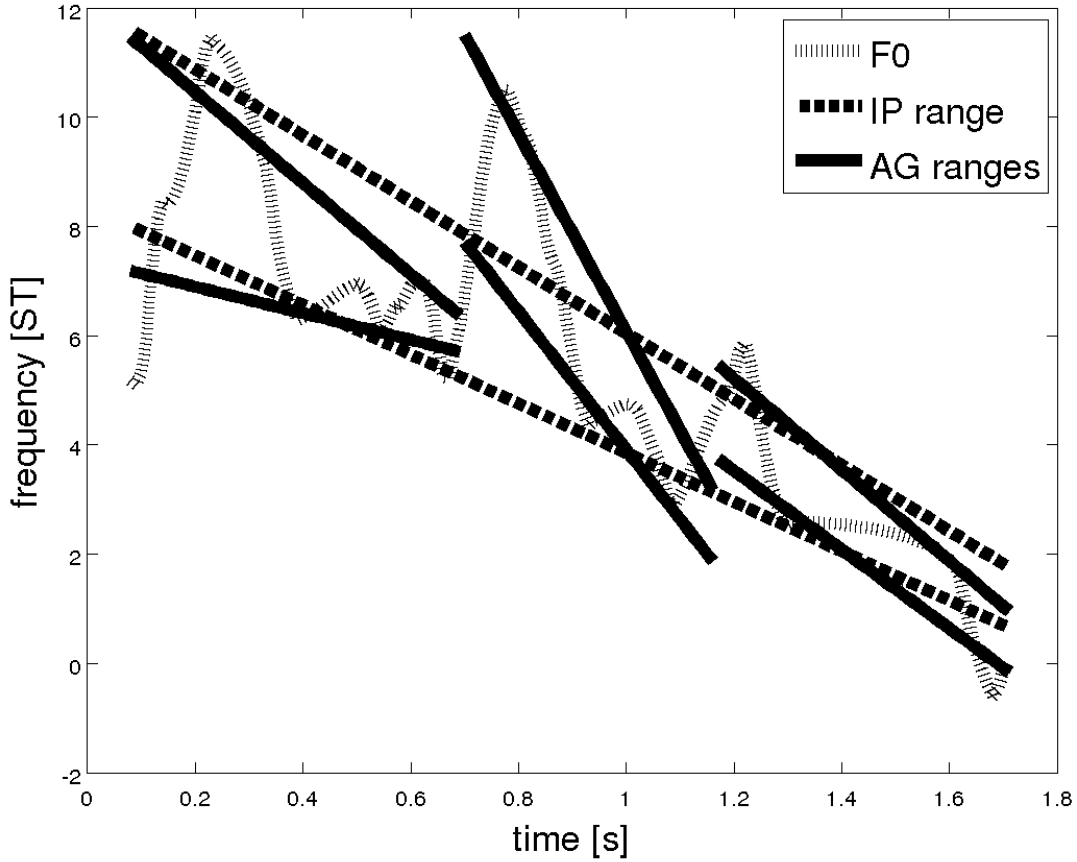
AG-IP deviation: Distance Measures



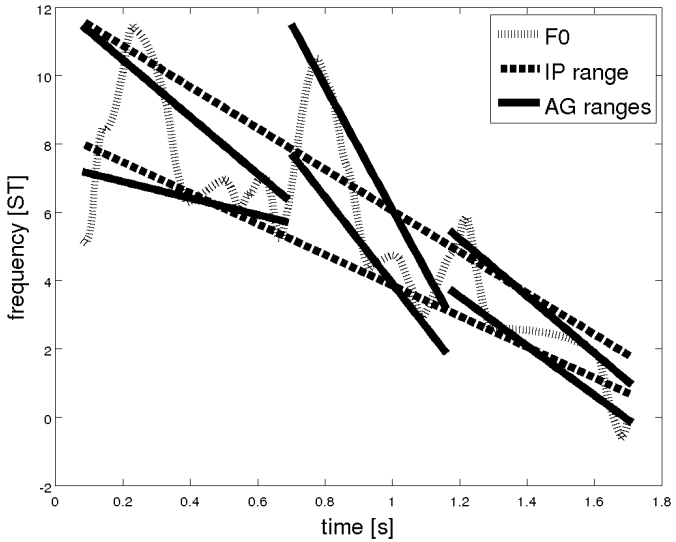
mlSlope	slope of AG midline
mlSlopeDiff	slope difference of AG and IP midline
mlRms	mean squared deviation of the AG line from the corresponding section of the IP line
mlInitDiff	(initial F0 value of AG midline) – (corresp. IP midline value)
mlFinDiff	(final F0 value of AG midline) – (corresp. IP midline value)

AG-IP deviation: Distance Measures

AG range



AG-IP deviation: Range Measures



rangeRms	RMS between AG base- and top line

F0 shape

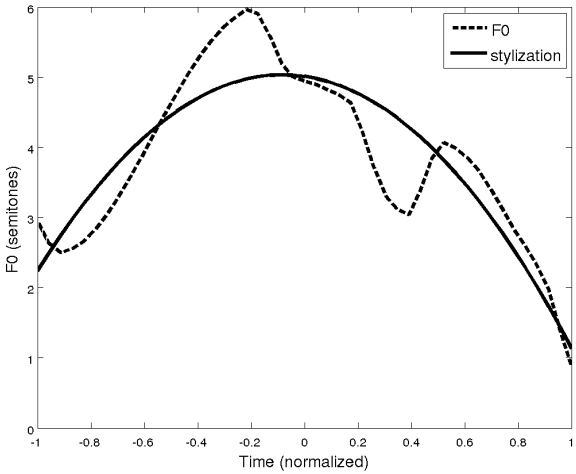
Method

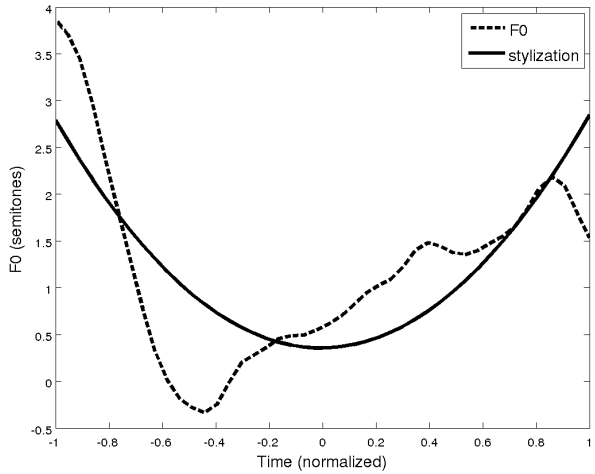
- within each AG a 2nd order polynomial was fitted to the F0 contour: $F0 = c_0 + c_1 \cdot t + c_2 \cdot t^2$
- curvature of the F0 contour quantified in terms of the quadratic polynomial coefficient c_2
- c_2 negative: **concave (rising–falling)**
- c_2 positive: **convex (falling–rising)**
- c_2 near 0: **low curvature (linear shape)**

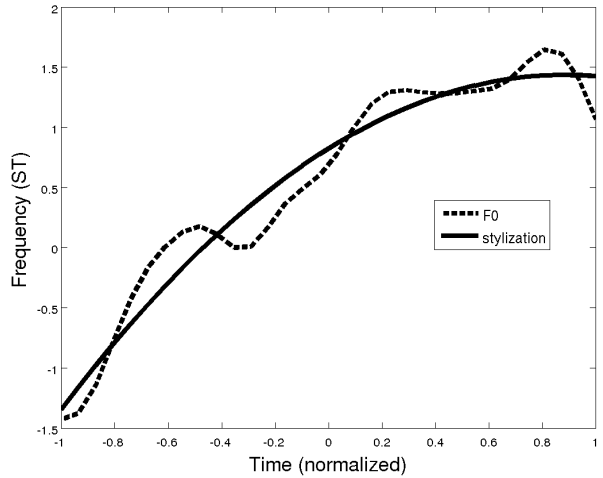
F0 shape

Shape examples

- c_2 negative (left), positive (mid), low absolute value (right)







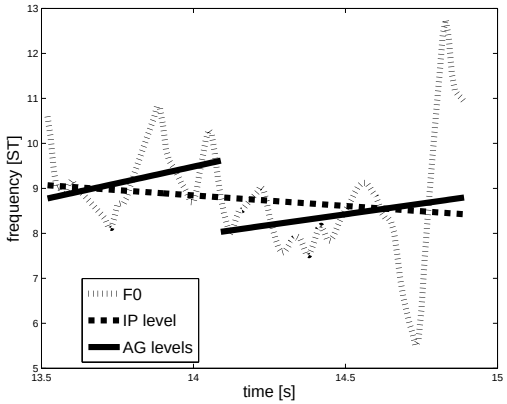
Statistical analysis

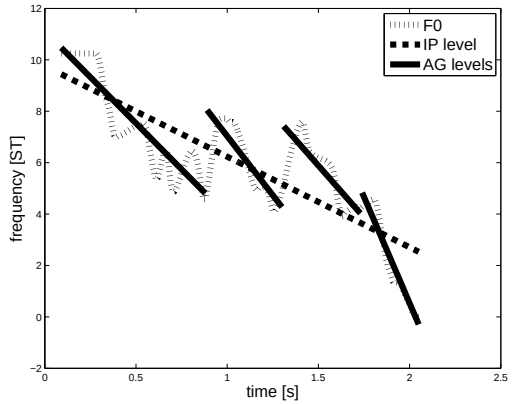
Kruskal-Wallis tests and Wilcoxon tests:

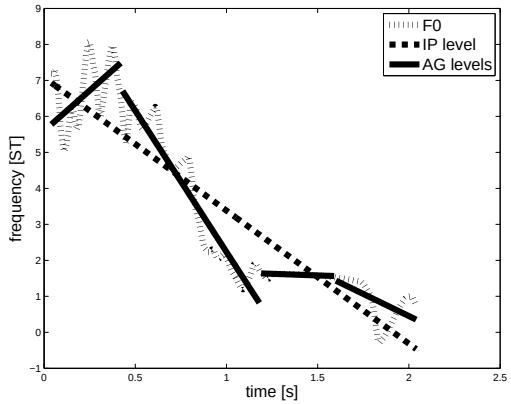
- Linear stylization:
  - the mean of each data set was compared to 0,
  - the means of the data for each language were compared.
- Parabolic stylization:
  - comparison of the quadratic coefficient c_2 between the languages,
  - the form of the parabola (convex or concave) for each language.

A significant difference from $mean = 0$ in the linear data refers to a steeper rise or fall of the AG pitch compared to the IP pitch.

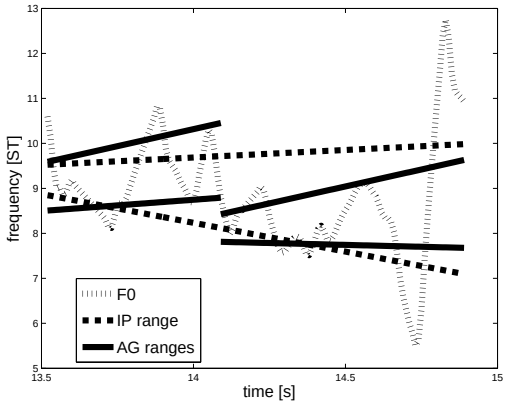
Typical F0 level patterns for French (left), Hungarian (mid) and Slovak (right).

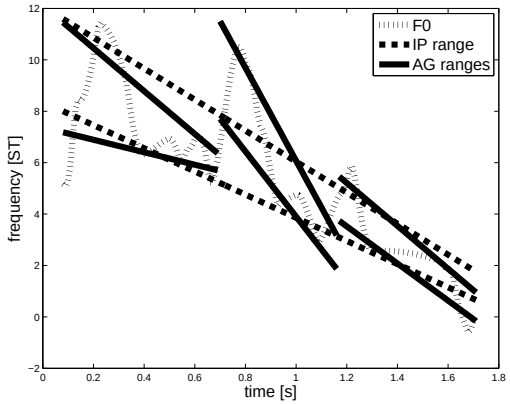


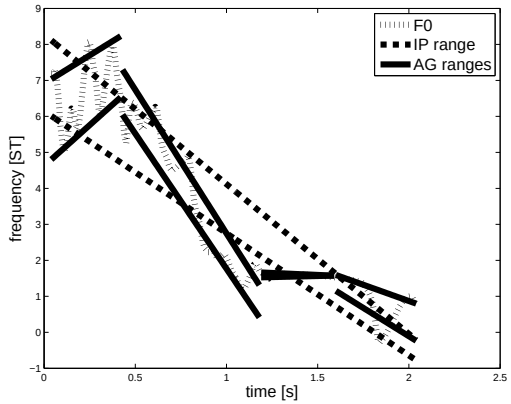




Typical F0 range patterns for French (left), Hungarian (mid) and Slovak (right)

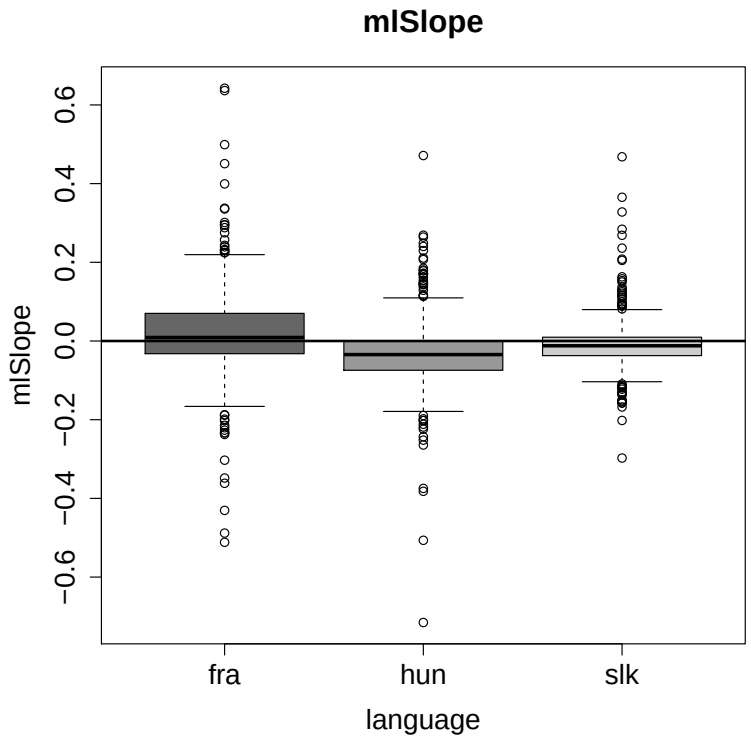






Midline slope

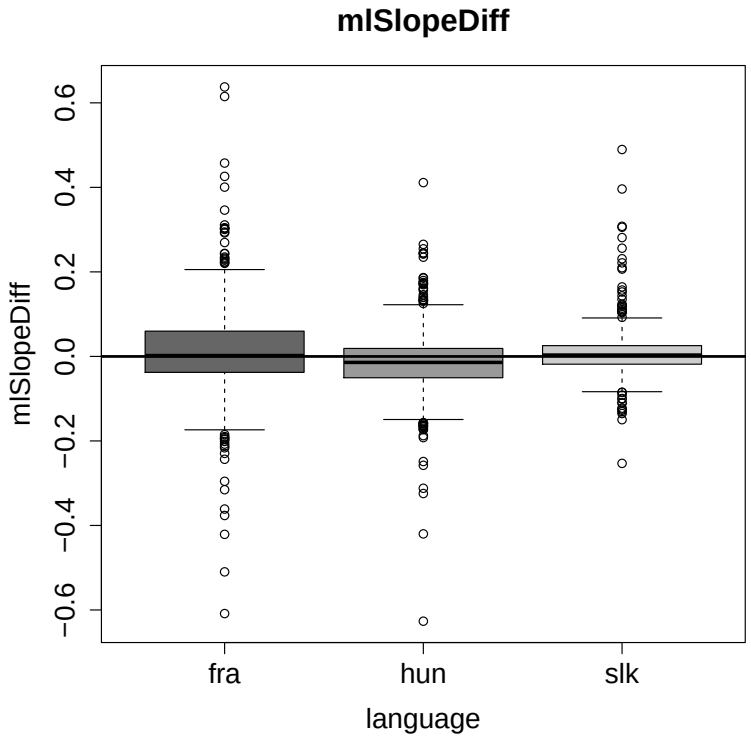
Positive: rising line, negative: falling line, 0: level line.



Negative slopes: Hungarian > Slovak > French. Languages differ significantly from each other and from 0 (identical AG and IP slopes).

Slope difference

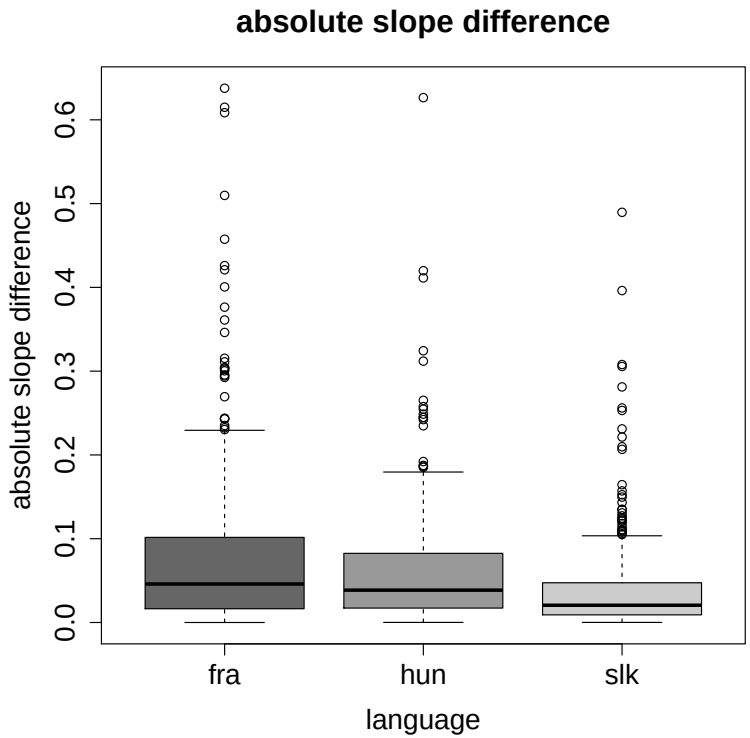
Positive value: the AG is higher (more rising or less falling) than the IP, negative: AG is lower, 0: no difference.



All languages differ significantly from each other. Only Hungarian differs highly significantly from 0, French and Slovak reach $0.5 > p > 0.1$.

Absolute slope difference

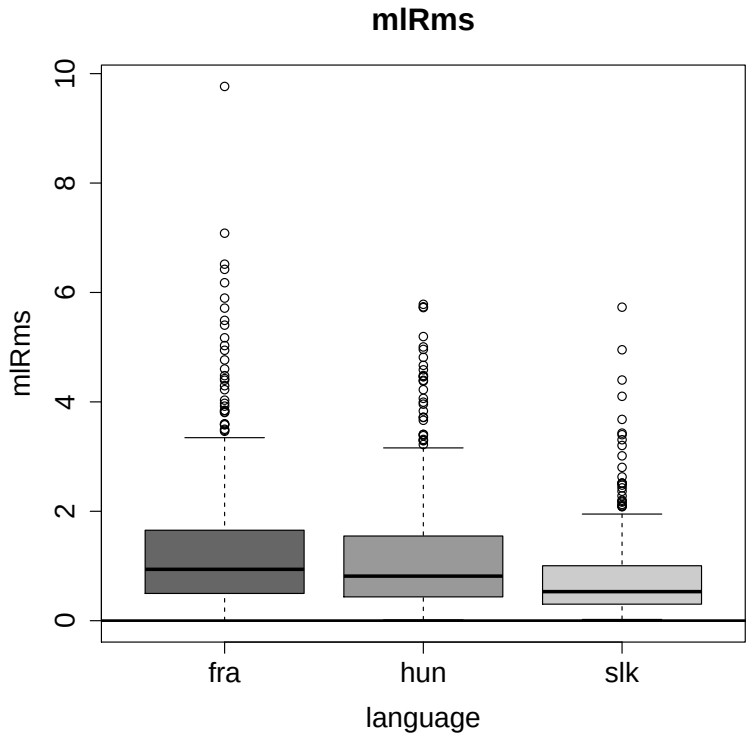
Higher value: larger difference, values close to 0: smaller difference.



French > Hungarian > Slovak. Languages differ significantly from each other and from 0.

Root mean squared deviation between AG and IP midline

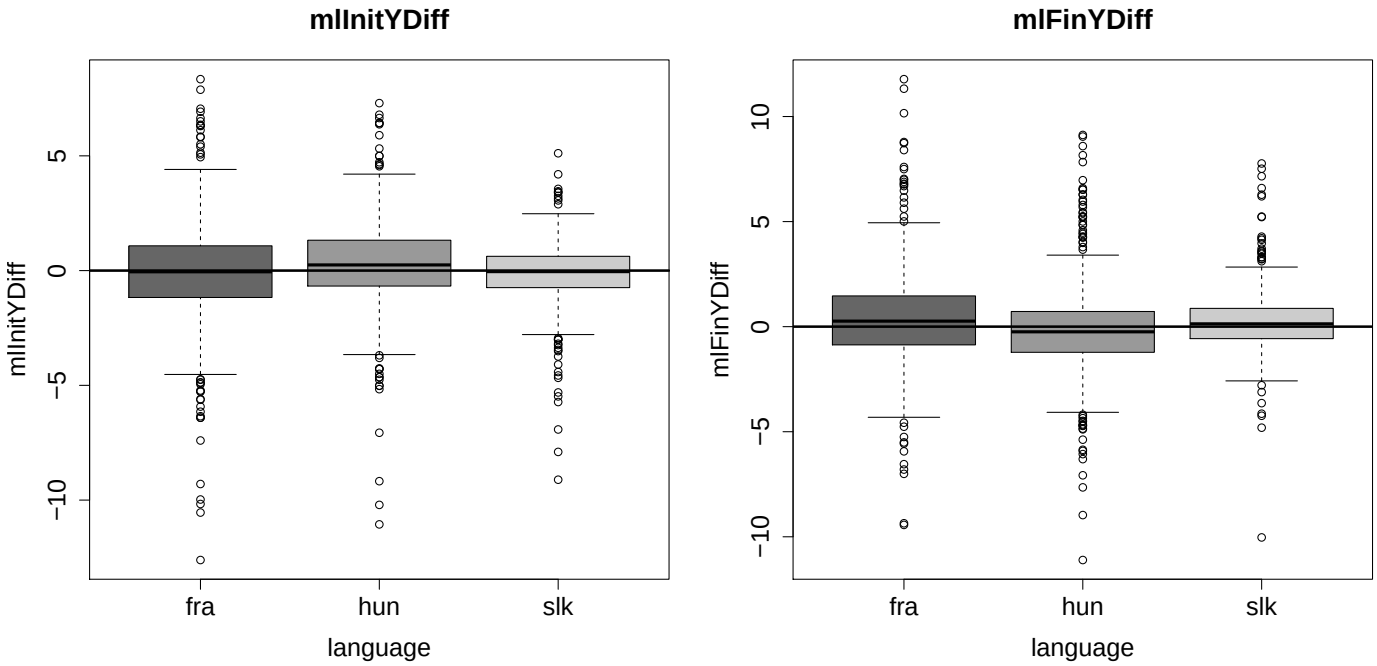
Similar to absolute midline slope difference, but also accounts for differences in pitch height (i.e. parallel lines).



French > Hungarian > Slovak. Languages differ significantly from each other and from 0.

AG-initial and final deviation from IP

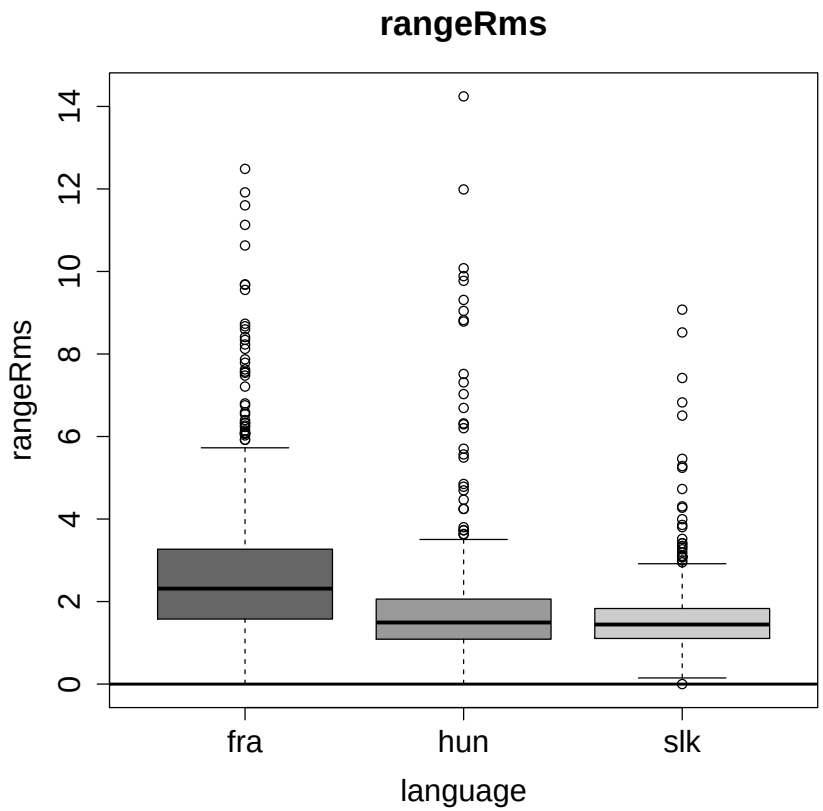
Initial and final AG F0 value compared to the corresponding IP value. Positive: higher AG F0, negative: lower AG F0, 0: identical values.



Phrase-initial F0 is significantly higher than 0 in Hungarian, but not in French and Slovak ($p > 0.2$ for both). Phrase-final F0 is negative in Hungarian and positive in both French and Slovak (all differences from 0 are significant).

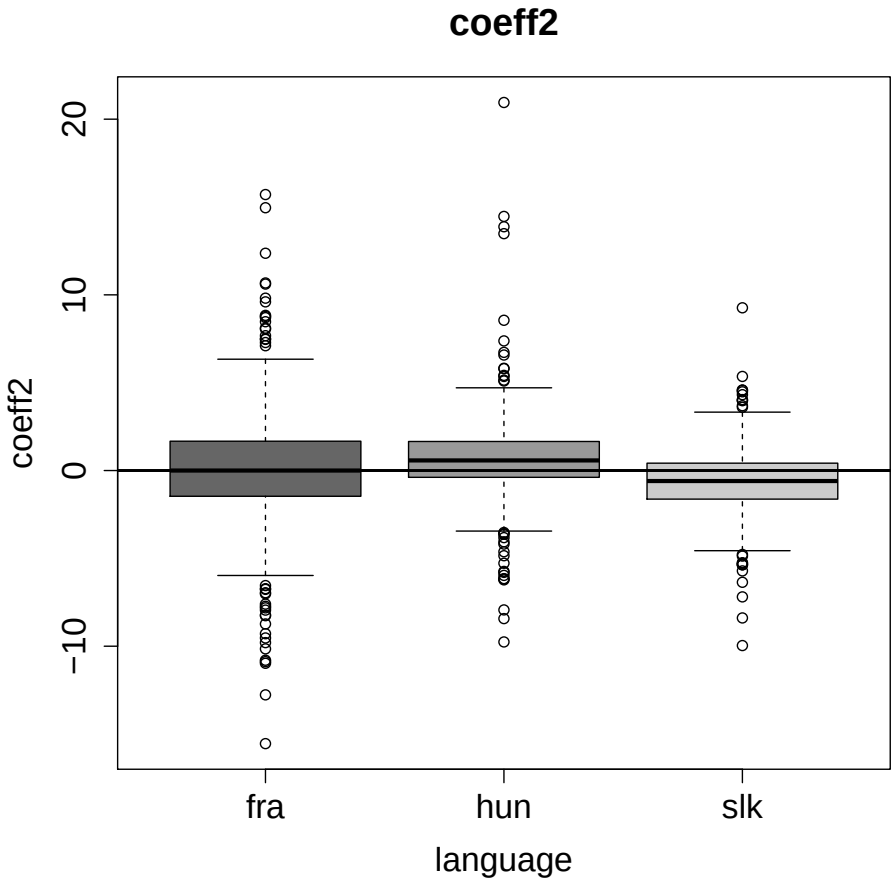
Root mean square between AG base- and topline

Pitch range as RMS:



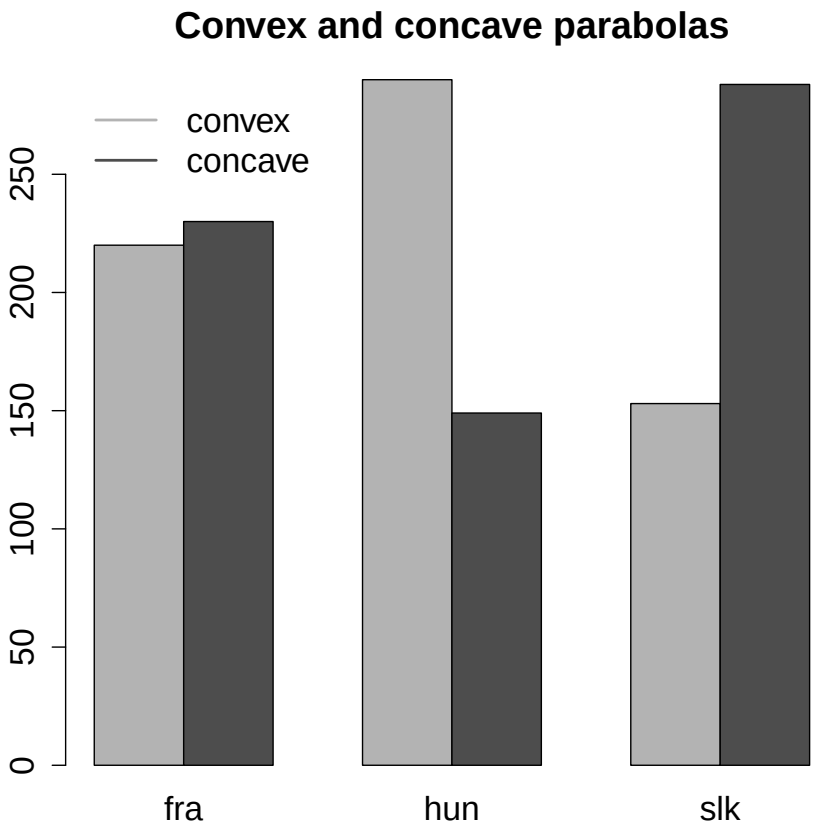
French > Hungarian > Slovak. All differences are significant.

Distribution of the quadratic coefficient c_2



Negative coefficients for Slovak → rising-falling (concave) pattern.
Positive coefficients for Hungarian → falling-rising or falling pattern.
Coefficients around 0 for French → no clear tendency.

Occurrence of convex and concave parabolas



More concave (rising-falling) patterns in Slovak and convex (falling-rising) patterns in Hungarian. No clear tendency for French.

Discussion

- AG contours are typically rising in French, falling in Hungarian, and rising-falling in Slovak.
- The mean quadratic coefficient c_2 is negative for Slovak, positive for Hungarian and around 0 for French $\rightarrow$ French contours do not have a parabolic shape.
- Slovak c_2 negative $\longrightarrow$ concave contour.
- AG-initial F0 is higher and AG-final F0 is lower than the IP in Hungarian, but the same tendency was not found for French or Slovak.
- Pitch range is considerably higher in French than in Hungarian or Slovak.
- $\Rightarrow$ Not each measure is equally relevant for each language.

Conclusions

1. Accent groups have a consistent pattern in all three languages → argument for the presence of accentual phrases.
2. Relevance for Hungarian and Slovak: an accent always starts a new prosodic unit → a prosodic unit always has phrase-initial emphasis.
3. Phrase boundaries enhance the perception of emphasis on the following word in Hungarian and Slovak and on the previous word in French.
4. A trade-off in marking emphasis? Accents are not necessarily marked by large pitch change (F0 maximum and range), but by the presence of a boundary.

Future research

- Phrase-initial low target in Slovak and high target in Hungarian: pitch accent or boundary tone? Shape of pitch accents?
- What other functions apart from prosodic phrasing do APs have? Semantic or pragmatic meaning, syntactic structuring?

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