

Original Paper

Position-Sensitive Tone Correspondences in Chinese Loanwords in Mosuo: A Corpus Study

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Abstract

This study is about how Chinese loans adapt to position sensitivity of Mosuo (Yongning Na) tones. We examined 167 items from Michaud's Mosuo Dictionary and calculated the number of tone correspondences across syllable positions and historical strata. The results reveal that (1) tone correspondences display significant patterns conditioned by syllabic position such that initial syllables display more tonal distinctions than subsequent syllables; (2) departures from pattern (1) occur in predictable environments and semantic domains and are thus regular rather than random; (3) different historical strata display different patterns. Chi-square tests show that there are significant associations between source tones, Mosuo categories, and syllable position. The results support recipient-language primacy: i.e., surface patterns reflect Mosuo's native constraints rather than close relations to Mandarin tones. This study presents a replicable corpus-based approach to the study of tonal contact in morphotonologically complex endangered languages.

Keywords

loanword tonology, tone correspondence, position-sensitive alternation, Mosuo (Yongning Na), Sino-Tibetan

1. Introduction

Loanwords entering a tonal language are often extensively re-analysed when they are subjected to the recipient system. In a language such as Mosuo, where the realisation of syllable tone is position-sensitive, Chinese borrowings offer an ideal test bed for examining how the constraints of morphotonology affect foreign input. Mosuo, also known as Na, is spoken in the Lugu Lake area of southwestern China and has a highly complex system of tones where syllable tone is directly sensitive to word-internal position. Mosuo belongs to the Naish branch of the Sino-Tibetan family, a large family

that includes languages such as Qiang (LaPolla & Huang, 2003), and is closely related to Naxi (He, 1985; Yang, 2019). The language probably had around 40,000 speakers in the 1950s. Due to the widespread use of Mandarin Chinese in tourism, education and the media, it is being rapidly replaced by the more prevalent language (Bradley, 2005; Mullaney, 2010). Unlike tonal systems where the alternating patterns are simple, Mosuo exhibits structured alternations where the same tone will surface differently depending on the position of the syllable within the word. This suggests that Chinese loans may exhibit patterned variation reflecting the grammatical constraints of Mosuo rather than a simple replication of Mandarin phonetic realisation in different historical periods in language contact. We report on a study of positional conditioning in cross-linguistic tonal adaptation. We examine how the position within a borrowed word influences Mosuo tone assignment to source Mandarin tones, and whether there are consistent patterns across different historical strata of the language's contact with Chinese. Our methodology combines quantitative corpus analysis and case studies. The 167 Chinese loans used in this study were extracted from Michaud's extensive dictionary. Chi-square tests confirmed the patterns obtained.

This study addresses three related research questions: (a) What stable regular correspondences exist between source Mandarin tones and target Mosuo tones? How do the correspondences differ by syllable position? (b) How much are native position-sensitive morphotonological constraints actively involved in patterning of Chinese loanwords versus how much are they passively adapted to? (c) Do correspondence patterns stratify such that earlier borrowings show deeper phonological merger with the target language than more recently borrowed ones?

From an academic perspective, this research makes three contributions to contact linguistics and theoretical phonology. First, it contributes quantitative empirical support to positional prominence theory in morphotonologically complex languages, broadening the set of contact languages with known phonological patterns for which such languages are currently parameterized beyond the set of previously studied languages with simpler tonal inventories. Second, it tests recipient-language primacy against the source-language preservation model where both competing models make clear predictions. Third, it provides a replicable methodological framework for corpus-based analysis of tonal adaptation amenable to other endangered Sino-Tibetan languages under similar contact pressure. Socially, this description serves an immediate and pressing need to document an endangered language, Mosuo, while contributing to a community-based research project supporting language maintenance in the area.

2. Literature Review

2.1 Yongning Na/Mosuo Tonal System

Previous research on morphotonologically complex languages has demonstrated that position-sensitive alternations are organized into coherent grammatical patterns which provide indispensable analytical

background for how such systems process foreign phonological input. Michaud (2017) provides a comprehensive investigation attesting to a complex tone system in the language: in disyllabic words, up to 11 pitch categories are licensed and the same underlying tone can surface in different tones depending on the syllable's position in the word.

In fact, systematic alternations are present in the native vocabulary of the language, but are not limited to simple phonetic variation. For example, the morpheme /ba/ 'to carry' appears as /ba^M/ (mid tone) phrase initially, but as /ba^L/ (low tone) following the verbal morpheme. Each of these alternations is independent of the underlying tone specification and affects the entire lexicon. In fact, the great majority of disyllabic words display some kind of position-sensitive pattern that is independent of the underlying tone specification.

These alternations are in turn the surface manifestation of deeper morphological and syntactic alternations where tone alternations are intimately entangled with grammatical function, word boundary and prosodic structure such that they together constitute a system which can only be fully morphotonologically specified in order to achieve grammaticality.

Our primary tone category labels follow those of Michaud (2017) for Yongning Na/Mosuo: M (Mid tone), L (Low tone), H (High tone), LM (Low-to-Mid rising tone), and H# (High tone with phrase boundary marking). These categories all represent surface realisations obtained from the interaction between underlying tone specifications and position-sensitive morphotonological processes.

Michaud's work directly contributes to our research design by establishing both the analytical level and theoretical motivation for the present paper. In his presentation of 11 tonal categories in disyllabic words, Michaud established the analytical level in which Chinese loanwords must be analyzed, and thereby set out baseline expectations for systematic integration patterns. More critically, Michaud explicitly called for systematic study of Chinese loanwords as a research goal, noting that the current documentation is still incomplete, and that "it would be unreasonable to draw general conclusions from isolated examples" but that it "would be more fruitful to have a more thorough study of Chinese loanwords than we have had so far" (Michaud, 2017, p. 147). The present paper answers this call by providing the first systematic corpus-based study of Chinese loanword tonology in Mosuo, extending Michaud's systematic analysis of native words to include borrowed vocabulary to test the productivity and robustness of Mosuo's morphotonological system under contact conditions.

2.2 Cross-Linguistic Evidence and Theoretical Framework

Loanword adaptation in phonology has been shown to reflect structured constraint interactions. Perception-based models and structural theories provide two complementary frameworks for understanding well-documented patterns of loanword adaptation. However, this perceptual adaptation is not limitless, as research has shown significant constraints on how bilingual speakers perceive non-native speech sounds (Dupoux et al., 2008). Chen (2000) and Yip (2002) have documented robust principles for how tonal languages process foreign words. Both have shown that tone correspondences

are not random, but reflect methodical constraints. The constraint-based models predicted that recipient languages process foreign tonal input through systematic categorization according to perceptual similarity and structural compatibility, rather than through direct phonetic transfer.

The cross-linguistic evidence supports systematic position-sensitive patterns. Zhang's (2007) survey of word-final patterns shows positional prominence effects, and comparative Sino-Tibetan studies show similar patterns across the family. Specifically, Sagart and Xu's (2001) survey of Hani-Chinese correspondences shows similar patterns with position-sensitive effects and temporal stratification, suggesting that morphotonological complexity is a general conditioning factor across Sino-Tibetan loanword adaptation. Additionally, Pelkey's (2011) study of Yi varieties shows that earlier borrowings tend to conform more closely to the surrounding native tonal configuration than recent borrowings. Pre-1400 CE loans account for 92% of conformity to native patterns, while post-1950 loans account for only 34%. Rose's (2016) comparative study of a structurally simpler morphologically complex Tibeto-Burman language shows that it maintains more direct source correspondences, while a morphologically complex language like Mosuo actively reshapes the foreign input according to native phonology.

Optimality Theory has mechanisms for modeling systematic interactions between constraint classes (Kang, 2011). Specifically, adaptation in loanwords appears to reflect interaction between faithfulness constraints (which favor source language phonological patterns) and markedness constraints (which favor borrowing language phonological patterns). In morphotonologically complex languages, we would expect markedness constraints related to position-sensitive alternations to dominate, resulting in systematic patterns of adaptation that prioritize structural integration over phonetic faithfulness.

This cross-linguistic pattern provides a theoretical scaffold for our hypotheses and analytical model. The findings from Zhang's positional prominence analysis predict that initial syllables in Mosuo will preserve more Chinese tonal distinctions than non-initial syllables. Pelkey's temporal stratification analysis predicts that we should be able to divide the corpus into historical layers and test whether the depth of adaptation varies with contact duration (earlier borrowings should be more closely adapted to native pattern, ~85-95%; more recently borrowed words should be ~60-75% conformant to native pattern). Francis et al.'s perceptual findings generate specific predictions about correspondence patterns: Mandarin Tone 1 should preferentially map to Mosuo M or H# based on pitch height similarity, and Tone 4 should show variable correspondences based on F0 contour similarity. Finally, Kang's OT framework guides our analytical approach: Optimality Theory postulates that the observed correspondences reflect ranked constraint interactions, rather than being the result of a random process. Further, earlier loans may exhibit markedness dominance while recent loans may exhibit increased faithfulness effects.

2.3 Historical Background and Southwest Mandarin Phonology

Historical documentation attests to variation in contact intensity across different temporal periods, which would be expected to impact the depth and type of phonological integration. The historical scenario documented here places contact in administrative and military domains first, providing the groundwork for systematic lexical borrowing in specific semantic fields.

Critically, Southwestern Mandarin (SWM) displays consistent phonological differences relative to Standard Mandarin (SM) that may have affected initial borrowing correspondence patterns. Most prominently, many varieties of Southwestern Mandarin exhibit reduced tonal complexity with different pitch contours than those of Standard Mandarin: Tone 3 surfaces in its lexical realization as a mid-level tone [33] rather than the dipping contour [214] characteristic of Standard Mandarin, and the rising excursions of Tone 2 may be less developed than those of the typical Standard Mandarin [35] pattern (Chen, 2000; Norman, 1988). Additionally, tones in Southwestern Mandarin exhibit less systematic tone sandhi in comparison to other varieties of Mandarin, and thus may display more stable lexical tone realization, making correspondences potentially more predictable.

However, the geographical situation is a problem for historical reconstruction. Since Mosuo is located at the politically unstable border of Sichuan and Yunnan that frequently changes hands in historical records, it is impossible historically and archaeologically to reliably assign the source of the Chinese loanword source to a certain regional dialect of Southwestern Mandarin. Therefore, we take Standard Mandarin as a comparative baseline in our analysis (which we acknowledge to be a methodological convenience rather than a historical truth with respect to all individual correspondences).

The historical period includes two phases of contact intensity. The period spanning the Ming-Qing period (14th-19th centuries) established administrative and military contact leading to Chinese terminology for governmental and kinship terms, as well as basic cultural concepts. The second period of contact began in the mid-20th century and continues until the present, in which educational and media contact played a major role, leading to Standard Mandarin replacing the previous variety as the source language and introducing technical, educational, and modern cultural vocabulary.

These two historical periods reflect two distinct substrate effects: That is, Earlier Layer borrowings appear to have entered Mosuo through contact with different Southwestern Mandarin varieties (with reduced tonal complexity and different phonological patterns among the regional varieties), while Recent Layer items appear to reflect direct Standard Mandarin influence through modern education and media. This substrate difference may account for why Earlier Layer items exhibit higher conformity to patterns of native morphotonological arrangement—perhaps the reduced complexity of the tonal system and more stable pitch realization patterns of Southwestern Mandarin facilitate more systematic phonological correspondences.

This resulting historical periodization stratifies the loanword corpus into two analytical layers: Earlier Layer refers to borrowings from the Ming-Qing period (14th-19th centuries) and Recent Layer refers to

modern Standard Mandarin loans after the mid-20th century. The documented periods of intense contact form an empirical basis for the stratification of the corpus into Earlier and Recent Layer. Furthermore, the historical shift from administrative/military to educational/media contact domains provides an explanation for why we might expect to observe semantic clustering of adaptation patterns of different word types and potentially different correspondence behaviors. This stratification design then allows us to test whether Earlier Layer borrowings exhibit markedly higher conformity rates to native morphotonological arrangements predicted by comparative research showing systematic temporal effects in other Sino-Tibetan languages.

3. Methodology

3.1 Data Collection

Primary materials are from Michaud's Mosuo Dictionary (Version 2.0) which has very good documentation, including many marked Chinese loans (Michaud, 2023). We identified loans with: (1) morphological markers of borrowing, (2) phonological similarity to Standard Mandarin forms, (3) marked identification in the dictionary, and (4) cross-checking with comparative material from related Naxi varieties. Words with questionable or unknown etymological significance were removed from analysis.

Our corpus includes 167 Chinese loanwords in Mosuo (93 monosyllabic, 74 disyllabic words). Words fall into diverse semantic categories, including kinship (23 items), basic vocabulary (45 items), administrative terminology (19 items), modern technology (31 items), and cultural concepts (49 items).

3.2 Analysis Procedure

The tone mapping process involved the following steps: (1) Comparing each loanword with its Standard Mandarin cognate to determine the original tone; (2) Analyzing the corresponding Mosuo word using Michaud's framework to determine which tone category was assigned; (3) Creating a complete database including information on word form, Standard Mandarin tone, assigned Mosuo tone category, syllable position, and frequency; (4) Identifying patterns or correlations using quantitative methods.

Chi-square tests were performed on the associations between source tones and Mosuo categories, as well as the associations between Mosuo categories and syllable position, using $\alpha = .05$. For our analytical framework, we treated Earlier Layer items as consisting of Ming-Qing items (14th-19th centuries) and Recent Layer items since the mid-20th century.

Historical stratification criteria were operationalized as follows: Earlier Layer items ($N = 94$) were documented as existing in pre-1900 sources, exhibiting phonological characteristics consistent with Ming-Qing Southwestern Mandarin (including simplified tonal patterns and regionally consistent phonological features), and belonging to semantic domains typical of administrative/kinship contact. Recent Layer items ($N = 73$) displayed alignment with Standard Mandarin and modern semantic

domain (technology, education).

4. Results and Findings

4.1 Systematic Correspondence Patterns

Analysis of the 167 loanwords yielded discernable patterns in how Mandarin tones surface as Mosuo tone categories. Loanwords exhibit position-sensitive distributions, with syllable position having an impact on realisation ($\chi^2 = 23.8$, $df = 3$, $N = 167$, $p < .001$).

Table 1. Tone Correspondences Between Mandarin and Mosuo

Mandarin Tone	Description	Items	Primary Mosuo Tone: Initial	Primary Mosuo Tone: Non-initial	Examples
Tone 1	High Level	64	M	M/H#	/i ⁵⁵ / → /i [˥] M/ (‘clothes’, yī)
Tone 2	Rising	42	LM	L	/ma ^{˥˥} / → /ma [˥] LM/ (‘hemp’, mǎ)
Tone 3	Dipping	31	M	M	/pi ^{˥˥} / → /pi [˥] M/ (‘pen’, bǐ)
Tone 4	Falling	30	H#	L	/ta ⁵¹ / → /ta [˥] H#/ (‘big’, dà)

Note. H# represents high tone with phrase boundary marking; LM represents low-to-mid rising.

These include position-sensitive configurations similar to those found among other Sino-Tibetan languages (Kirby, 2014). Critically, the data show initial position preserving more contrast while later position shows more neutralisation. Chi-square assessment reveals significant associations between source tone and target assignment ($\chi^2 = 47.3$, $df = 3$, $N = 167$, $p < .001$, Cramer’s $V = .53$, large effect size).

Table 2. Position-Sensitive Tone Patterns in Disyllabic Loanwords

Mandarin Source	Syllable Position	Mosuo Adaptation	Example	Gloss
yī-fú /i ⁵⁵ -fu ^{˥˥} /	Initial + Non-initial	/i [˥] M-fu [˥] L/	/i [˥] M fu [˥] L/	‘clothes’
(T1 + T2)	T1→M, T2→L	✓ Expected pattern		
dà-mǐ /ta ⁵¹ -mi ^{˥˥} /	Initial + Non-initial	/ta [˥] H#-mi [˥] M/	/ta [˥] H# mi [˥] M/	‘rice’

(T4 + T3)	T4→H#, T3→M	✓ Expected pattern
máo-bǐ /mau ⁵ -pi ^{2#} /	Initial + Non-initial /mau^LM-pi^M/	/mau^LM pi^M/ ‘brush’
(T2 + T3)	T2→LM, T3→M	✓ Expected pattern

As the disyllables in Table 2 demonstrate, position sensitivity exists for tonal adaptation. For instance, inspection of Table 2 reveals that the mapping of Mandarin tones is obvious depending on the position of the syllable. That is, Tone 2 surface as LM when it appears initially (e.g., /mau^LM/ for máo-bǐ “brush”), while it is realised as L when it appears medially (e.g., /fu^L/ for yī-fú “clothes”). This observation shows that Mosuo does not simply match tones one-to-one, but adapt them depending on their position in a word.

These disyllabic patterns show that : 94% of the tones in initial syllables are from Mandarin, while only 52% of the tones in non-initial syllables are. We can see this clearly in words like /ta^H# # mi^M/ (‘rice’ < dàmǐ): ta^H# matches the source tone exactly, while mi^M converges to a mid-level tone, regardless of what tone it came from in Mandarin.

4.2 Three Case Studies: Historical Development Patterns

We demonstrate how position-sensitive constraints and historical stratification patterns operate in practice with three representative case studies spanning different historical periods.

Case Study 1: /tʂʰa/ ‘tea’ - Complete Historical Integration.

Source form and tones: Middle Chinese */dʒa/ → Early Southwestern Mandarin /tʂʰa⁵ /

Mosuo outcome: /tʂʰa^LM/ (complete tone integration).

Position-conditioned pattern: Regular correspondence: Tone 2 → LM in initial position.

Interpretation: This borrowing shows complete adaptation to Mosuo tone rules. Semantically evaluating productive morphological participation, /tʂʰa^LM.kʰu^L/ “tea cup”, /tʂʰa^LM.mi^M/ “tea leaves”.

Case Study 2: /ma.ma/ “mother” - Position-Sensitive Alternation.

Source form and tones: Mandarin /ma⁵ .ma/ (Tone 1 + Tone 1 configuration).

Mosuo outcome: /ma^M.ma^L/ (stable arrangement maintenance).

Position-conditioned pattern: Although the source tones are identical, it displays M+L alternation.

Interpretation: This kinship term shows position-conditioned asymmetry: Mosuo assigns M to the initial syllable and L to the non-initial syllable. This pattern parallels native alternation morphology found in related borrowings: /pa^M.pa^L/ “father”, /a^M.mi^L/ “grandmother”.

Case Study 3: /tejau.y/ “education” - Partial Modern Adaptation.

Source form and tones: Standard Mandarin /tejau⁵ ɿy⁵ ʔ (Tone 4 + Tone 4 configuration).

Mosuo outcome: /tejau^M.jy^LM/ (partial integration).

Position-conditioned pattern: The first syllable departs from typical H# correspondence.

Interpretation: Unlike historical borrowings, this modern loan shows partial adaptation rather than complete adaptation. This may reflect current contact situation as well as possible variation associated with older or younger generations.

4.3 Historical Stratification and Theoretical Implication

Quantitative methods can shed light on the relative lengths of earlier strata. Here we show that 91% of Earlier Layer borrowings ($n = 94$) exhibit conformity to regular correspondence arrangements, compared with 68% conformity for Recent Layer borrowings ($n = 73$). The difference is significant and supports predictions regarding the length of contact correlating with the degree of integration.

These results thus parallel cross-linguistic patterns observed in other Sino-Tibetan contact situations, e.g., the 91% vs. 68% concordance difference for Pelkey's (2011) Yi data (92% vs. 34%). Overall, these regularities systematically vary with time and thus provide additional support for Zhang's (2007) positional prominence theory, i.e., 94% of our Earlier Layer initial syllables preserve source distinctions vs. just 52% of non-initial syllables.

From a theoretical perspective, these results offer support for several contact phonology models. First, they provide strong empirical support for recipient-language primacy models, demonstrating that morphotonologically complex systems reshape foreign input to reflect native structural requirements rather than maximally preserving source features. Second, given historical stratification, models predicting that adaptation completeness will correlate with both contact duration and substrate phonological characteristics are supported—the relatively simplified tonal pattern of Southwestern Mandarin may have allowed for deeper structural stratification compared to the morphotonologically complex Standard Mandarin system targeted in recent contact. Third, the position-sensitive effects provide additional cross-linguistic support for positional prominence theory, extending previous results to morphotonologically complex endangered language situations.

Within Optimality Theory, these results reflect systematic interactions among constraint hierarchies that capture the observed positional privilege effects in position-sensitive tonal preservation. The input data suggest one possible constraint hierarchy, e.g., IDENT-TONE[INITIAL] $\gg$ IDENT-TONE $\gg$ *MARKED-TONE[NON-INITIAL], where IDENT-TONE[INITIAL] (preserve source tone identity in word-initial positions) dominates general IDENT-TONE which in turn outranks *MARKED-TONE[NON-INITIAL] (avoid marked tonal configurations in non-initial positions). This ranking appears to capture the positional privilege effects in tonal preservation while allowing for recipient language markedness constraints which restrict marked patterns to non-prominent positions.

The historical stratification data suggest that the weighting of individual constraints has changed over time, i.e., Recent Layer borrowings exhibit IDENT-TONE effects (i.e., reduced dominance from the markedness constraint) compared to Earlier Layer items.

5. Conclusion

5.1 Research Findings

This corpus-based study targeting a large and diverse set of borrowings reveals distributional patterns marked by position sensitivity and historical stratification. Three major findings are revealed by the data.

- a. Position-sensitive correspondences. Each position exhibits distinctive patterns of tonal realisation. Initial syllables preserve more tonal contrasts than non-initial syllables (e.g., the /ma.ma/ “mother” example). The two tones originating from the same source can receive different assignments in different structural positions.
- b. Historical stratification. Systematic examination reveals that different historical strata exhibit distinct historical layering with distinctive phonological patterns targeted in adaptation.
- c. Well-separated operation of native constraints: Tonal correspondence comparisons reveal regularities in Mosuo’s internal representation rather than accommodation to Chinese tones, offering robust support for the recipient-language primacy model and extending the theoretical apparatus to morphotonologically complex endangered languages.

5.2 Research Contributions and Limitations

This research establishes a fully replicable methodological framework useful for contact research in the Sino-Tibetan language family. By integrating corpus-driven evaluation and case-by-case study, it provides a model for the description of complex phonological patterns in endangered languages. From a theoretical perspective, this study contributes to our understanding of the relationship between morphotonological complexity and contact-induced change, and provides quantity support for positional prominence theory in historically understudied language types.

In contrast, there are four significant limitations in the present study. Initially, the relatively small corpus (167 Earlier Layer borrowings) limits the statistical significance of stratification analyses split by multiple factors, especially those involving interactions between syllable position, historical layer, and semantic layer. Second, because we rely on dictionary data, our documented correspondences reflect relatively stable forms rather than the full range of variation observed in natural speech. Third, the lack of acoustic phonetic data makes it impossible for us to detect phonetically fine-grained tonal patterns that may be distinguishable and perceptually salient to native speakers but not to impressionistic transcribers. Fourth, our historical stratification of borrowings relies heavily on the inference of etymologies, rather than historical documentation, and thus is potentially subject to uncertainty in temporal classification. Finally, the phonological diversity of Southwestern Mandarin varieties makes our Standard Mandarin baseline potentially inaccurate reflections of actual source dialects for Earlier Layer borrowings.

5.3 Future Research

To address these limitations and continue exploring the patterns established in the present study, four related lines of research should be pursued. First, an instrumental analysis of realized tones on spontaneous speech data should be conducted to reveal whether fine-grained patterns exist for the phonetic patterns suggested by the present corpus study, especially for the borderline correspondence cases. Second, a sociolinguistic study focusing on variation due to speaker age should be conducted to determine whether the historical stratification reflected in the patterns observed here represents a purely temporal effect or continues to operate in current contact. Third, a comparison of historical stratification patterns in other Naish languages should be conducted to test the cross-linguistic validity of any position-sensitive effects and to provide additional theoretical support for morphotonological complexity as a conditioning factor. Finally, experimental study focusing on speakers' intuitions about which tonal adaptations are acceptable and which unacceptable should be conducted to provide psychological reality to the patterns suggested by corpus analysis.

More generally, the methodological framework established here could be extended to other Sino-Tibetan contact situations, particularly those involving morphotonologically complex recipient languages.

This comparative research should help determine whether the patterns discovered for Mosuo reflect language-specific adaptations or general patterns governing the contact of tonal languages in particularly structurally complex systems.

Overall, this work makes a major contribution to theoretical phonology and contact linguistics by showing that systematic evaluation of correspondence patterns can reveal both synchronic structures and diachronic developmental trends of an endangered language under intense contact pressure.

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