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Tonal Erosion in a Minority Ethnic Language and Its Implications for Language Education: Evidence from Intergenerational Tonal Change in Phuan, Northeastern Thailand

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Abstract

The Phuan language, a Tai-family language spoken by an ethnic minority community in northeastern Thailand, is critically endangered due to sustained contact with Northeastern Thai (Isan) and Standard Thai. As the Phuan-speaking population ages and younger generations shift toward dominant languages, the prospects for intergenerational language transmission and community-based language education are diminishing. This study investigates tonal change in progress in Phuan across four provinces—Loei, Nong Khai, Udon Thani, and Bueng Kan—through intergenerational comparison using Labov's (1972) apparent-time method, with the dual aim of documenting ongoing phonological change and informing evidence-based language education planning for minority communities. Data were collected from 48 informants equally divided between an elderly group (55–65 years) and an adolescent group (15–25 years) across eight districts. Tonal analysis employed Gedney's (1972) tone box framework alongside 60 elicitation words and 20 analogous-set words, with acoustic analysis performed using Praat version 6.2.03 and fundamental frequency (F0) values converted to semitones (ST). Results reveal that tonal change is actively underway in all eight research sites. A Tonal Change Index (TCI) was computed for each district, showing that Ban Phue District (Udon Thani) exhibits the highest degree of change (TCI = 1.00), while Pho Tak District (Nong Khai) shows the greatest tonal retention (TCI = 0.33). The direction of change consistently moves toward fewer tonal distinctions, reflecting contact-induced convergence toward Isan and Standard Thai. These findings carry direct implications for minority language education policy, heritage language curriculum design, and teacher training in multilingual communities across Southeast Asia.

Keywords: Phuan language, tonal change in progress, minority language education, heritage language, language endangerment, intergenerational transmission, language education policy, northeastern Thailand

1. Introduction

Minority languages worldwide are disappearing at an accelerating rate, with UNESCO estimating that approximately half of the world's roughly 7,000 languages are endangered (UNESCO, 2010). This linguistic attrition has profound consequences not only for cultural heritage but also for education: when a minority language disappears from the repertoire of younger generations, the possibility of community-based mother-tongue education, bilingual schooling, and culturally sustaining pedagogy disappears with it (Cummins, 2000; May, 2012). In mainland Southeast Asia, this crisis is particularly acute among Tai-family languages spoken by small ethnic communities embedded within larger dominant-language populations. The Phuan language presents a compelling case: originally from the Xieng Khouang region of the Lao People's Democratic Republic, Phuan-speaking communities migrated into Thailand over several centuries, with major waves during the reign of King Rama V (Saemlamchiak, 1994). Today, Phuan communities are found across multiple regions of Thailand—central, northern, eastern, and northeastern—yet the language has received no systematic attention in terms of education policy, curriculum development, or intergenerational language transmission programs. This gap is notable given the recent development of systematic approaches for documenting and analyzing multilingual repertoires in endangered-language settings (Sawanyavisuthi & Kwangmuang, 2026).

This study addresses that gap by applying Labov's (1972) apparent-time construct, which treats cross-sectional age differences in speech as a proxy for language change over real time. By comparing the tonal systems of elderly Phuan speakers (55–65 years) with those of adolescent speakers (15–25 years) across eight districts in four provinces, we ask: (1) To what degree are the tonal systems of Phuan currently changing? (2) Which tonal categories are most vulnerable? (3) How do the rate and direction of change differ across geographic locations? (4) What social and geographic factors predict the degree of change?

Answering these questions contributes to four intersecting bodies of scholarship. First, it advances the typology of tonal change in Tai languages, an area that has benefited from landmark comparative work (Li, 1959; Gedney, 1972; Pittayaporn, 2009) but lacks granular sociolinguistic depth at the community level. Second, it provides the most comprehensive empirical account of Phuan tonal dynamics in northeastern Thailand to date, building on recent work by Pornpottanamas (2023) and Toophom and colleagues. Third, it proposes a Tonal Change Index (TCI) as a replicable, quantitative metric for assessing tonal endangerment. Fourth, and most critically, it translates phonological findings into actionable recommendations for minority language education policy, heritage language curriculum design, and teacher preparation in multilingual communities—areas of growing concern in Thai educational reform (Office of the Basic Education Commission, 2020) and in Southeast Asian multilingual education more broadly. (Kosonen, 2010).

2. Review of Literature

Prior research relevant to this study can be organized into six thematic clusters: (1) biological and ecological foundations of tone; (2) tonal variation and change in tonal languages; (3) cross-linguistic tone perception and production; (4) sociolinguistic and ideological factors in tonal variation; (5) tonal variation in Tai languages of Thailand; and (6) Theoretical Framework. Together, these bodies of work provide the theoretical and empirical scaffolding for the present investigation.

2.1 Biological and Ecological Foundations of Tone

A growing body of research situates tonal systems within biological and environmental constraints. Di et al. (2024) investigated genetic influences on median voice pitch in Mandarin and Icelandic speakers, identifying a significant association between the genetic variant rs11046212-T in the ABCC9 gene and median pitch levels in both populations, with heritability estimates of approximately 20% in the Chinese sample and 17% in the Icelandic sample. Crucially, median F0 was shown to reflect physiological production processes rather than language-specific phonological properties, suggesting that the biological substrate of tonal production is shared across tone and non-tone languages. Liang et al. (2023) demonstrated a causal chain linking humidity, voice quality, and tonal complexity across 997 varieties of Chinese. Low-humidity environments were associated with significant increases in jitter and shimmer values ($p < 0.0001$), indicating that dry air impairs efficient vocal fold vibration and, over historical time, favors simplification of tonal inventories. These findings are directly relevant to the Phuan context: the contact-driven simplification documented here represents an anthropogenic rather than ecological pressure on tonal complexity.

2.2 Tonal Variation and Change in Tonal Languages

Research on tonal variation covers both geographic and diachronic dimensions. Sung and Prokić (2024) introduced a dialect tonometry methodology using a Modified Onset-Contour-Offset (mOCO) system to measure tonal distances across 104 survey points in Yue and Pinghua dialects of Chinese, finding that tonal variation clusters into clearly bounded dialect areas rather than continuous gradients, with a moderate positive correlation between tonal variation and phonetic contact ($r = 0.52$, $p < 0.001$). At the level of individual tone change, Yi (2023) identified three universal principles driving tonal evolution—simplification of contour shape, insertion of new tonal features, and raising or lowering of pitch register—all consistent with Ohala's labor-saving principle. Wang, Gao, and Zhang (2024) added a cognitive dimension, showing that individual differences in attention and working memory modulate the trajectory of tonal merger in Macau Cantonese. Ren and Chiew (2024) further demonstrated that contact with differently-toned languages produces systematic tonal flattening in Mandarin varieties across Malaysia, Singapore, and Taiwan, a pattern closely analogous to what is observed in adolescent Phuan speakers here. Liao (2023) documented bidirectional tonal diffusion between Chinese and Kam-Tai languages in the Lingnan region, demonstrating that even typologically distinct language families can influence each other's tonal categories under sustained contact.

2.3 Cross-Linguistic Tone Perception and Production

The literature on tone perception and production across languages illuminates why contact-induced tonal change is particularly likely among younger bilinguals. Vonessen and Zellou (2024) found that while native Mandarin listeners outperformed tone-naive listeners in discriminating tonal contrasts, both groups showed similar perceptual compensation patterns for tonal coarticulation, suggesting that low-level auditory mechanisms underlie perceptual compensation. This implies that adolescent Phuan speakers dominant in Isan may perceive Phuan tonal contrasts

through the filter of their dominant language's phonological categories, making distinctions absent in Isan perceptually less salient and therefore more susceptible to merger. Gao (2024) demonstrated that learners with a pitch-accent background achieved higher accuracy in Mandarin tone identification (89.9%) than those without (84.8%), confirming that prior prosodic experience facilitates tone discrimination. Chu, Chang, and Lin (2024) further showed that language transfer shapes tonal production, with learners producing systematically altered pitch levels across tones.

2.4 Sociolinguistic and Ideological Factors in Tonal Variation

Beyond phonetics, tonal variation is embedded in social meaning. Su, Wan, and Lee (2025) examined metapragmatic debates in Taiwan over the pronunciation of a common word through a third-wave sociolinguistic framework, finding that minute tonal differences can become the site of negotiation over linguistic authority and national identity through processes of enregisterment. Rajagukguk, Malems, and Ginting (2022) showed that in the Batak languages of Indonesia, complex tonal systems function as markers of ethnic identity and cultural heritage. Pornpottanamas (2023) demonstrated concretely that tonal patterns are a more accurate criterion for identifying Tai ethnic-language groups than ethnonyms, finding that a distinct Phuan group in Chachoengsao Province is identifiable precisely by its tonal characteristics. This underscores the value of tonal analysis as a tool for ethnic and linguistic documentation and, by extension, for culturally grounded language education.

2.5 Tonal Variation in Tai Languages of Thailand

Thavorn and Kraisame (2023). Regional tonal variation in Tai Khuen, Chiang Mai Province. Research on tonal variation within Tai languages of Thailand provides the most direct comparative context. Wongrikwaet and Sutthinon (2022) studied tonal variation in Southern Thai in Phatthalung Province as a function of age, documenting five tonal variants reflecting a trend from a traditional 7-tone system toward a 6-tone system, with contact with Standard Thai as a primary driver. Thavorn and Kraisame (2023) found that the Tai Khuen tonal system in Chiang Mai Province varies regionally into three patterns, driven by peak sliding, perceptual maximization, and contour reduction. Research directly on Phuan includes Teearam and Buakaw (2025), who found clear differentiation between two villages in Chiang Khan District: one retaining canonical Phuan features while the other has shifted toward a Lao-like system due to language contact. Inthajamarrak (2019) found that Lua and Hmong speakers in Nan Province exhibit contact-induced tonal simplification in their Thai. Akkharawatthanakul (2019) confirmed through lexical and phonological evidence that Phuan is genealogically and structurally distinct from Lao, making any convergence toward Isan a change against the grain of historical genetic affiliation.

2.6 Theoretical Framework

Labov's (1972, 1994) framework for studying language change in progress distinguishes between stable variation and ongoing change, in which younger speakers consistently exhibit forms diverging from those of older speakers in a directional manner. The apparent-time method operationalizes this by treating synchronic cross-generational data as a diachronic record: differences between older and younger speakers reflect changes that have occurred over the intervening decades (Bailey, 2002). Applied to tonal systems, apparent-time analysis requires demonstrating systematic, directional differences in (a) the number of phonemic tone contrasts and/or (b) the phonetic realization of shared tones across age groups. Contact-induced change provides the mechanism: phonological convergence toward the dominant language is a well-documented process when a minority language is embedded within a dominant-language community (Thomason & Kaufman, 1988; Winford, 2003). The perceptual filter hypothesis—supported by Vonessen and Zellou (2024) and Gao (2024)—predicts that speakers dominant in the contact language will perceive minority-language contrasts through their dominant-language categories, accelerating merger.

3. Methodology

3.1 Research Sites and Informants

Data were collected from eight districts across four provinces in northeastern Thailand where Phuan communities have resided continuously for multiple generations (Table 1). Sites were selected on the basis of prior literature confirming active Phuan use, verified through preliminary contact with village headmen and community elders.

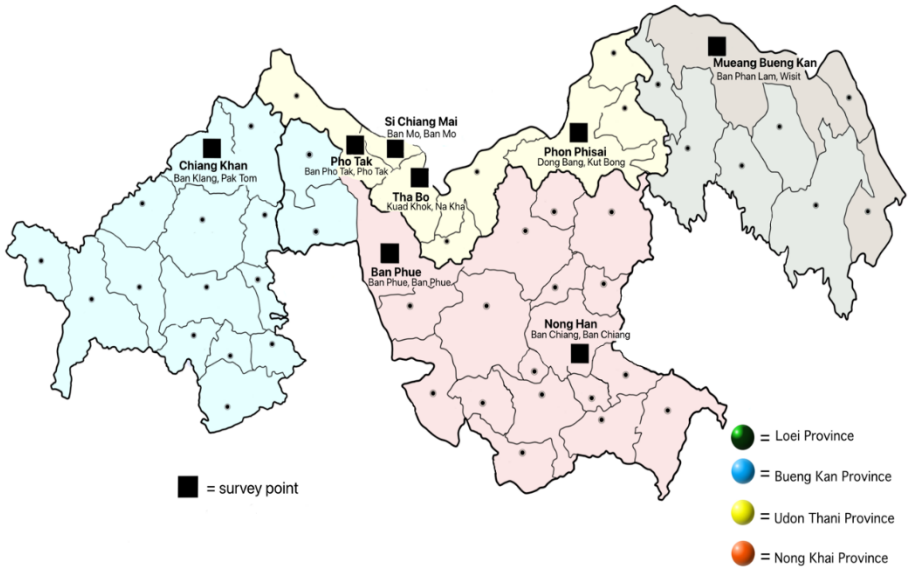


Figure 1. Map of eight Phuan research sites across four provinces in northeastern Thailand

Table 1. Research Sites and Informant Numbers

Province	District	Subdistrict / Village	Elderly (55–65)	Adolescent (15–25)
Loei	Chiang Khan	Ban Klang, Pak Tom	3	3
Nong Khai	Phon Phisai	Dong Bang, Kut Bong	3	3
	Tha Bo	Kuad Khok, Na Kha	3	3
	Pho Tak	Ban Pho Tak, Pho Tak	3	3
	Si Chiang Mai	Ban Mo, Ban Mo	3	3
Udon Thani	Ban Phue	Ban Phue Village	3	3
	Nong Han	Ban Chiang, Ban Chiang	3	3
Bueng Kan	Mueang Bueng Kan	Ban Phan Lam, Wisit	3	3
Total			24	24

Informants were required to (1) self-identify as Phuan, (2) have resided in the research site for at least 20 years without extended absence, (3) use Phuan regularly in daily communication, and (4) have parents who were also Phuan speakers. Ethical clearance was obtained from Khon Kaen University's Human Research Ethics Committee prior to data collection. All participants provided written informed consent.

3.2 Data Collection Instruments

Three instruments were used. First, a background questionnaire documented each informant's age, sex, educational background, and linguistic repertoire, following mixed-methods approaches to analyzing multilingual repertoires in endangered-language contexts (Sawanyavisuthi & Kwangmuang, 2026). Second, Gedney's (1972) Tone Box —a 60-word elicitation list organized into Proto-Tai tonal categories (A, B, C, DL, DS) across four laryngeal environments—was used to identify phonemic tonal contrasts through auditory analysis. Third, an analogous-set wordlist of 20 minimal and near-minimal pairs (Akkharawatthanakul, 2003) controlled for consonant and vowel environment to isolate tonal F0 trajectories for acoustic measurement.

3.3 Data Recording and Acoustic Analysis

All speech data were recorded in quiet indoor conditions using a Remax RP1 digital recorder. Each informant produced the 60-word tone box list three times (180 tokens) and the 20-word analogous set five times (100 tokens). Acoustic analysis was conducted in Praat version 6.2.03 (Boersma & Weenink, 2022). Fundamental frequency (F0) contours were extracted at 11 equidistant time points (0%, 10%, … 100%) for each token. F0 values in Hz were converted to semitones (ST) using the formula:

$$ST = 12 \times \log (F0 / F0_ref) / \log (2)$$

where F0 is the F0 value at each time point and F0_ref is the minimum F0 value across all tokens produces by that speaker. Speaker-averaged ST contours were computed for each tonal category and displayed as time-normalized graphs in Microsoft Excel 365.

3.4 Tonal Change Index (TCI)

To quantify the degree of tonal change at each site, we computed a Tonal Change Index (TCI) defined as:

$$TCI = C / T$$

where C is the number of tonal phoneme slots (Gedney tone box cells) showing a systematic difference between the elderly and adolescent groups, and T is the total number of tonal phoneme slots present in the elderly system at that site. A TCI of 0.00 indicates complete tonal stability; a TCI of 1.00 indicates that every tonal category has changed. A change was considered systematic if at least two of three adolescent informants at a site showed the same directional shift in split-merge pattern or phonetic realization relative to the elderly baseline.

4. Results

4.1 Overview: Tonal Systems of Elderly Speakers

Among the 24 elderly informants across the eight districts, two tonal system types were identified. Five districts produced informants with tonal systems ranging from 5 to 6 phonemic tones, with internal variation present in three of these sites. The remaining three districts showed 6 phonemic tones consistently. Across all eight sites, elderly speakers exhibited four distinct split-merge patterns in Gedney's tone box (Table 2), consistent with prior reports (Toophom & Buakaw, 2025); (Tanprasert, 2003).

Table 2. Tone Split-Merge Patterns and Number of Phonemic Tones among Elderly Speakers

District	Province	Split-Merge Pattern (Elderly)	Tones (Elderly)
Chiang Khan	Loei	A123-4, B1234, C1-234, DL/DS123-4	6*
Phon Phisai	Nong Khai	A1-234, B123-4, C1-234, DL/DS123-4	6
Tha Bo	Nong Khai	A1-234, B1234, C1-234, DL/DS123-4	5
Pho Tak	Nong Khai	A1-234, B123-4, C1-234, DL/DS123-4	6
Si Chiang Mai	Nong Khai	A1-234, B1234, C1-234, DL/DS123-4	5*
Ban Phue	Udon Thani	A123-4, B123-4, C1-234, DL/DS123-4	6
Nong Han	Udon Thani	A1-234, B123-4, C1-234, DL/DS123-4	6
Mueang Bueng Kan	Bueng Kan	A123-4, B123-4, C1-234, DL/DS123-4	6*

* Internal variation present: one or more informants show a different tonal count from the majority pattern.

4.2 Tonal Change across Age Groups: Tonal Change Index

Table 3 presents the Tonal Change Index for each district. TCI values range from 0.33 (Pho Tak) to 1.00 (Ban Phue), with a mean of 0.65 across all eight sites, indicating substantial ongoing change throughout the Phuan-speaking communities of northeastern Thailand.

Table 3. Tonal Change Index (TCI) by District

District	Province	Slots Changed (C)	Total Slots (T)	TCI	Degree
Ban Phue	Udon Thani	6	6	1.00	Very High
Si Chiang Mai	Nong Khai	5	5/6*	0.83	High
Mueang Bueng Kan	Bueng Kan	5	6	0.83	High
Tha Bo	Nong Khai	4	5	0.80	High
Chiang Khan	Loei	4	6	0.67	Moderate
Nong Han	Udon Thani	4	6	0.67	Moderate
Phon Phisai	Nong Khai	3	6	0.50	Moderate
Pho Tak	Nong Khai	2	6	0.33	Low
Mean		4.1	5.9	0.65	

* Si Chiang Mai elderly informants showed internal variation between 5- and 6-tone systems.

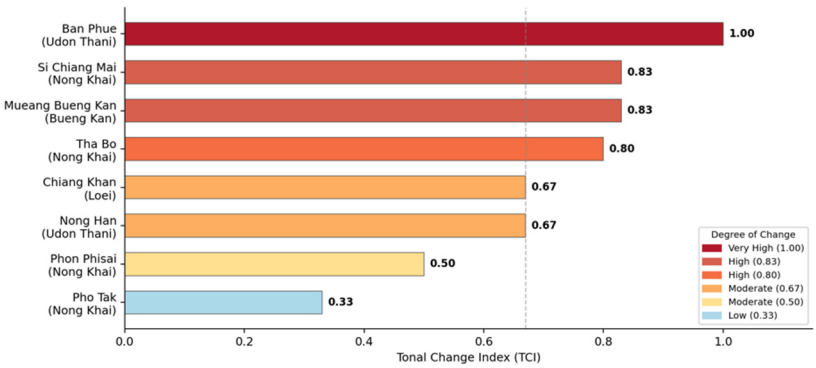


Figure 2. Tonal Change Index (TCI) scores across eight Phuan-speaking districts in northeastern Thailand, ordered by degree of change

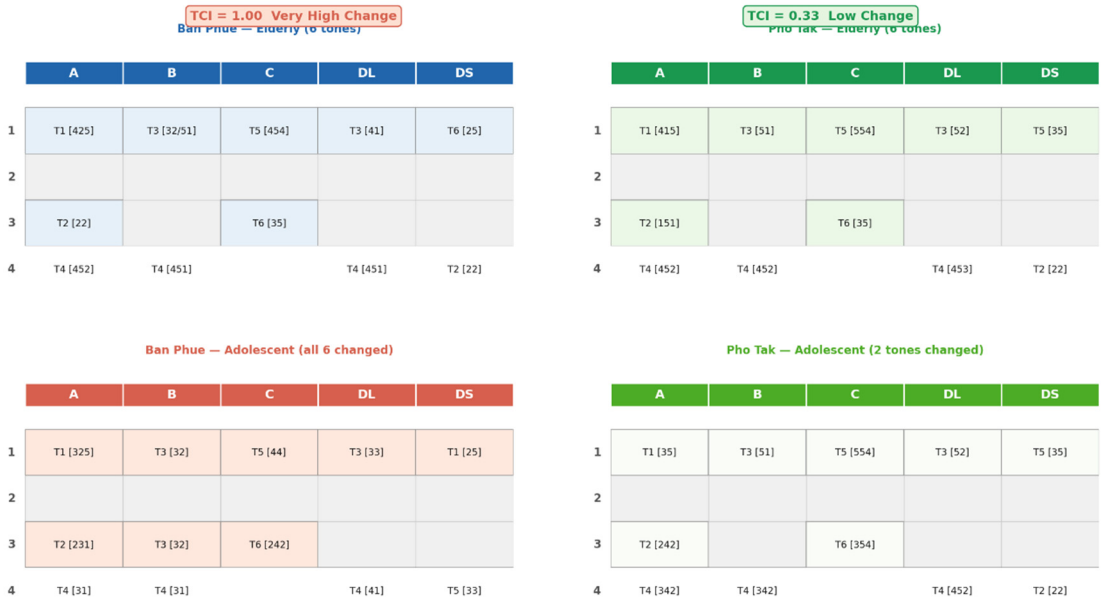


Figure 3. Tone split-merge patterns in Ban Phue District (TCI = 1.00) and Pho Tak District (TCI = 0.33): elderly (upper) vs. adolescent (lower) systems

4.3 Direction of Tonal Change: Patterns Across Sites

Analysis of which specific tonal categories showed change reveals three recurrent directional patterns.

4.3.1 Merger of C1 and C234 Tones

The most pervasive change across all eight districts involves the tonal categories in column C of Gedney's tone box. In the elderly systems, C1 and C234 constitute distinct phonemic tones. Among adolescent speakers, this contrast is weakened or neutralized in 7 of 8 districts. In Chiang Khan, for instance, elderly speakers produce C1 as a low-rising-falling contour [253] and C234 as a mid-rising-falling contour [254], clearly distinct. Adolescent speakers in the same community produce both in the range of [22] to [35], with substantial overlap. This pattern mirrors the Isan tonal system, which lacks the C1/C234 distinction found in canonical Phuan. The mechanism aligns with Yi (2023) simplification principle and is consistent with the contour reduction mechanism documented by Thavorn and Kraisame (2023) in Tai Khuen.

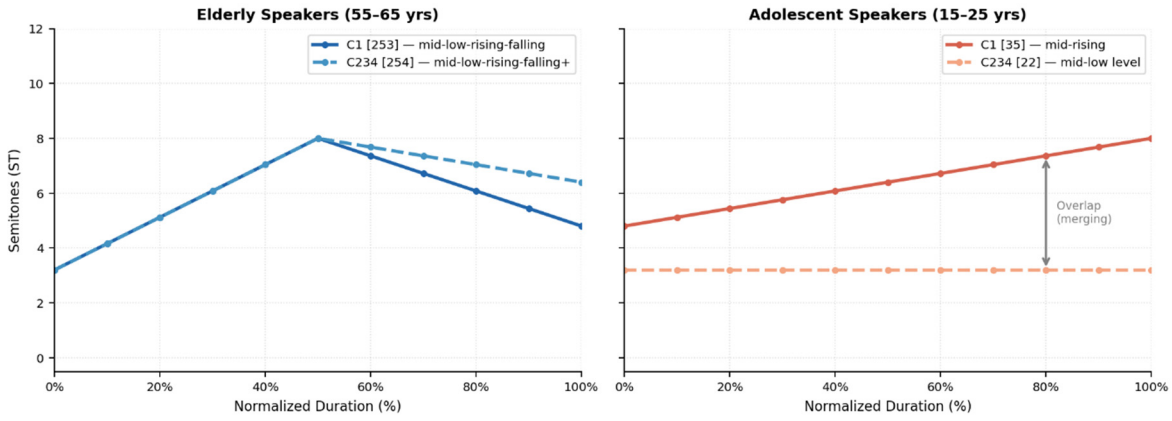


Figure 4. F0 contours (in semitones) of tonal categories C1 and C234 in Chiang Khan District: elderly speakers (left) vs. adolescent speakers (right)

4.3.2 Merger of A1 and A234 Tones

In four districts (Chiang Khan, Ban Phue, Mueang Bueng Kan, and Tha Bo), adolescent speakers show a merger or near-merger of A1 and A234. The merged realization typically patterns as a mid-rising contour [34] or mid-level [33], consistent with the unmarked tonal category in Isan. From a perceptual standpoint, Vonessen and Zellou (2024)

perceptual compensation framework predicts that Isan-dominant adolescents would perceive the A1/A234 distinction with diminished resolution, since their dominant language provides no phonological template for this contrast, facilitating its collapse.

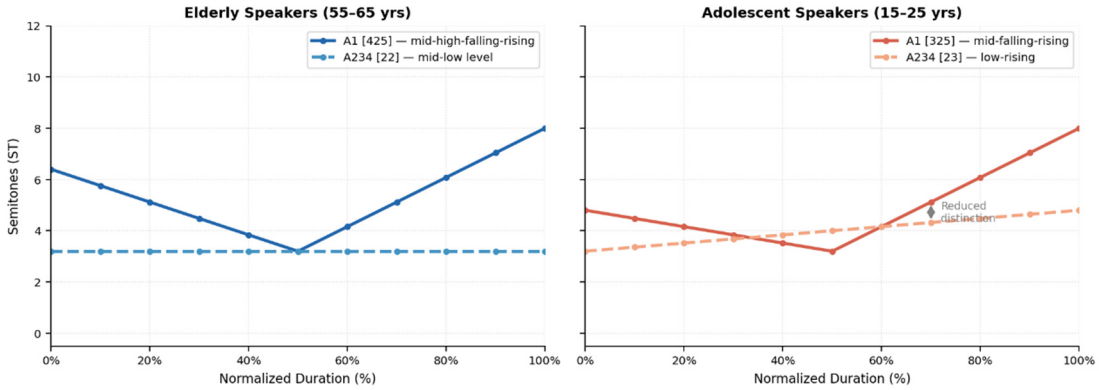


Figure 5. F0 contours (in semitones) of tonal categories A1 and A234 in Ban Phue District: elderly speakers (left) vs. adolescent speakers (right)

4.3.3 Restructuring of B Column Tones

In five districts, adolescent speakers show altered realizations of B column tones. The elderly B1234 pattern—a high-falling [51] contour—shifts toward a mid-falling [31] or mid-level [33] in adolescent speech. In Ban Phue and Mueang Bueng Kan, B1 and B234 merge in adolescent speech. This downward shift is consistent with Ren and Chiew (2024) finding that tonal flattening in contact varieties tends to collapse high-register tones toward mid-register values.

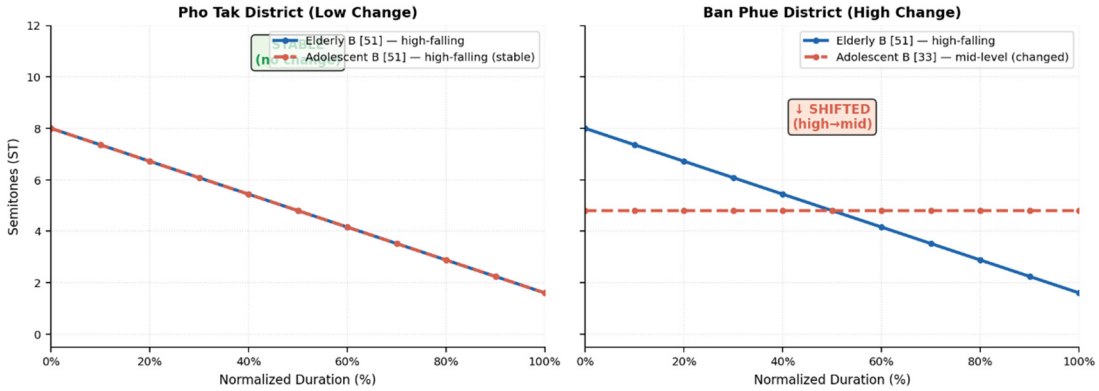


Figure 6. F0 contours (in semitones) of B column tones in Pho Tak District (low TCI) and Ban Phue District (high TCI) by age group

4.4 Geographic Predictors of Tonal Stability

The TCI values correlate inversely with the geographic isolation of communities from urban centers. Pho Tak District, which exhibits the lowest TCI (0.33), is situated in a rural area with limited transport connections and a relatively dense Phuan-speaking population. Ban Phue District, with the highest TCI (1.00), is located near an active commercial town with greater exposure to Standard Thai through schooling and media. Mueang Bueng Kan (TCI = 0.83) is the administrative center of Bueng Kan Province, a newly established province that has experienced rapid urbanization. These patterns suggest that urbanization, educational integration, and contact density with Standard Thai and Isan are the primary drivers of accelerated tonal change. Communities with stronger internal Phuan-language networks show lower TCI values, consistent with contact-linguistic theory predicting that dense minority-language networks retard shift (Milroy, 1987).

5. Discussion

5.1 Phuan Tonal Change as Contact-Induced Convergence

The pervasive directionality of tonal change in Phuan—consistent merger of categories that are distinct in Phuan but neutralized in Isan and Standard Thai—strongly implicates contact-induced convergence as the primary mechanism. The C1/C234 merger produces a tonal system structurally closer to Isan, while the A1/A234 merger similarly moves

Phuan toward a tonal inventory resembling Standard Thai. This dual convergence pressure, from two dominant contact languages simultaneously, is consistent with Muysken's (2008) model of convergence under plurilingual conditions. The changes are systematic, community-wide shifts satisfying Labov's (1972) criterion for genuine change in progress. The directionality toward Isan tonal categories is particularly significant: as Pornpottanamas (2023) demonstrated, the tonal boundary between Phuan and Isan is the most reliable diagnostic criterion for distinguishing these languages. As Phuan adolescents' tonal systems converge toward Isan norms, that diagnostic boundary erodes. Rajagukguk et al. (2022) emphasized that tonal distinctiveness functions as a marker of ethnic identity; its loss therefore carries consequences well beyond phonetics.

5.2 The Tonal Change Index as a Comparative Tool

The TCI proposed in this study offers a simple, replicable metric for quantifying tonal endangerment that does not require extensive phonological theory or complex statistical models. Its inputs—systematic differences between age groups in Gedney's tone box cells—are obtainable through standard field procedures widely used in Tai linguistics. The TCI complements the dialect tonometry approach of Sung and Prokić (2024) by providing a temporal trajectory of tonal change rather than a synchronic geographic snapshot. Future research could refine TCI by weighting categories according to functional load (Wedel, Kaplan, & Jackson, 2013) or by incorporating acoustic distance measures to capture gradient phonetic change preceding categorical merger. Incorporating individual-level cognitive variables, following Wang et al. (2024), could further illuminate why some speakers within a community lead the change while others retain more conservative forms.

5.3 Implications for Language Documentation and Revitalization

With a mean TCI of 0.65, Phuan in northeastern Thailand is undergoing rapid tonal restructuring. Communities such as Pho Tak (TCI = 0.33) retain the greatest tonal diversity and therefore offer the most complete documentation windows, while urgent efforts are needed in Ban Phue and Bueng Kan. These findings support UNESCO's call for endangered-language documentation programs that prioritize older speakers while simultaneously recording younger speakers' systems to capture change in real time. Community-based revitalization efforts should incorporate the specific tonal distinctions most at risk—particularly the C1/C234 and A1/A234 contrasts—into literacy and oral transmission materials.

5.4 Implications for Minority Language Education Policy and Practice

The findings of this study carry concrete implications for language education policy and classroom practice in minority-language communities. Four areas warrant particular attention.

5.4.1 Evidence-Based Language Education Planning

The Tonal Change Index provides education planners and policy-makers with a quantitative, community-specific measure of language vitality that can directly inform decisions about where and how urgently minority language education programs should be prioritized. Districts with high TCI values are in the most critical need of immediate educational intervention, while districts with lower TCI values offer a more viable foundation for mother-tongue-based multilingual education (MTB-MLE) programs, which UNESCO and UNICEF have identified as the most effective model for minority language communities (UNESCO, 2010; Kosonen, 2010). The TCI framework can be replicated by local education authorities without specialized linguistic training, making it a practical policy tool for resource allocation in multilingual education systems.

5.4.2 Heritage Language Curriculum Design

The specific tonal contrasts found to be most at risk—the C1/C234 merger and the A1/A234 merger—should be foregrounded in any heritage language curriculum designed for Phuan learners. Since these contrasts are absent in both Isan and Standard Thai (the languages of formal schooling), Phuan-speaking students receive no reinforcement of these distinctions through their regular education. Heritage language curricula must therefore explicitly address tonal contrasts that differ from the school language, using audio-visual materials, listening discrimination exercises, and contrastive tone production drills. The phonetic data collected in this study—F0 contour graphs for both age groups in all eight districts—can serve directly as teaching materials, providing authentic acoustic models of the traditional tonal system.

5.4.3 Teacher Training and Language Awareness

Effective minority language education requires teachers who understand not only the target language but also its sociolinguistic situation, including the specific ways in which the language is changing under contact pressure. Teacher training programs in multilingual regions of Thailand should incorporate awareness of the contact-induced tonal changes documented here, enabling teachers to recognize and appropriately respond to tonal variation that

Phuan-speaking students bring to the classroom. This is particularly important in communities such as Ban Phue and Mueang Bueng Kan, where the gap between elderly and adolescent tonal systems is greatest.

5.4.4 Intergenerational Transmission as an Educational Goal

The most powerful form of minority language education occurs not in the classroom but in the home and community, through intergenerational transmission from grandparents and parents to children (Fishman, 1991). The apparent-time data presented here demonstrate that elderly speakers (55–65 years) are the primary bearers of the traditional Phuan tonal system. Schools in Phuan-speaking districts can play a catalytic role by incorporating community elders as language resource persons, creating structured opportunities for elder-youth interaction around language, and validating Phuan as a language of cultural and educational prestige. The geographic data from this study—showing that communities with stronger internal language networks show stronger tonal retention—confirms Fishman's (1991) foundational argument that intergenerational transmission is the irreplaceable foundation of language vitality.

6. Conclusion

This study has provided the first systematic, cross-province, cross-generational analysis of tonal change in progress in Phuan, a Tai-family minority language of northeastern Thailand, with direct implications for minority language education policy and practice. Comparing 24 elderly and 24 adolescent speakers across eight districts in four provinces, we document active tonal restructuring in all communities, with a mean Tonal Change Index of 0.65. The direction of change consistently involves the merger of tonal categories that are distinct in traditional Phuan but absent or neutralized in the dominant contact languages Isan and Standard Thai—the very languages through which Phuan-speaking children receive their formal education. This structural mismatch between the language of the home community and the language of schooling lies at the heart of the educational challenge facing Phuan speakers.

The Tonal Change Index proposed here provides a straightforward, replicable tool for assessing tonal endangerment that education planners can apply to other minority languages without specialized training. Without knowing which specific tonal features are being lost, where, and at what rate, education policy-makers cannot design curricula, train teachers, or allocate resources with the specificity that effective minority language education requires. Communities of Pho Tak and Phon Phisai, where tonal retention is greatest, represent the most promising sites for MTB-MLE initiatives. Communities of Ban Phue and Mueang Bueng Kan, where tonal change is most advanced, require the most urgent intervention. In all eight communities, the elderly speakers documented in this study are an irreplaceable educational resource—living repositories of a phonological heritage that, without deliberate educational intervention, will not survive the next generation.

Phuan is not merely a linguistic curiosity; it is a test case for the viability of minority language education in a rapidly urbanizing, linguistically dominant environment. This study demonstrates that rigorous phonological documentation and sociolinguistic analysis are not merely academic exercises but essential foundations for informed and effective language education planning in multilingual communities.

Ethical Note

This study analyzes tone data recorded from language informants with voluntary informed consent. The research was approved by the Human Research Ethics Committee of Khon Kaen University in accordance with the criteria set out in the Belmont Report and GCP in Social and Behavioral Research, approval number HE673019. Upon completion of the tonal analysis, all primary audio recordings were permanently deleted in accordance with the conditions of ethics approval.

Artificial Intelligence Statement

Claude AI (Anthropic, 2025) was used in a limited and supplementary capacity during the preparation of this manuscript, specifically for academic language refinement and sentence structure review to improve clarity and readability. All research design, data collection, educational analysis, and intellectual content were conducted solely by the authors. The authors take full responsibility for the accuracy, completeness, and originality of all content reported in this manuscript, and confirm that Claude AI was not used to generate, fabricate, or interpret any research data or findings.

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Author Contributions

Toophom, T. was responsible for data collection, data handling, corpus processing, analysis, and drafting the manuscript. Buakaw, S. contributed to revising sections of the manuscript for intellectual content. All authors read and approved the final manuscript and contributed equally to the conceptual development of the study.

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Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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No additional data are available.

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