Mora count 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** (φs) in **Iron Ossetic**, an understudied East Iranian language of North Ossetia, Russia, and show that:

- 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** of these facts, by extending the existing analyses of rising pitch accents [1], [2].

Background on Iron Ossetic

- **Existing descriptions**: word stress 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

- Traditional descriptions also 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 **ŚW** 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

- Nominal phrases **of all sizes** map onto single φs.
- **Signature property** of a φ: a single **rising pitch accent**, realized on the **leftmost** prosodic word.
- The **distribution** of pitch accents tracks φ size ⇒ an instrumental validation of the existing descriptions.
- Pitch accents consist of two tonal targets: **L & H**.
- In all stress window 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** (within the same φ).

ŚS & ŚW stress windows

- **ŚS & ŚW**: in addition to the post-tonic syllable, the stressed syllable may also carry a **rise** in F0 ⇒ a **continuous rise** on the stressed and post-tonic syllables. We label this realization **L+H***.
- Alternatively, the stressed syllable may carry a **low flat contour**. We label this realization **L*+H**.

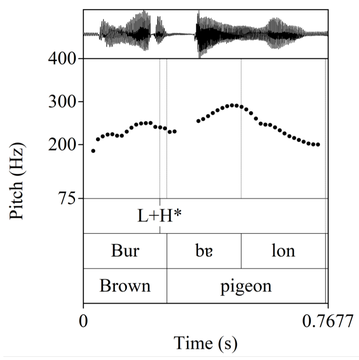

Fig. 1: A ŚW stress window with L+H*

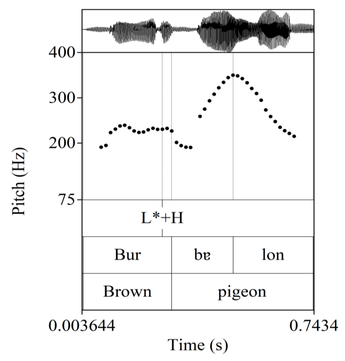

Fig. 2: A ŚW stress window with L*+H

WŚ stress windows

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

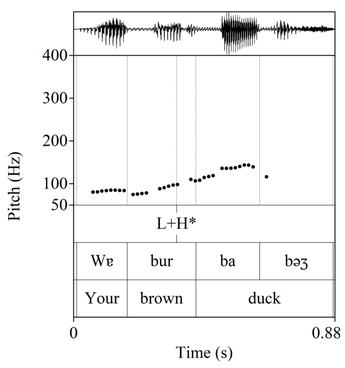

Fig. 3: A WŚ stress window with L+H*

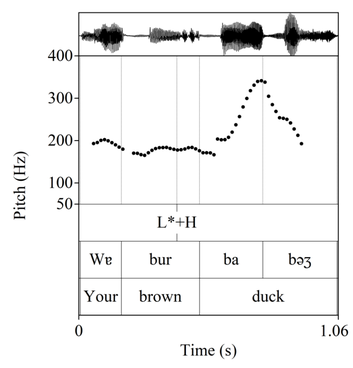

Fig. 4: A WŚ stress window with L*+H

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.

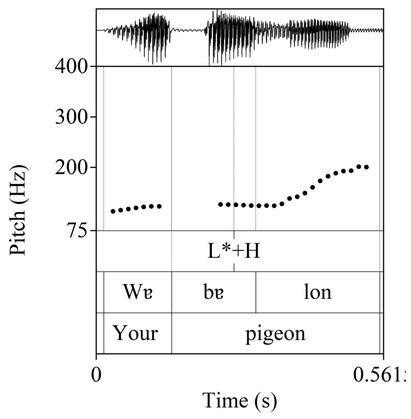

Fig. 4: A WẂ stress window

Stress placement

- Strong vowels are bimoraic (S = $\mu\mu$), and weak vowels are monomoraic (W = μ);
- Feet are iambic and binary in terms of mora count.

Constraints:

(2) a. ALIGN-FT-L
Feet align with left edges of prosodic words.

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

c. PARSE-SYLL
All syllables are contained in a foot.

d. FT-FORM=I
The foot type is iambic.

	ALIGN-FT-L	FT-BIN	PARSE-SYLL	FT-FORM=I
a. ☞ (Ś$_{\mu\mu}$)S$_{\mu\mu}$			*	
b. (S$_{\mu\mu}$Ś$_{\mu\mu}$)		*!		
c. (Ś$_{\mu\mu}$S$_{\mu\mu}$)		*!		*
d. S$_{\mu\mu}$(Ś$_{\mu\mu}$)	*!		*	
a. ☞ (Ś$_{\mu\mu}$)W$_{\mu}$			*	
b. (S$_{\mu\mu}$Ẃ$_{\mu}$)		*!		
c. (Ś$_{\mu\mu}$W$_{\mu}$)		*!		*
d. S$_{\mu\mu}$(Ẃ$_{\mu}$)	*!	*	*	
a. ☞ (W$_{\mu}$Ẃ$_{\mu}$)				
b. (Ẃ$_{\mu}$W$_{\mu}$)				*!
c. (Ẃ$_{\mu}$)W$_{\mu}$		*!	*	
d. W$_{\mu}$(Ẃ$_{\mu}$)	*!	*	*	
a. ☞ (W$_{\mu}$Ś$_{\mu\mu}$)		*		
b. (Ẃ$_{\mu}$)S$_{\mu\mu}$		*	*!	
c. (Ẃ$_{\mu}$S$_{\mu\mu}$)		*		*!
d. W$_{\mu}$(Ś$_{\mu\mu}$)	*!		*	

Tonal alignment

Constraints:

(3) a. ALIGN-L(T, $\acute{\sigma}$)
Align the left edge of the pitch accent with the left edge of the stressed syllable.

b. ALIGN-L($\acute{\sigma}$, T)
Align the left edge of the stressed syllable with the left edge of the pitch accent.

c. *CONTOUR(μ) [2]
No mora carries more than one tone.

d. $\mu_{Ft} \rightarrow$ T [2]
No mora within the foot can be tone-less.

e. *H(μ_{Ft}) [6]
A high tone cannot be realized on one mora (within the foot).

- The winning candidate among the tied winners in the **ŚS/ŚW** and **WŚ** tableaux is determined based on an additional criterion (e.g., a discourse-related one).

	(μ.$\mu\mu$.), LH	ALIGN(T, $\acute{\sigma}$)	ALIGN($\acute{\sigma}$, T)	$\mu_{Ft} \rightarrow$ T	*CONTOUR(μ)	*H(μ_{Ft})
WẂ	☞ a. (μ. $\acute{\mu\mu}$.) σ (L H)			*		
	b. (μ. $\acute{\mu\mu}$.) σ (L H)			*	*!	*
	c. ($\acute{\mu}$. $\mu\mu$.) σ (L H)	*	*!			*

	($\mu\mu$.)$\mu\mu$, LH	ALIGN(T, $\acute{\sigma}$)	ALIGN($\acute{\sigma}$, T)	$\mu_{Ft} \rightarrow$ T	*CONTOUR(μ)	*H(μ_{Ft})
ŚW / ŚS	☞ a. ($\acute{\mu}$ μ.) μ μ (L H)					
	☞ b. ($\grave{\mu}$ $\acute{\mu}$.) μ μ (L H)					
	c. ($\acute{\mu}$ μ.) μ μ (L H)					*!

	(μ.$\mu\mu$) LH	ALIGN(T, $\acute{\sigma}$)	ALIGN($\acute{\sigma}$, T)	$\mu_{Ft} \rightarrow$ T	*CONTOUR(μ)	*H(μ_{Ft})
WŚ	☞ a. (μ. $\acute{\mu}$ $\acute{\mu}$.) σ (L H)			*		
	☞ b. (μ. $\acute{\mu}$ $\acute{\mu}$.) σ (L H)			*		
	c. ($\grave{\mu}$. $\acute{\mu}$ $\acute{\mu}$.) σ (L H)	*!	*			

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