Combinative Markedness in Three-consonant Clusters

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1. Introduction

Introduction

- **Moenat Ladin** - a minority Romance language
- Phonotactics of prevocalic clusters show asymmetrical patterns:

  Well attested:
  - sibilant + plosive (SC-), e.g. ***sp**arpagna*
  - plosive + rhotic liquid (Cr-), e.g. ***pr**a*
  - sibilant + plosive + rhotic liquid (SCr-), e.g. ***spr**igolar*

  Less common
  - plosive + lateral liquid (Cl-), e.g. ***pl**ota*

  Exceedingly rare
  - sibilant + plosive + lateral liquid (SCl-)

What grammatical mechanism gives rise to these asymmetrical patterns?

Introduction

- Last phonetic/phonological investigation focused on Moenat Ladin of which we are aware is by Heilmann (1955).
- We investigated the phoneme system (Yang et al. in prep) and phonotactics via interviews and acoustic recordings.

While our findings were similar to those of Heilmann in broad strokes; we seek here particularly to

1. contribute an enriched and updated characterization of prevocalic cluster phonotactics, and
2. examine theoretical implications for cumulative markedness effects in three-consonant clusters, evidenced by acoustic data.

2. Ladin Phonotactics

2.1 The Ladin Language

Ladin (aka Rhaeto-Romance) is a minority Romance language spoken in northeastern Italy.

31,000 speakers (2013); threatened status (*Ethnologue*, Simons & Fennig 2018).

Data reported here is based on recent fieldwork in the Fassa (Faschia) Valley in Trentino; 8,100 speakers in this region (2011 census; Moroder 2016).

2.1 The Ladin Language

Ladin is spoken in 5 valleys in the Dolomites; a different variety is spoken in each valley, and valleys have subvarieties.

Moenat is the Fascian subvariety associated with Moena.

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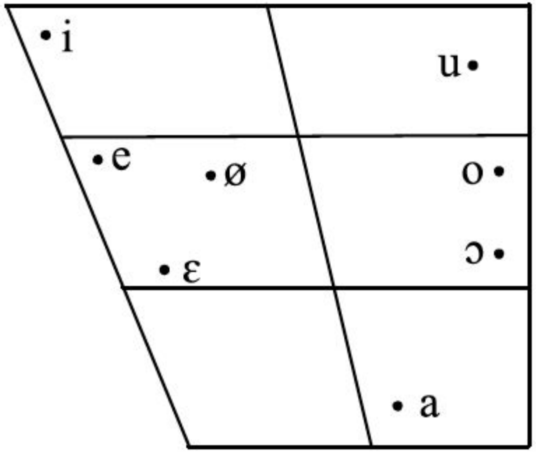
2.3 Moenat Ladin Phoneme Inventory

	Bilabial	Labio-dental	Dental/ Alveolar	Retroflex	Palatal	Velar
Plosive	p b		t d			k g
Affricate				tʂ dʐ		
Nasal	m		n		ɲ	
Trill			r			
Fricative		f v	s z	ʂ ʐ		
Lateral Appr.			l			



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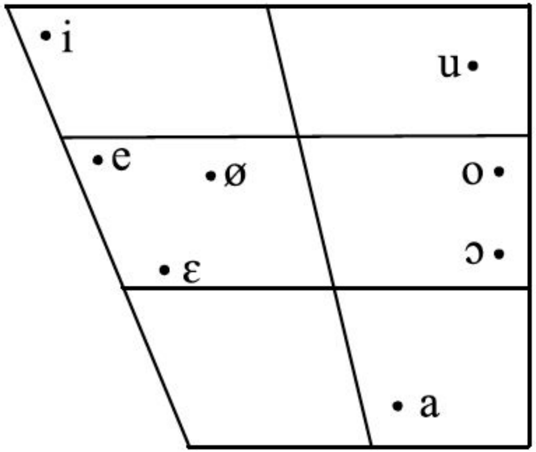

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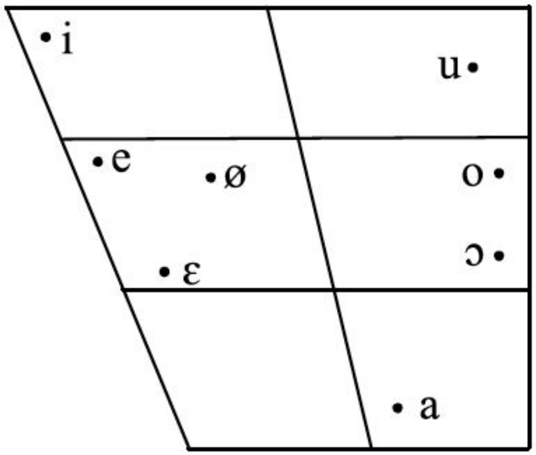

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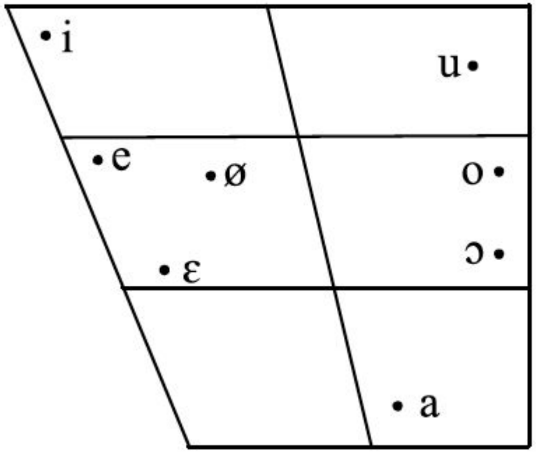

2.4 Moenat Ladin Onset Phonotactics - Obstruent + Liquid

C onset

Any singleton consonant can form an onset.

Cr onset (C = plosive)

Any plosive plus [r] can form an onset.

Fr onset (F = labiodental fricative)

[fr] can form an onset, but [vr] is unattested.

[pr]	[pra]	‘meadow’	***pr**a*
[br]	[bratʂ]	‘arm’	***br**ac*
[tr]	[troˈar]	‘to find’	***tr**oar*
[dr]	[drak]	‘dragon’	***dr**ach*
[kr]	[ˈkreda]	‘clay’	***cr**eda*
[gr]	[grɔs]	‘big’	***gr**os*
[fr]	[freit]	‘cold’	***fr**eit*
[vr]			

2.2 Moenat Ladin Onset Phonotactics - Obstruent + Liquid

Cl onset (C = plosive)
Any plosive plus [l] can form an onset, except for [tl] and [dl].

Fl onset (F = labiodental fricative)
[fl] can form an onset, but not [vl].

Summary so far
✔ – Cr, Cl, fr, fl
X – tl, dl, vr, vl

[pl]	[ˈplɔta]	‘plate’	***pl**ota*
[bl]	[blɔk]	‘block’	***bl**och*
[tl]			
[dl]			
[kl]	[ˈklampera]	‘clip for tree logs’	***cl**àmpera*
[gl]	[gloˈrjet]	‘kiosk, stand’	***gl**oriet*
[fl]	[fliŋk]	‘finch’	***fl**inch*
[vl]			

2.2 Moenat Ladin Onset Phonotactics - Sibilant + X

Sibilant fricatives in prevocalic clusters

A preconsonantal sibilant fricative is **retroflex** and it **agrees in voicing** with the following consonant. (e.g. [**ʂp**arpaˈɲa] vs. [**ʐb**iˈofa])

SX prevocalic clusters (S = sibilant fric.), X can be various:

- ✔ – sibilant plus liquid
- ✔ – sibilant plus nasal

Rise in sonority

- ✔ – sibilant plus nonsibilant fricative
- ✔ – sibilant plus plosive

Plateau or fall in sonority

2.2 Moenat Ladin Onset Phonotactics - Sibilant + X

SX prevocalic clusters (S = sibilant fric.)

Rise in sonority

✔ – sibilant plus liquid

✔ – sibilant plus nasal

[ʐr]	[ʐraˈmar]	‘to cut off branches from a tree’	***sr**amar*
[ʐl]	[ʐlonˈdʐar]	‘to make longer’	***sl**ongiar*
[ʐm]	[ʐmaus]	‘butter’	***sm**auz*
[ʐn]	[ʐnigoˈla]	‘cloudy’	***sn**igolà*
[ʐɲ]	[ʐɲaoˈlar]	‘to whine’	***sgn**aolar*

2.2 Moenat Ladin Onset Phonotactics - Sibilant + X

SX prevocalic clusters (S = sibilant fric.)

Plateau or fall in sonority

✔ – sibilant plus nonsibilant fricative

✔ – sibilant plus plosive

But Sd unattested except in Sdr

[s̺f]	[s̺fadiˈada]	‘effort’	***sf**adiada*
[z̺v]	[z̺vamˈpi]	‘careless’	***sv**ampì*
[s̺p]	[s̺parpaˈɲa]	‘widespread’	***sp**arpagna*
[z̺b]	[z̺biˈofa]	‘foam’	***sb**iofa*
[s̺t]	[s̺tinf]	‘sock’	***st**inf*
[z̺d]			
[s̺k]	[ˈs̺kaz̺i]	‘almost’	***sc**aji*
[z̺g]	[z̺goˈlar]	‘to fly’	***sg**olar*

2.2 Moenat Ladin Onset Phonotactics - Sibilant + X + Y

SXY prevocalic clusters

✔ – SCr, Sfr

[ʂpr]	[ʂprigoˈlar]	‘to frighten’	**_spr_**_igolar_
[ʐbr]	[ʐbralˈdʒar]	‘to scream’	**_sbr_**_algiar_
[ʂtr]	[ʂtroˈzet]	‘sledding’	**_str_**_oset_
[ʐdr]	[ˈʐdragola]	‘a large quantity’	**_sdr_**_agola_
[ʂkr]	[ˈʂkrɔza]	‘shell’	**_scr_**_osa_
[ʐgr]	[ʐgriˈfjon]	‘scratch’	**_sgr_**_ifion_
[ʂfr]	[ʂfreˈar]	‘to rub’	**_sfr_**_ear_
[ʐvr]			

✖ – SCl, Sfl, rare or unattested

[ʂpl]	[ʂplenˈdor]	‘splendor’	**_spl_**_endor_
[ʐbl]			
[ʂtl]			
[ʐdl]			
[ʂkl]	[ʂklenken]	‘unsteady’	**_scl_**_enchen_
[ʐgl]			
[ʂfl]	[ʂfladʒeˈlar]	‘scourge’	**_sfl_**_agelar_
[ʐvl]			

2.2 Moenat Ladin Onset Phonotactics - Interim Summary

Interim Summary: Prevocalic clusters

✔ – Cr, Cl, fr, fl (C = plosive)

OCP restrictions involving laterals

X – tl, dl

No consonants after [v]

X – vr, vl

S before any nonsibilant singleton or cluster

✔ – Sr, Sl, SN, SC, SCr, Sfr

Except SCl, which is rare or absent even though Cl is attested

2.2 Moenat Ladin Onset Phonotactics - Frequency

Further investigation - Frequency of cluster combinations

A fully documented lexicon of Moenat Ladin is not yet available, but based on our fieldwork with a Moenat consultant, we verified that:

- [kl-, gl-]: very rare
- [ʂpl-] and [ʂkl-]: one word only each; an Italian borrowing (*splendor*) and a word in a Moenat dictionary that was unfamiliar to our consultant (*sclenchen*)
- [ʂfl-]: only two words identified (*sflagel*, *sflagelar*)
- [ʐbl-, ʐgl-, ʐvl-]: unattested

2.2 Moenat Ladin Onset Phonotactics - Summary

Based on our fieldwork and description in literature:

	Labial		***Coronal***		***Dorsal***		***Labiodental***	
Cr	pr	br	tr	dr	kr	gr	fr	vr
Cl	pl	bl	tl	dl	kl	gl	fl	vl
SCr	ʂpr	ʐbr	ʂtr	ʐdr	ʂkr	ʐgr	ʂfr	ʐvr
SCl	ʂpl	ʐbl	ʂtl	ʐdl	ʂkl	ʐgl	ʂfl	ʐvl

- ***Well-attested***
- ***Rare***
- ***Unattested***

- ***Cl-*** clusters are less frequent in general (Heilmann 1955)
- ***SCl-*** is even more marked

2.2 Moenat Ladin Onset Phonotactics - Summary

Based on our fieldwork and description in literature:

	Labial		***Coronal***		***Dorsal***		***Labiodental***	
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SCl	ʂpl	ʐbl	ʂtl	ʐdl	ʂkl	ʐgl	ʂfl	ʐvl

- ***Well-attested***
- ***Rare***
- ***Unattested***

- ***Cl-*** clusters are less frequent in general (Heilmann 1955) **Why?**
- ***SCl-*** is even more marked **Why?**

Possible organization of pre-consonantal Cs **external** to the syllable?

➢ Acoustic investigation

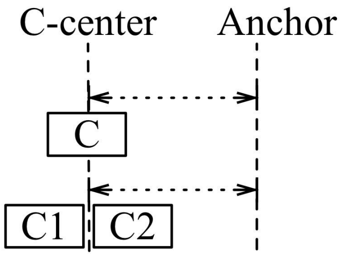
3. Acoustic Study

3.1. Cluster organization and C-Center effect

- Diagnosis of Cs belonging to a complex onset: <u>temporal coordination of the consonants in a prevocalic cluster with a later **anchor** point</u>, e.g. end of V.

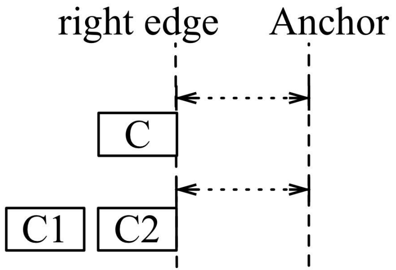
- **Complex onset shows C-centering effects** (Browman & Goldstein 1988, 2000; Marin & Pouplier 2010; Marin 2011; Pouplier 2012, etc.)

Complex onset



- **Consonants external to the onset do not show C-centering effects** (Shaw et al. 2009, 2011; Hermes et al. 2013; Ruthan et al. 2018, etc.; on extrasyllabicity see e.g. Green 2003)

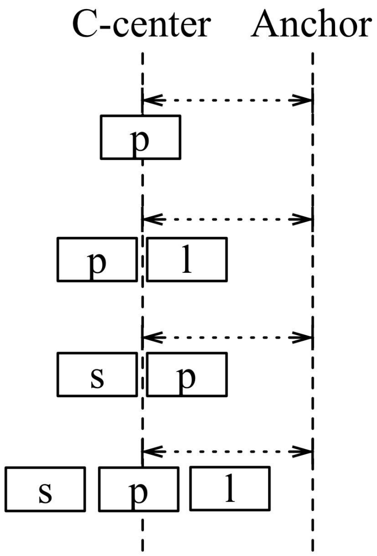
External C1



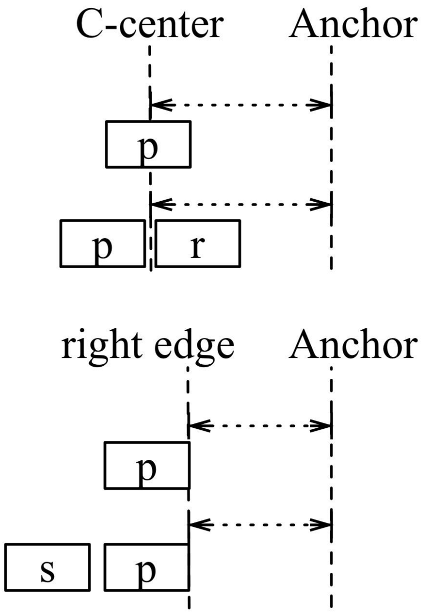
3.1. Cluster organisation and C-Center effect

- Previous articulatory studies on **English** and **Italian** prevocalic clusters

	English	**Italian**
Obs+Liquid (e.g. pr-)	complex onset (C-Center)	complex onset (C-Center)
S + Obs (e.g. sp-)	complex onset (C-Center)	S external (Right-edge)
S + Obs + Liq (e.g. spl-)	complex onset (C-Center)	-



English (adapted from Browman & Goldstein 1988)



Italian (adapted from Hermes et al. 2013)

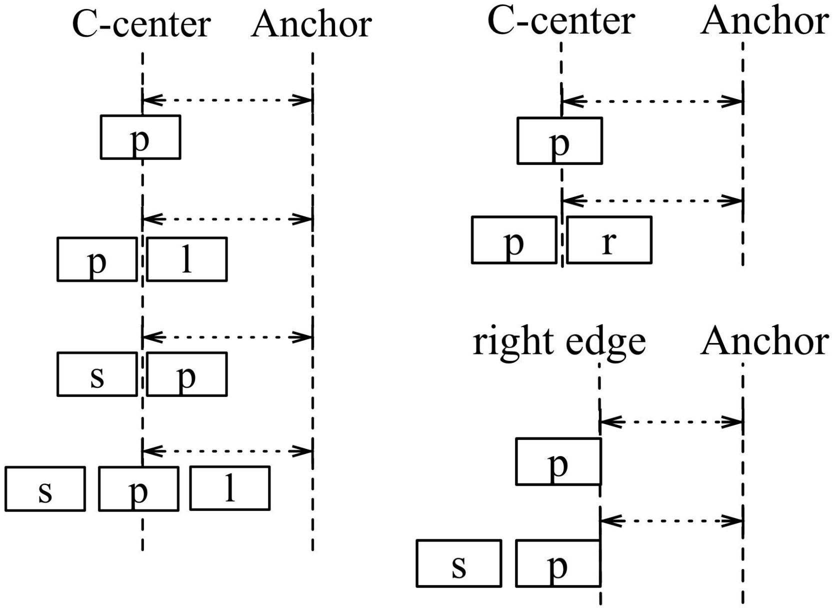
3.1. Cluster organization and C-Center effect

- Previous articulatory studies on **English** and **Italian** prevocalic clusters

What about Ladin?

- Do Ladin consonant clusters behave like English or Italian, or something else?

- Do Cl- and SCl- exhibit special patterns of temporal coordination? (C = plosive)

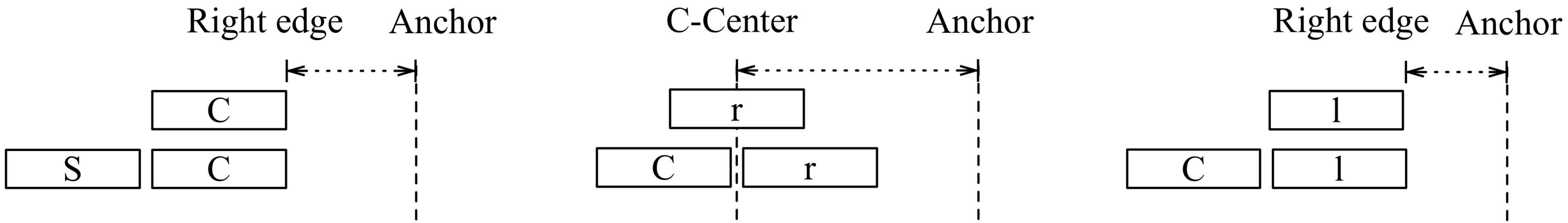


English (adapted from Browman & Goldstein 1988)

Italian (adapted from Hermes et al. 2013)

3.1. Cluster organization and C-Center effect

- **Hypotheses**
  - **H1**: Sibilant in SC(X)- is external to the onset (R-anchored), similar to Italian.
  - **H2**: Cr is a complex onset (C-centering), while Cl organization is less stable or C is external in Cl (R-anchored);



Right-edge effect
(external S)

C-Center effect
(complex onset)

Right-edge effect?
(external C?)

3.2. Design and analysis

- Selkirk & Durvasula (2013) have developed a technique using **<u>acoustic data</u>** to study the temporal coordination between segments (see also Ruthan et al. 2018).

- We applied this technique to conduct a pilot investigation of the coordination of sibilants in prevocalic clusters in Moenat Ladin:

  stimuli design - recording - acoustic analysis

3.2. Design and analysis

- **Stimuli**
  - 8 minimal sets (real and nonce words)
    - 4 sets for ‘*R-series*’: C ~ r ~ Cr ~ SC ~ SCr
      - e.g. [ˈ**p**ita] ~ [ˈ**r**ita] ~ [ˈ**pr**ita] ~ [ˈ**ʂp**ita] ~ [ˈ**ʂpr**ita]
    - 3 sets for ‘*L-series*’: C ~ l ~ Cl ~ SC
      - e.g. [ˈ**b**ata] ~ [ˈ**l**ata] ~ [ˈ**ʐl**ata] ~ [ˈ**ʐb**ata]
    - 1 set for Cl ~ SCl
      - [**pl**enˈdor] ~ [**ʂpl**enˈdor] (*splendor* is only ‘spl-’ word in Moenat)

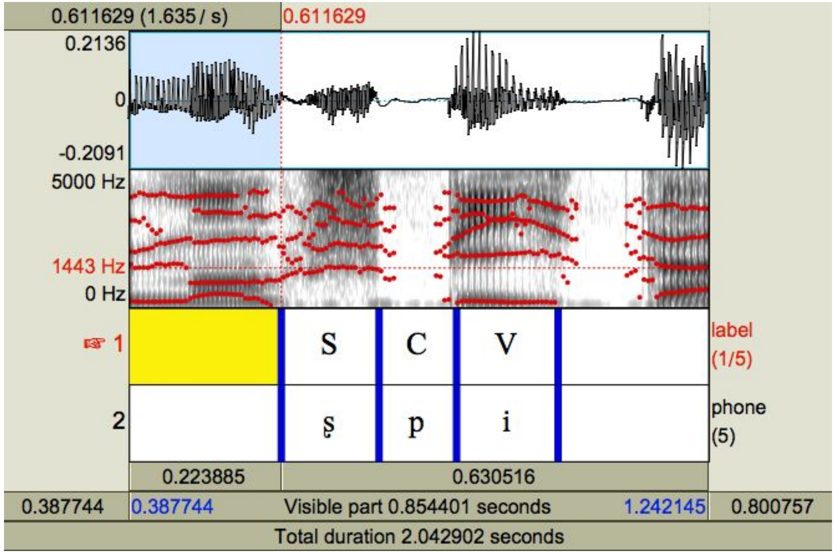
3.2. Design and analysis

- **Method**
  - Data were collected in Fassa Valley in January 2019.
  - 1 native speaker of Moenat Ladin (< 30 in age)
  - Each word has 12 repetitions (randomized), embedded in a carrier sentence
    - “dimo ____ ,Maria” (“say ___ , Maria”)
  - Recordings were made using Praat 6.0.43, with a Sennheiser microphone headset.

3.2. Design and analysis

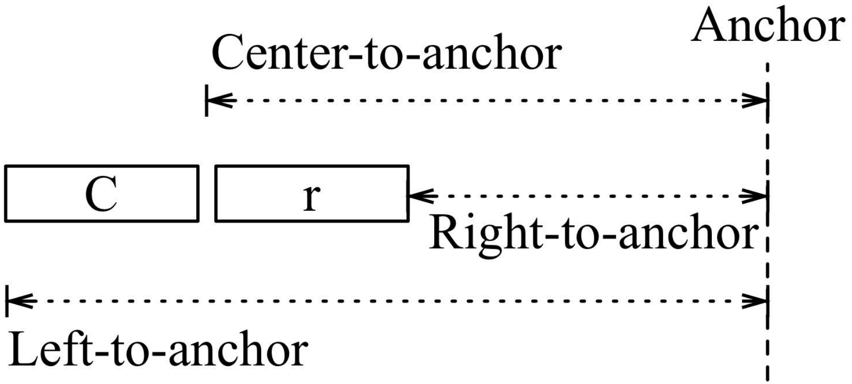
- **Analysis**
  - Each token was segmented in Praat
  - The following crucial time points were marked in textgrid:
    - **Left edge**: end of the preceding vowel
    - **Right edge**: release of the last prevocalic consonant
    - **Anchoring point**: end of the following vowel

C-Center: mean of midpoints of Cs in a cluster



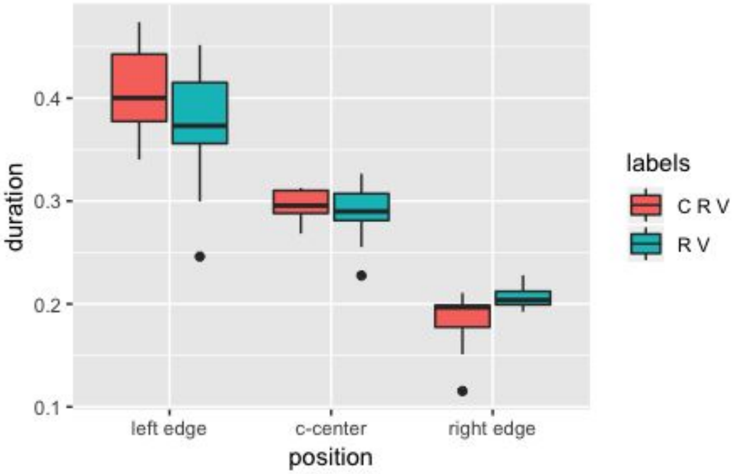
3.2. Design and analysis

- **Analysis (continued)**
  - *Left-to-anchor duration*, *right-to-anchor duration*, and *center-to-anchor duration* are calculated for each token
  - Relativized Standard Deviation (RSD) of the durations was calculated for each comparison:
    - r ~ Cr
    - C ~ SC
    - Cr ~ SCr
    - l ~ Cl
    - Cl ~ SCl



3.4. Results and discussion

- r ~ Cr



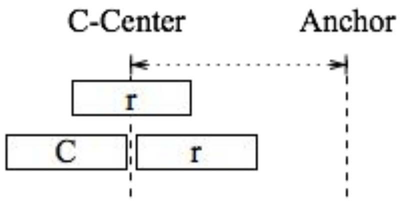
Plot: *rama ~ brama*

RSD value for each doublet
(least RSD, least variability)

	left edge	c-center	right edge
rita ~ prita	6.146	**5.009**	10.403
rama ~ brama	13.912	**7.939**	12.166
raz ~ gras	11.235	**9.350**	10.412
rata ~ brata	12.328	**10.066**	10.616

3.4. Results and discussion

- r ~ Cr



C-Center effect
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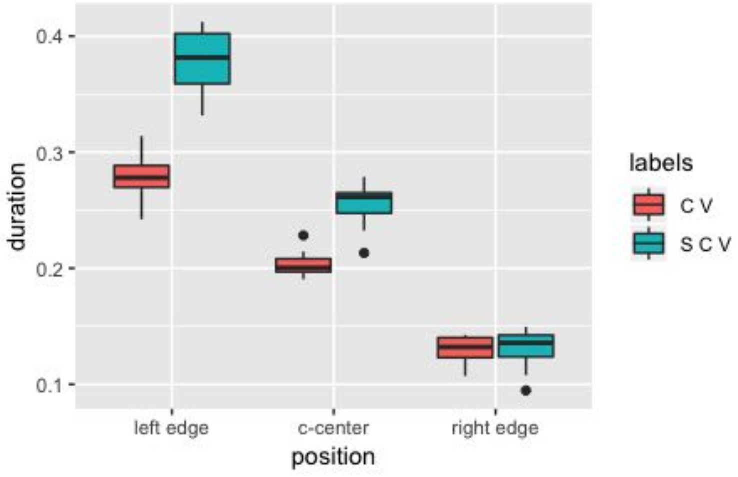
3.4. Results and discussion

- C ~ SC



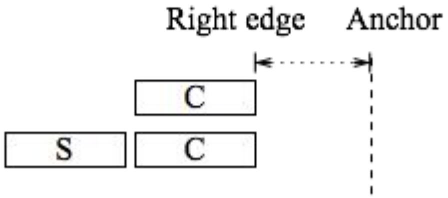
Plot: *pita ~ spita*

RSD value for each doublet
(least RSD, least variability)

	left edge	c-center	right edge
pita ~ spita	17.190	13.175	**9.216**
bama ~ sbama	4.206	**5.207**	6.778
gas ~ sgas	13.004	10.471	**6.075**
bata ~ sbata	10.706	8.728	**8.243**
cossa ~ scoza	10.605	9.019	**8.243**
bos ~ sboz	11.711	7.862	**5.611**

3.4. Results and discussion

- C ~ SC



Right-edge effect
(external S)

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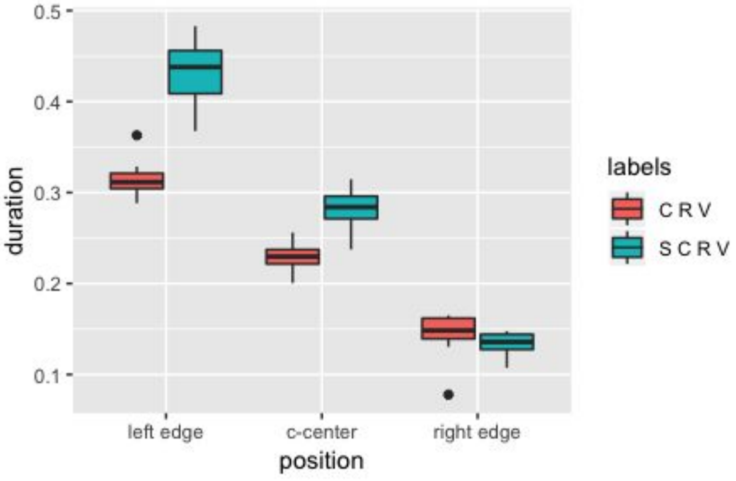
- Cr ~ SCr



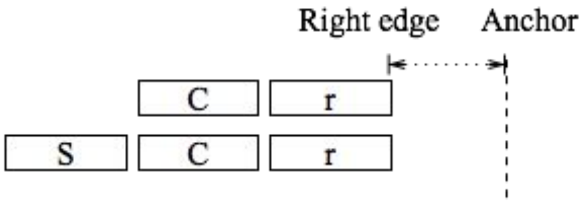
Plot: *prita ~ sprita*

RSD value for each doublet
(least RSD, least variability)

	left edge	**c-center**	**right edge**
prita ~ sprita	17.514	12.729	**10.569**
brama ~ sbrama	9.097	**3.567**	5.677
gras ~ sgras	12.306	9.269	**7.093**
brata ~ sbrata	14.885	12.059	**10.346**

3.4. Results and discussion

- Cr ~ SCr



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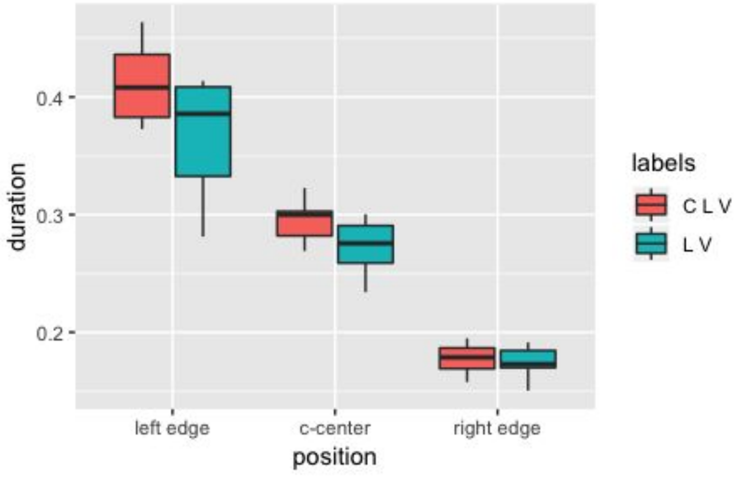
3.4. Results and discussion

- l ~ Cl



Plot: *lata ~ blata*

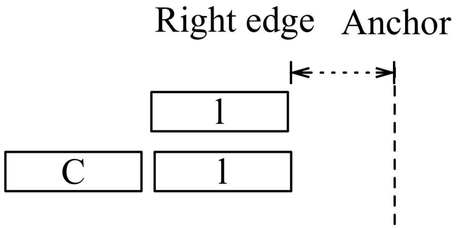
RSD value for each doublet
(least RSD, least variability)

	left edge	**c-center**	**right edge**
lata ~ blata	9.798	8.216	**6.450**
lossa ~ clossa	5.960	**5.856**	10.331
los ~ blos	12.715	9.568	**9.134**

(Right-edge effect? variation?)

3.4. Results and discussion

- l ~ Cl



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(external C?)

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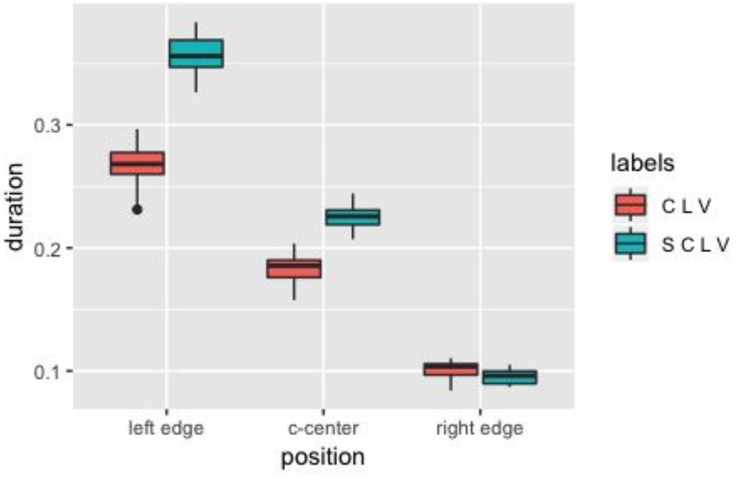
(Right-edge effect? variation?)

3.4. Results and discussion

- Cl ~ SCl



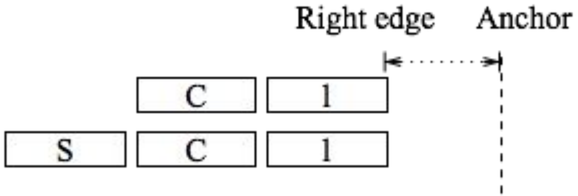
Plot: *plendor ~ splendor*

RSD value for each doublet
(least RSD, least variability)

	left edge	**c-center**	**right edge**
plendor ~ splendor	15.661	11.773	**7.905**

3.4. Results and discussion

- Cl ~ SCl



Right-edge effect
(external S)

RSD value for each doublet
(least RSD, least variability)

	left edge	**c-center**	**right edge**
plendor ~ splendor	15.661	11.773	**7.905**

3.4. Results and discussion

- Summary

	Results	Notes
C ~ SC	Right-edge effect	except for *bama ~ sbama*
Cr ~ SCr	Right-edge effect	except for *brama ~ sbrama*
Cl ~ SCl	Right-edge effect	
r ~ Cr	C-center effect	
l ~ Cl	Right-edge effect?	seem to show variation

3.4. Results and discussion

- Tendency shown in the results; **Hypothesis 1**

	Results
C ~ SC	Right-edge effect
Cr ~ SCr	Right-edge effect
Cl ~ SCl	Right-edge effect
r ~ Cr	C-center effect
l ~ Cl	Right-edge effect?

- Sibilant could be viewed as an external element of syllable structure, similar to Italian.

3.4. Results and discussion

- Tendency shown in the results; **Hypothesis 2**

	Results
C ~ SC	Right-edge effect
Cr ~ SCr	Right-edge effect
Cl ~ SCl	Right-edge effect
r ~ Cr	C-center effect
l ~ Cl	Right-edge effect?

- Cr could be viewed as a complex onset
- Cl behaves differently from Cr
- Potential right-alignment effect of Cl suggestive of unstable coordination between C and l and possibility that C is external to syllable.

4. Formal analysis

4.1 Proposal

Our claim:

The avoidance of *SCl-* clusters arises as a **cumulative markedness effect** deriving from parsing consonants external to the syllable, driven by:

- $*_{\sigma}$[Cl
- $*_{\sigma}$[SC

These constraints can be understood as marked on the basis of sonority (e.g. Clements 1990, note also Krämer, this conference)

-- SC by Sonority Sequencing Principle

-- Cl by Minimum Sonority Distance

4.2 Constraints

***$_\sigma$[Cl**: Assign a violation to a tautosyllabic obstruent-lateral sequence

Support for *$_\sigma$[Cl

- A historic sound change in Italo-Romance caused lenition of /l/ to [j] following an obstruent (Maiden 1995, Krämer 2009).
- Evidenced in Faschian (but not other Ladin varieties) in 19th c. (Salvi 2016)
  - **[fiˈɔk]** ‘flake’ (snowflake) < *floccum* (Latin), **[kiˈau]** ‘key’ < *clavis* (Latin)
  - Cl clusters are nevertheless represented in the lexicon of the present-day language
- In Campidanese, /l/ → [r] in Cl clusters (Frigeni 2009), interpreted as support for a markedness relationship Cl > Cr in onset (Baertsch & Davis 2009)
  - [prus] ‘more’ < *plus* (Latin)

4.2 Constraints

$*_{\sigma}$[SC: Assign a violation to a tautosyllabic sibilant-obstruent sequence

- After Coetzee (2004)
- OCP restrictions in English morphemes involving SC sequences provide cross-linguistic support (Davis 1991, Lamontagne 1993, Coetzee 2004).

Parse: Assign a violation to any segment that is not parsed into a syllable

- Cf. Prince & Smolensky (1993/2004) but with proviso that unparsed segments are nevertheless pronounced.

4.2 Constraints

MParse: Assign a violation to null realization. (Prince & Smolensky 1993/2004)

- The Null Parse (⊙) is a candidate, representing no structural realization (Prince & Smolensky 1993/2004; see also Albright 2012).
- The Null Parse incurs a single violation of **MParse** only (see Wolf and McCarthy 2009 for detailed discussion).
- The effect of MParse is as follows:

	Input	Markedness	MParse
a.	*cand a*	*	
b.	⊙		*

4.3 Analysis

- The analysis is couched in Harmonic Grammar (HG; Legendre, Miyata & Smolensky 1990; Pater 2016.)
  - Each constraint has a weight
  - The harmony score of a candidate (*H*): violations of each constraint are multiplied by its weight, and then all the products are summed.
  - A probabilistic version of HG, Maxent HG (Goldwater and Johnson 2003; Hayes & Wilson 2008, etc.), can be used to fit gradience in the lexicon in future work.

	Input	C1	C2	
	weight	*2*	*1*	***H***
☞	cand a		-1	-1
	cand b	-1		-2

4.3 Analysis

- Cumulative markedness via **multiple** violations of one constraint

Input	C1	C2	
weight	*3*	*2*	***H***
☞ cand a	-1		-3
cand b		-2	-4

- *candidate a* violates a constraint with greater weight
- but *candidate b* has a lower harmony score due to multiple violations of a lower-weighted constraint

4.3 Analysis

- Cl- input

	/ple/	Max-IO	Ident[cons]	MParse	*$_{\sigma}$[Cl	*$_{\sigma}$[SC	Parse	
	weight	5	5	3	3	3	2	***H***
☞ a.	p$_{\sigma}$[le						-1	-2
b.	$_{\sigma}$[ple				-1			-3
c.	$_{\sigma}$[pje		-1					-5
d.	⊙			-1				-3

4.3 Analysis

- SC- input

	/sp/	**Max-IO**	**Ident[cons]**	**MParse**	**$*_\sigma$[Cl**	**$*_\sigma$[SC**	**Parse**	
	weight	5	5	3	3	3	2	***H***
☞ a.	s_σ[pe						-1	-2
b.	$_\sigma$[spe					-1		-3
c.	$_\sigma$[pe	-1						-5
d.	⊙			-1				-3

4.3 Analysis

- SCl- input

/sple/	Max-IO	Ident[cons]	MParse	*$_\sigma$[Cl	*$_\sigma$[SC	Parse	
weight	5	5	3	3	3	2	***H***
☞ a. ⊙			-1				-3
b. sp$_\sigma$[le						-2	-4
c. s$_\sigma$[ple				-1		-1	-5
d. $_\sigma$[sple				-1	-1		-6

4.4 Summary

- We employed two constraints, $*_{\sigma}$[SC- and $*_{\sigma}$[Cl-, to drive consonants to be structurally organized external to the syllable in Ladin;
- SCl- is avoided by a cumulative markedness effect involving Parse.

5. Implications

5. Implications

Alternative approach to structure of SC:

SC is a complex segment with branching place/stricture (Selkirk 1982, Lamontagne 1993)

- Avoids needs to make an exception for SC with respect to sonority sequencing
- Predicts SC voicing identity

- But SC as a complex segment does not fit with the findings of our acoustic study

5. Implications

SC as complex segment: Also faces **duplication problems** in Moenat Ladin

1. **Voicing**

- Sibilants assimilate in voicing with any consonant, including sonorants
  - Exx. [ʐmaus] ‘butter’; [ʐlonˈdʒar] ‘to make longer’
- Sibilant-sonorant (S+son) sequences are not receptive to analysis as a complex segment:
  - in Moenat, S and sonorants potentially differ in any feature besides [voice] and [consonantal].
- Voicing assimilation must therefore be independently enforced in S+son sequences, duplicating sources of voicing agreement in SX clusters.

5. Implications

SC as complex segment: Also faces **duplication problems** in Moenat Ladin

2. **Free combination**

- If SCs were complex segments, we could expect them to be limited in number or restricted in place of articulation.
- However, the set of SCs in Ladin is precisely that which would arise from **every combination** of S plus obstruent stop or non-sibilant fricative, as derived in a cluster treatment (excepting the SD gap).
- Furthermore, word-initial S can occur before **every sonorant consonant**, suggesting that sibilants combine freely with any following nonsibilant consonant, subject to voicing agreement.

5. Future Research

Examine other languages where SCX clusters are restricted to a subset of what would be derived from freely combining all permissible SC and CX clusters (Goad 2011).

- English: ✔ [sk], ✔ [kl] but ***X*** [skl] (except loans)
- Greek: ✔ [sx], ✔ [xr] but ***X*** [sxr]

Thank you