φ-formation, stress, and the alignment of rising pitch accents in Iron Ossetic

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In a nutshell

We provide an Autosegmental-Metrical analysis of the patterns of **acoustic marking of Phonological Phrases** (*φ*s) in **Iron Ossetic**, an understudied East Iranian language of North Ossetia, Russia:

- Iron Ossetic consistently marks **left *φ*-edges** with **stress-aligned rising pitch accents**.
- The **distribution** of pitch accents, which we label L*+H and L+H*, depends on the **moraic structure** of the stressed syllable.
- We propose a monostratal **Optimality Theory account** for these facts by extending the existing analyses of rising pitch accents [1], [2].

Background

- **Existing descriptions**: word stress in Iron Ossetic targets the **1st or 2nd syllable** – the so-called '**stress window**' [3], [4].

- Stress placement is determined by vowel quality:
  - '**strong**' vowels, S: /a, e, i, o, u/
  - '**weak**' vowels, W: /ɐ, ə/
  - Stress falls on the **1st syllable** if it has a **strong** vowel and on the **2nd syllable** otherwise:

ŚS, ŚW; WŚ, WẂ

- Also, traditional descriptions emphasize that:
  - **nominal phrases** of any size form **'prosodic groups'**
  - within a 'prosodic group', only the **leftmost word is stressed**, regardless of its syntactic role.

- The rules of 'prosodic group'-formation and marking have not been tested instrumentally, nor provided with a theoretical analysis

Methods

Two **production studies**:

1. 13 speakers (8M, 5F, 20-60 y.o.) were recorded producing **WẂ** and **ŚW** stimuli. The study was run in Vladikavkaz (North Ossetia, Russia) in 2019, as part of an exploratory study on the prosody of Iron Ossetic.
2. 13 speakers (3M, 10F, 20-65 y.o.) were recorded producing **ŚS**, **WŚ**, and some **WŚ** stimuli. The study was run in Vladikavkaz in 2021.

The recordings were manually annotated in Praat, following the segmentation guidelines in [5].

Stimuli

•Stimuli (total for both studies): **36 nominal phrases** of the four stress window types (**ŚS** = 9; **ŚW** = 8; **WẂ** = 9: **WŚ** = 10).

•Nominal phrases: a **noun** + **1~3 modifiers** (adjectives, demonstratives, numerals, and possessive clitics).

(1) a. *gobi* *iron* *bogal* **ŚS**
mute iron wrestler
'a mute Iron wrestler'

b. *dəwwɐ* *lɐgwən* *gɐdəj-ə* **WẂ**
two bald cat-NUM
'two bald cats'

•Nominal phrases acted as **subjects** or **objects** in pre-constructed **SOV** clauses.

•Subsequent analysis: no significant tonal differences between the realizations of subjects and objects ⇒ **subjects** and **objects** considered together.

Results and Discussion

- Nominal phrases **of all sizes** map onto single *φ*s.
- **Signature property** of a *φ:* a single **rising pitch accent**, realized on the **leftmost** prosodic word.
- The **distribution** of pitch accents tracks the size of *φ*s ⇒ an instrumental validation to the existing descriptions.
- Pitch accents consist of two tonal targets: **L & H**.
- In all stress windows types, the **post-tonic syllable** carries a **rise in F0**.
- The tonal realization of the **stressed syllable varies** by stress-window type.
- If the stressed syllable is **final**, the rise is on the initial syllable of the **next prosodic word**.

ŚS & ŚW stress windows

- **ŚS & ŚW**: the stressed syllable may also carry a **rise** in F0 ⇒ a **continuous rise** throughout the stressed and post-tonic syllables. We label this pitch accent **L+H***.
- Alternatively, the stressed syllable may be **low and flat**. We label this pitch accent **L*+H**.

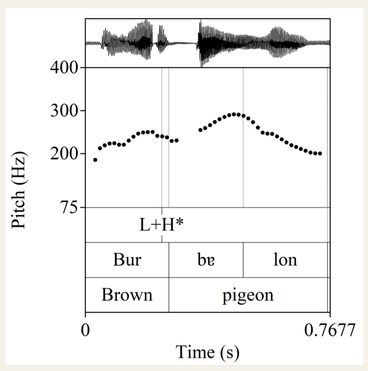

Fig. 1: A ŚW stress window with L+H*

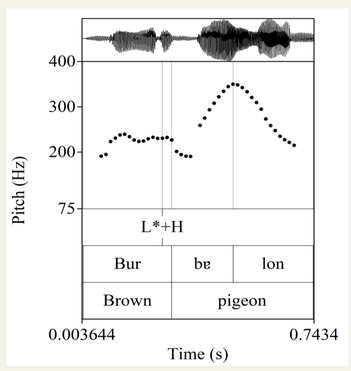

Fig. 2: A ŚW stress window with L*+H

WŚ stress windows

- **Similarly, WŚ** stress windows can also carry **L+H*** or **L+H***.

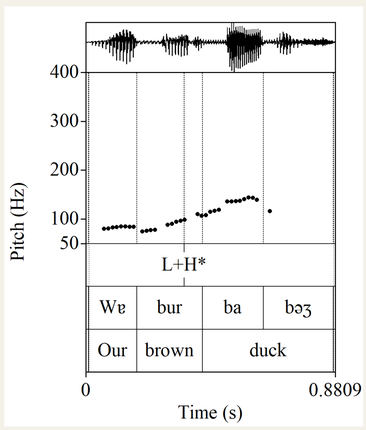

Fig. 3: A WŚ stress window with L+H*

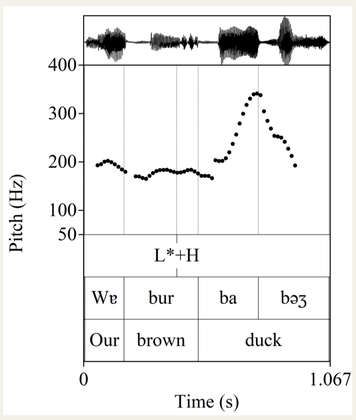

Fig. 4: A WŚ stress window with L*+H

WẂ stress windows

- In contrast, in **WẂ** stress windows, the stressed syllable carries a **low flat contour**, followed by a rise on the post-tonic syllable: the **L*+H** pitch accent.

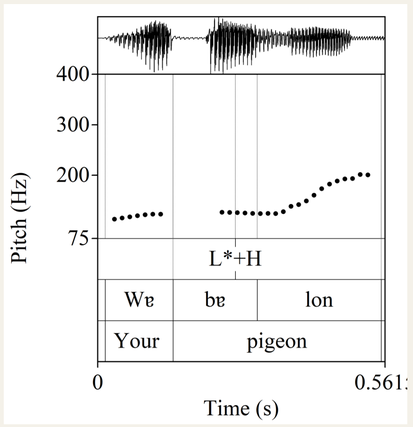

Fig. 4: A WẂ stress window

OT Analysis

- We propose two groups of constraints: (i) those that ensure the correct metrical parsing of a word, and (ii) those that derive the correct alignment of the tones.

Parsing into Feet and Placing the Stress

- Strong vowels are bi-moraic (Ś = μμ), and weak vowels are monomoraic (Ẃ = μ).
- Iron Ossetic has binary iambic feet, under a moraic analysis; unfooted vowels, both strong and week, are non-moraic.
- The constraints that ensure the correct parsing are given in (2).

(2) a. FT-FORM=I
The foot type is iambic.

b. FT-BIN
Feet are binary (under a moraic analysis).

c. ALIGN-FT-L
Feet are aligned with the left edge of a prosodic word.

d. PARSE-SYLL
All syllables should be contained in a foot.

	FT-FORM=I	ALIGN-FT-L	FT-BIN	PARSE-SYLL
☞ (Ś)S				*
(SŚ)			*!	
(ŚS)	*!		*	
S(Ś)		*!		*
☞(Ś)W				*
(SẂ)			*!	
(ŚW)	*!		*	
S(Ẃ)		*!	*	*
(Ẃ)W			*!	*
☞ (WẂ)				
(ẂW)	*!			
W(Ẃ)		*!	*	*
(Ẃ)S			*	*!
☞ (WŚ)			*	
(ẂS)	*!		*	
W(Ś)		!*		*

Tonal alignment

- To ensure the correct tone alignment, we adopt the following constraints [2], [6]:

(3) a. *CONTOUR(μ)
No mora can be associated with more than one tone.

b. μ → T
No mora can be tone-less.

c. *H(μ)
A high tone cannot be realized on one mora.

- The winning candidate among the tied winners in Ś = μμ is determined based on an additional criterion (e.g., a discourse-related one).

μ, LH	*CONTOUR(*μ*)	*μ* → T	*H(*μ*)
☞ L H (μ σ)			
L H (μ σ)	*!		*
L H (μ σ)		*!	
μμ, LH	*CONTOUR(*μ*)	*μ* → T	*H(*μ*)
L H (μ μ) σ		*!	
L H (μ μ) σ			*!
☞ L H (μ μ) σ			
☞ L H (μ μ) σ			

References: **[1]** P. Prieto, M. d'Imperio, and B. G. Fivela, "Pitch accent alignment in Romance: primary and secondary associations with metrical structure," *Language and speech*, vol. 48, no. 4, pp. 359–396, 2005. **[2]** B. Köhnlein, "Contrastive foot structure in Franconian tone-accent dialects," *Phonology*, vol. 33, no. 1, pp. 87–123, 2016. **[3]** N. K. Bagaev, *Sovremennyj osetinskij jazyk (fonetika i morfologija)*, vol. 1. Orjonikidze: North-Ossetian Publishing, 1965. **[4]** M. I. Isaev, *Očerk fonetiki osetinskogo literaturnogo jazyka.* Orjonikidze: North-Ossetian Publishing, 1959. **[5]** P. Machač and R. Skarnitzl, *Principles of phonetic segmentation*. Praha: Epocha, 2009. **[6]** L. S. Bickmore, "High tone spread in Ekegusii revisited: An optimality theoretic account," *Lingua*, vol. 109, no. 2, pp. 109–153, 1999.