The intonational realization of stress in Udmurt

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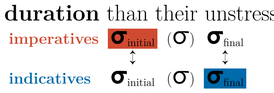
Introduction

Object of study
Prosodic realization of stress in Udmurt (Uralic, Permic), in the context of minimal pairs consisting of:
indicative verbs (PRS.3SG) final stress
imperative verbs (IMP.2SG/PL) initial stress

Background
Udmurt has fixed **final** stress; there are morphologically-motivated exceptions with **initial** stress: imperative and negated indicative verbs, reduplicated adjectives, etc. (Yemelyanov 1927; GSUJa I 1962; Denisov 1980; Winkler 2001).

Existing experimental results (Denisov 1980):
- **f_0** and **intensity** results seemed inconsistent between di- and trisyllables
- in minimal pairs of indicative and imperative verbs, stressed vowels had **greater duration** than their unstressed counterparts:



NB: items uttered in isolation; 2 speakers; no statistical analysis

Preview of the results
- Both stress contexts are reliably cued by alignment with tonal targets:
  - indicatives carry H* or (H+)L* on the final syllable
  - imperatives carry H* on the initial syllable
- **Initial** stress is cued by **vowel duration** and vowel quality (only for some vowels)
- **Final** stress is cued by **vowel quality**, but not consistently by vowel duration
- Individual speakers may preferentially rely on a **subset** of these acoustic parameters to cue stress

Experimental design & setup

- String-identical **minimal pairs** formed by **indicative** and **imperative** verbs
  - di- and trisyllabic
  - CV syllables
  - vowel height: low, mid, and mixed high/mid (for morphological reasons)
  - information structure: focused (F) vs. non-focused (non-F) (Roettger & Gordon 2017):

    I [Foc ***vàla*** / ***valà***] word said, but ***gàža*** / ***gažà*** word didn't. [F]
    I ***vàla*** / ***valà*** word [Foc quietly] said, but loudly didn't. [non-F]

  - total n=172
  - all items collected from a dictionary and checked by a native speaker who did not participate in the experiment
- Recordings were made in a quiet room with a head-worn microphone
- Target sentences were displayed on the screen one at a time; imperatives were marked with an exclamation mark
- 6 native speakers (5 f, 1 m; age range 20–40)

Processing
- The sound files were manually annotated in Praat (Boersma & Weenink 2021)
- Duration and formant values were measured for each vowel
- f_0 measurements were made at 10 fixed points per vowel (Xu 2013)
- Statistical analysis was carried out using the `lmer` (Bates et al. 2015) and `lmertest` (Kuznetsova et al. 2017) packages in R (R Core Team 2020)

Discussion

Main conclusions
- Vowel duration systematically cues **initial** but not **final** stress
- Vowel quality (F1 and/or F2 values) consistently cues **final**, and, to some extent, **initial** stress
- Both **initial** and **final** stress is aligned with f_0 targets
- The tonal realization of indicatives is more **varied** than that of imperatives
- **Individual speakers** differed with respect to the cues they mainly relied on:

	word-level stress		**f_0 in IS contexts**
	duration	vowel quality	
Speaker 5	✓	✗	✗ (F/non-F)
Speaker 6	✗	✓	✓ (F)

Implications
◆ In a single language, different stress loci may be marked by different cues
◆ Speakers may use different acoustic cues to mark a single phonological category (stress) → implications for the phonetics-phonology interface and processing of stress (Honbolygó et al. 2017)

Selected references:
Denisov, V. 1980. *Foneticheskaja xarakteristika udarenija v sovremennom udmurtskom jazyke*, Leningrad University dissertation. • GSUJa I. 1962. *Grammatika sovremennogo udmurtskogo yazyka. I. Fonetika i morfologija*, Izhevsk: Udmurtia. • Honbolygó, F., O. Kolozsvári & V. Csépe. 2017. Processing of word stress related acoustic information: A multi-feature MMN study. *International Journal of Psychophysiology* 118, 9-17. • Roettger, T. & Gordon, M. 2017. Methodological issues in the study of word stress correlates. *Linguistics Vanguard* 3(1), 1-11.

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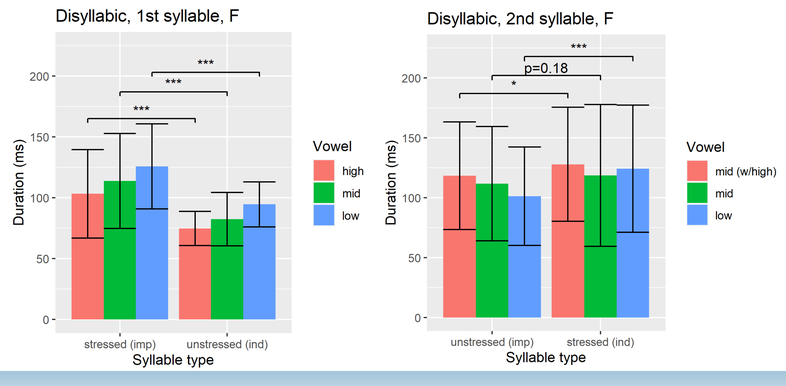
Results

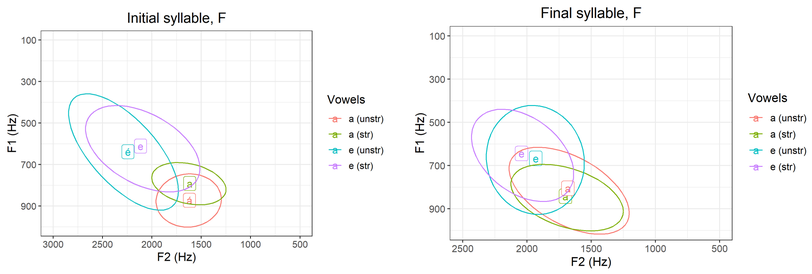
① vowel duration

- **Initial** stress is systematically cued by vowel duration
- **Final** stress is less so



② vowel quality

- Stressed and unstressed **/a/** systematically differ in **F1** values (p<0.001***, both in initial and final syllables)
- Stressed and unstressed **/e/** systematically differ in **F1** and **F2** values (p<0.01** and p<0.001***, respectively) when final, but not when initial



③ f_0

- **Imperatives** carry **H*** on the initial syllable (delayed till the juncture with the second syllable)
- **Indicatives** carry **(H+)L*** or **H*** on the final syllable
- Focused contexts have **higher overall f_0** values