กลุ่มสาขาภาษาศาสตร์

การศึกษาลักษณะแบบไดอะโครนิกเกี่ยวกับวิวัฒนาการของความซับซ้อนของวรรณยุกต์ในภาษาวรรณยุกต์เอเชีย

A Diachronic Typological Study on The Evolution of Tonal Complexity in Asian tonal languages

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การศึกษาครั้งนี้ใช้วิธีการจัดประเภทตามลำดับเวลาเพื่อตรวจสอบวิวัฒนาการของความซับซ้อนของวรรณยุกต์ในภาษาเอเชีย ตัวอย่างแสดงลำดับชั้นของความซับซ้อนของวรรณยุกต์ โดยรูปทรงที่ซับซ้อนวิวัฒนาการมาจากรูปทรงที่เรียบง่าย และรูปทรงที่เรียบง่ายวิวัฒนาการมาจากโทนสีระดับอันเป็นผลมาจากกระบวนการสัทศาสตร์และระบบสัทวิทยา กระบวนการสัทศาสตร์หลักสองกระบวนการที่พบในตัวอย่างภาษาวรรณยุกต์เอเชียคือการดูดซับแบบส่งต่อและการสลายแบบคาดการณ์ล่วงหน้า ทั้งสองกระบวนการสามารถเพิ่มความซับซ้อนได้ นอกจากนี้ กระบวนการทางขวามีแนวโน้มเพิ่มความซับซ้อนของรูปร่าง ในขณะที่กระบวนการทางซ้ายมีศักยภาพในการเพิ่มหรือลดความซับซ้อนของรูปร่าง ขึ้นอยู่กับระดับที่กระบวนการทำงาน ภายในกระบวนการทางด้านซ้าย กระบวนการสัทศาสตร์มีแนวโน้มที่จะเพิ่มความซับซ้อนของโทนเสียง ในขณะที่กระบวนการทางเสียงมีแนวโน้ม ลดความซับซ้อนของโทนสี

คำสำคัญ : การจำแนกแบบไดอะโครนิก ความซับซ้อนของวรรณยุกต์ กระบวนการสัทศาสตร์ การดูดซึมแบบยกยอด การแยกแบบที่คาดการณ์ไว้

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Abstract

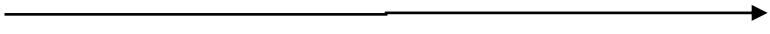
The present study takes the diachronic typological approach to investigate the evolution of tonal complexity in Asian languages. The sample shows a hierarchy of tonal complexity whereby complex contours evolve from simple contours, and simple contours evolve from level tones as a result of phonetic and phonological processes. Two primary phonetic processes found in Asian tonal language samples are carry-over assimilation and anticipatory dissimilation. Both processes can increase complexity. Furthermore, rightward processes tend to increase contour complexity while leftward processes have the potential to either increase or decrease contour complexity, depending on the level at which they operate. Within the leftward direction processes, phonetic processes tend to increase tonal complexity, while phonological processes tend to decrease tonal complexity.

Keywords: diachronic typology, tonal complexity, phonetic processes, carry-over assimilation, anticipatory dissimilation

1. Introduction

Tone is a fundamental linguistic feature in a significant number of the world's languages, with a crucial role in expressing lexical and grammatical meaning. Maddieson (2013) states that many languages of East and Southeast Asia have tone systems that include contour tones. Tones can be broadly categorized into three groups based on their distinct tonal shapes: level, simple contour, and complex contour (Gordon, 2016). Level tones exhibit flat fundamental frequency trajectories, while simple contour tones have a single slope, either rising or falling. Complex contour tones, on the other hand, display two tonal slopes, which can be either rise-falling or fall-rising (Gordon, 2016). The three tonal shapes can be arranged on a scale of tonal complexity based on the number of slopes, with the level being the least complex and the complex contour being the most complex (Gordon, 2016). The purpose of the present study is to use a diachronic typological approach to investigate the evolution of tonal complexity, as shown in **Figure 1**:

Figure 1: The evolution of tonal complexity



Level Simple contour Complex contour

Easterday & Bybee (2023) define diachronic typology as a method of incorporating both synchronic and diachronic facts into a dynamic theory of language. Diachronic typologists view language as a complex adaptive system whose structure emerges from dynamic processes over time (p. 5). Bybee & Easterday (2022) take a diachronic typological approach to the evolution of consonant inventories and test the hypothesis that elaborate consonants evolve from basic consonants (e.g., /p, t, k/) through phonetic and phonological processes. They found evidence supporting their hypothesis. The findings of their research are significant because it provides insight into the diachronic evolution of phonetically elaborate, or complex, consonants.

In contrast with typological studies on consonant and vowel systems, there is a research gap on the diachronic typology of tonal complexity. This research extends the diachronic typological approach to the study of the evolution of tonal complexity in Asian sample languages by testing the hypothesis that parallels that of Bybee & Easterday (2022): more elaborate contours can develop from simpler contours as a result of phonetic and phonological processes. This research is the first to test such a hypothesis.

2. Literature review

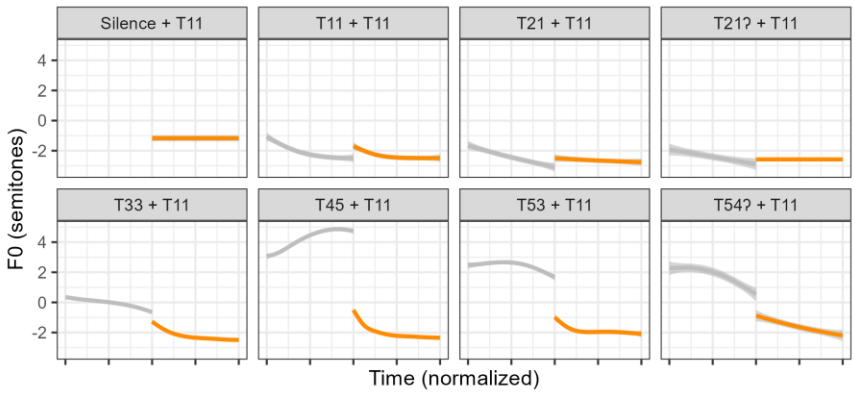
Diachronic typology, a framework that seeks to explain synchronic phonological patterns through an understanding of the dynamic processes and sound changes that give rise to them over time, has been utilized effectively in studying consonant evolution (Bybee & Easterday, 2022). The study of Bybee & Easterday (2022) is based on a database of 81 languages. They documented phonetic and allophonic processes, input and output outcomes, and contextual details. Their emphasis is on synchronic variation, as synchronic variation provides a link to diachronic change. In diachronic typology, “explanation for phonological structure must appeal to dynamic processes” (Easterday & Bybee, 2023, p. 1), because “the [phonological] inventory is in a constant state of becoming” (p. 3). The present study adopts a similar approach and methodology to test the hypothesis that elaborated contour tones arise from basic tone shapes.

From the typological observation of Gordon (2016), level tones are found to be more prevalent overall and more basic than non-level tones, and simple contour tones are more basic than complex tones. The existence of contour tones in a language suggests the presence of level tones, while the presence of complex tones implies the existence of contour tones (Gordon, 2016). This finding is consistent with results from Maddieson's (2013) survey that contour tones appear in languages with many tone categories. Maddieson & Disner (2009) suggest contour and complex tones provide a useful way to differentiate tone as the tone space becomes saturated in the vertical dimension. This observation leads to the hypothesis of tonal complexity evolving from simple tones.

The present study explores the phonetic and phonological processes affecting tone shapes in a sample of Asian tonal languages, with an emphasis on exploring the diverse outcomes generated by these processes. Phonetic tone processes are gradient, articulatory processes that reflect universal phonetic tendencies in tone production and perception. These phonetic processes are often referred to as “tonal coarticulation” (Chen, 2012). Two directions of coarticulation have been identified in many Asian tonal languages: carry-over (i.e., rightward) and anticipatory (i.e., leftward) effects.

The carry-over effect, where a tone is influenced by a preceding tone, tends to result in assimilation. For example, carry-over effects in Black Lahu are shown in **Figure 2**. Tone 11, a low-level tone, is influenced by the preceding tones: the tone onset is raised after a high tone, resulting in a level tone surfacing as the more complex contour shape of falling. Carryover effects have been documented in many Asian tonal languages like Vietnamese, Thai, Mandarin, and Lao (Brunelle, 2003; Gandour et al., 1994; Xu, 1997; Yanagimura, 2011).

Figure 2: Carry-over effects in Black Lahu. Tone 11 in orange. Data from (Yang et al., 2022).



Conversely, the anticipatory effect, where a tone is influenced by a following tone, tends to result in dissimilation (Xu,1997). For example, in Mandarin, when the high-level tone is before a low tone, the high tone is raised at the offset, and the resulting tone shape is slightly rising. Xu also noted that pre-low raising seems to have the largest effect at the end of the syllable in Mandarin, If Xu's (1997) finding for Mandarin is a general trend, then anticipatory dissimilation could also introduce more complex contour.

There is also carryover dissimilation, for instance in Malaysian Hokkien, the level tone after the high offset is lower in pitch, but the resulting tone shape is still level. The anticipatory assimilation is also found in Malaysian Hokkien, such as the Tone 2 sandhi (falling tone) before the high offset is higher in pitch, but the resulting tone shape is still a falling tone. Carry-over dissimilation and anticipatory assimilation do not happen often, but their occurrence does prove that the process (assimilation vs. dissimilation) and the direction (rightwards vs. leftwards) are independent. Assimilation and dissimilation processes can occur in both directions.

Moreover, one process by which contour tones convert to level tones is identified by Hyman (2007). This process is absorption, where the endpoint of a contour is deleted following a tone with the same level at the beginning. For instance, in Mandarin there is a tonal absorption process in which the falling-rising tone before any other tone does not rise, and the resulting contour is a falling tone. Tonal absorption tends to decrease the tonal complexity.

Phonological processes are language-specific tone rules. They create categorical alternations in a language's tonal grammar. They may originate from phonetic precursors but become conventionalized (Chen, 1992). Tone sandhi refers to the phonological process that results in the alternation the adjacent tones when they interact in connected speech. These alternations result in a different tonal pattern compared to the individual tones in isolation (Chen, 2000). For example, in Mandarin: *xiao*^{214} 'small' and *gou*^{214} 'dog' *are* pronounced as Tone 3 fall-rising [214] separately, but when they occur as a sequence, the first tone surfaces as the Tone 2 rising [35] tone. *xiao*^{35} *gou*^{214} 'small dog, puppy' which are pronounced as rising (35) and fall-rising (214) (p. 42). Zhang (2007) classified tone sandhi rules as left-dominant or right-dominant in Chinese

tone sandhi systems. It should be noted that whether the tone sandhi rules are left-dominant or right-dominant, both of them generate tones with less contour complexity (p. 278)

Pittayaporn (2018, p. 260) stated that "diachronic sound changes are the result of phonologization of synchronic patterns of phonetic variation." Pittayaporn (2018) offers a phonetically-oriented explanation of change in tonal contours within Bangkok Thai that occurred throughout the 20th century, with an emphasis on the examination of synchronic variations. In my analysis, I examine the synchronic patterns of tonal processes that result in new tonal variants, and in this way, the research will contribute toward building a diachronic typology of tonal complexity in Asian tonal languages.

3. Research Methodology

In this study, a convenience sample approach will be employed, involving languages that are readily accessible for analysis (Song, 2018). The convenience sample is regarded as efficient in the initial phases of research, serving as a basis for preliminary findings and aiding in determining the topic's value (p.88). It is worth noting that many studies in linguistic typology rely on convenience samples rather than probability samples (Song, 2018).

The sample contains 10 tonal languages of Asia. In order to minimize the genealogical bias, I selected languages from different language families or different branches of the family: Lao and Thai from the Kra-Dai language family; Vietnamese from the Austro-Asiatic family; Japanese from the Japonic family, and six from the Sino-Tibetan family. The six languages from the Sino-Tibetan family are from two separate sub-branches of Tibeto-Burman and three sub-branches of Sinitic. Mizo and Black Lahu are two minority languages which belong to Kuki-Chin sub-branch and Ngwi-Burmese branch respectively (Künstler, 2019). Mandarin Chinese is represented by Beijing Mandarin and Tianjin Mandarin; Malaysian Hokkien is the Min dialect of Chinese and has a completely different tonal variation from other Asian languages; Cantonese is the Yue dialect of Chinese bearing different tonal variation from Mandarin. The genealogical diversity in the sample languages attempts to minimize genealogical bias in the analysis.

In line with the objectives of my study, I established a database. The database comprises 13 distinct columns, each serving a unique purpose. From the leftmost, the "Language" refers to the name of the language. Then "Glottolog code" is a "unique and stable identifier to all languoids" (Hammarström et al., 2023). The "Language family" provides information on the ancestral group that the language belongs to. These three columns offer language-related details. The "Source" column specifies the data's bibliographic source.

The "Input label" refers to the label given to the tone category by the sources. The "Input value" refers to the citation tone shape corresponding with the tone category. The "Input contour" refers to the category of tone shape which is level, simple contour, or complex contour. The basis for deciding the tone shape of the input contour is based on the surface form of the citation tone (the tone as uttered in isolation). For example, the high- level tone in Mandarin, Tone 1, would be classified as having an input contour as "Level".

The "Environment" column indicates the prosodic environment that the tonal process applies to, which may refer to neighboring tones or to the target's position in the utterance. The "Output contour" refers to the category of surface tone shape, whether it is level, simple contour or complex contour. The "Output contour" represents the outcome of the tonal process. For example, after a preceding low tone, Mandarin Tone 1 (high level) surfaces as a rising contour, so that output contour would be classified as "Rise," a simple contour.

The criteria for describing the output contour tone shape should also consider the time of the f0 turning point, where the fundamental frequency dramatically changed. I classify a tone shape as a complex contour if the turning point occurs in the middle, because it is an unambiguous complex contour. If the turning point occurs at early in the syllable, I treat the tone shape as a simple contour instead of a complex contour. When the turning point occurs in the final portion of the syllable and the final offset falls, I treat the tone shape as a simple contour instead of a complex contour, because the falling that occur at the very end of the tone may be considered as an artifact of an intonational low boundary tone or of f0 declination, and therefore are not considered as part of the phonological specification of the tone (Gussenhoven, 2004). But when the turning point occurs at the final and the final offset rises, I treat the tone shape as a complex contour instead of a simple contour. Because late rising is considered as part of the phonological specification of the tone. It is not a product of f0 declination.

The tone may exert either a significant or a minor influence by the neighboring tones. Thus, the criteria of the output contour tone shape should also consider the f0 excursion. If the f0 excursion does not change from level, the term "level" is employed to describe the result of the "output contour". If contour excursion is slight, then the contour shape is ambiguous between level and contour, and the term "slightly' is employed to describe the resulting contour. When a tone shows a large excursion, it is a clear contour, and the terms "rise" or "fall" are employed to describe the result.

The following column distinguishes between different levels of process, whether the phonetic or phonological level. The "Processes" specifies the name that the researcher used to describe the processes, such as assimilation, dissimilation, tone absorption, and tone sandhi. The "Direction" clarifies the process direction (rightward/carryover or leftward/anticipatory). Lastly, the "Inventory" provides the number of tones in the chosen language.

4. Results

This section explores tonal complexity through both phonetic and phonological processes, focusing on specific processes such as assimilation, dissimilation, rightward, and leftward processes. The findings are organized and presented in tables to facilitate a clear understanding of the outcomes.

4.1 Output results of tonal processes

This section shows the outcomes of input contour resulting from phonetic and phonological processes.

Table 1 shows the number of languages with phonetic or phonological processes producing output tones of varying complexity. Notably, 7 languages showcase the generation of simple contour variants from level tones via processes, while complex contours never emerge directly from level tones. For instance, in Lao, Tone 1 (mid-level tone) after a high offset results in a falling tone. Furthermore, the table reveals that in 5 languages, complex contours can be generated through processes involving simple contours. Such as, in Mandarin, Tone 2 (rising tone) after a high offset surfaces as a falling-rising tone. Outputs are one level higher or lower than inputs on the hierarchy of tonal complexity, supporting the hypothesis that complex contours evolve from simple contours, and simple contours evolve from level tones as a result of phonetic and phonological processes.

Table 1: Output results of tonal processes

Output contour	Input contour		
	Level	Simple Contour	Complex contour
Level	/	4	0
Simple Contour	7	/	3
Complex Contour	0	5	/

Additionally, 3 languages demonstrate the simplification of complex contours to simple contours. In Lao, for instance, when tone 5 (fall-rising tone) precedes a high onset, the resulting output contour simplifies to a falling tone, a case of tonal absorption. Additionally, 4 languages exhibit the simplification of simple contours to level tones. For example, in Mizo, a rising tone before a high tone yields a low-level tone, an instance of tone sandhi.

This pattern shows that tonal complexity may increase or decrease by one level on the complexity hierarchy, but almost never show an increase or decrease of two levels, as shown in **Figure 3**:

Figure 3: The hierarchy of tonal complexity

Level ⇄ simple contour ⇄ complex contour

4.2 Assimilation vs. Dissimilation

This section delves into the impact of assimilation process and the dissimilation process on tonal complexity.

Table 2 shows the outcomes of assimilation processes, showcasing the tonal complexity in the sample. Notably, 5 languages exhibit the generation of simple contour variants from level tones through assimilation processes. Also, 5 languages demonstrate the generation of complex contours form simple contours through assimilation. Additionally, 2 languages show the simplification of complex contours to simple contours.

Table 2: Output results of assimilation processes

Output contour	Assimilation (input contour)		
	Level	Simple Contour	Complex contour
Level	/	1	0
Simple contour	5	/	2
Complex contour	0	5	/

Table 3 summarizes the complexity outcomes of assimilation processes. Notably, half the languages (5/10) exhibit an increase in complexity for level tones and the same as for simple contours, aligning with the trend that assimilation processes generally increase tonal complexity.

Table 3: Assimilation process complexity summary

Input contour	Output complexity	
	increase	decrease
Level	5	/
Simple Contour	5	1
Complex contour	/	2

Table 4 shows the outcomes of dissimilation processes, finding that 5 languages generate simple contours from level tones, while 1 language produces complex contours through dissimilation processes.

Table 4: Output results of dissimilation processes

Output contour	Dissimilation (input contour)		
	Level	Simple contour	Complex contour
Level	/	1	0
Simple Contour	5	/	0
Complex contour	0	1	/

Table 5 provides a summary of the complexity changes resulting from dissimilation processes. There is a decrease in complexity for complex contours in 1 language. The majority of languages (5) exhibit an increase in complexity for level tones and 1 language exhibit an increase in complexity for simple contours. The evidence indicates that dissimilation processes tend to increase tonal complexity as well.

Table 5: Dissimilation process complexity summary

Input contour	Output complexity	
	increase	decrease
level	5	/
Simple contour	1	1
Complex contour	/	0

In conclusion, the results presented in Tables 2-5 indicates that both assimilation and dissimilation processes tend to increase tonal complexity.

4.3 Rightward process complexity vs. Leftward process complexity

This section delves into the examination of rightward and leftward processes, exploring their impact on tonal complexity.

The outcomes of rightward processes which shows a similar pattern with assimilation processes. Because in the data sample, most of the rightward direction processes are found in assimilation processes. The complexity results align with assimilation processes, which the rightward process generally increases complexity. While a different pattern is found in leftward processes, which are presented in **Table 6** and **Table 7**.

Table 6 details the outcomes of leftward processes, showcasing that 5 languages generate simple contours from level tones and 2 languages produce complex contours from simple contours. Additionally, 3 languages through the simplification of simple contours to level tones, and 2 languages are observed complex contours being simplified to simple contours.

Table 6: Output results of leftward processes

Output contour	Leftward (input contour)		
	Level	Simple contour	Complex contour
Level	/	3	0
Simple Contour	5	/	2
Complex contour	0	2	/

Table 7 provides a summary of the complexity changes resulting from leftward processes. it shows that, while level tones often experience an increase in complexity, both simple and complex contours may undergo either an increase or decrease in complexity. In fact, for simple contours, leftward direction resulted in complexity decrease in more languages than increase.

Table 7: Leftward process complexity summary

Input contour	Output complexity	
	increase	decrease
level	5	/
Simple contour	2	3
Complex contour	/	2

In conclusion, the examination of rightward and leftward processes, as presented above, indicates distinct patterns in tonal complexity. Rightward processes show the similar pattern with the assimilation processes, which generally increase complexity, while leftward processes have the potential either to increase or decrease the complexity.

Phonetic processes generally increase the tonal complexity. Due to the small sample size, it is not possible to tease apart the level of process from the direction of process, because tone sandhi almost always occurs in a leftward direction in the sample languages; only one instance of rightward direction is seen, in Mizo. Whether rightward phonological processes increase or decrease tonal complexity is left for future research. According to Zhang (2007), tone sandhi rules may decrease the tonal complexity. In the sample, leftward tone sandhi tends to decrease tonal complexity, while leftward phonetic process (usually anticipatory dissimilation) tends to increase, as seen in **Table 8**:

Table 8: Phonetic vs. phonological leftward

Input contour	Output complexity			
	Phonetic		Phonological	
	increase	decrease	increase	decrease
level	5	/	0	/
Simple contour	2	2	0	1
Complex contour	/	2	/	1

5. Conclusion

Bybee & Easterday 's (2022) diachronic typology study laid the foundation for my research. While their work contributes to understanding on consonants, a notable gap existed in exploring the diachronic typology of tonal complexity. My study addresses this by investigating the hypothesis that more elaborate contours can develop from simpler contours through phonetic and phonological processes within a sample of Asian tonal languages.

To achieve this objective, I constructed a database encompassing 10 Asian tonal languages, documenting variations in tone and the associated phonetic or phonological processes. The analysis of this data shows a hierarchy of tonal complexity within the sample, confirming the hypothesis: complex contours

may evolve from simple contours, and simple contours may evolve from level tones through phonetic and phonological processes.

The data analysis further demonstrated that both assimilation and dissimilation processes contribute to an increase in tonal complexity. Additionally, rightward processes were identified as increasing tonal complexity, while leftward processes exhibited the potential to either increase or decrease it. The findings suggest a general trend where phonetic processes tend to increase tonal complexity. However, within leftward direction processes, phonological processes (tone sandhi) tend to decrease the tonal complexity.

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