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Diachronic developments in fricative + nasal sequences: a Tibeto-Burman case study

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Diachronic developments in fricative + nasal sequences

Abstract: Through comparison of regular sound correspondences in three closely related Tibeto-Burman (TB) languages, Ersu, Lizu, and Duoxu (collectively “ELD”), informed by external comparison with other TB languages and recent phonetic analyses of the production of voiceless nasals, we reconstruct *fricative-nasal sequences in their common ancestor, Proto-ELD.

In the development of these historic clusters, two pathways of change can be recognized. Their difference lies in the divergent relative phasing of velic and oral gestures in the original fricative-nasal sequences:

- (i) fricative weakening (from a tight cluster): *FN > N̥ > ĥ > x
- (ii) fricative strengthening (from a loose cluster): *F-n > *F-t > t > k or *F-n > s

The different reflexes observed in Ersu, Lizu, and Duoxu represent different points along these two developmental pathways. These reconstructions and pathways of development have implications for our understanding of both universal (phonetic) and language-specific aspects of change in fricative-nasal sequences. The first pathway makes it possible to explore the process of nasal devoicing beyond voiceless nasals so as to enrich our understanding of nasal devoicing in natural languages. The co-existence of two opposite pathways of change, on the other hand, provides insights into the morphological and syllabic structure of words with contiguous fricative-nasal sequences in ELD languages at different points in time—insights that may be valuable in examining the history of other languages and language families beyond the ELD cluster.

Keywords: fricative-nasal sequences; nasal devoicing; voiceless nasal; epenthetic stop; Tibeto-Burman; Qiangic

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1. Introduction

Patterns of coarticulation in contiguous fricative and nasal sequences (in both orders, that is, a sequence of a fricative followed by a nasal or of a nasal followed by a fricative) have been extensively explored during the past few decades in relation to both synchronic variation and diachronic change in a variety of languages (e.g. Ali, Daniloff & Hammarberg 1979; Ohala

1975, 1997; Greenlee & Ohala 1980; Ohala & Ohala 1993; Ohala & Busà 1995; Ohala & Solé 2010: 64-66; Rossato 2004; Solé 2007, 2012; Busà 2007; Tsuchida et al. 2000; Bombien 2006; Warner 2002; Warner & Weber 2002; Tucker & Warner 2010; Shosted 2011; Recasens 2012; Blevins 2018). It has been argued that the antagonistic requirements of turbulence generation for the production of fricatives (a tightly closed velum to allow turbulent airflow in the oral tract) and that of nasals (a lowered velum to allow airflow through the nasal cavity) severely constrain the timing of velic movements. Specifically, in connection to sequences of fricatives followed by nasals, as discussed in Solé (2007), the relative phasing of velic and oral gestures has been demonstrated to result in the following diachronic outcomes (examples based on Solé 2007: 47, 50-51):

(i) fricative weakening

Anticipatory velopharyngeal opening for nasality during the acoustic duration of the fricative diminishes the oral pressure build-up behind the fricative constriction, and attenuates the amplitude of friction. In perceptual terms, this gradient attenuation of the friction noise may result in (a) identification of a discrete segment in place of the original fricative (such as a frictionless continuant, a rhotic, a vowel), or (b) loss of the original fricative. Examples include: Latin *mesnata* ‘kids’ > Catalan *maiñada*; Latin *elemos(i)na* ‘alms’ > Catalan *almoïna*; Latin *spasmu* ‘spasm’ > Roussillon *esparme*; PIE **snusos* ‘daughter-in-law’ > Latin *nurus*, Spanish *nuera*.

(ii) fricative strengthening

By contrast, delayed velum lowering typically results in denasalization of the initial portion of the nasal. The delayed opening of the velic valve preserves friction, but the air accumulated behind the constriction causes a burst and an intervening stop or a vowel. Examples include: Old English *glisnian* > *glisten*; Old English *hām + stede* > *Hampstead*, *hām + scīr* > *Hampshire*.

One more historical change that is linked to anticipatory velopharyngeal opening for nasality and the ensuing sharing of a single laryngeal spreading gesture for the fricative and the nasal is nasal devoicing, ultimately leading to the development of distinctive voiceless nasals, as in Burmese (Tibeto-Burman) **sna* > /ŋa/ ‘nose’.¹ However, owing to the relative rarity of phonemic voiceless nasals in languages of the world,² this historical pathway is less well documented. As a result, related generalizations and analysis in previous studies are essentially based on one single language, Burmese, as in the example above (e.g. Ohala 1975; Ohala & Ohala 1993; Shosted 2006: 107-108, see also section 3).

¹ Note that developments related to breathy voiced nasals are beyond the scope of this study.

² The Phoible database (Moran & McCloy 2019), a repository of cross-linguistic phonological inventory data in 2186 languages, contains 75 languages with voiceless bilabial nasal stops, 61 languages with voiceless alveolar nasal stops, 41 languages with voiceless palatal nasal stops, and 48 languages with voiceless velar nasal stops. Put differently, languages with any type of voiceless nasals only account for 2 to 3.4% of all languages in the database. Voiceless nasals are commonly attested in several language families of Southeast Asia, including Tibeto-Burman (e.g. Tibetan, Burmese, Pumi, Achang, Dhimal, Angami, Mizo), Tai-Kadai (e.g. Sui, Lakkia), Hmong-Mien (e.g. Iu-Mien), and Austroasiatic (e.g. Zhangkang Wa, Blang, Nyah kur, Sedang). In addition, individual languages with voiceless nasals are found among Indo-European languages (Icelandic, Faroese, Welsh, Breton), Bantu languages (Kwanyama, Mbalanhu, Ndonga, Ngandyera, Kagulu, Nyamwezi), Eskimo-Aleut (Aleut, Yupik), and Oto-Manguean languages (Mazahua, Chinantec).

Within the Tibeto-Burman language family, Burmese represents just one of several subgroups that have phonemic voiceless nasals, that is, Lolo-Burmese; other subgroups being Himalayish or Bodic, Qiangic,³ Jingpho-Nungish-Luish, and Kuki-Chin-Naga (see Matisoff 2003: 37). In terms of their distribution, most of the above subgroups (the exception being Kuki-Chin-Naga) come together and overlap in one geographical area, viz. Southwest China, possibly making it one of the densest constellations of languages with phonemic voiceless nasals in the world. A circumstance that facilitates diachronic analysis of the development of phonemic voiceless nasals in the local languages is that in the Lolo-Burmese, Bodic, and Qiangic subgroups, phonemic voiceless nasals fairly transparently derive from contiguous sequences of voiceless oral fricatives and voiced nasal stops at the proto stages of ancestral languages. That is evidenced by the presence of such clusters in languages with written traditions and historical records (Written Tibetan, dating from the 7th century, in the Bodic subgroup; Written Burmese, dating from the 11th century, in the Lolo-Burmese subgroup), and in modern phonologically conservative languages (such as rGyalrongic languages in the Qiangic subgroup). Consequently, fricative-nasal clusters are reconstructed for the proto-stage of the Tibeto-Burman language family (Matisoff 2003). Table 1, adapted from Huang (1987: 19-20), provides examples of cognate sets descended from fricative-nasal sequences in area languages. Reconstructed Proto-Tibeto-Burman (PTB) forms from Matisoff (2003: 103) are provided for comparison.

| Language | ‘nose’ | ‘to smell’ | ‘seven’ | ‘heart/mind’ |
|----------------------|--|--|--------------------------------------|--|
| PTB | *s-na ✕ *s-na:r | *m/s-nam | *s-ni-s | *s-niŋ ✕ *s-nik |
| Bodic | | | | |
| Written Tibetan | sna | snom (tr.)~ mnam (intr.) | -- | spniŋ |
| Xiahe Tibetan | hna (ɣoŋ) | hnəm | -- | hɲaŋ |
| Kami Tibetan | ŋã ^L | ŋũ ^H | -- | ʃũ ^H |
| Qiangic | | | | |
| Qiang (Mawo) | stɣ(q) | -- | stə | sti:(mi) |
| Qiang (Ekou) | ɕtɕyə(s) | ɕɛɛ | ɕtɕə | ɕtɕij(miɛ) |
| Qiang (Taoping) | χɲi ³¹ (qo ⁵⁵ pə ³¹) | χmi ⁵⁵ | ɕiŋ ⁵³ | χtie ⁵⁵ (mə ⁵⁵) |
| rGyalrong (Jinchuan) | (tu)ɣnie | (kana)suŋsuŋ | (ku)ɣnuw | (tu)ɣni |
| Stau | sni | (nə)no | zɲe | -- |
| Queyu | ɕɲi ⁵⁵ | ɣno ¹³ | sna ⁵⁵ | sme ⁵⁵ (rmi ³³) |
| Zhaba | ɲu ³³ (cɕu ⁵⁵) | (ŋa ³³)mni ⁵⁵ mni ³³ | ɣne ⁵⁵ ŋe ⁵⁵ | ɣne ¹³ ~ ŋe ¹³ |
| Pumi (Jiulong) | ʃi ¹¹ (gõ ³⁵) | ŋy ¹¹ ŋe ⁵⁵ | ʃu ⁵⁵ (li ⁵⁵) | xuə ⁵⁵ |
| Ersu (Jiulong) | ki ⁵⁵ (mə ⁵⁵) | (k ^h a ¹¹)ni ⁵⁵ ni ³¹ | ki ⁵⁵ (bu ³⁵) | ki ⁵⁵ (mi ⁵⁵) |
| Guiqiong | ɲə ⁵⁵ (kũ ⁵⁵) | (ji)hõ ³⁵ | ɲi ³⁵ | tã ³³ (jã ⁵³) |
| Muya | sə ⁵³ | (k ^h i ³³)sø ⁵⁵ mæ ³³ | ɲuə ⁵³ | -- |
| Lolo-Burmese | | | | |
| Written Burmese | hna ² (k ^h ɔŋ ³) | nam ³ | (khu ³)hnas ¹ | hna ² (lum ³) |

³ The term “Qiangic” is here used in its broadest sense, as referring to the thirteen, geographically adjacent and little-studied Tibeto-Burman languages of Southwest China. Twelve of these languages are still spoken (e.g., Qiang, rGyalrong, Lavrung, Muya or Minyak, Pumi or Prinmi, Guiqiong, Ersu), and one is extinct (Tangut). Qiangic is an under-documented and a highly heterogeneous subgroup, which can be further subdivided into a few more homogeneous language clusters, such as rGyalrongic (including rGyalrong proper, Lavrung and Horpa) and Ersu-Lizu-Duoxu, discussed presently.

| | | | | |
|-----------------------|--------------------------------------|------------------------------------|-------------------------------------|--|
| Yi (Nuosu) | ŋa ²¹ (bi ⁵⁵) | ni ³³ | ʂ ²¹ | he ³³ (ma ⁵⁵) |
| Zaiwa | no ⁵¹ | nam ⁵¹ | ŋjit ⁵⁵ | nik ⁵⁵ (lum ²¹) |
| Jingpho-Nungish-Luish | | | | |
| Jingpho | -- | mǎ ³¹ nam ⁵⁵ | sǎ ³¹ -nit ³¹ | sǎ ³¹ (lum ³³) |

Table 1. Fricative-nasal clusters and their reflexes across cognates in various Tibeto-Burman languages of Southwest China. Adapted from Huang (1987: 19-20) with additional data on Xiahe (bla brang) Tibetan (Dai et al. 1992) and Kami Tibetan (Chirkova 2014) to exemplify developments in local Bodic languages. PTB forms from Matisoff (2003) are provided for comparison. In this and the following tables, superscript numbers indicate tone. Two-number notations are based on the five-scale pitch system developed by Yuen Ren Chao (1930). In one-number notations for Written Burmese, “1” stands for the creaky tone; “2” for the low tone; and “3” for the high tone. Superscript letters “L” and “H” stand for Low and High tone, respectively, in Kami Tibetan. Parentheses enclose morphemes that do not participate in the comparison.

The data given in Table 1 reveal two essential characteristics in the developments of fricative-nasal clusters in Tibeto-Burman languages of Southwest China.

First, there is a great diversity of outcomes. These not only include the three diachronic outcomes mentioned above as explicated in Solé (2007) (that is, (i) loss of the original fricative, as in Zaiwa; (ii) stop epenthesis, as in Qiang; and (iii) voiceless nasals, as in Kami Tibetan; see Huang 1987 for discussion), but they also suggest additional outcomes of fricative-nasal cluster development, such as voiceless fricatives (as in /h̃³⁵/ ‘to smell’ in Guiqiong; or in /xuə⁵⁵/ ‘heart’ in Pumi), and the voiceless velar stop (as in /ki⁵⁵(mǎ⁵⁵)/ ‘nose’, /ki⁵⁵(bu³⁵)/ ‘seven’, /ki⁵⁵(mi⁵⁵)/ ‘heart/mind’ in Ersu). These novel and heretofore unexplored outcomes have the potential to further our understanding of historical change in contiguous fricative-nasal sequences in natural languages.

Second, there is a complexity of interrelationship among modern reflexes of fricative-nasal clusters, both within one language and across different languages, which appears to be in conflict with principles of regularity of sound change. That can be illustrated by the modern reflexes of fricative-nasal clusters in Yi in Table 1, which differ per word: a voiceless nasal in ‘nose’ (/ŋa²¹(bi⁵⁵)/), a voiced nasal in ‘to smell’ (/ni³³/), a retroflex voiceless fricative in ‘seven’ (/ʂ²¹/), and a voiceless glottal fricative in ‘heart/mind’ (/he³³(ma⁵⁵)/). To compare, in the same set of cognates in Ersu, the reflexes in the words for ‘nose’, ‘seven’, and ‘heart/mind’ are identical (a voiceless velar stop), whereas that in the word ‘to smell’ is a voiced nasal (/k^ha¹¹ni⁵⁵ni³¹/). Variability of reflexes is a natural consequence of the articulatory constraints on coordination of articulation in contiguous fricatives and nasal sequences. For example, nasal devoicing in Romanian has been demonstrated to be gradient in whether it occurs (occurring in some tokens and not in others), and to what extent it occurs (full or partial devoicing in a given token) (Tucker & Warner 2010). At the same time, given that the interpretation of phonetic variability is governed by language-specific phonological constraints (cf. Beddor et al. 2002; in relation to fricative weakening and strengthening, see Warner & Weber 2002; Busà 2007; Tucker & Warner 2010), the variability of reflexes of fricative-nasal sequences, as observed among Tibeto-Burman languages in Southwest China, is liable to shed light on language-specific differences, hence contributing to our understanding of the history of these languages and their relationship to each other.

In this study, we explore these two characteristics (diversity of outcomes in the development of fricative-nasal clusters, and complexity of interrelationship among modern

reflexes of fricative-nasal clusters) on the basis of a small subset of closely related Tibeto-Burman (Qiangic) languages of Southwest China, for which we have in-depth data that allow us to make specific claims about pathways of change: Ersu (as spoken in Ganluo County),⁴ Lizu (represented by two dialects: Kala and Ga'er), and Duoxu. Examination of cognate sets in these languages shows the existence of regular sound correspondences involving voiced nasal stops (N), voiceless nasal stops (N̥), the voiceless velar fricative (/x/), the voiceless nasal glottal fricative /h̥/ (a sound we discuss in detail in section 3), and voiceless stops (specifically, /t/ and /k/). Words that exemplify these sound correspondences within Ersu, Lizu, and Douxu are often cognate to words with fricative-nasal sequences in some neighboring phonologically complex Tibeto-Burman languages and in Tibeto-Burman languages with written traditions, and are therefore frequently reconstructed with *fricative-nasal sequences in Proto-Tibeto-Burman, pointing to their common historical origin. We claim that the regular sound correspondences in ELD languages make it possible to recognize and explore two distinct pathways of change, which were determined by the relative phasing of velic and oral gestures in the original fricative-nasal sequences. These two pathways of change can be summarized as:

- (i) *FN > N̥ > h̥ > x
- (ii) *F-n > *F-t > t > k or *F-n > s

In the formulation of pathway (ii), “-” indicates a looser cohesion of the surrounding segments. The reason for the use of “n” rather than “N” in the formulation of pathway (ii) is that we have only identified data supporting this pathway when the nasal element is alveolar. (An explanation for the variability indicated by “or” will be discussed below.)

The different reflexes seen in the ELD cognate sets represent different points along the developmental pathways. The first pathway makes it possible to explore the process of nasal devoicing beyond the stage of voiceless nasals so as to enrich our understanding of nasal devoicing in natural languages. Hypotheses about historical events are strengthened when they can be supported by laboratory measurements of articulatory and acoustic properties. In our argument, we rely on an instrumental investigation of voiceless nasals and the typologically infrequent nasal fricative /h̥/ in several Tibeto-Burman languages by Chirkova, Basset & Amelot (2019) to provide evidence for the plausibility of the proposed pathway of change.

We argue that the co-existence of two opposite pathways of change (fricative weakening and fricative strengthening) in one set of closely related languages possibly reflects differences in the degree of cohesion between the fricative and nasal elements of the original sequence. Specifically, a tighter cohesion between the fricative and the nasal likely leads to a greater coarticulatory overlap and the spread of a single laryngeal gesture for both elements, i.e. to nasal devoicing. Such tighter cohesion may be achieved when a fricative-nasal sequence is part of one syllable (notated above as *FN). A looser cohesion for the fricative and the nasal likely results in a different temporal distance between the articulatory gestures for the fricative and the nasal, leading, in the case of the examined languages, to a delayed opening of the velic valve (stop or vowel epenthesis). Such looser cohesion of the fricative and nasal elements may be achieved when a fricative and a nasal are parts of different syllables (possibly, a syllabic prefix and a root) (notated above as *F-n).

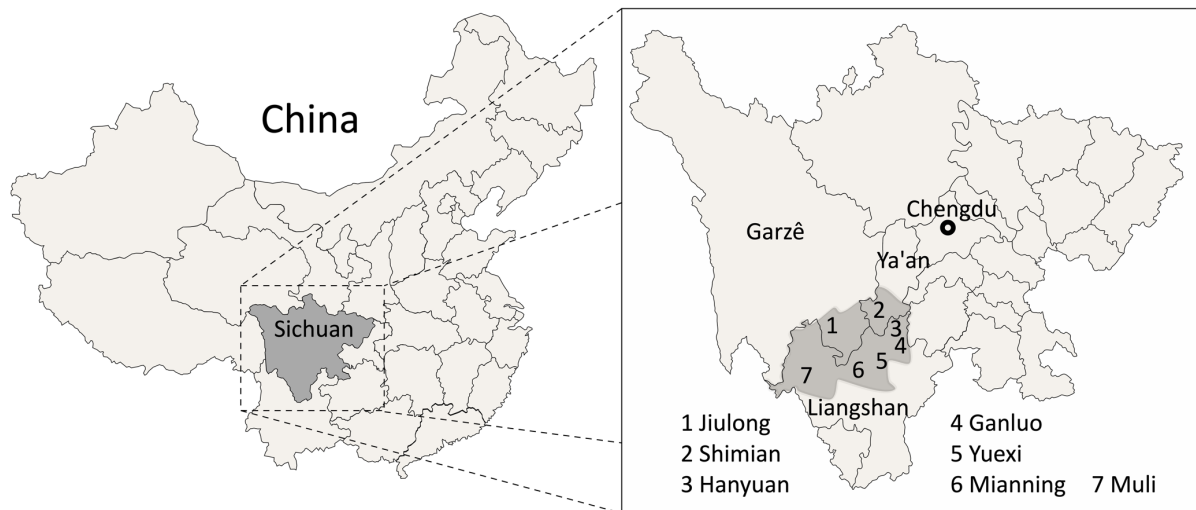
In sum, the two sound correspondence patterns in ELD languages allow us to explore both universal (phonetic) and language-specific aspects of change in fricative-nasal sequences.

⁴ “Jiulong Ersu” cited in Huang (1987) (see Table 1) appears to be closely related to the variety that we surveyed in Ga'er Township, Jiulong County. Speakers of that variety identify themselves as members of the “Lizu” ethnic group, speaking the Lizu language (hereafter Ga'er Lizu).

The remainder of the study is organized as follows. Section 2 first presents ELD-internal evidence (the two sound correspondence patterns); and then brings into discussion broader comparative evidence from other Tibeto-Burman languages bearing on the origin and developments of fricative-nasal sequences in ELD languages. Section 3 proposes a phonetic explanation for the specific developments in these languages. Section 4 concludes the paper with a summary of essential findings.

2. ELD-internal evidence and comparative evidence from TB for reconstruction of *fricative-nasal sequences in proto-ELD

Ersu, Lizu, and Duoxu (collectively ELD) are three closely related, Tibeto-Burman languages of Sichuan Province in China (see Map 1). They share one ISO-639 code: *ers*. The three languages were first brought to the attention of the linguistic audience in the 1980s (Sun 1982, 1983); and they have been systematically investigated since the late 2000s (e.g. Chirkova 2008, 2014, 2015, 2016, 2019; Yu 2008; Chirkova & Chen 2013; Zhang 2013; Chirkova et al. 2015).



Map 1. Distribution of the Ersu, Lizu, and Duoxu languages in Garzê Prefecture, Liangshan Prefecture, and Ya'an Municipality in Sichuan Province in the People's Republic of China. The double circle shows the capital city of Sichuan Province, Chengdu. Shaded areas show counties where Ersu, Lizu, and Duoxu are spoken.

The hypothetical ancestor language of Ersu, Lizu, and Duoxu has been reconstructed by Dominic Yu (2012), later revised after the inclusion of more Duoxu data (Yu 2019). The following discussion of the correspondence patterns in ELD represents a revised and improved version of the original argument in Chirkova & Handel (2013a, b), supported by additional data. Discussion is based on firsthand data on Ersu (the variety of Ganluo County), Duoxu, and two varieties of Lizu, that of Kala Township, Muli Tibetan Autonomous County, and of Ga'er Township, Jiulong County.⁵

ELD-internal comparative evidence shows two patterns involving a nasal in Duoxu corresponding to a non-nasal segment in Ersu and in Lizu. The two correspondence patterns

⁵ Ersu, Lizu, and Duoxu data are provided in broad phonemic transcription in the IPA. The phonemic analysis on which the transcriptions are based are outlined in Chirkova & Chen (2013) and Chirkova (2016) for Lizu (the variety of Kala township, Muli County), Chirkova et al. (2015) for Ersu, and Chirkova (2015) for Duoxu. Data from the Ga'er variety of Lizu, spoken in Jiulong county, is provided in phonetic transcription. In transcriptions, “-” stands for a morpheme boundary. Tones in Duoxu are provided in Chao's (1930) five-scale pitch system.

are distinct from, on the one hand, three-way fricative correspondences in the three languages and, on the other hand, three-way nasal correspondences in these languages.⁶

The first correspondence pattern among Ersu, Lizu and Duoxu may be notated:

$x \mid \tilde{h} \sim \tilde{N} \mid N$

That is to say, Ersu onset /x/ corresponds to Lizu onset / \tilde{h} / (in Kala Lizu) or a voiceless nasal (\tilde{N}) (in the Ga'er variety of Lizu) and to a Duoxu nasal onset.⁷ Examples of the “ $x \mid \tilde{h} \sim \tilde{N} \mid N$ ” correspondence pattern are given in Table 2a. Note that the Duoxu and Ga'er Lizu forms have nasals at various places of articulation that participate in the correspondence pattern.

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga'er) | Duoxu |
|---|--|--|---|---|
| ‘be ripe’ | xì, (dè-)xì | (dè-) \tilde{h} é | (da ³³ -)m̥e ⁴⁴ | mje ²² |
| ‘bamboo’ | xì | \tilde{h} é | m̥i ⁴⁴ | mi ³³ |
| ‘this year’ ‘last year’ ‘next year’ | (ts ^h é-)xí (já-)xí (só-)xí | (ts ^h è-) \tilde{h} é (jǎ-) \tilde{h} e (só-) \tilde{h} é | (ts ^h e ³³ -) \tilde{h} e ⁵⁵ (jǎ ³³ -) \tilde{h} e ⁵⁵ (so ³³ -) \tilde{h} e ⁵⁵ | (tɕ ^h i ²² -)nje ³³ (ja ²² -)nje ³³ (ʃəu ⁵³ -)nje ³³ |
| ‘to borrow’ | (k ^h è-)xì | (p ^h éŋgò) \tilde{h} è | (k ^h a ³¹ -) \tilde{h} e ⁴⁴ | nje ³³ |
| ‘to smell good, fragrant’ | xè, (dè-)xè | (dé-) \tilde{h} jò | -- | ŋo ³³ |
| ‘to smell’ | xíxí | \tilde{h} íó \tilde{h} íó | (k ^h a ³¹)ŋje ⁴⁴ ŋje ⁴⁴⁸ | na ³¹ na ⁵³ , ji ²² na ³³ |
| ‘younger sister’ | xí(má) | \tilde{h} í(mǎ) | \tilde{h} e ³³ (mi ⁴⁴) | na ³¹ (ma ⁵³) |

⁶ This means that the correspondence patterns cannot be reconstructed to Proto-ELD *fricatives or *voiced nasals. See the table below for examples of the correspondence patterns reconstructed as *fricatives and *voiced nasals by Yu (2019).

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga'er) | Duoxu | Yu (2019) |
|--------|----------|-------------|---|------------------------------------|------------------|
| | F | F | F | F | F |
| ‘walk’ | ʃž-ʃž | xú-xú | xu ³³ xu ⁵³ | ɕe ³³ -ɕe ³³ | *xui |
| ‘long’ | ʃé | ʃè-ʃé | ʃæ ³¹ ʃæ ⁴⁴ | xe ³¹ | *ʃa |
| | N | N | N | N | N |
| ‘fire’ | mè | mé | me ³⁵ | mie ³¹ | *me ¹ |
| ‘two’ | né | nè | næ ³³ -bu ⁴⁴ , nuæ ²³ | ni ⁵³ | *ne ¹ |
| ‘day’ | ŋjó | ŋé | ne ²³ | ne ³³ | *niu |

⁷ Kala Lizu / \tilde{h} / is a voiceless sound that is produced with an open glottis. In monosyllabic words beginning with / \tilde{h} / (see examples in the main text), the entire syllable including the initial consonant is perceptually nasalized. That sound has been reported in a number of Lolo-Burmese, Naic, and Qiangic languages, an instrumental description of / \tilde{h} / is provided in Chirkova et al. (2019), see section 3 for more details.

⁸ Huang (1987: 20) gives the form (k^ha¹¹)ni⁵⁵ni³¹ for Jiulong Ersu (see Table 1 and footnote 3).

| | | | | |
|------------|-----|---------|--|---|
| ‘language’ | xó | h̃ú-h̃ú | (ts ^h o ³³ -)ŋũ ⁴⁴ ~ (ts ^h o ³³ -)h̃u ⁴⁴⁹ | na ³¹ |
| ‘mushroom’ | xʒ̣ | h̃ɪə | h̃u ⁴⁴ | mo ³³ (tɕ ^h i ³³) |

Table 2a. The Ersu-Lizu-Duoxu correspondence pattern “x | h̃~ŋ | N”

We may also include presumed examples of this correspondence pattern for which a cognate has not been identified in one of the three languages. These are listed in Table 2b.

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga’er) | Duoxu |
|--|--------------|----------------|--|------------------------------------|
| ‘to teach’ | xá-xá | -- | (k ^h a ³³ -)m̩e ⁴⁴ m̩e ⁴⁴ | ma ²² -ma ⁵³ |
| ‘stretch out’ | (ŋé-)xó | (nè-)h̃ó | h̃o ⁴⁴ | -- |
| ‘to stir up, foment; to convulse, disturb’ | (dá-)xá(rʒ̣) | (dè-)h̃ɪə-h̃ɪə | (da ³³ -)m̩u ⁴⁴ (ɪə ⁴⁴ ɪə ⁴⁴) | -- |
| ‘know’ ¹⁰ | xa(se) | h̃ú(sə) | -- | (se ²²) |

Table 2b. Incomplete cognate sets illustrating the same correspondence pattern as Table 2a

There are also a few cognate sets in which the Lizu form does not perfectly conform to this pattern, having /x/ instead of /h̃/. Some examples are given in Table 3. In one case (‘to hatch, to incubate’), Kala Lizu /x/ has a corresponding voiceless nasal in Ga’er Lizu. We will label this correspondence pattern “x | x~ŋ | N”, and consider it a sub-type or variant of pattern 1.

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga’er) | Duoxu |
|-------------------------|-----------------------|-----------------------|---|------------------------------------|
| ‘bird’ | xwá-jí | xwè | xɑ ²³ | ŋo ³³ tɕi ³³ |
| ‘to hatch, to incubate’ | (k ^h è-)xè | (k ^h è-)xé | (k ^h a ³¹ -)m̩u ⁴⁴ | -- |
| ‘to yawn’ | xá | xwǎ | xɑ ³³ xɑ ⁴⁴ (mu ⁴⁴) | -- |

Table 3. The Ersu-Lizu-Duoxu correspondence pattern “x | x~ŋ | N”

Note that when a Duoxu cognate form is absent and the initial of Lizu cognate forms is /x/, as is the case for the word ‘to yawn’ in Table 3, there is no direct evidence for a nasal origin of the onset correspondence. However, the correspondence between the Ersu and Lizu onsets still looks quite different from those that can be confidently reconstructed with a Proto-ELD fricative (see Yu 2012: 41-42, 54-56, 196-197; Yu 2019: 11-14). Indeed, so far in our data there are no clear-cut examples of sound correspondences where Ersu has x- and Lizu has x-, h̃-, or a voiceless nasal, but Duoxu has a fricative instead of a nasal. This suggests that the Table 2b examples belong to the correspondence pattern seen in Table 2a rather than belonging to another three-way fricative correspondence (see footnote 5). As we shall see below, additional comparative evidence further supports this conclusion.

The second sound correspondence pattern may be notated:

⁹ Literally, person-language ‘human language’.

¹⁰ Note the cognate forms in the Guiqiong language: /mǎ³³sə⁵⁵/ (Rao 2015), and various dialects of the Pumi languages: /ma¹³sə⁵⁵, mā¹³sə⁵⁵, mǎ¹³sə⁵⁵, mǎ¹³si⁵⁵, mā¹³si⁵⁵, mǎ¹³si⁵⁵/ (Lu 2001: 430, 534), which corroborate the proposed correspondence pattern (“x | h̃~ŋ | N”).

s | t~k | n

That is to say, Ersu onset /s/ corresponds to Lizu onset /t/ (in Kala Lizu) or /k/ (in Ga'er Lizu) and to /n/ in Duoxu. Note that in contrast to the first sound correspondence pattern, where we have evidence of nasals at different places of articulation in the Duoxu forms, in the second correspondence pattern, we only find the alveolar nasal in Duoxu forms. Table 4 provides illustrative examples.

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga'er) | Duoxu |
|-------------|-------------------------------|-----------------------|---|--|
| 'heart' | sʒ(ní) | tè(mí) | ke ³³ (mi ⁴⁴) | nje ²² (ma ⁵³) |
| 'nose' | sý(Nbý) | tó(Nbù) | ke ³³ (mɛ ⁴⁴) | nja ²² (ku ⁵³) |
| 'snot' | sý(ký) | təŋ(-ɬǎ) | kje ³³ (Nbɬa ⁴⁴) | nja ²² (ku ⁵³) ? |
| 'lip; beak' | sý(pí), sý(mp ^h á) | tó(Np ^h é) | ko ³³ (Np ^h ɔ ⁴⁴) | -- |
| 'finger' | (lé)sý | (lé)tù | -- | (lo ³³)ni ³³ (-p ^h a ³³) |
| 'seven' | sʒŋ | təŋ | ki ⁵³ | nje ²² |

Table 4. The Ersu-Lizu-Duoxu correspondence pattern "s | t~k | n"

The two correspondence patterns are observed in words whose cognates have fricative-nasal sequences in written languages and modern phonologically complex languages, and where comparative evidence across the family makes it clear that a fricative, most likely sibilant (*s-) element was present in the earliest reconstructible forms. PTB forms with *sN clusters constitute ancillary evidence for the reconstruction of *fricative-nasal sequences in Proto-ELD (presumably inherited from their common ancestor, Proto-Tibeto-Burman). Table 5 lists reconstructed PTB forms for a subset of the cognate sets from Tables 2 and 3. It is important to remember that these forms were independently reconstructed without reference to ELD language data.¹¹

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga'er) | Duoxu | PTB |
|---------------------------|-------------------------|----------------------------|--|--|---------------------------|
| 'be ripe, ripen' | xì, (dè-)xì | (dè-)héhé | (da ³³ -)ŋɛ ⁴⁴ | mje ³¹ | *s-min |
| 'bamboo' | xì | héhé | mi ⁴⁴ | mi ³³ | *s-m(y)ik 'bamboo sprout' |
| 'this year' | (ts ^h é-)xí, | (ts ^h è-)héhé, | (ts ^h e ³³ -)héhé ⁵⁵ | (tɕ ^h i ²² -)nje ³³ | *s-niŋ |
| 'last year' | (já-)xí, | (jǎ-)héhé, | (jǎ ³³ -)héhé ⁵⁵ | (ja ²² -)nje ³³ | |
| 'next year' | (só-)xí | (só-)héhé | (so ³³ -)héhé ⁵⁵ | (ʃəu ⁵³ -)nje ³³ | |
| 'to borrow' | (k ^h è-)xì | (p ^h éŋgò) héhé | (k ^h a ³¹ -)héhé ⁴⁴ | nje ³³ | *r/s-ŋ(y)a |
| 'to smell good, fragrant' | xè, (dè-)xè | (dè-)héhó | -- | ŋo ³³ | -- |
| 'to smell' | xíxí | héhéhéhé | (k ^h a ³¹)ŋje ⁴⁴ ŋje ⁴⁴ | na ³¹ na ⁵³ ji ²² na ³³ | *m/s-nam |
| 'younger sister' | xí(má) | héhí(mǎ) | héhé ³³ (mi ⁴⁴) | na ³¹ (ma ⁵³) | *s-nam 'daughter-in-law' |

¹¹ Reconstructed PTB and PLB forms are from Matisoff (2003) unless otherwise noted. Absent from Table 5 are a number of forms for which no nasal-initial TB cognates are in evidence, including 'to stretch out', and 'to yawn'. In general, reliable Duoxu cognates have not yet been identified. We cannot discount the possibility that these cognate sets have an origin distinct from the Proto-ELD *sN clusters.

| | | | | | |
|-------------------------|-----------------------|-----------------------|---|---|----------|
| ‘language’ | xó | h̃ú-h̃ú | (ts ^h o ³³ -)ŋũ ⁴⁴ ~ (ts ^h o ³³ -)h̃u ⁴⁴ | na ³¹ | -- |
| ‘mushroom’ | xž | h̃ɪə | h̃u ⁴⁴ | mo ³³ (tɕ ^h i ³³) | *g/s-məw |
| ‘to teach’ | xá-xá | -- | (k ^h a ³³ -)m̥e ⁴⁴ m̥e ⁴⁴ | ma ²² -ma ⁵³ | -- |
| ‘stir up, foment’ | (dá-)xá(rž) | (dè-)h̃ɪə-h̃ɪə | (da ³³ -)m̥u ⁴⁴ (ɪə ⁴⁴ ,ɪə ⁴⁴) | -- | *ŋwal |
| ‘to hatch, to incubate’ | (k ^h è-)xè | (k ^h è-)xé | (k ^h a ³¹ -)m̥u ⁴⁴ | -- | *mu |
| ‘bird’ | xwá(-jǐ) | xwè | xɑ ²³ | ŋo ³³ (-tɕi ³³) | *s-ŋak |

Table 5. Cognate sets from Tables 2-3 with the Ersu-Lizu-Duoxu correspondence pattern “x | x~N̥ | N̥”, where PTB cognate evidence supports the reconstruction of a fricative-nasal cluster and/or voiceless nasal

The developments in the cognate sets in Table 6 also appear to be related to forms with fricative-nasal sequences in written languages and modern phonologically complex languages. This is illustrated in Table 6 with PTB forms for a subset of the cognate sets from Table 4.

| Gloss | Ersu | Lizu (Kala) | Lizu (Ga’er) | Duoxu | PTB |
|------------------------|-------------------------------|-----------------------|---|--|--------|
| ‘heart’ | sž(ńí) | tè(mí) | ke ³³ (mí ⁴⁴) | nje ²² (ma ⁵³) | *s-niŋ |
| ‘nose’ | sý(Nbý) | tó(Nbù) | ke ³³ (m̥e ⁴⁴) | nja ²² (ku ⁵³) | *s-na |
| ‘snot’ | sý(ký) | təŋ(-ɹǎé) | kje ³³ (Nbɪa ⁴⁴) | nja ²² (ku ⁵³) | *s-nap |
| ‘lip; beak’ | sý(pí), sý(mp ^h á) | tó(Np ^h é) | ko ³³ (Np ^h a ⁴⁴) | -- | *s-nes |
| ‘finger’ ¹² | (lé)sý | (lé)tù | -- | (lo ³³)ni ³³ (-p ^h a ³³) | -- |
| ‘seven’ | sžǐ | tǎŋ | ki ⁵³ | nje ²² | *s-nis |

Table 6. The Ersu-Lizu-Duoxu correspondence pattern “s | t~k | n” with PTB cognate evidence

In both correspondence patterns, reflexes in Duoxu (voiced nasals) suggest loss of the fricative element of the original fricative-nasal sequence in that language.¹³ The development in Duoxu can therefore be schematized as follows:

fricative loss: Duoxu: *FN > /m n ŋ/

Ersu and Lizu reflexes in Tables 5 and 6 differ, likely representing various stages of nasal devoicing in Table 5, and various stages of fricative strengthening (stop or vowel epenthesis) in Table 6. The diachronic plausibility of these reconstructions is discussed in the following section.

3. Synchronic and diachronic aspects of the developments of fricative-nasal sequences in ELD languages

¹² The first element in the compounds is derived from PTB *lak ‘hand’.

¹³ In the previous versions of the paper (Chirkova & Handel 2013a, b), we argued for the existence of voiceless nasals rather than fricative-nasal clusters at the Proto-ELD stage. The advantage of the present revised reconstruction is that both correspondence patterns involving Duoxu N- initials can be accounted for by a single sound change rule of fricative loss. However, we acknowledge the possibility that the first correspondence pattern might be reconstructed with Proto-ELD voiceless nasals, with an additional rule that those nasals re-voiced in the development of Duoxu. If that were the case, there would still be two pathways of development of *FN- clusters as discussed in section 3.3 below, but the change leading to voiceless nasals would have been already completed at the late Proto-ELD stage.

3.1. First correspondence pattern in Ersu and Lizu: $x \mid \tilde{h}\sim N$ (fricative weakening: nasal devoicing)

Until recently, owing to the relative rarity of voiceless nasals in the languages of the world, instrumental phonetic studies of voiceless nasals have been mostly limited to Burmese (Ladefoged 1971: 11; Dantsuji 1984, 1986) as well as two other Tibeto-Burman languages (of the Kuki-Chin-Naga group): Mizo and Angami (Bhaskararao & Ladefoged 1991; Blankenship et al. 1993; Blankenship 1994).¹⁴ A comparison of voiceless nasals in these languages suggests that voiceless nasals typically consist of two parts: (a) a period characterized by both nasal and oral airflow, which is voiceless, and (b) a period characterized only by nasal airflow, which is voiced. Of the two periods, it is the voiced period that contains the place-of-articulation information. The examined languages attest to both possible orderings of the two parts, yielding the following two subtypes of voiceless nasals (Bhaskararao & Ladefoged 1991):¹⁵

(1) Voiceless nasals in Burmese and Mizo represent one subtype, in which voiceless nasals begin with a period characterized by both nasal and oral airflow, and end in a period characterized only by nasal airflow. This subtype can be schematized as $[\tilde{h}N]$, where “N” stands for nasals at different places of articulation, that is $[\tilde{h}m]$, $[\tilde{h}n]$, $[\tilde{h}ŋ]$, etc.

(2) Voiceless nasals in Angami constitute another subtype, in which voiceless nasals begin with a period characterized only by nasal airflow, and end in a period characterized by both nasal and oral airflow. These voiceless nasals start out voiced and end in a voiceless period. They remain voiceless even beyond the release, so that the vowel may be only partly voiced at the beginning. The continuous nasal airflow persists into the following vowel. This subtype of voiceless nasals is also known as “aspirated voiceless nasals” for they are characterized by the same timing relationship between oral and glottal articulations as that seen in aspirated stops. More specifically, the glottal opening gesture begins only after the oral closure is completed, and the peak opening occurs at or after the oral release (Ladefoged & Maddieson 1996: 115-116). However, in contrast to aspirated stops, where the air is released orally following complete closure of the articulators, in aspirated voiceless nasals there is continuous nasal airflow following complete closure of the articulators. This subtype can be schematized as $[N\tilde{h}]$ (or $[m\tilde{h}]$, $[n\tilde{h}]$, $[\eta\tilde{h}]$).

Of the two subtypes of voiceless nasals, the better-known former subtype was taken to be representative of all phonemically distinctive voiceless nasals in languages of the world (Ladefoged 1971: 11; Ohala 1975, 1983; Ohala & Ohala 1993: 232-233). As a consequence, characteristic properties of voiceless nasals as a class, which informed claims about their diachronic development, were based only on that subtype of voiceless nasals. In a series of publications (e.g. Ohala 1975, 1983, Ohala & Ohala 1993: 232-233), Ohala notes the following properties of voiceless nasals that account for their diachronic development.

(1) Auditorily, voiceless nasals are non-optimal as speech sounds. This is the reason why distinctive voiceless nasals are cross-linguistically rare and unstable. The principal point of disturbance of voiceless nasal airflow is at the nostrils, regardless of where airflow is blocked

¹⁴ Phonetic studies bearing on voiceless nasals in language families other than Tibeto-Burman include Huffman & Hinnebusch (1998) on Pokomo (Bantu) and Jessen & Pétursson (1998) on Icelandic.

¹⁵ Voiceless nasals in Pokomo, reported in Huffman & Hinnebusch (1998), appear to belong to the first subtype of voiceless nasals, as discussed in Bhaskararao & Ladefoged (1991), whereas voiceless nasals in Icelandic, reported in Jessen & Pétursson (1998), appear to belong to the second subtype of voiceless nasals.

in the oral cavity. Since it is the location of the constriction producing turbulence that creates the distinctive frequency spectrum of a fricative, all voiceless nasals will produce a nearly identical auditory effect regardless of place of oral articulation.

(2) It is impossible for speakers to significantly narrow the passageways through the nostrils, so the maximum degree of friction is necessarily limited; moreover, there is no resonating cavity beyond the point of constriction. As a result, voiceless nasal sounds are low intensity, making any slight differences in frequency spectrum that might result from the different oral blockage points extremely difficult to hear. The most effective way to allow the hearer to recover the place-of-articulation distinction in voiceless nasals is therefore to voice the latter part of its articulation, hence the canonical partially-voiced realization of voiceless nasals of the Burmese type.

(3) In historical terms, the voiceless+voiced (= fricative+sonorant) realization of voiceless nasals like those of Burmese (that is, /m̥/ [h̥m], /ŋ̥/ [h̥ŋ], etc.) may be understood as a continuation of the same phonetic features found in the *sN clusters that give rise to them: a sequence of voiceless fricative + voiced sonorant (Ohala & Ohala 1993:232-233).

Recent years have seen numerous acoustic and perceptual studies on voiceless nasals in lesser-known Tibeto-Burman languages. These studies have mostly focused on the languages of the Kuki-Chin-Naga and Bodo-Garo groups: Mizo and Angami (Gogoi 2018; Gogoi & Wayland 2018; Terhija & Sarmah 2020); Hakha Chin (Hoffmann 2018); Rabha and Angami (Rabha et al. 2019); but they also include a comparative instrumental study of Burmese (Lolo-Burmese), Kham (Litang) Tibetan (Tibetic), and Xumi (aka Shuhi, Shixing) (Qiangic) (Chirkova, Basset & Amelot 2019). That study also brought into discussion another voiceless sound, which is produced with an open glottis and associated with nasalization, as reported for some Tibeto-Burman languages of the Lolo-Burmese and Qiangic subgroups. That voiceless sound is variously transcribed in phonological descriptions of the languages where it is attested as /h/ or /h̃/. The former notation (/h/) is used in languages that have contrastive oral and nasal vowels (such as Naxi, Michaud 2006, 2008; or Xumi, Chirkova & Chen 2013a, b; Chirkova, Chen & Kocjančič Antolík 2013; see Guiqiong examples in Table 1). The latter notation (/h̃/) is adopted in those languages that only have oral vowels (such as Lisu, Bradley 2003; Tabain, Bradley & Yu 2019; or Lizu, Chirkova 2016). An instrumental investigation (acoustic and aerodynamic) of that sound in the Xumi language in Chirkova et al. (2019) suggests that (i) it is a physiologically nasal segment, characterized by a lowering of the velum, and (ii) that it may be related to voiceless nasals.

In addition, in recent years, the number of phonetic and phonological descriptions of various languages with voiceless nasals in the Tibetic, Lolo-Burmese, and Qiangic groups has been increasing (e.g. Dongwang Tibetan, Bartee 2014; Pumi, Daudey 2014). As a result, new descriptive and instrumental data on voiceless nasals have made it possible to update and further develop existing analyses of synchronic and diachronic properties of this type of sound.

The first contribution of these new studies is to demonstrate that among the two subtypes of voiceless nasals (as outlined in Bhaskararao & Ladefoged 1991), it is the second subtype (viz., aspirated voiceless nasals, or [N̥h̃]) that is more common, at least among Tibeto-Burman languages. Put differently, voiceless nasals in many Tibeto-Burman languages pattern in a similar way to aspirated stops and affricates. This means that historical developments of voiceless nasals as described on the basis of Burmese may not be representative of or generalizable to all phonemically distinctive voiceless nasals in languages of the world.

Another important observation is that, when compared across languages, voiceless nasals differ considerably in terms of their total duration, voicing rate (that is, percentage of

the period of nasal articulation that is voiced and voiceless),¹⁶ and oral and nasal airflow maxima. That has been demonstrated in a comparative study of the voiceless nasals /m̥/ and /ŋ̥/ in three Tibeto-Burman languages belonging to three distinct subgroups: Burmese (Lolo-Burmese), Litang Tibetan (Bodic), Xumi (Qiangic) (Chirkova et al. 2019). For example, the voicing rate of voiceless nasals may range from over 95% in connected speech (as in Litang Tibetan) to just 16% (in Xumi). Put differently, the voiced period in aspirated voiceless nasals is not only far removed from the vowel, but it may also be extremely brief, making it additionally difficult to hear any slight differences in frequency spectrum that might result from the different oral blockage points. In relation to Xumi, it has been suggested that in addition to formant transitions from the vowel into the nasal, listeners may resort to some other cues, such as elevated rates of both nasal and oral airflow, and possibly also visual cues for the place of articulation (specifically, a visible lip closure in [m] and, to an extent, even a visible tongue tip closure in [n], cf. Johnson, DiCano & MacKenzie 2007).

The third observation of relevance to the present study, is that the voiceless fricative sound ([h̥]) associated with nasalization, as studied instrumentally in Xumi, is a physiologically nasal segment, characterized by a lowering of the velum. Xumi [h̥] is comparable to Xumi voiceless nasals ([m̥h] and [ŋ̥h]) in terms of duration, voicing rate, and nasal and oral flow rates. One difference between the two types of segments ([h̥], on the one hand, versus [m̥h] and [ŋ̥h], on the other hand) obviously lies in the absence of an oral constriction in [h̥]. It has been hypothesized that when the period of oral constriction is very brief and entirely devoiced (as in Xumi [m̥h] and [ŋ̥h]), cues for the place of articulation may become weakened. In perceptual terms, that could result in the failure on the part of the hearer to perceive place-of-articulation information in the signal, leaving the velic lowering gesture as the only remaining characteristic gesture of the sound. In that way, an alternation between voiceless nasals and [h̥] may become possible, and [m̥h] and [ŋ̥h] may change to [h̥].¹⁷

In light of these findings, the specific developments seen in Lizu can be outlined as follows.

Within the development of that language, we must first posit a period in which original fricative-nasal clusters began to devoice, giving rise to voiceless nasals (which in view of their realization in Ga'er Lizu, are likely to have been aspirated voiceless nasals, or [N̥h̥]). Devoicing proceeded until the closure period became too brief to be perceptually effective. The oral closure period then disappeared, leaving the velic lowering gesture as the only remaining gesture, resulting in a voiceless nasal glottal fricative /h̥/. The changes just described account for the development of voiceless nasals in Lizu and can be schematized as follows:

Lizu: *FN > /m̥ ŋ̥ n̥/ [m̥h̥ n̥h̥ ŋ̥h̥] > h̥

¹⁶ The voicing rate (in %) of the target phoneme is calculated by multiplying the duration of the voiced period by 100 and then dividing it by the total duration of the target phoneme.

¹⁷ Note that this development from fricative-nasal clusters to /h̥/, which is characterized by lowering of the velum, as discussed in our paper (i.e. *FN > h̥), appears to be distinct from documented cases of sound change whereby breathy sounds are either (i) derived from nasal ones (that is, *n > *n̥ [misperception of nasal consonant as also being breathy] > h̥ [loss of nasality]) or (ii) become nasalized ('spontaneous nasalization' adjacent to sounds produced with glottal spreading, that is, *ha > *h̃ā > h̃ā) (e.g. Matisoff 1975; Ohala 1975; Blevins & Garrett 1993; Ohala & Busà 1995:10-14; Shosted 2006:16, see Garellek et al. 2016 for an overview and analysis). It remains a possibility that the developments in Ersu, Lizu, and Duoxu have also involved a stage where breathiness was part of the phonetic implementation of nasality as an enhancement strategy, but we find no clear evidence for this in our data.

As shown in the instrumental study by Chirkova et al. (2019), / \tilde{h} / is characterized by elevated rates of nasal and oral airflow, which leads to an allophonic nasalization of the following vowel. Given that the Lizu vowel system (similar to the vowel systems of its sister languages Ersu and Duoxu) has no phonemic nasal vowels, this allophonic nasalization of the vowel following / \tilde{h} / appears to be compensated for by vowel raising. It has been argued that an effect on spectral changes along F1 similar to that caused by nasalization can also be independently achieved through changes in oral configuration (e.g. Beddor et al. 1986; Krakow et al. 1988: 1146; Shosted et al. 2012). Given that F1 can be independently modulated by these two articulatory mechanisms, it may be possible for listeners to confuse them when attending to nasal vowel quality (e.g. Wright 1986: 54-55). Notably, misinterpretation of nasalization in terms of oral configuration typically arises when nasal coupling is excessive or when nasalization occurs without a conditioning environment (Beddor et al. 1986: 214; Krakow et al. 1988).¹⁸ Our ELD data illustrate this tendency. In cognate sets with Duoxu words with nasal onsets and low vowels, corresponding forms in Lizu have / \tilde{h} / onsets and higher vowels. Examples include: ‘younger sister’: Kala Lizu / $\tilde{h}\acute{í}(m\acute{e})$ /, Ga’er Lizu / $\tilde{h}e^{33}(mi^{44})$ /, Duoxu / $na^{31}(ma^{53})$ /, PTB *s-nam; ‘to smell’: Kala Lizu / $\tilde{h}\acute{r}\acute{ó}\tilde{h}\acute{r}\acute{ó}$ /, Ga’er Lizu / $(k^ha^{31})\eta je^{44}\eta je^{44}$ /, Duoxu / $na^{31}na^{53}$ /, PTB *m/s-nam.

The diachronic development in Ersu appears to have been identical to that in Lizu, including the raising of vowels in cognate sets with Duoxu words with nasal onsets and low vowels, as in ‘younger sister’: Duoxu / $na^{31}(ma^{53})$ /, Ersu / $x\acute{í}(m\acute{a})$ /; ‘to smell’: Duoxu / $na^{31}na^{53}$ /, Ersu / $x\acute{í}x\acute{í}$ / (see Tables 2a and 5 for additional examples). Following the loss of allophonic nasalization of the vowel adjacent to the original nasal segment, the nasalization of the initial (/ \tilde{h} /) was likely reinterpreted as an unintentional effect and no longer produced. The stages of development of Proto-ELD fricative-nasal clusters into Ersu can therefore be schematized as follows:

Ersu: $*FN > */\mathfrak{m} \ \mathfrak{n} \ \mathfrak{ŋ}/ [m\tilde{h} \ n\tilde{h} \ \eta\tilde{h}] > \tilde{h} > x$

Here [x] can be considered a realization of /h/; or equivalently that the non-phonemic sound change [h] > [x] occurred; or that the separate existence of /x/ [x] in the phonological system “absorbed” [h] once it lost its nasalization, causing a merger.

Taken together, these developments neatly explain the sound change sequence $*FN > \mathfrak{N} > \tilde{h} > x$, seen in Tables 2-3.

3.2. Second correspondence pattern in Ersu and Lizu: s | t~k (fricative strengthening: stop or vowel epenthesis)

Distinct developments exemplified by cognate sets in Table 4 (vowel or stop epenthesis in Ersu and Lizu) can be outlined as follows.

In Lizu, the original fricative-nasal sequences give rise to a cluster with an epenthetic stop, which further simplifies to a stop. In relation to the cognate sets in Table 6, in Kala Lizu, the stop has the same place of articulation as the original nasal, as revealed by cognate forms

¹⁸ That may provide an explanation for some instances of “brightening”, a term referring to the strong tendency for *-a, the best-attested rhyme in Proto-Sino-Tibetan, to raise and front in Qiangic languages (Matisoff 2004; see Chirkova & Handel 2019).

in Duoxu with the alveolar nasal (that is, *F-n > *F-t > t).¹⁹ The vowel, following the epenthetic stop is likely to have been allophonically nasalized, for, as a result, Duoxu forms with low vowels correspond to Lizu forms with high vowels, as in ‘nose’: Duoxu /nja²²(ku⁵³)/, Kala Lizu tó(Nbù). The original allophonic nasalization in Lizu is also seen in some forms as a velar nasal coda (due to the acoustic and visual similarity of velar nasals and nasalized vowels, e.g. Ohala 1975; Ohala & Ohala 1993: 234-235; Johnson et al. 2007). Examples include: ‘snot’: Kala Lizu tən(-ɿǎ), Ga’er Lizu kje³³(Nbɿa⁴⁴), PTB *s-nap. Alternatively, the original allophonic nasalization is detectable as prenasalization of the initial of the following syllable. Examples include: ‘lip, beak’: Kala Lizu /tó(Np^hé)/, Ga’er Lizu /ko³³(Np^hɑ⁴⁴)/.

In Ersu, on the other hand, the original fricative-nasal sequences appear to retain the fricative part, strengthened by the addition of an epenthetic vowel, whereas the original nasal is lost, as in (lɛ)sý ‘finger’, sý(ký) ‘snot’ (see also below).

3.3. Coexistence of two opposite pathways of change

The coexistence of two opposite pathways of change in ELD languages (nasal devoicing, on the one hand, and stop or vowel epenthesis, on the other hand) can be explained if we assume a different degree of cohesion among the two elements of the original fricative-nasal sequences. We note that a tighter cohesion between the fricative and nasal elements of the original sequence (or a closer temporal distance between the articulatory gestures for the fricative and nasal elements of the cluster) may result in coarticulatory overlap of velic and oral gestures, leading to fricative weakening and nasal devoicing (*FN > N̥ > h̥ > x). By contrast, an increase in the temporal distance between the articulatory gestures for the fricative and nasal elements of the original sequence (denoted below by a hyphen, “-”) may result in a delayed velic lowering and oral closure for the nasal relative to the end of the fricative, leading to an epenthetic stop or a vowel (*F-n > *F-t > t > k or *F-n > s). A tighter cohesion between the two elements of the cluster likely characterizes a fricative-nasal sequence when it is part of one syllable (specifically, occurs in the syllable-initial position). By contrast, a looser cohesion between the two elements of the cluster likely characterizes a fricative-nasal sequence, when its constituent elements are located in adjacent syllables, making them adjacent segments with varying degrees of coarticulatory overlap. The latter situation would be more likely to arise if the fricative were part of a prefix, and the nasal were part of the root: *F-n.²⁰

An analysis of fricative-nasal sequences in words in Table 6 (which essentially denote parts of the body) as belonging to two different syllables is corroborated by independent evidence in other Tibeto-Burman languages. Matisoff (2003: 102-103) cites examples of several Tibeto-Burman languages, where words for animals and parts of the body consist of two elements, one containing a fricative (specifically, *s*) and being either a fully syllabic element (e.g. *sa-*, as in Lushai), or an element that has become unstressed (e.g. *sə-*, as in Jingpho-Nung; see the prefix *sǎ*³¹- in the Jingpho words *sǎ*³¹-*nit*³¹ ‘seven’ and *sǎ*³¹(*lum*³³) ‘hear/mind’ in Table 1); and the other element being the root. The former element is analyzed as likely representing a reduction of the syllable **sya* ‘animal / flesh / body’ (Matisoff 2003:

¹⁹ These developments are consistent with the proposals of Yu (2012:32-33, 202; 2019: 8-9).

²⁰ See Matisoff (2003: 11 note 1) on such “sesquisyllabic” word structures.

102).²¹ These elements are taken to reflect the historical sibilant prefix, *s-, held to be among “the most important and semantically transparent of all TB prefixes” (Matisoff 2003: 99).

Assuming that in proto-ELD, words in Table 6 consisted of a syllabic prefix and a root, we tentatively suggest that one explanation for differences in the development between Lizu (stop epenthesis) and Ersu (vowel epenthesis) could be that the two languages had different stress placement patterns: the original syllabic prefix being unstressed in Lizu and stressed in Ersu.

In sum, the coexistence of two pathways of change related to sequences of fricatives and nasals in ELD languages suggests differences in the word structure at the proto stage, cognates showing vowel devoicing likely derived from roots with initial *FN clusters; and cognates showing stop or vowel epenthesis likely derived from roots consisting of a syllabic prefix with a fricative and a nasal-initial root (*F-n).

4. Conclusion

Comparison of regular sound correspondences in three closely related Tibeto-Burman languages Ersu, Lizu, and Duoxu, supported by external comparison with phonologically complex TB languages and TB languages with written traditions, leads to the reconstruction of *fricative-nasal sequences in their common ancestor, Proto-ELD. External comparisons show that the ELD correspondence pattern correlates highly with *fricative-nasal sequences that take different pathways of change in various Bodic, Lolo-Burmese, and Qiangic languages of Southwest China.

Our ELD data allows us to recognize two multi-step pathways of change that likely reflect two different types of segments: those in which fricative and nasal elements co-occur in one syllable (*FN, root-initial cluster); and those in which fricative and nasal elements occur in two adjacent syllables (*F-n; a syllabic prefix with a fricative (likely, sibilant) onset followed by a nasal-initial root).

The pathway of change linked to the former type of segments can be summarized as:

$$*FN > \underset{\cdot}{N} > \tilde{h} > x$$

Our data allows us to present a detailed overview of the consecutive stages of nasal devoicing, from nasal clusters to voiceless nasals to a voiceless nasal fricative to non-nasal fricatives. This pathway of change enriches our understanding of possible stages of nasal devoicing in natural languages. Although individual sound changes within this sequence are widely known (within different subgroups of TB), relevant phonetic mechanisms and constraints have so far only been detailed in relation to semi-voiced nasals in Burmese (the only type of voiceless nasals which has been researched in some detail). Recognition of this pathway of nasal devoicing contributes to the furthering of our understanding of synchronic and diachronic aspects of the development of fricative-nasal sequences. The insights gained in regard to Tibeto-Burman languages may well be applicable to other languages and language families of the world in which similar sounds and correspondence patterns are found, helping us to understand and reconstruct historical developments in those languages. An analysis of cognate sets showing this set of sound correspondences also sheds light on some other phenomena, currently without a comprehensive explanation, such as “brightening”, the term coined by Matisoff for the strong

²¹ Notably, the presence of this loosely attached prefix in Ersu and Lizu is detectable also in those roots for parts of the body that begin with a liquid and where, similar to nasal contexts, epenthetic stops may emerge (e.g. Ohala 1997; Ohala & Solé 2010: 79-82). Examples include: ‘tongue’: Ersu /s̀p̀z̀á/ or /hts̀p̀z̀á/, Lizu (Kala) /tépí/, Duoxu /je⁵³pu/, PTB *s-l(y)a.

tendency for *-a, the best-attested rhyme in Proto-Sino-Tibetan, to raise and front in Qiangic languages (Matisoff 2004, see Chirkova & Handel 2019).

The pathway of change linked to the latter type of segments can be summarized as:

*F-n > *F-t > t > k (Lizu); *F-n > s (Ersu)

Our data suggests that different pathways of change taken by fricative-nasal sequences across different languages and also within one closely related language cluster (as can be observed from our ELD comparative data) may provide additional insights into the morphological and syllabic structure of words with contiguous fricative-nasal sequences at particular points in time. Therefore, different pathways of change followed by individual languages may have some diagnostic value in relation to subgrouping at higher-level nodes on the Tibeto-Burman family tree.

By combining comparative analysis with phonetic analysis, our study provides further insights into nasal devoicing and sheds light on the language-specific word structure in ELD languages.

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