Mora count and the alignment of rising pitch accents in Iron Ossetic*

Lena Borise[1], *David Erschler*[2]

[1]Hungarian Research Centre for Linguistics, Hungary
[2]Ben-Gurion University of the Negev, Israel
lena.borise@nytud.hu, erschler@bgu.ac.il

Abstract

Based on instrumental results, this paper provides an Autosegmental-Metrical analysis of the patterns of formation and acoustic marking of Phonological Phrases (*φ*s) in Iron Ossetic, an understudied East Iranian language of Russia. We demonstrate that (i) nominal phrases in Iron Ossetic correspond to *φ*s, (ii) left *φ*-edges are consistently marked with stress-aligned rising pitch accents, (iii) there are two distinct rising pitch accents, which we label L*+H and L+H*, and (iv) the anchoring of individual tones to metrical targets is determined by the moraic structure of the stressed syllable. We account for these facts by extending the analysis of rising pitch accents in Romance in [1] and the analysis of Franconian prosody in [2]. We argue that stressed vowels carry a rising pitch accent. Strong vowels are bi-moraic; when stressed, the two morae can either carry L and H (with H undergoing secondary association with the next syllable), producing L+H*, or both carry L, with H docking on the next syllable, producing L*+H. Mono-moraic stressed vowels can only host L, with H realized on the next syllable, producing L*+H. Our account, therefore, provides further support for the *contrastive metrical structure* approaches to tonal phenomena [2]–[6].

Index Terms: stress, pitch accent, alignment, mora count, Iron Ossetic, Iranian

1. Introduction

1.1. Rising accents in the Autosegmental-Metrical theory

The key insight of the Autosegmental-Metrical (AM) theory, one of the main approaches to the analysis of intonation, is that intonation can be described as a sequence of tonal targets, aligned with specific hosts in the prosodic structure [7]–[10]. The values of tonal targets are relative and can be high (H) or low (L). The tonal targets that align with stressed syllables are called pitch accents. They can be simple/mono-tonal (H*, L*) or complex/bi-tonal.

Within a complex pitch accent, the two tones are taken to be of unequal importance: the tone that is understood to be the main one is asterisked, with a leading or trailing tone preceding or following it (e.g., L+H*, L*+H). The relative importance of the two tones is decided based on which tone is more closely aligned with the stressed syllable itself, as opposed to its edges or preceding or following syllables [9]. (Deciding on which component of a bitonal pitch accent should be asterisked is sometimes non-trivial [11], especially in the face of cross-linguistic variation in tonal contours, but this issue is beyond the scope of the current paper.)

The analytical set-up of the AM theory leads to there being alignment-based contrasts between pitch accents. A canonical example is the contrast between L+H* and L*+H in English [12]–[15]. L+H*, with a rise on the stressed syllable preceded by a low tone on the pre-tonic syllable, conveys assertion and is commonly used to mark contrast. L*+H, with a low tone on the stressed syllable followed by a rise on the post-tonic syllable, conveys uncertainty or disapproval. The two pitch accents are, therefore, phonologically and pragmatically contrastive.

Alignment-based contrasts between pitch accents can be correlated with multiple factors. In Neapolitan Italian, different types of rising accents are found in different clause types: a combination of a low and a high tone (LH) with an early peak within a stressed syllable is characteristic of declaratives, and one with a later peak marks interrogatives [16]. In Peninsular Spanish, different rising pitch accents are found in different positions in the prosodic structure. In a prenuclear L*+H, often found in yes-no questions, the stressed syllable is low and flat, with a rise on the post-tonic syllable. In a prenuclear L*>+H, often found in broad focus contexts, the stressed syllable carries a rise, and the tonal peak is reached on the post-tonic syllable ('>' indicates a delayed peak). In a nuclear L+H*, the rise and peak are contained within the stressed syllable [1], [17], [18].

As these examples show, alignment-based contrasts between pitch accents can correspond to different kinds of linguistic contrasts: those that have to do with a pragmatic effect, clause type, or the position of an accent in a clause. In this paper, we show that the opposition between two kinds of rising pitch accents in Iron Ossetic is, at least in part, determined by yet another factor, the moraic structure of the stressed vowel.

1.2. Prosodic organization of Iron Ossetic

Iron Ossetic is an East Iranian language spoken in North Ossetia (Russia) and in South Ossetia, a breakaway part of Georgia. Phrasal prosody of the language has not been subject to a detailed theoretical investigation (though see [19] for some descriptive generalizations). The existing grammars of Iron Ossetic ascribe a prominent role to prosodic phrasing, which is closely connected with word stress, and its intonational rendition. Descriptively, the first and second syllables in a prosodic word in Iron Ossetic comprise the 'stress window' – i.e., the part of the word where stress might be assigned. The location of stress within the stress window is determined by vowel quality [20]–[22]. Iron Ossetic has 'strong' (S) and 'weak' (W) vowels: /*a, e, i, o, u*/ and /*ɐ, ə*/, respectively. Stress targets the initial syllable if the first vowel of the stress window is 'strong' (ŚS: *rálizən* 'to run away', *χábar* 'news'; ŚW: *rázmɐ* 'forward', *sólpə* 'ladle'), and the second syllable if the first vowel of the stress window is 'weak' (WẂ: *kɐʃtér* 'young', *ʃɐnákk* 'lamb'; WŚ: *bɐláʃ* 'tree', *χɐdón* 'shirt'). As an exception, personal names are uniformly stressed on the second syllable.[1]

In connected speech, stress is described as assigned and realized within 'prosodic groups': nominal phrases – as well as other smaller constituents, e.g., postpositional phrases, and certain more complex contexts that include the verb and preverbal constituents – as opposed to individual prosodic words. The stressed syllable is determined according to the same principles, described above. That is, within a 'prosodic group', only the stress on the leftmost word is intonationally expressed; other words are described as 'stressless' [20], [21], [24], [26], [27]. The rules of the formation of 'prosodic groups', detailed in the grammars, have not been tested instrumentally, nor provided with a theoretical analysis.

2. Methods

Our stimuli consisted of 36 nominal phrases of the four stress-window types (ŚS: n = 9; ŚW: n = 8; WẂ: n = 9: WŚ: n = 10), as illustrated in (1) (the vowels within the stress window are boldfaced). Each nominal phrase consisted of a noun preceded by one or more (up to three) modifiers (adjectives, demonstratives, numerals, and possessive clitics).

(1) a. *g**o**b**i*** *iron* *bogal* ŚS
mute Iron wrestler
'a mute Iron wrestler'

b. ***i**wɐ**n**dɐš* *rɐʁɐd* *banan-ə* ŚW
eleven ripe banana-NUM[2]
'eleven ripe bananas'

c. *d**ə**ww**ɐ*** *lɐgwən* *gɐdəj-ə* WẂ
two bald cat-NUM
'two bald cats'

d. *n**ə**v**o**ndag* *gal-ə* WŚ
sacrificial bull-ACC
'a sacrificial bull'

The nominal phrases acted as subjects or objects in pre-constructed SOV clauses (subsequent analysis revealed no significant tonal differences in the realization of subjects and objects; therefore, they are considered together in the remainder of the paper).

The data came from two production studies. During the first one, conducted in Vladikavkaz (North Ossetia, Russia) in 2019, as part of an exploratory study on the prosody of Iron Ossetic, 13 speakers (8M, 5F, 20-60 y.o.) were recorded producing the WẂ and ŚW stimuli. In an additional study, ran in Vladikavkaz in 2021, 13 speakers (3M, 10F female, 20-65 y.o.) were recorded producing ŚS, WŚ, and some additional ŚW stimuli. All speakers had a complete or in-progress university degree and came from North Ossetia. Only one of the speakers took part in both studies. During the recording sessions, the utterances were presented to participants one at a time on a computer screen. Participants were instructed to first familiarize themselves with the utterance and then pronounce it using natural intonation.

In total, 468 nominal phrases were recorded and analyzed. The recordings were manually annotated in Praat [28] by trained research assistants, following the segmentation guidelines in [29], and checked by the authors.

3. Results

Nominal phrases of all sizes (in our data, those consisting of a noun and up to three modifiers) map onto single *φ*s. This is the case for both subjects and objects in SOV clauses. The signature property of a *φ* is a single pitch accent, which is realized on the leftmost prosodic word of a *φ*. The distribution of pitch accents, therefore, allows for tracking the size of *φ*s; these results provide an instrumental validation to the existing descriptions of Iron Ossetic, as discussed in Section 1.2.

Pitch accents found in all stress-window types consist of two tonal targets, L and H. In all stress-window types, the post-tonic syllable is the locus of a rise and peak in F0. That is, when the first vowel is stressed (in ŚS and ŚW stress windows), the F0 peak is reached on the second syllable; when the second vowel is stressed (in WẂ and WŚ stress windows), the F0 peak is reached on the third syllable. If the stressed syllable is final in a prosodic word, the rise is found on the initial syllable of the next prosodic word, as long as the two words are part of the same *φ*. Mean F0 peak locations in the stress windows of the four types, time-normalized so that each syllable's duration equals 1, are provided in Table 1.

Table 1: *F0 peak location in time-normalized stress window types (1 = first syllable, 2 = second syllable).*

Stress window	mean F0 peak location
ŚS	1.77
ŚW	1.67
WŚ	2.74
WẂ	2.38

In ŚS and ŚW stress windows, where the stressed initial vowel is strong, the stressed syllable can have two different realizations. It may carry a rise in F0, which means that there is a continuous tonal rise throughout the stressed and post-tonic syllables, reaching its peak on the post-tonic syllable. We label this pitch accent L+H* (the reasons for using this label, which stem from the anchoring of the two tones, are provided in Section 4). Alternatively, the stressed syllable may receive a low and flat realization, with the F0 rise and peak contained within the post-tonic syllable. We label this pitch accent L*+H. The two realizations are illustrated in Figures 1 and 2, respectively, with the same ŚS example, ***we**'rm**a**χwər bɐlon* 'your (pl.) tame pigeon'. In Figure 1, the stressed syllable, ***we**'r*, carries a rise in F0; in Figure 2, it receives a flat realization. In both, the F0 peak is reached on the post-tonic syllable, ***ma**χ*. The two realizations are also obtained in ŚW examples; illustrations are omitted in the interest of space.

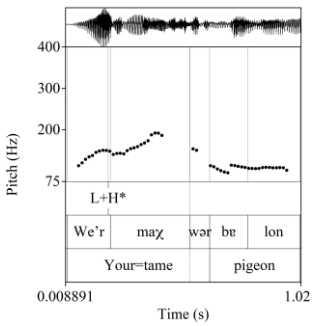

Figure 1: *A ŚS stress window, L+H**

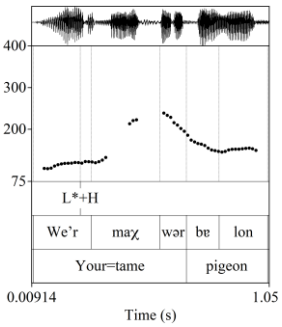

Figure 2: *A ŚS stress window, L*+H*

Similarly, we find that WŚ stress windows, with the stressed second vowel (strong), can also carry an L+H* or L*+H pitch accent. Here, the F0 peak is on the third syllable, and the stressed one can have two different realizations. They

are illustrated in Figures 3 and 4, respectively, with the example *wɐ* ***bu****r babəʒ* 'your (pl.) brown duck'. With the L+H* pitch accent in Figure 3, the stressed syllable, ***bur***, carries an F0 rise. With the L*+H pitch accent in Figure 4, ***bur*** has a flat levelled tone. In both cases, the F0 peak is on the post-tonic syllable, *ba*.

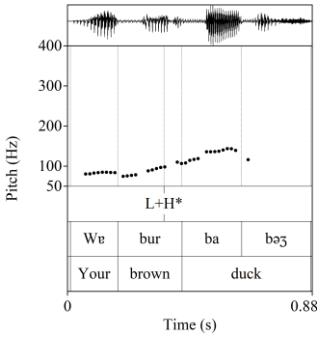

Figure 3: *A wś stress window, L+H**

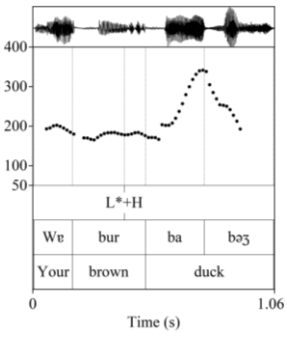

Figure 4: *A wś stress window, L*+H*

Finally, wẃ stress windows are the only context where the stressed vowel is weak, and only one of the pitch accents is attested for these contexts. In our wẃ examples, the rise on the post-tonic syllable is preceded by a low flat contour on the stressed syllable, which corresponds to the L*+H accent. This is illustrated in Figure 5 with *wɐ bɐlon* 'your (pl.) pigeon'.

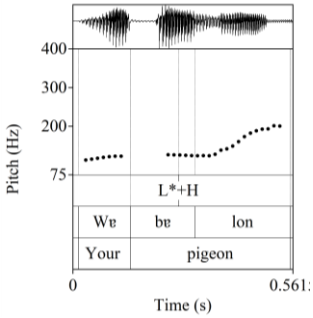

Figure 5: *A wẃ stress window, L*+H*

4. Optimality Theory account

To account for the distribution and alignment of pitch accents in Iron Ossetic, we offer an analysis couched in the classic (monostratal) Optimality Theory (OT) framework.

First, let us derive stress placement. We propose that strong vowels are bi-moraic (S = $\mu\mu$), and weak vowels are mono-moraic (W = μ) (cf. [30]). We also assume that Iron Ossetic has binary iambic feet, under a moraic analysis. This is enforced by constraints FT-BIN and FT-FORM=I [31], as defined in (2a-b). Parsing proceeds from left to right, which means that a foot can consist of a single strong vowel or two vowels if the vowel in the first syllable is weak. Feet are left-aligned in a prosodic word. This is enforced by constraints ALIGN-FT-L and PARSE-SYLL [32], as defined in (2c-d). The ranking is: ALIGN-FT-L >> FT-BIN >> PARSE-SYLL; FT-FORM=I is unranked with respect to the other constraints. The derivation of stress placement in the four stress-window types is provided in the tableaux in Table 2.

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

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

c. ALIGN-FT-L
Feet are aligned with left edges of prosodic words.

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

Table 2: *Tableaux deriving stress placement in śs, św, wẃ, and wś stress windows.*

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

With respect to tonal alignment, we propose that, if the stressed vowel is weak, as in wẃ contexts, the single mora that it contains carries L, and the post-tonic syllable carries a trailing tone H. This accounts for the low and flat F0 contour on the stressed weak vowel, and the F0 rise being confined to the post-tonic syllable, as in Figure 5. Accordingly, we label this pitch accent L*+H; the asterisk marks the tone realized on the stressed syllable.

In contrast, a strong stressed vowel contains two morae, which means that there are more possibilities for tonal alignment. When the stressed strong vowel has a flat contour and the post-tonic syllable carries a rise, as in Figures 2 and 4, we take it to be the L*+H accent. We propose that, in these cases, L is aligned with the first mora of the stressed vowel and undergoes secondary association [1] with the second mora, while H docks on the post-tonic syllable. The other attested realization of strong stressed vowels is a continuous F0 rise throughout the stressed and post-tonic syllables, as in Figures 1 and 3. Here, we propose, only the first mora of the stressed vowel carries L, and the second one carries H. H also undergoes secondary association to the post-tonic syllable, which accounts for the further rise in F0 on the post-tonic syllable. We label this pitch accent L+H*, to reflect the presence of the high tone on the stressed syllable. [3]

Our OT account of tonal alignment is the following. Within a φ, the position of the word in which stress is intonationally realized (i.e., leftmost) is derived by a high-ranking constraint ALIGN-L(HD-PRWD, φ) [31], not shown in the tableaux. The alignment of the LH tonal contour with the stressed syllable is derived by ALIGN-L(T, $\acute{\sigma}$) and ALIGN-L($\acute{\sigma}$, T), (3a-b). The anchoring of the pitch accent tones, L and H, obeys the constraints $\mu_{Ft} \rightarrow$ T and *CONTOUR(μ), as defined in (3c-d), [2]. Because high tones in Iron Ossetic are rises, we

assume that a high tone cannot be realized on a single mora, which is enforced by the constraint *H(μ_{Ft}), (3e) [33]. Note that *H(μ_{Ft}) in Iron Ossetic, as far as we can tell, only applies to the morae contained within the foot. The ranking is ALIGN-L(T, $\acute{\sigma}$), ALIGN-L($\acute{\sigma}$, T) >> *CONTOUR(μ), $\mu_{Ft} \rightarrow$ T, *H(μ_{Ft}).

(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. $\mu_{Ft} \rightarrow$ T
No mora within the foot can be tone-less.

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

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

Table 3 derives the anchoring of L and H in the simplest context, WẂ, which can only carry L*+H. Here, (*μ.**μ***.) refers to the two weak vowels in the foot, each containing a mora. The morae corresponding to the stressed syllable are boldfaced, and *σ* represents the following syllable.

Table 3: *Pitch accent placement in WẂ stress windows*

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

Table 4 derives pitch accent placement in ŚS stress windows; the moraic content of ŚS is rendered as (***μμ***.)*μμ*. The two winners correspond to L+H* and L*+H, respectively. In L+H*, H undergoes secondary association with the post-tonic syllable. In L*+H, L undergoes secondary association with the second mora of the stressed vowel. The choice of an accent in a given situation is determined by other, possibly pragmatic factors. Note that ŚW stress windows work in a similar way, except that the moraic input in this case is (***μμ***.)*μ*.

Table 4: *Pitch accent placement in ŚS stress windows*

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

Table 5 derives pitch accent placement in WŚ contexts, represented as (*μ.**μμ***). Like in Table 4, there are two winners.

Table 5: *Pitch accent placement in WŚ stress windows*

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

5. Discussion and conclusions

Our results show that (i) Iron Ossetic consistently maps nominal phrases onto *φ*s and (ii) left *φ*-edges are marked with stress-aligned rising pitch accents. This confirms the observation made in the grammars that 'stress' in Iron Ossetic is only realized on the first word of a 'prosodic group'. We propose an OT account of stress distribution, based on the idea that Iron Ossetic has binary iambic feet, under a moraic analysis, and strong and weak vowels contain two and one morae, respectively.

The results further show that (iii) Iron Ossetic has two types of stress-aligned rising pitch accents, which we label L*+H and L+H*. In our OT analysis, we demonstrate that (iv) the anchoring of individual tones to metrical targets is determined by the moraic structure of the stressed syllable. Weak stressed vowels can only carry L*+H. The single mora of the vowel houses L, and H is realized on the subsequent syllable. This results in a flat low tone on the stressed vowel, followed by a rise on the post-tonic one. When a L*+H pitch accent is realized on a bi-moraic stressed vowel, L aligns with the first mora and undergoes secondary association with the second mora of the stressed vowel. In the L+H* accent, which only anchors to strong stressed vowels, the two morae of the stressed vowel house L and H, respectively, and H undergoes secondary association with the following syllable. This tonal alignment results in a rising contour spanning the stressed and post-tonic syllables.

On the theoretical front, our account of the Iron Ossetic facts makes two contributions. First, it contributes to the growing typology of rising pitch accents and demonstrates that the anchoring of the individual tones in different kinds of rising pitch accents may be determined by the moraic weight of the stressed vowel. Second, it provides further support for the so-called *contrastive metrical structure* approaches to tonal phenomena: approaches that derive tonal contrasts from metrical contrasts like mora/syllable count, as opposed e.g., storing tone shapes in the lexicon [2]–[6].

6. Acknowledgements

We are grateful to Andzhela Kudzoeva, Ruslan Bzarov, Rustem Fidarov, and Tsara Dzhanaev for their help in organizing the recordings in Vladikavkaz, and to Andzhela Kudzoeva and Tsara Dzhanaev for the help with preparing the stimuli. We thank the speakers of Iron Ossetic who participated in our study. For feedback, we thank Irina Burukina, Marcel den Dikken, Gorka Elordieta, Katalin É. Kiss, Aleksei Nazarov, Xico Torres-Tamarit, and three anonymous reviewers. This project was supported by the Hungarian Scientific Research Fund's grants NKFIH KKP-129921 and NKFIH K-135958. All remaining errors are our responsibility.

7. References

[1] P. Prieto, M. d'Imperio, and B. Gili 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] M. Hammond, N. Warner, A. Davis, A. Carnie, D. Archangeli, and M. Fisher, "Vowel insertion in Scottish Gaelic," *Phonology*, vol. 31, no. 1, pp. 123–153, 2014.

[4] B. T. Morén-Duolljá, "The prosody of Swedish underived nouns: No lexical tones required," 2013.

[5] P. Iosad, "'Pitch accent' and prosodic structure in Scottish Gaelic: reassessing the role of contact," in *New trends in Nordic and general linguistics*, De Gruyter, 2015, pp. 28–54.

[6] P. Iosad, "Prosodic structure and suprasegmental features," *The Journal of Comparative Germanic Linguistics*, vol. 19, no. 3, pp. 221–268, 2016.

[7] M. Y. Liberman, "The intonational system of English," PhD Dissertation, MIT, 1975.

[8] G. Bruce, "Swedish word accents in sentence perspective," PhD Dissertation, Lund University, 1977.

[9] J. Pierrehumbert, "The phonetics and phonology of English intonation," PhD Dissertation, MIT, 1980.

[10] J. B. Pierrehumbert and M. Beckman, *Japanese tone structure*. Cambridge, MA: MIT Press, 1988.

[11] M. Grice, *The intonation of Palermo Italian: implications for intonation theory*. Tübingen: Niemeyer, 1995.

[12] J. B. Pierrehumbert and S. A. Steele, "Categories of tonal alignment in English," *Phonetica*, vol. 46, no. 4, pp. 181–196, 1989.

[13] G. Ward and J. Hirschberg, "Implicating uncertainty: The pragmatics of fall-rise intonation," *Language*, pp. 747–776, 1985.

[14] J. Hirschberg and G. Ward, "The influence of pitch range, duration, amplitude and spectral features on the interpretation of the rise-fall-rise intonation contour in English," *Journal of phonetics*, vol. 20, no. 2, pp. 241–251, 1992.

[15] N. Veilleux, S. Shattuck-Hufnagel, and A. Brugos, "6.911 Transcribing Prosodic Structure of Spoken Utterances with ToBI. January IAP 2006. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.," 2006.

[16] M. D'Imperio, "The role of perception in defining tonal targets and their alignment," PhD Thesis, The Ohio State University, 2000.

[17] E. Estebas-Vilaplana and P. Prieto, "Castilian Spanish Intonation," in *Transcription of intonation of the Spanish language*, P. Prieto and P. Roseano, Eds. Munich: Lincom Europa, 2010, pp. 17–48.

[18] J. I. Hualde and P. Prieto, "Intonational variation in Spanish: European and American varieties," in *Prosody in Romance*, S. Frota and P. Prieto, Eds. Oxford; New York: Oxford University Press, 2015, pp. 350–391.

[19] V. T. Dzakhova, "Realizacija slovesnogo udarenija vo fraze (na materiale analiza prostyx povestvovatel'nyx predloženij osetinskogo jazyka) [The realization of word stress in a phrase (based on the analysis of simple declarative clauses in Ossetic)]," *Vestnik Kalmyckogo Universiteta*, vol. 4, no. 24, pp. 31–40, 2014.

[20] N. K. Bagaev, *Sovremennyj osetinskij jazyk (fonetika i morfologija) [The contemporary Ossetic Language (phonetics and morphology)]*, vol. 1. Orjonikidze: North-Ossetian Publishing, 1965.

[21] M. I. Isaev, *Očerk fonetiki osetinskogo literaturnogo jazyka [Studies in the phonetics of the literary Ossetic language]*. Orjonikidze: North-Ossetian Publishing, 1959.

[22] V. T. Dzakhova, "Ob osetinskom udarenii [On Ossetic stress]," *Vestnik Rossijskogo Gosudarstvennogo Gumanitarnogo Universiteta*, vol. 9, pp. 9–26, 2010.

[23] M. I. Isaev, *Digorskij dialekt osetinskogo jazyka [The Digor dialect of the Ossetic language]*. Moscow: Nauka, 1966.

[24] V. I. Abaev, *Iz osetinskogo èposa: 10 nartovskix skazanij [From Ossetian epos: 10 Nart legends]*. Leningrad: USSR Academy of Sciences, 1939.

[25] V. I. Abaev, *Osetinskij jazyk i fol'klor [Ossetic language and folklore]*, vol. 1. Moscow, Leningrad: USSR Academy of Sciences, 1949.

[26] V. I. Abaev, "Ob udarenii v osetinskom jazyke [On stress in the Ossetic language]," *Doklady Akademii Nauk, Serija B [Reports of the Academy of Sciences, Series B], (oktjabr'-dekabr')*, pp. 152–155, 1924.

[27] D. Testen, "Ossetic Phonology," in *Phonologies of Asia and Africa (Including the Caucasus)*, vol. 2, A. S. Kaye and P. T. Daniels, Eds. Winona Lake, IN: Eisenbrauns, 1997, pp. 707–731.

[28] P. Boersma and D. Weenink, *Praat: doing phonetics by computer [Computer program]*. 2021. Accessed: Mar. 25, 2021. [Online]. Available: http://www.praat.org/

[29] P. Machač and R. Skarnitzl, *Principles of phonetic segmentation*. Praha: Epocha, 2009.

[30] P. Ladefoged, *A course in phonetics*, 3rd ed. New York: Harcourt Brace Javanovich, 1993.

[31] A. Prince and P. Smolensky, "Optimality Theory: Constraint interaction in generative grammar," Rutgers University Center for Cognitive Science, Technical report 2, 1993.

[32] J. J. McCarthy and A. Prince, "Generalized alignment," in *Yearbook of Morphology 1993*, Springer, 1993, pp. 79–153.

[33] L. S. Bickmore, "High tone spread in Ekegusii revisited: An optimality theoretic account," *Lingua*, vol. 109, no. 2, pp. 109–153, 1999.

---

[*] This is an amended version of the Speech Prosody 2022 proceedings paper, with the constraint ranking in the tableaux in Table 2 revised.

[1] Some cases of unexpected initial stress have historically had an initial /ə/, which has since been lost but still affects stress placement [20]. Additionally, if the second syllable in a św context is heavy, it may attract stress [21], [23]. Further variability in stress placement in śs contexts is discussed in [24], [25].

[2] Glosses used: ACC – accusative, NUM – suffix appearing on a noun in the presence of a numeral.

[3] A reviewer suggests that L*>+H, borrowed from the analysis of Spanish intonation, may be a more accurate label for the accent that we call L+H*, because it explicitly refers to a delayed F0 peak. This label, however, is only meaningful in opposition to a pitch accent in which the F0 peak is reached within the stressed syllable itself. We find no such opposition: in all the data reported here, F0 peaks are reached on post-tonic syllables. Accordingly, we refrain from implementing L*>+H at this time, though it might be called for once we know more about the full tonal inventory of Iron Ossetic.