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Consonant Phonotactics in the Moenat Variety of Ladin

Rachel Walker,[a] Yifan Yang[b]

[a] Department of Linguistics, University of California, Santa Cruz, USA <rachelwalker@ucsc.edu>
[b] School of Foreign Languages, Shanghai Jiao Tong University, China <yifanyang@stju.edu.cn>

This paper provides a study of consonant phonotactics in the present-day Moenat variety of Ladin. This research focuses on the speech of the current generation of younger adults, based on an investigation with a primary consultant and acoustic recordings of multiple speakers. This work systematically investigates singleton consonants and consonant clusters in each position in the word (initial, medial, final) with accompanying illustrations in example words. An accompanying archive of sound files exemplifies the production of each word by two native speakers, one male and one female. Several phonological patterns involving consonants are discussed, including voicing agreement and place neutralization in preconsonantal sibilants, final obstruent devoicing, and nasal place assimilation. In addition, variation in the realization of sibilants is identified.

KEYWORDS: consonant, phonotactics, Moenat, Ladin, sibilants, final devoicing.

1. Introduction[1]

This paper provides a study of consonant phonotactics in the Moenat variety of Ladin, an understudied minority Romance language spoken in the Italian Central-Eastern Alps. Based on detailed investigation with a primary consultant and acoustic recordings of words produced by multiple native speakers, it is the first study of this topic in Moenat Ladin with acoustic analysis. The last detailed work on Moenat Ladin phonology was published over 65 years ago (Heilmann 1955). This paper focuses on the speech of the current generation of younger adults. It combines phonological and phonetic description and analysis and provides systematic exemplification of sound patterns with an accompanying archive of recordings to illustrate the examples.

[1] This paper is the product of a joint collaboration as follows. Walker: Conceptualization; formation of word list; phonological analysis; writing (original draft), sections 1, 2, 3, 4, 5, appendices: I, II; review, editing and revision. Yang: Conceptualization; formation of word list; collection of speech recordings; phonological analysis; vowel space analysis; writing (original draft), sections 2, 4 appendices I, III; review, editing and revision. Both authors approved the final version.

1.1 Background and specific aims

The Ladin language shows considerable regional variation, with major varieties associated with valleys around the Sella massif. As discussed by Yang *et al.* (2021), the Ladin spoken in the Val di Fassa (Fassa Valley) is known as Fascian Ladin, with three subvarieties: Moenat, Brach, and Cazet. Moenat, which is the focus of this study, is spoken in the village of Moena, situated in the lower valley. The Ladin-speaking community is characterized by multilingual proficiency and language contact which varies by valley. In the Fassa Valley there is considerable contact with Italian and the Trentino dialect. The influence of Italian puts the continued vitality of Fascian Ladin at risk, and Italian law protects Ladin as a minority language. The Ladin language as a whole has been characterized as 'threatened' (Simons & Fennig 2018). Standard Fascian Ladin, which is based on Cazet, is taught in school in Val di Fassa. The influence of Standard Fascian Ladin on Moenat places the preservation of this variety at further risk.

Previous documentation of Moenat phonology and phonetics is provided by Heilmann (1955). More recently, Yang *et al.* (2021) provided an illustration of the phonemes of the three Val di Fassa Ladin varieties. Further significant resources are two dictionaries: *PODLM (Prontuarie ortografich del ladin moenat dal vocabolario ladino moenese - italiano di Giuseppe Dell'Antonio (1972)* – 2015), and *DILF (Dizionario italiano-ladino fassano / Dizionèr talian-ladin fascian* – 2013). *PODLM* (2015) provides words of Moenat; however, it is not a comprehensive contemporary lexicon. *DILF* (2013) is based on Standard Fascian Ladin (the Cazet variety), and as such, it is not representative of Moenat, but the variety is closely related. In addition, while not focused on documentation, Walker & Yang (2023) conducted an acoustic study investigating syllabification of word-initial sibilant-stop sequences in Moenat, an issue we touch on later in this paper.

The primary goal of this study is broadly to characterize the consonant phonotactics of Moenat as spoken by the current generation of younger adults. This work seeks to fill some gaps in the documentation of the phonology and phonetics of contemporary Moenat. The study by Heilmann (1955) does not include acoustic analysis. Furthermore, we could expect to potentially find some changes in Moenat as spoken by present-day younger generations, especially given the influence of Italian and Standard Fascian Ladin. The study by Yang *et al.* (2021) offers a recent investigation; however, the description of Moenat in that work centered primarily on the phoneme system rather than phonotactics and it was based on a single Moenat speaker. With respect to the lexicon, contact with other languages and varieties, especially Italian, may have given rise to lexical changes. While it is not our aim here to

comprehensively document the lexicon, we sought to use words that are part of present-day Moenat. In the course of this work, we address consonant contrasts, contexts of neutralization, possible consonant clusters, and primary segmental processes. We also discuss variation that we observed with respect to these phenomena. This work expands on the research by Yang *et al.* (2021) in terms of scope of phenomena, number of speakers, and detail of documentation. The vowel contrasts of Moenat were addressed by Yang *et al.* (2021). For completeness, we include evidence for the vowel phonemes in an appendix and we provide an acoustic mapping of the Moenat vowel space based on five speakers.

The initial stages of documentation for this work were based on the materials described above and consultation with a primary consultant to identify Moenat words in current use. From these we assembled the word lists presented in section 3. Where possible, we list two examples for each sound or cluster. In cases where we identified only a single example that was familiar to our consultants, we have annotated accordingly. Acoustic recordings of these lists were acquired in Moena in 2019. The recordings were made with a laptop computer using a head-mounted Logitech microphone and Praat software at a sampling rate of 44,100 Hz (Boersma 2001). Words were recorded in the frame [ˈdimo __ ˈmaria], *dimo __ Maria!* 'say __ Maria!' We note that in some cases we hear stress on the second syllable of *Maria* for some speakers. It is possible that the location of stress on this word, or our perception of it, is influenced by intonation. Six native speakers of Moenat were recorded, three males and three females. For any given word, we sought to record at least four speakers, two male and two female, with at least two repetitions.

We did not record words that speakers were not familiar with. There was some variation on this point across our speakers. In some cases, a word was identified by Heilmann (1955) or our primary consultant as originally a loan. As a contact language, Moenat has acquired a number of words through loans over its history. We excluded words that were known to be recent loans (acquired from the 20th century to present). Where we have information that a sound pattern is known to have originated through loans in the language history and it is relevant to our discussion, we have made note of that.

The documentation provided in this work consists of transcriptions and an accompanying archive of sound files containing two example productions selected for each word, one spoken by a male and one by a female. A link to the archive of sound files is in Appendix I. Words are provided in transcription using the International Phonetic Alphabet as well as in the Ladin-Fascian standard orthography for Ladin, based on Chiocchetti & Iori (2002) and *DILF* (2013). All phonetic transcriptions

in this paper are broad and limited to the symbols used for the phoneme inventory except where indicated otherwise. Some phenomena are further illustrated with spectrograms and waveforms. Primary stress is marked in transcriptions. Primary stress generally falls on one of the last three syllables of the word (Yang *et al.* 2021), but a detailed analysis of Ladin metrical structure remains for future research.

The paper is organized as follows. In section 2, we present the consonant and vowel inventories of Moenat. In section 3, we turn to consonant phonotactics, presenting first the distribution of singleton consonants in each position in the word (initial, medial, final), and then the clusters that may occur in each position. In section 4, we discuss phonological patterns observed in consonant clusters and variation in the realization of consonants. The primary patterns addressed in this section are voicing agreement and place neutralization in preconsonantal sibilants, final obstruent devoicing, and nasal place assimilation. The variation that we discuss involves the realization of sibilants. Section 5 presents the conclusion.

2. Consonant and vowel inventories of Moenat Ladin

The consonant phoneme inventory of Moenat Ladin is given in Table 1.

	BILABIAL		LABIO-DENTAL		DENTAL/ ALVEOLAR		POST-ALVEOLAR		PALATAL		VELAR	
PLOSIVE	p	b			t	d					k	g
AFFRICATE							t̪s̪	d̪z̪				
FRICATIVE			f	v	s	z	s̪	z̪				
NASAL STOP		m				n				ɲ		
TRILL						r						
LATERAL APPROXIMANT						l						

Table 1. Consonant phoneme inventory of Moenat Ladin.

Yang *et al.* (2021) illustrated consonantal contrasts with word pairs; however, many of those pairs were near-minimal, matching in the following vowel only. In support of the contrastive status of the consonants

in Table 1, we identified minimal pairs for distinctions along the lines of voicing, place and manner.[2] These are provided in Appendix II.

We analyze the series of post-alveolar sibilant phonemes as retroflex, consistent with the observations of Yang *et al.* (2021) regarding these consonants in Moenat. However, some speakers vary between what the authors perceive as retroflex and non-retroflex productions, as we discuss in section 4. In the transcription that we use in this paper, we represent these sibilants as retroflex. Nevertheless, some of them are realized as [t̲s̲, d̲z̲, s̲, z̲], without audible retroflexion, in the accompanying recordings, which is representative of the variation that exists in present-day Moenat.

Our analysis of the consonant inventory agrees with that of Heilmann (1955) in identifying 19 phonemes, but the specific coronal phonemes differ in some respects. Heilmann constructed the following eight coronal obstruent phonemes: /t, d, ts, dz, s, z, c, ɟ/. In our investigation of present-day Moenat, the basic place of articulation and manner that we found for the coronal obstruents gives rise to our different classification of these phonemes, except for /t/ and /d/, which remain the same. It is not very surprising that we found some differences involving sibilants from that of Heilmann's study, since contrasts and realizations among these consonants are prone to differ across Val di Fassa Ladin varieties, and they appear to be undergoing change (Chiocchetti 2017, Yang *et al.* 2021). With respect to place, we found post-alveolar voiced and voiceless fricatives and affricates, as noted above. With respect to manner, we found a contrast between dental/alveolar and post-alveolar fricatives, but we did not find a contrastive palatal oral stop series. In Table 2, we show the correspondences for the present-day Moenat sibilant fricatives and affricates in relation to the phonemes Heilmann identified in 1955. The phonetic descriptions of the latter phonemes are based on primary properties of Heilmann's description of their realization. In this table and those that follow, each entry consists of the Moenat form in transcription and Ladin orthography (italicized) and an accompanying English gloss. The relationships between the phonemes that Heilmann constructed and our system are as follows, with our phonemes on the right of the arrow in each case: /c, ɟ/ → /tʂ, dʐ/, /ts, dz/ → /s, z/, /s, z/ → /ʂ, ʐ/. These correspondences indicate differences in analysis with respect to affrication and advancement/retraction and suggest shifts along these lines.

[2] Length is not a distinctive property of consonants in Moenat.

Present-day Moenat phoneme	Phonetic description	Example	Corresponding phoneme in Heilmann (1955)	Phonetic description	Example in Heilmann's notation with Italian gloss
/s/	Voiceless Alveolar Fricative	[ors] *ors* 'bear'	/ts/ <z>	Voiceless Alveolar Affricate	<o̱rz> 'orso'
/z/	Voiced Alveolar Fricative	[zal] *śal* 'yellow'	/dz/ <ʒ>	Voiced Alveolar Affricate	<ʒal> 'giallo'
/ʂ/	Voiceless Post-alveolar Fricative	[kuˈʂin] *cuscin* 'pillow'	/s/ <s>	Voiceless Alveolar Fricative	<k̇usín> 'cuscino'
/ʐ/	Voiced Post-alveolar Fricative	[kuˈʐin] *cujin* 'cousin'	/z/ <ʃ>	Voiced Alveolar Fricative	<k̇uʃín> 'cugino'
/tʂ/	Voiceless Post-alveolar Affricate	[ˈtʂata] *ciata* 'paw'	/c/ <ć>	Voiceless Mediopalatal Stop	<ćata> 'zampa'
/dʐ/	Voiced Post-alveolar Affricate	[ˈdʐata] *giata* 'female cat'	/ɟ/ <ǵ>	Voiced Mediopalatal Stop	<ǵata> 'gatta'

Table 2. Correspondences between the present-day Moenat sibilant fricatives and affricates and phonemes constructed by Heilmann (1955). The symbols used by Heilmann are indicated in angle brackets.

The phonemic organization of the coronal consonants that we present here largely agrees with more recent studies of Val di Fassa Ladin based on descriptions of the phonetic equivalences of the Ladin-Fascian orthography. However, speakers of standard Fascian Ladin (Cazet) exhibit a second voiceless affricate /ts/ at the dental/alveolar place of articulation, and this is also true for speakers of Brach (Yang *et al.* 2021). In Moenat, the historical phoneme /ts/, spelled with *z*, has shifted to /s/. Nevertheless, we observed that some speakers occasionally or frequently pronounce orthographic *z* in Moenat words as [ts]. This may be an influence of Standard Fascian Ladin or Italian.

With respect to vowels, Moenat has an inventory of eight monophthongs, /i, u, e, ø, o, ɛ, ɔ, a/, compared to a seven-vowel inventory in the other varieties of Fascian Ladin (/i, u, e, o, ɛ, ɔ, a/). However, /ø/ is not very frequent in the Moenat lexicon. The mid vowel pairs /e, ɛ/ and

/o, ɔ/ neutralize in unstressed syllables, which was noted by Heilmann (1955: 14) and also verified in our fieldwork. Minimal pairs supporting vowel contrasts are presented in Appendix III together with a formant chart to illustrate the acoustic vowel space. Yang *et al.* (2021) computed the acoustic vowel space for a single male speaker of Moenat. We expand the empirical basis for the computation with datapoints from five speakers and separate plots for males and females.

Moenat presents a number of diphthongs in which [i] or [u] (potentially realized as a semi-vowel) appears adjacent to a mid or low vowel. Yang *et al.* (2021) report eight falling diphthongs and several combinations that are usually called 'rising diphthongs'. Heilmann (1955: 260) does not consider diphthongs in Moenat to be formed with a phonemic glide. Whether diphthongs involve phonemic glides distinct from a high vowel is a matter of debate for the related language of Italian (Bertinetto & Loporcaro 2005, Krämer 2009). We represent the high vocoid in Moenat diphthongs with a high vowel, but note that a semi-vowel or glide may ultimately be more appropriate.[3] We set aside the issues surrounding glides and diphthongs in this paper noting that they warrant further investigation in Moenat.

3. Consonant phonotactics

Next we examine singleton consonants and consonant clusters in different positions in the word: initial, final and medial. Word-medial position here refers to intervocalic context. Shaded cells in tables of examples represent gaps apart from unassimilated loans.

3.1 Singleton consonants

All consonants may occur as singletons at the beginning of a word and in word-medial context. All consonants except voiced obstruents are attested in word-final position. As we discuss in section 4.1, voicing alternations provide evidence for active devoicing of morpheme-final voiced obstruents in word-final position, e.g. [ˈøves] *öves* 'egg PL' ~ [øf] *öf* 'egg'. Our phonetic transcriptions represent the surface realizations in which the voicing contrast in obstruents is neutralized.

[3] The locus of stress peaks may contribute to indicating the property of the high vocoid, but we leave this issue for future investigation.

Two examples of each consonant in each possible position are provided in Table 3. Here and subsequently, for examples that are reflexive verbs, an obligatory preceding [se] 'self' is notated in parentheses.

CONSONANT	WORD INITIAL	WORD MEDIAL	WORD FINAL
[p]	[pɛl] *pel* 'skin' [pai] *pai* 'pole PL'	[ˈzɲapa] *sgnapa* 'acquavite, grape-based brandy' [ˈpɔpes] *popes* 'kid PL'	[grɔp] *grop* 'knot' [pɔp] *pop* 'kid'
[b]	[bɛl] *bel* 'beautiful' [bas] *bas* 'low'	[gaˈban] *gabàn* 'mantle' (se) [goˈbar] *(se) gobar* 'to stoop, to bend'	
[t]	[taˈzę] *tajé* 'shut up 2PL.IMP' [tai] *tai* 'cut N'	[oiˈtar] *oitar* 'to turn' [ˈplɔta] *plota* 'floor tile'	[bɔt] *bòt* 'pop, shot' [ʂtroˈzet] *stroset* 'sled (for children)'
[d]	[daˈzę] *dajé* 'give 2PL.IMP' [dut] *dut* 'all, everything'	[aiˈdar] *aidar* 'to help' [ˈkreda] *creda* 'clay'	
[k]	[ˈkola] *cola* 'filter 3SG.PRS' [kel] *chel* 'that'	[ˈfiɔkes] *fiòches* 'snowflake PL' [ˈkikera] *chichera* 'cup'	[tɛk] *tech* 'wet' [blɔk] *bloch* 'block'
[g]	[ˈgola] *gola* 'throat' [gas] *gas* 'gas'	[ˈblaga] *blaga* 'snooty/arrogant person' [fiˈga] *figà* 'liver'	
[tʂ]	[ˈtʂatʂa] *ciacia* 'hunt N' [tʂɔf] *ciof* 'lock (of hair); bunch (of flowers)'	[ˈdzɻatʂa] *giacia* 'ice' [ˈtʂatʂa] *ciacia* 'hunt N'	[potʂ] *poc* 'well PL' [bratʂ] *brac* 'arm'
[dzɻ]	[ˈdzɻatʂa] *giacia* 'ice' [ˈdzɻata] *giata* 'female cat'	[ʂflaˈdzęl] *sflagel* 'a large quantity' [ʂfladzęˈlar] *sflagelar* 'lash (strike with violence)'	
[f]	[fɛrs] *fers* 'hot' [fɔrt] *fort* 'strong'	[zɮboliˈfar] *sbolifar* 'to sparkle' [ˈzɮbiɔfa] *sbiofa* 'foam'	[nøf] *nöf* 'new' [tʂɔf] *ciof* 'lock (of hair); bunch (of flowers)'

[v]	[vɛrs] *vers* 'scream' [val] *val* 'valley'	[ˈʂkriver] *scriver* 'to write' [engreˈva] *engrevà* 'stiff (usually of body parts)'	
[s]	[sɛn(t)] *sèn(t)* 'saint' [sɔrt] *sort* 'kind, sort'	[ˈpusa] *puza* 'bad smell' [ˈpisa] *piza* 'itch N'	[das] *das* 'give 2SG.PRS' [grɔs] *gros* 'big'
[z]	[zes] *śes* 'chalk' [zal] *śal* 'yellow'	[ˈʂkrɔza] *scrosa* 'shell' [ˈzn̥aza] *snasa* 'sense of smell'	
[ʂ]	[ʂi] *scì* 'yes' [ˈʂempie] *scempie* 'simple'	[kuˈʂin] *cuscin* 'pillow' [ˈpiʂa] *piscia* 'urinate 3SG.PRS'	[daʂ] *dasc* 'give 3SG.PRS' [ˈmarteʂ] *martesc* 'Tuesday'
[ʐ]	[ʐi] *jì* 'go 2PL.IMP' [ʐent] *jent* 'people'	[kuˈʐin] *cujin* 'cousin' [arpeˈʐon] *arpejon* 'heredity, heritage'	
[m]	[mut] *mut* 'dumb' [mas] *maz* 'deck of cards'	[ˈfemena] *fémena* 'woman' [ˈlɛgrema] *lègrema* 'tear, tear drop'	[dʐom] *giom* 'ball of wool' [fum] *fum* 'smoke'
[n]	[nut] *nut* 'naked' [nas] *nas* 'nose'	[ˈtʂaneva] *ciàneva* 'cellar' [paˈtrona] *patrona* 'cartridge'	[tʂan] *cian* 'dog' [ʐbriˈon] *sbrion* 'scratch'
[ɲ]	[ɲɔk] *gnoch* 'dumpling' [ɲiˈɲɔla] *gnignola* 'lizard'	[maˈɲar] *magnar* 'to eat' [ɲiˈɲɔla] *gnignola* 'lizard'	[puɲ] *pugn* 'fist' [arˈgaɲ] *argagn* 'device'
[l]	[ˈlana] *lana* 'wool' [lɛt] *let* 'bed'	[zɲauˈlar] *sgnaolar* 'to whine' [zgoˈlar] *sgolar* 'to fly'	[fal] *fal* 'error, mistake' [kapriˈɔl] *capriòl* 'roe deer'
[r]	[ˈrana] *rana* 'frog' [ˈroe] *roe* 'water spring PL'	[ˈlareʂ] *laresc* 'larch' [ˈklampera] *clàmpera* 'clip for tree logs'	[far] *far* 'to do' [ʂprigoˈlar] *sprigolar* 'to frighten'

Table 3. Singleton consonants in word-initial, word-medial and word-final positions.

To summarize, all 19 consonants in Moenat Ladin occur at the beginning of words and between vowels. At the end of words, the voicing contrast in obstruents is neutralized to voiceless.

3.2 Consonant clusters

Turning now to clusters, we structure tables of consonant clusters as follows. Using Heilmann 1955, dictionaries, and the current phoneme inventory as an initial guide, we compiled the clusters we could reasonably expect might occur. Based on the manner of consonants in these clusters, we then enlarged the scope of inquiry to the level of a category that includes all contrasting consonants within a given manner. In other words, if [pl-] was attested, we investigated all plosive-[l] sequences and indicated for each whether they are attested or not. Exemplification is based on non-compound words.[4] Where there are multiple unattested sequences for a given category, we list them in the same cell in the table. Beyond exemplification, we make note of clusters that we observed to be rare, though we have not conducted a detailed examination of consonant cluster frequencies.

3.2.1 Word-initial consonant clusters

At the beginning of a word, consonant clusters are attested consisting of an obstruent stop or fricative followed by a liquid. However, the following sequences are not found in this context: a coronal stop followed by a lateral liquid, or [v] followed by a rhotic or lateral liquid. Additional word-initial clusters beginning with a sibilant fricative are possible. A sibilant fricative may occur before any nonsibilant consonant and before a well-formed two-consonant cluster consisting of a nonsibilant obstruent followed by [r] or [l], although triconsonantal clusters ending in [l] are very rare or absent. We address the status of clusters with [l] in more detail below. A preconsonantal sibilant fricative tends to be post-alveolar and agree in voicing with the following consonant, and we have represented them as such in our broad transcriptions. We discuss variation and voicing agreement involving preconsonantal sibilant fricatives in section 4. The cluster [ʐd-] occurs only in the sequence [ʐdr-]. The absence of [ʐd-] before a vowel at the beginning of a word

[4] In future work it would be valuable to identify clusters that may only occur at morpheme boundaries (see Dressler & Dziubalska-Kołaczyk 2006 on morphonotactics). This issue will be better addressed when documentation of the morphology of present-day Moenat has progressed further.

might be an accidental gap, because [ʒ̩dr-] is possible and also [-ʒ̩d-] may occur before a vowel in word-medial context (see section 3.2.3).

A list of word-initial clusters with words to exemplify is provided in Table 4, organized by type of cluster. Sibilant and nonsibilant fricatives are presented separately, because they show different distributional properties. Rows for clusters that would have involved [tl], [dl], [vl] or [vr] are not shown here, because they are systematically absent. However rows for other gaps that are not so clearly systematic are left in the table.

	EXAMPLE
Plosive-[r]	
[pr-]	[pra] *prà* 'meadow' [preˈar] *prear* 'to pray'
[br-]	[bratʂ] *brac* 'arm' [brøt] *bröt* 'broth'
[tr-]	[trar] *trar* 'to throw' [troˈar] *troar* 'to find'
[dr-]	[drak] *drach* 'dragon' [drɛ] *drè* 'sieve (for grains)'
[kr-]	[ˈkreda] *creda* 'clay' [ˈkraʂpe] *craspe* 'snow shoes'
[gr-]	[grɔs] *gros* 'big' [graˈmial] *gramiàl* 'apron'[5]
Plosive-[l]	
[pl-]	[ˈplɔta] *plota* 'floor tile' [plau] *plao* 'rest, relax'
[bl-]	[blɔk] *bloch* 'block' [ˈblaga] *blaga* 'snooty/arrogant person'
[kl-]	[ˈklampera] *clàmpera* 'clip for tree logs' [klingeˈnar] *clinghenar* 'to ring, to clang'
[gl-]	[gloˈriet] *gloriet* 'kiosk, stand' [ˈglɔria] *gloria* 'glory'
Nonsibilant fricative-[r]	
[fr-]	[ˈfrata] *frata* 'deforested area' [freit] *freit* 'cold'

[5] This form vacillates with [garˈmial] *garmiál*. Both are acceptable forms for the word meaning 'apron'.

Nonsibilant fricative-[l]	
[fl-]	[flink] *flinch* ‘finch’ [flaut] *flaut* ‘flute’
Sibilant fricative-[r]	
[ʐr-]	[ʐraˈmar] *sramar* ‘to cut off the branches from a tree’ (Only example found)
Sibilant fricative-[l]	
[ʐl-]	[ʐlonˈdzɑr] *slongiar* ‘to make longer; to throw away’ [ʐlink] *slinch* ‘a jump, a leap’
Sibilant fricative-nasal	
[ʐm-]	[ʐmaus] *smauz* ‘butter’ [ʐmaˈsar] *smazar* ‘to use/work with a big hammer’
[ʐn-]	[ˈʐnaza] *snasa* ‘sense of smell’ [ʐnigoˈla] *snigolà* ‘cloudy’
[ʐɲ-]	[ʐɲauˈlar] *sgnaolar* ‘to whine’ [ˈʐɲapa] *sgnapa* ‘acquavite, grape-based brandy’
Sibilant fricative-nonsibilant fricative	
[ʂf-]	[ʂfadiˈada] *sfadiada* ‘effort’ [ˈʂfener] *sfener* ‘break, split’
[ʐv-]	[ʐvas] *svaz* ‘a sudden rain’ [ʐvamˈpi] *svampì* ‘careless’
Sibilant fricative-plosive	
[ʂp-]	[ʂpuˈdar] *spudar* ‘to spit’ [ʂparpaˈɲa] *sparpagnà* ‘widespread’
[ʐb-]	[ˈʐbiɔfa] *sbiofa* ‘foam’ [ʐbiˈaf] *sbiàf* ‘faded’
[ʂt-]	[ˈʂtala] *stala* ‘stall’ [ʂtimf] *stinf* ‘sock’
[ʂk-]	[ʂkoiˈtar] *scoitar* ‘to listen’ [ˈʂkazi] *scaji* ‘almost’
[ʐg-]	[ʐgoˈlar] *sgolar* ‘to fly’ [ˈʐgaisa] *sgaiza* ‘eagerness’
[ʐd-]	
Sibilant fricative-nonsibilant fricative-[r]	
[ʂfr-]	[ʂfreˈar] *sfrear* ‘to rub’ [ʂfreiˈdar] *sfreidar* ‘to cool something down’

Sibilant fricative-nonsibilant fricative-[l]	
[ʂfl-]	[ʂfladzɻˈlar] *sflagelar* ‘lash (strike with violence)’ [ʂflaˈdzɻɛl] *sflagel* ‘a large quantity’
Sibilant fricative-plosive-[r]	
[ʂpr-]	[ʂprigoˈlar] *sprigolar* ‘to frighten’ [ʂpriseteˈnada] *sprizetenada* ‘splash N’
[ʐbr-]	[ʐbriˈon] *sbrion* ‘scratch’ [ʐbralˈdzɻar] *sbralgiar* ‘to scream’
[ʂtr-]	[ʂtroˈzet] *stroset* ‘sled (for children)’ [ʂtraneˈos] *straneos* ‘strange’
[ʐdr-]	[ʐdraˈmatʂ] *sdramac* ‘mattress’ [ˈʐdravia] *sdravia* ‘heavy sudden rain’
[ʂkr-]	[ˈʂkrɔza] *scrosa* ‘shell’ [ˈʂkriver] *scriver* ‘to write’
[ʐgr-]	[ʐgriˈfion] *sgrifion* ‘scratch’ [ʐgriʐoˈlon] *sgrijolon* ‘shiver’
Sibilant fricative-plosive-[l]	
[ʂpl-]	[ʂplenˈdor] *splendor* ‘splendor’ (Only example found)
[ʂkl-]	[ˈʂklɛnken] *sclenchen* ‘unsteady’ (Only example found)
[ʐgl-]	[ʐglingeˈnar] *sglinghenar* ‘jingle, ring’ (Only example found)
[ʐɻbl-]	

Table 4. Word-initial consonant clusters.

Word-initial clusters ending in /l/ are generally less common. A historical sound change in Italo-Romance caused lenition of /l/ following an obstruent (Maiden 1995, Krämer 2009). This sound change was evinced in varieties of Val di Fassa Ladin in the 19th century (Salvi 2016), although it did not affect Ladin varieties in other regions. Examples in Moenat that reflect this historical change from words of Latin include [fiɔk] *fioch* ‘snowflake’ < *floccum*, [pien] *pien* ‘full’ < *plenus*, and [kiau] *chiau* ‘key’ < *clavis*. Words beginning with obstruent-[l] clusters are nevertheless attested in the lexicon of present-day varieties of Val di Fassa Ladin. Heilmann (1955: 275) characterizes all such clusters as originating in borrowings, except for the cluster that we transcribe as [ʐɻ-]. Our investigation thus far indicates that [kl-] and [gl-]

are quite uncommon. Furthermore, triconsonantal clusters ending in [l] are strikingly rare. Just two words were identified for [ʂfl-] and only a single word was identified for each of [ʂpl-], [ʂkl-] and [ʐgl-]. Among these, the word beginning with [ʂkl-] ([ˈʂklɛnken] *sclenchen* 'unsteady') was unfamiliar to some of our speakers. No examples were found for [ʐbl-].

Several generalizations emerge regarding word-initial consonant clusters. Apart from clusters with sibilants, word-initial clusters consist of an obstruent followed by a liquid consonant. The range of permissible obstruent-liquid combinations is limited by some restrictions: /l/ never occurs in clusters with a coronal stop, /v/ may not occur before another consonant, and affricates do not occur in word-initial clusters. Sibilant fricatives show special distributional properties. Unlike other obstruents, their distribution does not appear to be constrained by sonority sequencing (Clements 1990), because they can occur before any other consonant except a sibilant. They can also occur preceding any otherwise-attested two-consonant cluster, although triconsonantal clusters ending in /l/ are rare or absent.[6] Nevertheless, preconsonantal sibilant fricatives are more constrained than preconsonantal plosives in that they do not display contrasts for place and voicing.

3.2.2 Word-final consonant clusters

Consonant clusters at the end of a word do not exceed two consonants. Sonorant consonants (i.e. liquids and nasals) may be followed by an obstruent. In addition, liquids may be followed by a nasal. A sibilant fricative may be followed by a plosive or affricate. As seen in word-initial clusters, a preconsonantal sibilant fricative does not show place and voicing contrasts. Like final singletons, final obstruents in a cluster are always realized as voiceless, so both consonants in a final sibilant-obstruent cluster are voiceless. Preconsonantal nasals do not display place contrasts; a nasal is homorganic with a following obstruent (Yang *et al.* 2021), a pattern that we discuss in section 4. Examples of word-final clusters are given in Table 5. Within the range of possible combinations fitting with these parameters, we noted a few gaps that we discuss below.

[6] This gap could perhaps be due to the relative rarity of obstruent-/l/ clusters more generally, but investigating this possibility awaits a detailed examination of frequencies of consonants and cluster combinations.

	EXAMPLE
[r]-plosive	
[-rp]	[kɔrp] *corp* ‘body’ (only example found)
[-rt]	[kurt] *curt* ‘short’ [pɛrt] *pert* ‘lose 3SG’
[-rk]	[alˈbɛrk] *alberch* ‘hotel’ [lark] *larch* ‘large’
[r]-affricate	
[-rtʂ]	[martʂ] *marc* ‘rotten’ [kurtʂ] *curc* ‘short PL’
[r]-nonsibilant fricative	
[-rf]	[sɛrf] *serf* ‘to be needed 3SG’ [nɛrf] *nerf* ‘nerve’
[r]-sibilant fricative	
[-rs]	[ors] *ors* ‘bear’ [mars] *marz* ‘March’
[-rʂ]	[orʂ] *orsc* ‘bear PL’ [korʂ] *corsc* ‘course PL’
[r]-nasal	
[-rm]	[marm] *marm* ‘marble’ [vɛrm] *verm* ‘worm’
[-rn]	[kɔrn] *corn* ‘horn’ [forn] *forn* ‘oven’
[-rɲ]	[kɔrɲ] *corgn* ‘horn PL’ [ʂtorɲ] *storgn* ‘drunk PL’
[l]-plosive	
[-lp]	[bolp] *bolp* ‘fox’ [kolp] *colp* ‘smash, hit N’
[-lt]	[pult] *pult* ‘coffer with many drawers’ [omˈbɔlt] *ombòlt* ‘major’
[-lk]	[solk] *solch* ‘groove’ [valk] *valch* ‘something’
[l]-affricate	
[-ltʂ]	[ʐbaltʂ] *sbalc* ‘jump PL’ [ʂtoltʂ] *stolc* ‘proud PL’

[l]-nonsibilant fricative	
[-lf][7]	
[l]-sibilant fricative	
[-ls]	[zʲbals] *sbalz* 'jump' [ʂkals] *scalz* 'drawer'
[-lʂ]	
[l]-nasal	
[-lm]	[kolm] *colm* 'ridgeline of a roof' (Only example found)
[-ln], [-lɲ]	
Nasal-plosive	
[-mp]	[tʂamp] *ciamp* 'field' [temp] *temp* 'time'
[-nt]	[iˈnant] *inant* 'before' [koˈtant] *cotant* 'how much'
[-nk]	[sank] *sanch* 'blood' [fonk] *fonch* 'mushroom'
Nasal-affricate	
[-ntʂ]	[mantʂ] *manc* 'young bull PL' [pontʂ] *ponc* 'bridge PL'
Nasal-nonsibilant fricative	
[-mf]	[sɛmf] *senf* 'mustard' [ʂtimf] *stinf* 'sock'
Nasal-sibilant fricative	
[-ns]	[mans] *manz* 'young bull (about 1-2 years old)' [aˈsɛns] *asenz* 'absinthe'
[-nʂ]	[inˈtʂenʂ] *incensc* 'incense' (Only example found)
Sibilant fricative-plosive	
[-ʂp]	[aʂp] *asp* 'spindle (on a spinning wheel)' [ruʂp] *rusp* 'hoard (money saved)'

[7] *PODLM* lists a single word with final [-lf] *salf* 'home storage room, closet'; however, none of the six speakers with whom we consulted were familiar with this word, so it appears to not be used by the younger generation. We could not identify any other words with this cluster.

[-ʂt]	[ɔʂt] *ost* 'host, innkeeper' [koʂt] *cost* 'cost N'
[-ʂk]	[bɔʂk] *bosch* 'forest' [freʂk] *fresch* 'fresh'
Sibilant fricative-affricate	
[-ʂtʂ]	[bɔʂtʂ] *bosć* 'forest PL' [pɔʂtʂ] *posć* 'place PL'

Table 5. Word-final consonant clusters.

With respect to gaps and rare clusters, we found only one word ending in [-nʂ]. Clusters of the form [l]-fricative and [l]-nasal are very sparse: the only final [l]-fricative cluster we found was [ls] and the only [l]-nasal cluster was [-lm], the latter in only a single word. Furthermore, word-final [-ns] and [-ls] clusters are not very common; the spelling of the examples we identified, ending in *-nz* and *-lz*, points to these sequences being historically derived from [-nts] and [-lts]. These clusters become [-ntʂ] and [-ltʂ] in the plural, as shown for some examples in Table 5.[8] These considerations suggest that fricatives are largely absent after [n] and [l], except for clusters arising from the development of [ts] to [s]. Nevertheless nasal-[f] clusters are acceptable. This interpretation is consistent for the most part with Heilmann's description of the status of these clusters in word-final position (1955: 275). Heilmann lists nasal-[f] as possible but not [-ns], [-nʂ] or [l]-fricative. Additional final clusters that we found to be uncommon are [-rp], for which we found only one word, and [-ʂp], for which we were able to find just two words, one of which was unfamiliar to some of our speakers – [ruʂp] *rusp* 'hoard (money saved)'. Clusters with /l/ were overall less common, and we found that [-lt]/[-ltʂ] are often associated with words that trace back to German in origin (e.g. [ʂtoltʂ] *stolc* 'proud PL').

To summarize, in word-final position the following two-consonant cluster-types are permitted: sonorant-obstruent, liquid-nasal, sibilant fricative-plosive, and sibilant fricative-affricate. However, clusters with [l] are generally uncommon or absent, and nasal-coronal fricative clusters are also uncommon. Final obstruents in clusters are realized

[8] Instances of final [s] that are spelled with *-s* in Ladin-Fascian orthography become [ʂ] in the plural, e.g. [ors]/[orʂ] *ors/orsc* 'bear SG/PL'. Examples like this, as well as those where [-nts]/[-lts] become [-ntʂ]/[-ltʂ] in the plural, are cases where the plurals are realized with stem modification in the form of 'palatalization' of the final consonant, tracing back to plurals in *-i* for which the *-i* ending is no longer retained (Salvi 2016: 158). However, in Moenat, the post-alveolar realization of the final consonant is not necessarily palatalized, as it may be retroflex.

as voiceless, like final singleton obstruents. Within final clusters, a pre-obstruent sibilant tends to be post-alveolar and it is voiceless, consistent with the voicing agreement seen in word-initial clusters. Nasals are homorganic with a following obstruent.

3.2.3 Word-medial consonant clusters

In word-medial position, consonant clusters have a maximum of three consonants. Word-medial clusters are listed in Table 6. We have divided the table of word-medial clusters into those with rising sonority and those with a plateau or fall in sonority. All triconsonantal clusters are of the latter type with respect to the first two consonants. For clusters that are rising in sonority, we find sequences of a liquid following a plosive, fricative, or nasal. Further, a nasal may follow a sibilant fricative. However, a nonsibilant fricative does not occur before [l] nor did we find any examples of a sibilant fricative before [r]. In addition, affricates do not occur before a liquid, a distribution also seen in word-initial position. These categories are therefore not included in Table 6. In clusters with a plateau or fall in sonority, liquids, nasals and sibilant fricatives occur before the range of classes with lesser sonority. Some further gaps within categories are discussed below.

	EXAMPLE
RISING SONORITY	
Plosive-[r]	
[-pr-]	[kaˈprise] *caprize* ‘whim’ [apriˈʐia] *aprijià* ‘welcome’
[-br-]	[liˈbrar] *librar* ‘to free, liberate’ [ˈlibres] *libres* ‘book PL’
[-tr-]	[paˈtrona] *patrona* ‘cartridge’ [paˈtron] *patrón* ‘master’
[-dr-]	[ˈladro] *ladro* ‘thief’ [føˈdreta] *födreta* ‘pillowcase’
[-kr-]	[maˈʂakro] *masciacro* ‘massacre’ [sakreʂˈtia] *sacrestìa* ‘sacresty’
[-gr-]	[ˈlɛgrema] *lègrema* ‘tear, tear drop’ [saˈgra] *sagrà* ‘cemetery’
Plosive-[l]	
[-kl-]	[peˈklin] *peclin* ‘herring’ [reˈklam] *reclam* ‘complaint; publicity, advertisement’

[-pl-], [-bl-] [-gl-]	
Nonsibilant fricative-[r]	
[-fr-]	[oˈfrir] *ofrir* ‘to offer’ [ˈsifra] *zifra* ‘digit; cypher’
Sibilant fricative-[l]	
[-ʐl-]	[dezʲeˈar] *deslear* ‘to unfasten’ [ˈtiʐʲer] *tisler* ‘carpenter’
Sibilant fricative-nasal	
[-ʐm-]	[dezʲmonˈtar] *desmontar* ‘to get off’ [dezʲˈmeter] *desmeter* ‘to quit’
[-ʐn-]	[dezʲnikiˈta] *desnichità* ‘restless, frantic’ [diʐʲnar] *disnar* ‘to have breakfast’
[-ʐɲ-]	
Nasal-[r]	
[-nr-]	(se) [enraˈbiar] *(se) enrabiar* ‘get angry’ [enrizoˈlar] *enrisolar* ‘curl up’
Nasal-[l]	
[-nl-]	[enlumeˈnar] *enlumenar* ‘light up, illuminate’ [enˈlondʐa] *enlongia* ‘along’
FALLING/PLATEAU IN SONORITY	
[r]-plosive	
[-rp-]	[ʂparpaˈɲa] *sparpagnà* ‘widespread’ [karˈpɛle] *carpele* ‘nailed sole to put under the shoes which prevents one from slipping’
[-rb-]	[endorˈbir] *endorbír* ‘dazzle’ [ˈbarba] *barba* ‘beard; uncle’
[-rt-]	[korˈtɛl] *cortèl* ‘knife’ [ˈmarteʂ] *martesc* ‘Tuesday’
[-rd-]	[tarˈdif] *tardif* ‘late’ [kerˈdeva] *cherdeva* ‘believe 3SG.PST’
[-rk-]	[ˈmɛrkol] *mèrcol* ‘Wednesday’ [ˈsarkie] *sarchie* ‘hoe’
[-rg-]	[arˈgaɲ] *argagn* ‘device’ [ˈpɛrgol] *pèrgol* ‘pulpit’
[r]-affricate	
[-rtʂ-]	[porˈtʂɛl] *porcèl* ‘pig’ [ˈfortʂa] *forcia* ‘pitchfork’

[-rdʐ-]	[karˈdʐega] *cargega* ‘chair’ [arˈdʐa] *argià* ‘larch resin’
[r]-nonsibilant fricative	
[-rf-]	[ˈfɔrfiʂ] *fòrfisc* ‘scissors’ [ˈɔrfen] *òrfen* ‘orphan’
[-rv-]	[ˈkɔrves] *corves* ‘crow PL’ [ˈnɛrves] *nerves* ‘nerve PL’
[r]-sibilant fricative	
[-rs-]	[ˈfɛrsa] *fèrza* ‘hot F’ [perˈsut] *persùt* ‘prosciutto’
[-rz-]	[arˈzent] *arzent* ‘silver’ [ˈverza] *versa* ‘leaf of the cabbage’
[-rʂ-]	[morˈʂil] *morscil* ‘common shrew’ [ʐborˈʂar] *sborsciar* ‘to brush’
[-rʐ-]	[ˈʂkuɛrʐer] *scuerjer* ‘to cover’ [averˈʐon] *averjon* ‘open 1PL.PRS’
[r]-nasal	
[-rm-]	[armentaˈrøla] *armentaröla* ‘one year old calf’ [forˈmia] *formìa* ‘ant’
[-rn-]	[ˈtʂɛrner] *cèrner* ‘to choose’ [ɡarˈneta] *garnéta* ‘cranberry’
[-rɲ-]	[zɡorˈɲela] *sgorgniela* ‘sort of tunic used in winter, overcoat’ (only example found)
[r]-[l]	
[-rl-]	[parˈlar] *parlar* ‘to speak’ [ˈfimferlo] *finferlo* ‘chanterelle’
[l]-plosive	
[-lp-]	[ˈkolpes] *colpes* ‘beat PL’ [ˈpalpa] *palpa* ‘palpate 3SG.PRS; person who is incapable of doing things properly (derogatory)’
[-lb-]	[alˈbɛrk] *alberch* ‘hotel’ [ˈalber] *alber* ‘tree’
[-lt-]	[ˈvɔlto] *volto* ‘arch/barrel roof’ [ˈpalta] *palta* ‘mud’
[-ld-]	[solˈda] *soldà* ‘soldier’ [kalˈdɛra] *caldera* ‘boiler for the cheese’
[-lk-]	[falˈket] *falchét* ‘hawk’ [ˈkalke] *calche* ‘some’

[-lg-]	[ˈbolga] *bolga* ‘bag’ [valˈguŋ] *valgùgn* ‘someone PL’
[l]-affricate	
[-ldz̨-]	[tʂalˈdz̨ɛ] *cialgè* ‘shoemaker’ [ˈøldz̨e] *ölge* ‘eye’
[-ltʂ-]	
[l]-nonsibilant fricative	
[-lf-]	[ʂkalfaˈrɔt] *scalfarot* ‘sock’ [z̨galˈfar] *sgalfar* ‘purloin, steal’
[-lv-]	[salˈvar] *salvar* ‘save’ [ˈpolver] *pólver* ‘powder’
[l]-sibilant fricative	
[-ls-]	[ˈz̨milsa] *smilza* ‘spleen’ [z̨balˈsa] *sbalzà* ‘leapt’
[-lz-], [-lʂ-], [-lz̨-]	
[l]-nasal	
[-lm-]	[ˈpalma] *palma* ‘palm of hand F’ [kolˈmal] *colmal* ‘concave tiles put on the ridge-line of the roof’
[-ln-], [-lɲ-]	
Nasal-plosive	
[-mp-]	[z̨vamˈpi] *svampì* ‘careless’ [ˈʂempie] *scempie* ‘simple’
[-mb-]	[ˈamba] *amba* ‘leg’ [bomˈbɔna] *bombona* ‘kind of sweet cake having the shape of a donut but much bigger eaten at new year’
[-nt-]	[monˈtaŋa] *montagna* ‘mountain’ [ˈpinter] *pinter* ‘cooper’
[-nd-]	[ˈtʂender] *cender* ‘ash’ [ˈvender] *vender* ‘Friday’
[-nk-]	[anˈkø] *ancö* ‘today’ [anˈkona] *ancona* ‘sacred image’
[-ng-]	[ranˈgon] *rangon* ‘billhook’ [ˈlenga] *lenga* ‘tongue’
Nasal-affricate	
[-ntʂ-]	[konˈtʂar] *conciar* ‘repair, fix’ [ˈventʂer] *véncer* ‘win’

[-ndʐ-]	[zɻonˈdʐar] *slongiar* ‘to make longer, to fling’ (se) [ranˈdʐar] *(se) rangiar* ‘to do by yourself’
Nasal-nonsibilant fricative	
[-mf-]	[ˈgomfet] *gónfet* ‘snow carried by the wind’ [imˈfɛrn] *infèrn* ‘hell’
[-mv-]	[emˈvese] *enveze* ‘instead’ [imˈvɛrn] *invèrn* ‘winter’
Nasal-sibilant fricative	
[-ns-]	[linˈsøl] *linzöl* ‘bed sheet’ [tʂanˈson] *cianzón* ‘song’
[-nz-]	[ˈmanza] *mansa* ‘heifer’ [ˈʂfranza] *sfransa* ‘fringe (of hair)’
[-nʂ-]	[enʂemeˈni] *enscemenì* ‘dumb, stoned’ [enʂinaˈmai] *enscinamai* ‘even’
[-nʐ-]	[ˈʂpenʐer] *spénjer* ‘to pull’ [ˈʂtrenʐer] *strénjer* ‘to tighten’
Nasal-nasal	
[-nm-]	[enmadzɻˈnar] *enmaginar* ‘imagine’ [enmulˈdʐar] *enmulgiar* ‘to pile up’
[-mm-], [-ɲm-], [-mn-], [-nn-], [-ɲn-], [-mɲ-], [-nɲ-], [-ɲɲ-]	
Sibilant fricative-plosive	
[-ʂp-]	[deʂˈpɛt] *despet* ‘prank (bad joke)’ [ˈkraʂpe] *craspe* ‘snow shoes’
[-ʐb-]	[dezʐboˈir] *desboir* ‘cool down, stop boiling’ [dezʐˈbater] *desbater* ‘to destroy, demolish’
[-ʂt-]	[ˈmɛʂtie] *mestie* ‘tame, meek’ [tʂaʂˈtɛl] *ciastel* ‘castle’
[-ʐd-]	[dezʐˈdeta] *desdeta* ‘misfortune, accident’ [dezʐˈdɔt] *desdot* ‘eighteen’
[-ʂk-]	[ˈmuʂkie] *muschie* ‘moss’ [ˈiʂkia] *ischia* ‘cane thicket’
[-ʐg-]	[dezʐˈgɔrta] *desgorta* ‘leave-taking’ [dezʐgoˈʐar] *desgojar* ‘unclog, unblock’
Sibilant fricative-affricate	
[-ʂtʂ-]	[ˈmoʂtʂa] *mosćia* ‘a fly’ [ˈmaʂtʂo] *masćio* ‘male’

[-ʐ̪dz̪-]	[dezʐ̪dz̪onˈfar] *desgionfar* ‘to deflate’ [dezʐ̪dz̪aˈʈʂar] *desgiaciar* ‘to defrost’
Sibilant fricative-nonsibilant fricative	
[-ʂf-]	[deʂˈfar] *desfar* ‘to decompose, break down’ [deʂfanˈtar] *desfantar* ‘to dissipate’
[-z̪v-]	[dez̪vaˈnir] *desvanìr* ‘to dissolve’ [az̪ˈvɛlto] *asvelto* ‘quick’
TRICONSONANTAL CLUSTERS	
Sibilant fricative-plosive-[r]	
[-ʂpr-]	[deʂproveˈdu] *desprovedù* ‘unprovided’ [deʂpreˈʐ̪iar] *desprejiar* ‘to despise’
[-z̪br-]	(se) [dez̪braˈnar] *(se) desbranar* ‘to arise from a state of inattention or carelessness’ [dez̪broˈiar] *desbroiar* ‘to disentangle’
[-ʂtr-]	[kaʂˈtra] *castrà* ‘castrated’ [ˈɛʂtro] *estro* ‘the will’
[-ʂkr-]	[deʂˈkrɛdit] *descredit* ‘discredit’ [deʂkrozoˈla] *descrosolà* ‘ready, disentangled, resolved’ (lit. of something whose shell has been removed)
[-ʐ̪gr-]	[dezʐ̪groˈpar] *desgropar* ‘to dissolve, disentangle’ [dezʐ̪groˈsir] *desgrossìr* ‘hew, rough-hew’
[-ʐ̪dr-]	
Sibilant fricative-nonsibilant fricative-[r]	
[-ʂfr-]	[deʂfraˈta] *desfratà* ‘evicted’ (only example found)
Nasal-nonsibilant fricative-[r]	
[-mfr-]	[remfreʂˈʈʂar] *renfresćiar* ‘to cool down (weather)’ [komˈfront] *confrónt* ‘comparison’
Nasal-sibilant fricative-plosive	
[-nʂt-]	[enʂˈtes] *enstes* ‘himself’ (only example found)[9]
[-nʂp-], [-nz̪b-], [-nz̪d-], [-nʂk-], [-nz̪g-]	

[9] Other examples of nasal-sibilant fricative-plosive sequences found in the dictionaries were identified by our primary consultant as occurring in compounds or recent loans.

Nasal-plosive-[r]	
[-mpr-]	[empreʂˈtar] *emprestar* ‘to lend’ [komˈprar] *comprar* ‘to buy’
[-mbr-]	[omˈbria] *ombria* ‘shadow’ [ˈkambra] *cambra* ‘bedroom’
[-ntr-]	[enˈtrek] *entrech* ‘full, whole’ [ʂkonˈtrar] *scontrar* ‘to come across, encounter’
[-ndr-]	[ˈmandra] *mandra* ‘open space surrounded by forest where cattle can graze’ [ˈsondra] *zondra* ‘alpenrose’ (*Rhododendron ferrugineum*)
[-nkr-]	[konkretiˈzar] *concretisar* ‘to realize’ [enkroˈzą] *encrojà* ‘criss cross’
[-ngr-]	[konˈgres] *congress* ‘congress’ [engroˈpar] *engropar* ‘to tie’
[l]-plosive-[r]	
[-ltr-]	[polˈtron] *poltron* ‘lazy’ [kolˈtrina] *coltrina* ‘curtain’
[-lpr-], [-lbr-], [-ldr-], [-lkr-], [-lgr]	
[r]-sibilant fricative-plosive	
[-rʂt-]	[ferʂˈtɔnt] *ferstont* ‘intelligence’ (only example found)
[-rʂp-], [-rʐb-], [-rʐd-], [-rʂk-], [-rʐg-]	

Table 6. Word-medial consonant clusters.

In word-medial context we observed several gaps and rare clusters on which we provide some further comments here. For clusters that rise in sonority, the lack of affricate-liquid clusters is consistent with Heilmann (1955). The lack of [v]-liquid sequences matches what was observed in word-initial context, but the absence of [-fl-] differs from word-initial position. Overall, the lateral is rare following an obstruent except in the cluster [-ʐl-]. Similar to word-initial context, Heilmann characterizes all other obstruent-[l] clusters as unattested or in loans. We identified two words with [-kl-] that originated in borrowings and otherwise did not find examples with nonsibilant obstruent-[l] sequences that were familiar to our speakers.

In clusters with a plateau or fall in sonority, [l] is more robustly attested overall, though combinations with some affricates, fricatives and nasals are sporadically rare or missing. For example, following [l], the only affricate is [dzʐ], the only sibilant fricative is [s] and the only nasal is [m]. These observations are consistent with what Heilmann reports.

We also found that words with [-lf-] are few and unfamiliar to some of our speakers. There were a few uncommon sequences beginning with [r]: we identified only one word with [-rɲ-] and it was only familiar to one of our speakers, and [-rf-] is not very common, though it occurs in loans. Nasal-nasal sequences are limited to [-nm-]. We return to the realization of these clusters in the discussion of nasal place assimilation in section 4.

Triconsonantal clusters are attested consisting of a sibilant fricative, nasal or [l] followed by a plosive or nonsibilant fricative, followed by [r]; however, in triconsonantal clusters, [l] occurs only in the sequence [-ltr-]. We also identified an example each of a nasal or liquid followed by a sibilant fricative, followed by a plosive, though these sequences are rare, and were not identified as possible intervocalic sequences by Heilmann (1955). We therefore treat these latter clusters as marginal in the Moenat lexicon.

Finally, although sibilant fricatives can precede most consonants, we did not find words with [-zr-] or [-zɲ-]. We also did not identify any words with [-zdr-], although this sequence is attested in word-initial position.

3.3 Summary and discussion

In overview, the possible consonant cluster types in Moenat are summarized in Table 7.

# OF CS	WORD INITIAL	WORD MEDIAL	WORD FINAL
1	C	C	C except voiced obstruents
2	T + L F + L S + C	T + L F + L N + C L + C S + C	L + T L + A L + F L + S L + N N + T N + A N + F N + S S + T S + A
3	S + T + L S + F + L	L + T + L (L + S + T) N + T + L N + F + L (N + S + T) S + F + L S + T + L	None

Table 7. Types of consonant clusters in Moenat. C = any consonant, T = plosive, A = affricate, F = nonsibilant fricative, S = sibilant fricative, N = nasal, L = liquid.

Marginal clusters are indicated with parentheses.

Table 7 spotlights the types of consonant sequences that are possible based on manner. Within these sequences, a few systematic cooccurrence restrictions limit combinations across the board. Sequences of sibilant fricatives do not occur (*SS), nor do sequences of a coronal stop followed by [l] (*tl, *dl) and [v] followed by a liquid (*vr, *vl). Some additional limits on combinations arise from assimilation (obstruent voicing and nasal place) and neutralization (final devoicing, sibilant place). We discuss these in the next section. While [l] is generally rare in clusters, we will not treat this further here, as it warrants further study in the context of frequency.

Some general observations about the distribution of consonants in syllables can be made in terms of a scale of sonority (see Parker 2002 for an overview) or 'consonantal strength' (Vennemann 1988). Apart from clusters with sibilants, word-initial clusters are of the form obstruent-liquid and respect the Sonority Sequencing Principle (Clements 1990). Sibilant fricatives freely precede possible onsets without a sibilant: they may occur before any single consonant (excluding a sibilant fricative or affricate) or an obstruent-liquid cluster. Sibilant fricatives that precede an obstruent in word-initial position would not respect sonority sequencing in the syllable onset, and could therefore potentially be analyzed as an appendix that is external to the syllable at the left word edge (e.g. Davis 1990, Goad & Rose 2004, Baertsch 2012). This structure is consistent with findings of the aforementioned acoustic study of temporal alignment in word-initial sibilant-stop clusters of Moenat by Walker & Yang (2023), which suggests that a sibilant in this context is external to the syllable onset. The restriction to sibilants in an appendix could be related to their perceptual cues (Wright 2004, Goad 2011, Henke *et al.* 2012).

In broad terms, word-medial clusters essentially mirror word-initial clusters with the additional possibility for liquids and nasals to precede another single consonant or an obstruent-liquid cluster.[10] These additional clusters are consistent with all cluster-initial sonorant consonants belonging to a preceding simple coda in intervocalic clusters. As mentioned above, the occurrence of a liquid or nasal before a sibilant fricative-plosive sequence is marginal. The sole example of [-nʂt-] identified in Table 6 may have originated historically in a compound, and the

[10] In addition, an affricate may follow a sibilant fricative word-medially.

sole example of [-rʂt-] listed in Table 6 originated in a borrowing from German. The marginality of clusters with these sonority profiles suggests that word-medial syllables beginning with a sibilant fricative-plosive sequence are not structurally robust in Moenat. Therefore, word-medial clusters in which a sibilant fricative precedes an obstruent are plausibly syllabified with the sibilant fricative in the coda of the syllable with the preceding vowel. Nonetheless, given empirical issues involving the syllabification of intervocalic sC sequences in the related language of Italian (Bertinetto 2004), further research on this issue is warranted. If sibilant fricatives can form a word-medial coda and be external to the onset in a word-initial cluster, as suggested above, the constituents of singleton onsets and onset clusters can be considered to be parallel in structure in word-initial and word-medial position.

Given the postulated syllabification of word-medial clusters, the set of consonants that can occur in a word-medial coda, consisting of {liquids, nasals, sibilant fricative}, is parallel to that which can occur as the first member of a word-final cluster. However, word-final simple codas allow all consonants except voiced obstruents. The contexts of a word-medial simple coda and the first member of a coda cluster share coda status and the frame of V_C. As for word-final clusters, they regularly fall in sonority. Falling sonority can be generalized over four main categories: Liquid > Nasal > Fricative > Noncontinuant Obstruent. However, sequences of a fricative followed by a non-continuant obstruent (plosive or affricate) are limited to clusters beginning with a sibilant fricative.

The structure of Moenat syllables can be situated in general terms with respect to related languages. Schmid (1997, 1998) has compared properties of syllable markedness, including margin complexity and sonority, in a number of Italo-Romance varieties (on syllable markedness, see the preference laws of Vennemann 1988). Syllables that are more marked along these lines show more association with stress-timing than syllable-timing, terms that characterize properties on a continuum. Schmid finds that the most complex syllables occur in northern varieties, such as Feltrino, Friulian and Romagnolo, tending in the direction of the stress-timed pole. For example, these varieties allow many closed syllables and a large variety of syllable types, in contrast to varieties such as Sicilian, Standard Italian and Venetian. Like the northern varieties in question, Moenat has many syllables with word-final codas, including biconsonantal complex codas and codas with a voiceless obstruent. While these characteristics contribute to a more marked range of syllable structures, Moenat complex codas nevertheless respect sonority sequencing. However, in Friulian, which belongs with Ladin varieties in the Rhaeto-Romance group (Haiman & Benincà 1992), word-final clus-

ters with three consonants are allowed, arising from suffixation of plural *-s*, even after an obstruent. With respect to onset complexity, Moenat is relatively conservative, exhibiting biconsonantal clusters with rising sonority. It also allows word-initial triconsonantal clusters with a sibilant preceding a stop or labiodental fricative. While the triconsonantal clusters do not rise in sonority, the word-initial sibilant may be considered external to the onset, and word-initial sequences of this kind are not unusual across Italo-Romance varieties. This situation stands in contrast to word-initial consonant clusters in Romagnolo, which may contain up to four consonants and show a wider range of sonority sequencing reversals and plateaus as a result of diachronic syncope, e.g. *dstrut* 'destroyed', *vspre* 'wasp's nest', *pké* 'sin' *sbdel* 'hospital' (Schmid 1997: 261). Moenat thus shows a degree of syllable markedness that fits broadly with other northern varieties, though it does not fall at the extreme.

4. Phonological patterns and variation

We now turn to phonological patterns involving assimilation and neutralization as well as variation in the realization of consonants.

4.1 Final devoicing

As is evident in the presentation of distribution of singleton consonants in Table 3 and word-final clusters in Table 5, Moenat systematically excludes final voiced obstruents. Examples of voicing alternations are provided in Table 8.

	WORD-MEDIAL OBSTRUENT	WORD-FINAL OBSTRUENT
[v] ~ [f]	[ˈrives] *rives* 'river PL'	[rif] *rif* 'river'
	[ˈøves] *öves* 'egg PL'	[øf] *öf* 'egg'
[ʐ] ~ [ʂ]	[ˈlarezes] *larejes* 'larch PL'	[ˈlareʂ] *laresc* 'larch'
	[ˈuzes] *ujes* 'door PL'	[uʂ] *usc* 'door'
[g] ~ [k]	[ˈfonges] *fonghes* 'mushroom PL'	[fonk] *fonch* 'mushroom'
	[ˈspages] *spaghes* 'string PL'	[spak] *spach* 'string'

Table 8. Voicing alternations in obstruents in word-medial versus word-final position.

Voicing alternations are illustrated in Figures 1-2. Figure 1 shows the spectrogram and waveform for [ˈøves] *öves* 'egg PL' and [øf] *öf* 'egg'. In [ˈøves], the word-medial labiodental fricative is voiced, while in [øf],

the fricative is voiceless in word-final position. A similar alternation is seen in a post-nasal stop in Figure 2. In [ˈfonges] *fonghes* 'mushroom PL', the word-medial velar stop is voiced (and very short), but it is voiceless in word-final position in [fonk] *fonch* 'mushroom'. Though this detail is not shown in our broad transcription, the nasal in these words undergoes place assimilation to the following velar stop, as we discuss in section 4.3.

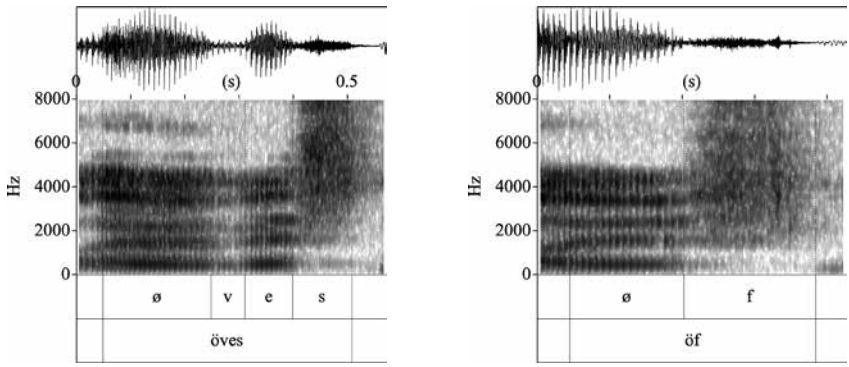

Figure 1. Sample spectrogram and waveform for [ˈøves] *öves* 'egg PL' (left) with a voiced labiodental fricative and [øf] *öf* 'egg' (right) with a voiceless labiodental fricative, produced by speaker 5 (M).

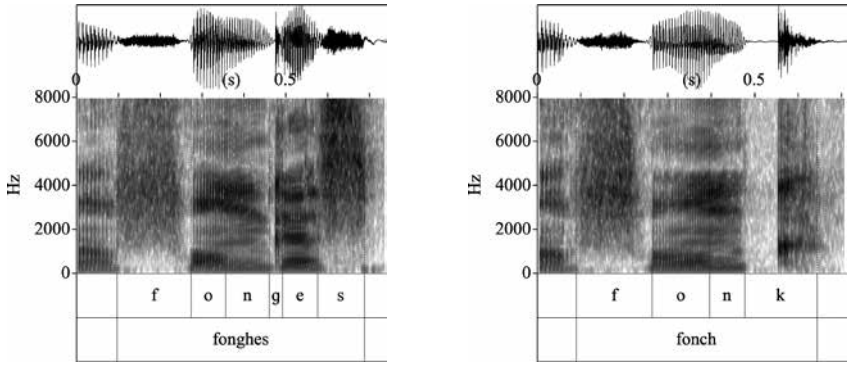

Figure 2. Sample spectrogram and waveform for [ˈfonges] *fonghes* 'mushroom PL' (left) with a voiced velar stop and [fonk] *fonch* 'mushroom' (right) with a voiceless velar stop, produced by speaker 6 (M).

In some cases, an intervocalic obstruent was originally voiceless in the Latin form and became voiced in Ladin, e.g. [ˈlarezes] 'larch PL' <

larices. Nevertheless, in Moenat, the distribution has evolved such that voicing is contrastive in intervocalic context but is neutralized word finally. This is supported by the occurrence of word-medial voiceless obstruents, exemplified in Table 3 and by plural/singular pairs where a stem-final voiceless obstruent is voiceless in both word-medial and final position, shown in Table 9. We therefore posit that voiced obstruents in intervocalic position are represented as voiced underlyingly for speakers of present-day Moenat.

	WORD-MEDIAL OBSTRUENT	WORD-FINAL OBSTRUENT
[p]	[ˈgrɔpes] *gropes* 'knot PL' [ˈpɔpes] *popes* 'kid PL'	[grɔp] *grop* 'knot' [pɔp] *pop* 'kid'
[f]	[ˈtʂɔfes] *ciofes* 'lock (of hair); bunch (of flowers) PL'	[tʂɔf] *ciof* 'lock (of hair); bunch (of flowers)'
[ʂ]	[ˈfaʂes] *fasces* 'bundle PL'	[ˈfaʂ] *fasc* 'bundle'
[k]	[ˈfiɔkes] *fiòches* 'snowflake PL'	[fiɔk] *fiòch* 'snowflake'

Table 9. Non-alternating voiceless obstruents.

In word-final obstruent clusters, both obstruents are voiceless. An example of a word-final cluster of a voiceless sibilant followed by a voiceless stop is shown in Figure 3 for the word [freʂk] *fresch* 'fresh'.

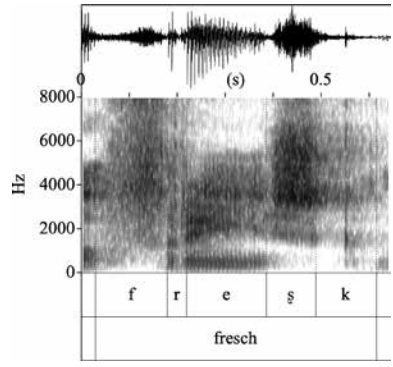

Figure 3. Sample spectrogram and waveform for [freʂk] *fresch* 'fresh' with a word-final sequence of a voiceless sibilant fricative followed by a voiceless stop, produced by speaker 5 (M).

Obstruents thus show devoicing in word final position and show voicing agreement with a following obstruent. Voicing agreement is

further confirmed by clusters with sibilant fricatives in word-initial and word-medial position, discussed in the next section.

4.2 Sibilant fricatives

Sibiliant fricatives exhibit voicing agreement and neutralization in contrast for place of articulation as well as variation of various kinds. To begin, in preconsonantal context, sibilant fricatives tend to show voicing agreement with the following consonant. An example in word-final position preceding a voiceless plosive was presented in Figure 3. Waveforms and spectrograms in Figure 4 provide some further examples. A sibilant is voiced in [ʐvamˈpi] *svampì* 'careless', where it appears before a voiced consonant, but it is voiceless in [ʂfadiˈada] *sfadiada* 'effort', where it appears before a voiceless consonant.

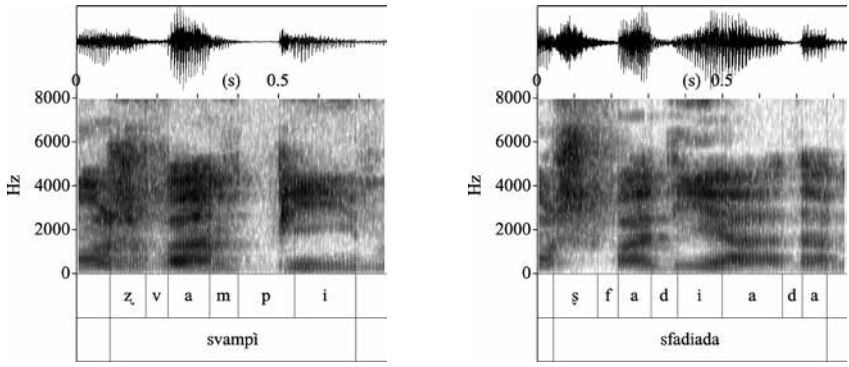

Figure 4. Sample spectrogram and waveform for [ʐvamˈpi] *svampì* 'careless' (left) with a voiced post-alveolar sibilant and [ʂfadiˈada] *sfadiada* 'effort' (right) with a voiceless post-alveolar sibilant, produced by speaker 5 (M).

However, for some speakers a preconsonantal sibilant fricative may vacillate in voicing before a voiced consonant. Vacillation in voicing in word-initial context was also noted by Heilmann (1955: 274-5). Vacillation is illustrated in Figure 5 with a comparison of two sibilant fricatives produced before a voiced sonorant consonant by the same speaker. In the production of the word [ʐlonˈdʐar] *slongiar* 'to make longer, to fling', the word-initial fricative is at least partially voiced, with a voicing bar evident before release of the fricative, while in the production of the word *smilza* 'spleen', the word-initial fricative is voiceless [ˈʂmilsa] rather than the more typical pronunciation [ˈʐmilsa]. Vacillation in voicing of a sibilant before a voiced consonant is more

prone to occur before a sonorant consonant, although a few instances were also observed before a voiced obstruent.

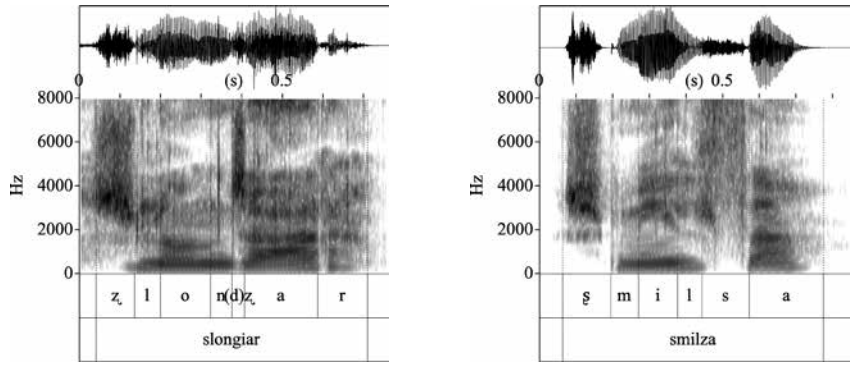

Figure 5. Sample spectrogram and waveform for [zɻonˈdzɻar] *slongiar* 'to make longer, to fling' (left) with a word-initial post-alveolar sibilant that is at least partially voiced and [ˈʂmilsa] *smilza* 'spleen' (right) with a word-initial voiceless post-alveolar sibilant, produced by speaker 1 (F).

We turn next to place of articulation, starting with variation in the place of singleton sibilants in Moenat. The observations reported here are based on the authors' audible perception of differences that we characterize as 'retroflex' and 'non-retroflex'; however, we do not have direct information about the articulation of these sounds. Among the four Val di Fassa Ladin speakers examined in Yang *et al.* (2021), the single Moenat speaker consistently produced what Yang *et al.* characterized as retroflex realizations, while the speakers of Brach and Cazet in that study produced non-retroflex post-alveolar sibilants. Though acoustic distinctions between retroflex and non-retroflex fricatives are subtle (Hamann 2003, 2004), Yang *et al.* (2021) found that the spectral shape of retroflex sibilants produced by the Moenat speaker showed a lower peak frequency than non-retroflex post-alveolar sibilant fricatives in Brach and Cazet, suggesting a potential qualitative difference.[11] Furthermore, based on spectral analysis, Yang *et al.* (2021) found that the Brach and Cazet speakers showed some fronting of post-alveolar fricatives resulting in (near-)merger with the dental/alveolar fricative. Among the Moenat speakers in this study, we observed that some

[11] However, caution is needed in comparison of fricative spectra across speakers (Hamann 2003, 2004).

speakers are generally consistent in producing post-alveolar sibilants of the kind that we refer to as retroflex [ʂ, ʐ, tʂ, dʐ], while others vary between retroflex and non-retroflex productions. Though the transcriptions may seem to suggest a categorical difference, the variation in degree of perceived retroflexion is gradient in some cases. The words in Table 10 illustrate instances of perceived variable realizations of post-alveolar sibilant fricatives in different syllable positions, using narrower transcription than we do for these fricatives elsewhere in this paper. As illustrated here, speaker 2 varied between retroflex and non-retroflex productions. In comparison, all of the sibilants shown in bold produced by speaker 5 in these words were perceived as retroflex. Following Yang *et al.* (2021), we transcribe the non-retroflex voiceless post-alveolar fricatives as [**s̠**]. Nevertheless, it is possible that some of these are also produced with some degree of fronting, approaching alveolar.

ORTHOGRAPHY	SPEAKER 2	SPEAKER 5	GLOSS
stolz	[s̠tolts]	[ʂtols]	'proud'
sflagel	[s̠flaˈdzɛ̠l]	[ʂflaˈdzɛ̠l]	'a large quantity'
laresc	[ˈlares̠]	[ˈlareʂ]	'larch'
usc	[us̠]	[uʂ]	'door'
scì	[ʂi]	[ʂi]	'yes'
orsc	[orʂ]	[orʂ]	'bear PL'
dasc	[daʂ]	[daʂ]	'give 3SG.PRS'

Table 10. Variation in realization of post-alveolar sibilant fricatives.

Chiocchetti (2017) found a retroflex realization of post-alveolar fricatives for three Cazet speakers recorded in 1960. This is suggestive that the retroflex realization was previously more widespread in Val di Fassa Ladin, but has gradually shifted to a non-retroflex form, perhaps driven by contact with Italian. Nevertheless, the retroflex forms are characteristic of the speech of some speakers of Moenat.

The dental/alveolar fricative phonemes vary in production along a dental-alveolar continuum, with some fricatives considerably fronted (dentalized). We observed this to be more common with /s/, and with some speakers more than others. An example of variation is shown in Figure 6, which shows the spectrogram and waveform for a production of [ˈbronsa] *bronza* 'embers', for which the fricative is a dental/alveolar sibilant [s] and a production of [linˈsøl] *linzöl* 'bed sheet' for which a

narrower transcription of the fricative would be dental [θ]. Both words were produced by the same speaker and are in a similar context, prevocalic and following a nasal. In the spectrograms, it can be observed that the energy during the fricative is concentrated in the 4000 Hz - 5000 Hz range for this production of [ˈbronsa], while for [linˈsøl], the energy is distributed more evenly over a wider frequency range.

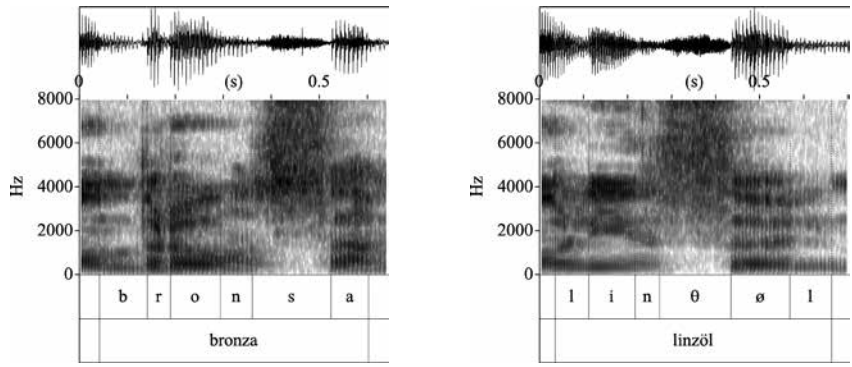

Figure 6. Sample spectrogram and waveform for [ˈbronsa] *bronza* 'embers', (left) with a more posterior dental/alveolar fricative and [linˈsøl] *linzöl* 'bed sheet' (right) with a fronted (dentalized) fricative, produced by speaker 5 (M).

In preconsonantal context, a sibilant fricative tends to be post-alveolar or it vacillates between dental/alveolar and post-alveolar. This might be due to an influence of Italian. We found that some speakers are especially prone to produce a dental/alveolar fricative before a dental/alveolar plosive stop.

To summarize, contrasts in place and voicing among sibilant fricatives are neutralized in preconsonantal context. While the tendency is for a preconsonantal sibilant fricative to be neutralized to a post-alveolar place that agrees in voicing with a following consonant, a preconsonantal sibilant may be neutralized to voiceless, i.e. a sibilant fricative may be voiceless before a voiced consonant, and it may show some variation in place/retroflexion. Singleton and prevocalic sibilants are also susceptible to some range of variation in place and retroflexion both within and across speakers. For a more complete picture of the production and variation of Moenat place in sibilants, an articulatory study would be valuable, as would a spectral analysis of multiple speakers and within-speaker variation, to expand on the single-speaker study of Moenat by Yang *et al.* (2021).

4.3 Nasal place assimilation

Nasal place assimilation to a following obstruent is illustrated in Table 11, with a finer level of phonetic detail than our broad transcriptions.

[mp]	[temp] *temp* 'time'
[mf]	[ʂtimf] *stinf* 'sock'
[nt]	[iˈnant] *inant* 'before'
[ns]	[mans] *manz* 'young bull (about 1-2 years old)'
[nʈʂ]	[manʈʂ] *manc* 'young bull PL'
[nʂ]	[inˈʈʂenʂ] *incensc* 'incense'
[ŋk]	[foŋk] *fonch* 'mushroom'

Table 11. Nasal place assimilation.

Nasal-nasal clusters are limited to [-nm-]. One speaker produced these on occasion as [mm-]. These productions appeared to be realized as a long bilabial nasal rather than deletion of the first nasal; however, further analysis is needed on the length of this consonant.

Preconsonantal nasals are sometimes weakened word-medially. In some instances, the preceding vowel is at least partially nasalized when a nasal stop is weakened. Nasal weakening is especially prone to occur before [r]. An example is shown in Figure 7, with the word [(se) enraˈbiar] *(se) enrabiar* 'get angry'. The spectrogram and waveform on the left show a representative production for one speaker, in which the nasal is partially or fully absent, while another speaker, whose production is illustrated on the right, tends to preserve the nasal before [r].

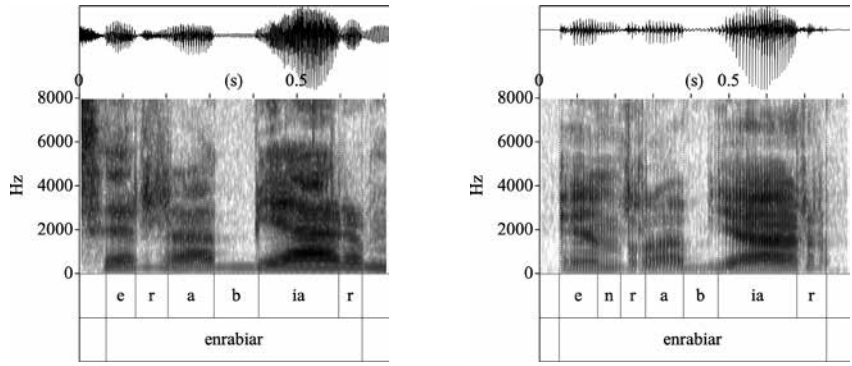

Figure 7. Sample spectrograms and waveforms for [(se) enraˈbiar] *(se) enrabiar* 'get angry' with a reduced/absent nasal (left), produced by speaker 2 (F), and with retention of the nasal (right), produced by speaker 6 (M).

Possibly a nasal before [r] is more prone to be elided because of aerodynamic and articulatory demands of the trill. Kochetov & Colantoni (2013) have suggested that such factors could be related to sound changes in Romance languages that have altered historical nasal-trill sequences (see also Solé 2002).

5. Conclusion

In this paper we have contributed new data and analysis on the understudied Moenat variety of Ladin, with focus on the speech of the current generation of younger adults. In this study, we have examined the consonants of Moenat and their phonotactic patterns. With respect to the consonantal phonemic system, we have proposed six sibilant phonemes based on present-day speech that are classified differently from the investigation of Moenat in 1955. In addition, we have found some variability in the realization of sibilant fricatives in place and voicing. With respect to the distribution of consonants, we have provided a systematic investigation and exemplification of possible singletons and clusters in different positions in the word and related the available clusters to sonority sequencing profiles, syllable structure and phonological patterns of assimilation and neutralization. While many open issues remain, this work paves the way for future experimental and theoretical investigations into the phonology and phonetics of Moenat Ladin.

Abbreviations

1, 2, 3 = first, second, third person; A = affricate; C = any consonant; F = nonsibilant fricative / female speaker; F = feminine; IMP = imperative; L = liquid; M = male speaker; N = nasal; N = noun; PL = plural; PRS = present; PST = past; PTCP = participle; S = sibilant fricative; SG = singular; T = plosive.

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Appendix I

The archive of sound files associated with this article can be found here: https://osf.io/emgbn/

Appendix II
Minimal pairs for consonants

	MINIMAL PAIRS		
VOICING			
/p/ ~ /b/	[pal] *pal* 'pole'	~	[bal] *bal* 'dance N'
/t/ ~ /d/	[ton] *ton* 'thunder'	~	[don] *don* 'gift'
/k/ ~ /g/	[ˈkola] *cola* 'filter 3SG.PRS'	~	[ˈgola] *gola* 'throat'
/tʂ/ ~ /dʐ/	[ˈtʂata] *ciata* 'paw'	~	[ˈdʐata] *giata* 'female cat'
/f/ ~ /v/	[fal] *fal* 'error, mistake'	~	[val] *val* 'valley'
/s/ ~ /z/	[sal] *sal* 'salt'	~	[zal] *śal* 'yellow'
/ʂ/ ~ /ʐ/	[ʂi] *scì* 'yes'	~	[ʐi] *jì* 'go 2PL.IMP'
PLACE			

/p/ ~ /t/	[pai] *pai* ‘pole PL’	~	[tai] *tai* ‘cut N’
/p/ ~ /k/	[pel] *pel* ‘body hair’	~	[kel] *chel* ‘that’
/t/ ~ /k/	[tai] *tai* ‘cut N’	~	[kai] *cai* ‘corn (dead skin) PL’
/b/ ~ /d/	[but] *but* ‘shoot, sprout (botany)’	~	[dut] *dut* ‘all, everything’
/b/ ~ /g/	[bas] *bas* ‘low’	~	[gas] *gas* ‘gas’
/d/ ~ /g/	[fiˈda] *fidà* ‘trust PST.PTCP’	~	[fiˈga] *figà* ‘liver’
/f/ ~ /s/	[fɔrt] *fort* ‘strong’	~	[sɔrt] *sòrt* ‘kind, sort’
/f/ ~ /ʂ/	[fior] *fior* ‘flower’	~	[ʂior] *scior* ‘gentleman (often referring to a tourist)’
/s/ ~ /ʂ/	[ˈpisa] *piza* ‘itch N’	~	[ˈpiʂa] *piscia* ‘urinate 3SG.PRS’
/v/ ~ /z/	[val] *val* ‘valley’	~	[zal] *śal* ‘yellow’
/v/ ~ /ʐ/	[vent] *vent* ‘wind’	~	[ʐent] *jent* ‘people’
/z/ ~ /ʐ/	[zal] *śal* ‘yellow’	~	[ʐal] *jal* ‘at (downwards) the’
/m/ ~ /n/	[mas] *maz* ‘deck of cards’	~	[nas] *nas* ‘nose’
/m/ ~ /ɲ/	[ˈmama] *mama* ‘mummy’	~	[ˈmaɲa] *magna* ‘eat 2SG.IMP’
/n/ ~ /ɲ/	[ˈmana] *mana* ‘drive 3SG.PRS’	~	[ˈmaɲa] *magna* ‘eat 2SG.IMP
MANNER			
/t/ ~ /tʂ/	[ˈtʂata] *ciata* ‘paw’	~	[ˈtʂatʂa] *ciacia* ‘hunt N’
/d/ ~ /dʐ/	[dal] *dal* ‘from the’	~	[dʐal] *gial* ‘rooster’
/p/ ~ /f/	[par] *par* ‘couple’	~	[far] *far* ‘to do’
/t/ ~ /s/	[ton] *ton* ‘thunder’	~	[son] *son* ‘sound’
/b/ ~ /v/	[bal] *bal* ‘dance N’	~	[val] *val* ‘valley’
/d/ ~ /z/	[dal] *dal* ‘from the’	~	[zal] *śal* ‘yellow’
/b/ ~ /m/	[bal] *bal* ‘dance N’	~	[mal] *mal* ‘pain’
/d/ ~ /n/	[dut] *dut* ‘all, everything’	~	[nut] *nut* ‘naked’
/d/ ~ /l/	[dutʂ] *duc* ‘all PL’	~	[lutʂ] *luc* ‘wolfsbane’
/d/ ~ /r/	[deʂˈpɛt] *despet* ‘prank (bad joke)’	~	[reʂˈpɛt] *respet* ‘respect’
/tʂ/ ~ /ʂ/	[ˈtʂɔdo] *ciodo* ‘nail’	~	[ˈʂɔdo] *sciodo* ‘hard (hard-boiled)’
/dʐ/ ~ /ʐ/	[dʐal] *gial* ‘rooster’	~	[ʐal] *jal* ‘at (downwards) the’
/n/ ~ /l/	[nɛt] *net* ‘clean’	~	[lɛt] *let* ‘bed’
/n/ ~ /r/	[ˈnoe] *noe* ‘really (only used as a question, ‘really?’)’	~	[ˈroe] *roe* ‘water spring PL’

/l/ ~ /r/	[ˈlana] *lana* ‘wool’	~	[ˈrana] *rana* ‘frog’

Table A1. Minimal pairs to illustrate contrasts for voicing, place of articulation, and manner among consonants.

Appendix III
Minimal pairs for vowels

The vowel contrasts are illustrated with minimal sets in Table A2, after Yang *et al.* (2021).

CONTRAST	MINIMAL PAIRS/SETS
/i/ ~ /e/ ~ /ɛ/ ~ /a/ ~ /u/	[mis] *miz* ‘wet’ [mus] *mus* ‘face’ [mes] *mes* ‘month’ [mɛs] *mez* ‘half’ [mas] *maz* ‘deck of cards’
/e/ ~ /o/	[petʂ] *pec* ‘fir’ [potʂ] *poc* ‘water well PL’
/ɛ/ ~ /ɔ/	[tɛk] *tech* ‘wet’ [tɔk] *toch* ‘piece’
/o/ ~ /ɔ/	[bot] *bot* ‘barrel’ [bɔt] *bòt* ‘heart attack; pop sound’
/ɔ/ ~ /a/	[ɔs] *ɔs* ‘bone’ [as] *as* ‘ace’
/ø/ ~ /e/	[nøf] *nöf* ‘new’ [nef] *nef* ‘snow’
/ø/ ~ /o/	[kør] *cör* ‘heart’ [kor] *cor* ‘run 3SG.PRS’
/ø/ ~ /ɔ/	[nøʂ] *nösc* ‘our PL’ [nɔʂ] *nosc* ‘our SG’

Table A2. Minimal pairs for Moenat vowel contrasts.

The acoustic vowel space was computed based on five native speakers of Moenat, three female and two male, plotted separately by gender. To produce the formant chart, we used the list of words in Table A3. Each word had ten repetitions. The audio files were annotated by trained research assistants, then the formants were extracted with the

script *FormantPro* (Xu & Gao 2018) in Praat (Boersma 2001).[12] The vowel space was plotted with the *phonR* library (McCloy 2012) in R (R core team 2020, <www.r-project.org/index.html>), as shown in Figure A1. We observe that for male speakers the vowel space is more compressed and back than for female speakers.

VOWEL	WORD	VOWEL	WORD
[i]	[piʂ] *pisc* 'urination'	[o]	[pos] *poz* 'well N'
[u]	[mus] *mus* 'face'	[ɛ]	[mɛs] *mez* 'half'
[e]	[peʂ] *pesc* 'fish'	[ɔ]	[bɔt] *bòt* 'pop, shot N'
[ø]	[nøf] *nöf* 'new'	[a]	[paʂ] *pasc* 'peace'

Table A3. Words used to illustrate the vowel space of Moenat.

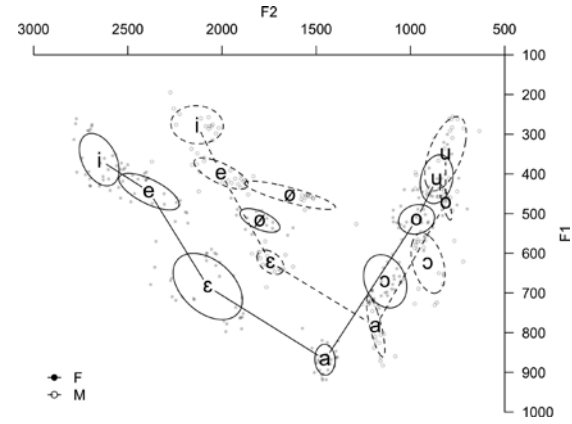

Figure A1. Vowel space of Moenat plotted by gender. Solid lines correspond to the vowel space for female speakers and dashed lines for male speakers.

[12] For tokens that posed difficulty for automatic formant extraction, the formants were manually measured by the authors.