Desegmentalization: Towards a Common Framework for the Modeling of Tonogenesis and Registrogenesis in Mainland Southeast Asia with Case Studies from Austroasiatic

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Abstract

Suprasegmental contrasts of tone and register are commonplace phonological phenomena among the languages of Mainland Southeast Asia and its periphery (MSEA) (Matisoff 1990, 2001). Insofar as we have come to understand the origins and evolution of such contrasts, two theories predominate: tonogenesis (Haudricourt 1954) and registrogenesis (Huffman 1976). In their classical forms, tonogenesis and registrogenesis are well suited for modeling the development of tone and register in the best known, most studied languages of MSEA, but there is much additional complexity that they fail to capture. This is especially true for languages of Austroasiatic stock, which in many cases have developed tone and register in ways that must be considered 'unorthodox' with respect to the received models (Ferlus 1979, 2004, 2011; Diffloth 1982a, 1982b; Svantesson 1989; Gehrmann 2015; Sidwell 2015, 2019).

The goal of this thesis is to present a possible way forward towards a unified conceptual framework for tone and register evolution in the languages of MSEA: *desegmentalization*. Expanding on Dockum's (2019) concept of *desegmental phonology*, desegmentalization is the process by which one or more segmental properties (onset phonation, vowel height, vowel length or coda phonation) condition changes in the distribution of a language's suprasegmental contrasts. A general survey of the Austroasiatic language family is presented, in which documented examples of desegmentalization are presented and discussed. Austroasiatic constitutes a useful laboratory for such a survey, because the identification of the segmental origins of suprasegmental contrasts in Austroasiatic languages is relatively straightforward in comparison to the other language families of MSEA. Based on this survey of desegmentalization processes in Austroasiatic, ten discrete desegmentalization models are proposed. The output typologies for the suprasegmental contrasts produced by each model are compared and implications for a general model of tonogenesis and registrogenesis are explored.

This thesis offers (1) a digestible introduction for the non-specialist to the historical development of suprasegmental contrast in MSEA, (2) a resynthesis of current tonogenetic theory which integrates classical tonogenesis, classical registrogenesis and various other, lesser-known evolutionary pathways under the larger umbrella of desegmentalization and (3) a comprehensive overview of tone and register origins in the Austroasiatic family.

Lay Summary

It is widely accepted that all human languages make use of *segments*. These segments, better known as consonants and vowels, are like building blocks that may be combined into meaningful strings called *morphemes*. Morphemes, in turn, are the building blocks of words.

In addition to consonants and vowels, many languages (perhaps the majority) employ a third type of building block called *suprasegments*. Suprasegments differ from segments in that they transcend the linear, ordered string of consonants and vowels. In an abstract sense, they hover above the segment strings on a separate but interconnected level, attaching themselves to specific groups of segments (syllables, morphemes, etc…) following patterns that differ from language to language. From the suprasegmental tier, suprasegments interact with the segments to which they are attached, and with one another in their own ordered strings.

Among the languages of Mainland Southeast Asia (MSEA), suprasegments are commonplace in the form of *tone* or *register* and, in the vast majority of cases, we can trace the historical origins of MSEA tones and registers back to segments. In other words, words that were formerly differentiable by differences of consonants or vowels have shifted to being differentiable by differences of tone or register instead. We may draw an example from the Khmu language. Words with initial consonants such as /b/ that are produced with vocal fold vibration (i.e. *voicing*) in Eastern Khmu are pronounced differently in Western Khmu. In the west, these words are realized with relatively lower pitch and with a /p/ initial consonant (e.g. example below). The /p/ consonant is like /b/ only without vocal fold vibration (i.e. *voiceless*). Words with voiceless initial consonants like /p/ in the west are also realized with voiceless initial consonants in the east, but with a relatively high pitch. This pattern is encountered in languages all around the world, and linguists have determined that it is quite natural for *voiced onsets* like /b/ to become *voiceless onsets* like /p/ over time. In many cases, a difference in pitch remains where there was formerly a difference of onset voicing. This difference of pitch represents a difference in the suprasegmental content of the two words: a difference of tone.

Historical Khmu	**Western Khmu**	**Eastern Khmu**
initial consonant voicing is different	*initial consonant voicing is different*	*tone is different*
***bu**ː**c** *rice wine*	/buːc/	/pùːc/
***pu**ː**c** *to take off clothes*	/puːc/	/púːc/

The goal of this study is to present a thorough investigation into the transition of segmental differences into suprasegmental differences in MSEA languages. I propose the term *desegmentalization* as a way to refer to this particular kind of sound change. Among the languages of the Austroasiatic family, which includes Khmu, we find scores of discrete examples of desegmentalization. In this thesis, I isolate four primary segmental properties which are demonstrably susceptible to desegmentalization: initial consonant voicing (as in Eastern Khmu), vowel length, vowel height (a property of vowel articulation involving relative tongue position), and final consonant phonation (a property of consonants involving laryngeal articulation). Different languages have desegmentalized one or more of these four segmental properties in different combinations. Ten different formal combinations are documented in Austroasiatic languages resulting in ten formal *desegmentalization models*. Each of these models and the different types of suprasegments which they produce are explored. Some, such as the model which produced tone in Vietnamese or register in Khmer, are already well known and well studied, but the other models are comparatively poorly known and under-researched.

This thesis offers (1) a digestible introduction for the non-specialist to the historical development of suprasegments in MSEA, (2) a resynthesis of current theory regarding the innovation of tones and registers under the umbrella of desegmentalization and (3) a comprehensive overview of the origins of suprasegments among languages of the Austroasiatic family.

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As the proverb goes, “there is a friend who sticks closer than a brother.” Though I have no biological brother against which to compare him, this could easily have been written about Luth, without whose friendship, encouragement and sage advice, my time spent working on this thesis would have been much duller and lonelier.

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"It is perhaps not to be wondered at, since fortune is ever changing her course and time is infinite, that the same incidents should occur many times, spontaneously. For, if the multitude of elements is unlimited, fortune has in the abundance of her material an ample provider of coincidences; ***and if, on the other hand, there is a limited number of elements from which events are interwoven, the same things must happen many times, being brought to pass by the same agencies****."*

-Plutarch, *Parallel Lives*

1 Introduction

1.1 Background to the Study

Among the languages of Mainland Southeast Asia (MSEA), suprasegmental contrasts are conventionally divided into two broad subcategories, *lexical tone* and *register*, each of which is associated with a separate model of historical phonological development. Haudricourt (1954) proposed a model of *tonogenesis*[1] inspired by the phonological history of the Vietnamese language. In this model, historical laryngeal contrasts of coda consonants become reanalyzed as tonal contrasts and historical onset voicing contrasts subsequently condition a split in the original tone inventory. Due to its wide applicability to languages of the region, Haudricourt's model has become the general model for tone formation in MSEA (Matisoff 1973). As for register, the classical model of *registrogenesis*[2] was proposed by Huffman (1976), based on a comparative study of a variety of Austroasiatic register languages at different stages of register development (variously pre-registral, registral and post-registral). In Huffman's model, onset voicing contrasts evolve into a binary suprasegmental contrast of register (i.e. high register /^{H}/ vs. low register /^{L}/) without any involvement from the right edge of the word. Table 1 lays out a basic schematic of conventional tonogenesis and registrogenesis.

Table 1: *Conventional tonogenesis (Haudricourt 1954) and registrogenesis (Huffman 1976)*

	***-ø**	***-ʔ**	***-h**
***p**	*pa > /pa^{A1}/	*paʔ > /pa^{B1}/	*pah > /pa^{C1}/
***b**	*ba > /pa^{A2}/	*baʔ > /pa^{B2}/	*bah > /pa^{C2}/

	any coda
***p**	*pa > /pa^{H}/
***b**	*ba > /pa^{L}/

These two models are broadly explanatory for MSEA languages, but they are not sufficient to model all documented instances of tone and register formation in the region. While only two categories of segmental contrast are recognized in these models (*onset phonation* and *coda phonation*), two additional types of segmental contrast (*vowel length* and *vowel height*) are documented as having been reanalyzed as register and tone in MSEA languages (Diffloth 1982b; Svantesson 1989, 1991; Sidwell 2002b, 2015b; Gehrmann 2015, 2019). Furthermore, these four basic segmental > suprasegmental sound change processes occur in many different combinations, while only one combination (*onset phonation* + *coda phonation*) is enshrined in the received models.

Table 2 catalogs ten documented patterns of segmental > suprasegmental sound change in MSEA's Austroasiatic language family, all of which will be explored in detail in this thesis. Here, a distinction has been made between simple cases, where only one formerly segmental contrast is involved, and complex cases, where modern suprasegmental phoneme inventories were born out of the reanalysis of two or more formerly segmental contrasts. Table 2 offers a look at the larger picture of documented tonogenetic and registrogenetic mechanisms in MSEA. From this perspective, we discover that conventional tonogenesis from onset phonation + coda phonation and conventional registrogenesis from onset phonation (both shown in bold in Table 2) are simply two well-documented, well-known and oft-recurring sub-categories of segmental > suprasegmental sound change. They are but two pathways among many, all of which are bound together by the transfer of phonemic complexity from the segmental level to the suprasegmental.

[1] Matisoff (1973) coined the term *tonogenesis*.
[2] The earliest use of registrogenesis that I am aware of is Diffloth's (1982b).

Table 2: *Documented segmental > suprasegmental sound change processes in Austroasiatic*[3]

Simple	Complex
Onset Phonation	**Onset Phonation + Coda Phonation**
Vowel Height	Vowel Height + Coda Phonation
Vowel Length	Vowel Length + Coda Phonation
	Onset Phonation + Vowel Height
	Onset Phonation + Vowel Height + Coda Phonation
	Onset Phonation + Vowel Length + Coda Phonation
	Vowel Height + Vowel Length + Coda Phonation

In light of these facts, a broader framework for the innovation of suprasegmental contrasts in MSEA, *desegmentalization*, is proposed here, building on the recently proposed concept of *desegmental phonology* (Dockum 2019). This framework subsumes conventional tonogenesis and registrogenesis as two well-defined, constituent *desegmentalization models* comprising different combinations of *desegmentalization processes* (i.e. onset phonation desegmentalization, vowel height desegmentalization, etc.) while also providing the context and terminology needed to identify and describe a broader range of desegmentalization models. Taken together, the desegmentalization models have the requisite scope to explain and classify the actual diversity of tono-/registrogenetic mechanisms in MSEA languages, thus promoting a more holistic view of desegmental sound change in the region.

1.2 Research Questions

Research Question 1:
Given that (1) suprasegmental contrasts developed in the vast majority of Mainland Southeast Asian languages under conditioning from historically segmental contrasts and (2) the received models of tonogenesis and registrogenesis for the region are insufficient to capture the diversity of environments in which segmental > suprasegmental sound change may take place, can a broader framework (i.e. desegmentalization*) be designed, which incorporates both the traditional models and the purportedly "unorthodox" models?*

Research Question 2:
What kinds of segmental contrast are documented as undergoing segmental > suprasegmental sound change in MSEA (i.e. desegmentalization processes)*?*

Research Question 3:
In what combinations do these desegmentalization processes occur (i.e. desegmentalization models*) and which of them occur more frequently (i.e. in a greater number of discrete cases) than others?*

Research Question 4:
What are the characteristics of the tone/register contrasts that emerge out of each desegmentalization model and, for those models that combine more than one desegmentalization process, is there any evidence to indicate that the order in which the constituent processes have obtained (i.e. relative chronology) affects the output typology?

1.3 Structure of the Thesis

Chapter 2 begins by setting the scope and the context of the discussion. The Mainland Southeast Asian language contact area is introduced (Section 2.1), followed by a brief orientation to the peculiarities of the phonological word in MSEA (Section 2.2). Introductions to tone and register in synchrony are then presented (Section 2.3) and an overview of the conventional models of tonogenesis and registrogenesis for MSEA languages follows

[3] See Table 106 in Section 4.13 for a list of languages exhibiting each of these combinations with references to relevant literature.

(Section 2.4). Finally, we point out the limitations and insufficiencies of these models, presenting examples of tono-/registrogenetic mechanisms that fall outside their explanatory scope (Section 2.5).

In Chapter 3, we begin with an introduction to Dockum's (2019) *desegmental phonology*, which refers to suprasegmental contrasts that have arisen out of historically segmental contrasts in the MSEA context (Section 3.1). Building on this concept, an overarching framework for segmental > suprasegmental sound change is then introduced in the form of desegmentalization: the chief conceptual innovation proposed in this thesis (Section 3.2). Thereafter, new terminology and principles for schematic representation associated with desegmentalization are proposed (Section 3.3) along with a new tool to facilitate the graphical representation of desegmentalization: the *desegmentalization box* (Section 3.4).

Next, in Chapter 4, a general survey of documented instances of desegmentalization in MSEA's Austroasiatic language family is presented in order to generate an inventory of attested desegmentalization processes and combinations thereof. The chapter begins with the proposal that different formal combinations of desegmentalization processes should be arranged into discrete *desegmentalization models* (Section 4.1). A brief introduction to the reconstructed phonology of Proto-Austroasiatic is then provided (Section 4.2) followed by descriptions of ten desegmentalization models, which were identified in the process of researching this topic (Sections 4.3 through 4.12).

Finally, in Chapter 5, a summary of the thesis and discussion on its findings in response to the research questions listed above is offered (Section 5.1), and an outlook on future work related to desegmentalization is provided with specific suggestions for further investigation (Section 5.2).

1.4 Methodology

In this thesis, a new conceptual framework, desegmentalization, is proposed for modeling alterations to suprasegmental phoneme distribution under conditioning from contrasts present in a language's segmental phonology. This framework was developed based on patterns apparent in the origin and evolution of tone and register contrasts in languages of the Austroasiatic family. In light of the long history of tonogenetic insights being gleaned by the comparative study of Austroasiatic phonology, it was determined that a formal survey of desegmentalization in this family would very likely yield further insights pertinent to the research questions listed above.

There are several reasons why the Austroasiatic family is particularly useful for the investigation of segmental > suprasegmental sound change, which led to its selection for this study. These include:

1. One particular model of tonogenesis, Haudricourt's (1954) tonogenetic model, is ubiquitous among the languages of the so-called *Sinospheric Tonbund*, which includes languages of the Sinitic, Hmong-Mien and Kra-Dai families and certain branches of Tibeto-Burman spoken in MSEA (Matisoff 2001). While there is much diverse variation in how the desegmental phonology of these languages subsequently evolved, the parallelism in their origins set them all on a common trajectory from which few have significantly diverged. This renders them unsuitable for this particular project.
2. To the best of our current knowledge, no desegmental phonology is securely reconstructable for Proto-Austroasiatic or for the most recent common ancestor of any of its primary branches.[4] Consequently, the desegmental developments which have occurred in Austroasiatic languages have been, in the majority of cases, local innovations. Desegmentalization has occurred independently in many discrete events across the Austroasiatic language family and the sheer number of these natural experiments in desegmentalization constitutes a fantastically diverse sample of possible processes and outcomes.
3. The segmental origins of the desegmental phonemes in Austroasiatic languages are, in almost all cases, readily reconstructable. This is because cognate segmental contrasts remain directly attested in other, more conservative modern languages.

[4] A probable exception to this generalalization is the ancestor of Mang and the Pakanic languages, which is tentatively classified as Proto-Mangic (Sidwell 2015, 2021), but this branch of Autroasaitic is under-researched and poorly understood at this time.

1.5 Contributions

The specific contributions of this thesis include:

1. A digestible introduction for non-specialists to suprasegmental contrast in MSEA (i.e. tone and register) and the segmental origins of these contrasts (see Chapter 2)
2. The desegmentalization framework, within which various diverse models of tonogenesis and registrogenesis conditioned by historically segmental contrasts are readily identifiable (see Section 3.2)
3. A proposed convention of using curly brackets {} to refer to historically segmental conditioning environments in place of the confusing array of alphanumeric category designations that have arisen within various language family traditions over time (see Section 3.3)
4. A proposed standard means of graphically summarizing desegmentalization in a language with reference to historically segmental conditioning environments in the form of the desegmentalization box (see Section 3.4)
5. A comprehensive review of desegmentalization in Austroasiatic, drawing on other researchers' analyses in published and unpublished literature and, in some cases, my own analysis of primary data (see Chapter 4)
6. Confirmation of Edmondson & Gregerson's hypothesis that Bolyu (< Mangic) tonal contrasts are cognate with Vietnamese tonal contrasts, linking both to cognate patterns of historical rime glottalization (see Section 4.6.1)
7. An initial description of a previously undocumented, highly restructured Bahnaric language of Vietnam, Li Xei, which developed a complex register system in a manner comparable to that of Vietic tonogenesis (see Section 4.6.2).
8. A proposal for the environmental conditioning which led to complex registrogenesis in Chong, building on Sidwell's initial proposal (Section 4.10)
9. A suite of new desegmentalization models to add to Huffman's Khmer Model of Registrogenesis and Haudricourt's Vietnamese Model of Tonogenesis, based on the results of the survey of desegmentalization in Austroasiatic languages (Section 5.1.4).
10. An expanded general model of registrogenesis (Section 5.2.2)
11. A proposal that coda phonation desegmentalization is a necessarily secondary process, with ramifications for the received periodization of Haudricourtian tonogenesis (Section 5.2.3)
12. A new hypothesis for origins of rime glottalization in Proto-Vietic (Section 5.2.4.3)

2 Tone, Register and their Segmental Origins in Mainland Southeast Asia

2.1 The Mainland Southeast Asian Language Contact Area

MSEA sits at a crossroads. To its south and east, across the waters, lies Insular Southeast Asia, where people speak almost exclusively Austronesian languages. To the west, across the Eastern Himalayas into the Brahmaputra valley, one enters South Asia, where people speaking predominantly Indo-Aryan and Dravidian languages are encountered. And to the north lies China, where Sinitic languages predominate. When it comes to culture, politics and religion, there is overlap between MSEA and all three of these surrounding regions. When it comes to language, however, the general linguistic typology of MSEA languages is quite different from that of Insular SEA and South Asia and much more similar to that of China. We may speak of an expansive linguistic convergence area covering most of MSEA, encompassing the modern nations of Thailand, Laos, Cambodia and Vietnam and adjacent areas in Myanmar, southern China and northern Malaysia (Enfield 2005). Languages from the five major language families of the region (Sino-Tibetan, Kra-Dai, Hmong-Mien, Austroasiatic and Austronesian) participate in this convergence area which Matisoff (1990, 2001) has dubbed the *Sinosphere* in contrast to the *Indosphere* to the west and, we might add, the *Austronesian Sphere* to the south and east. While there are languages belonging to the core MSEA language families which are spoken today outside of MSEA proper and have been restructured through participation in other language contact areas, by and large, the languages in these phyla are convergent towards the common MSEA linguistic typology.[5]

Hallmarks of the MSEA contact area include monosyllabicity, large phoneme inventories, isolating/analytic grammatical typology and, the topic of this thesis, suprasegmental lexical contrasts of *tone* or *register*. Table 3 presents the general overview of the linguistic typology of Sinospheric languages in comparison to Indospheric languages, based on the summary in Post (2011).

Table 3: *Sinospheric vs. Indospheric*

	Sinosphere	**Indosphere**
Morphological Word:	*Simple*	*Complex*
Phonological/Prosodic Word:	*Monosyllabic*	*Polysyllabic*
Affixation:	*Prefixation*	*Suffixation*
Syllable Onset:	*Permits Complexity*	*Largely Simple*
Vocalism:	*Permits Diphthongs*	*Largely Monophthongal*
Complex Predicates:	*Verb Serialization*	*Finiteness Asymmetries*

Not mentioned in Table 3 is suprasegmental contrast. This is because a subset of both Sinospheric and Indospheric languages employ suprasegmental contrast. Contrasts of *tone* or *register* are much more commonly associated with languages of the Sinosphere, but tone also plays a contrastive role in many Indospheric languages (Matisoff 2000). Nevertheless, because the typological profile and historical origin of Indospheric tone are often quite different from that of Sinospheric tone (Evans 2009; Mazaudon 1977, 2005, 2012; Caplow 2009), we will set the Indosphere to one side for the remainder of this thesis. Within the Sinosphere itself, typologically similar contrasts of lexical tone and register have been emerging over and over again for at least the past thousand years in a process which continues to this day. As will be detailed below, these developments proceeded along largely parallel developmental pathways and are one of the primary examples of areal convergence and typological drift in the MSEA language contact area (Matisoff 1973; Thurgood 1996, 1999, 2021; Ratliff 2002; Enfield 2005; Comrie 2007; DeLancey 2013; Brunelle & Kirby 2015; Sidwell 2015b; Alves 2021).

[5] Examples of languages from the core MSEA phyla entering the Indosphere include the Munda branch of Austroasiatic and various geographically western branches of Sino-Tibetan, including Kiranti and Kuki-Naga, among others. Other languages show an intermediate typology, combining aspects of both the Indosphere and the Sinosphere, such as the Khasic branch of Austroasiatic and the Bodish and Kham branches of Sino-Tibetan. To the south, the Aslian branch of Austroasiatic has entered the Austronesian sphere where it has undergone contact-induced restructuring towards Malayic languages. Conversely, the Chamic group of Austronesian languages has entered MSEA and restructured in that direction.

Tone and register work in concert with segmental consonant and vowel phonemes to uphold lexical contrast in the vast majority of the languages of MSEA. Tone is occasionally co-opted for grammatical purposes here, but only peripherally and never coming close to the kinds of grammatical tone alternations or morphotonemic interactions found in the tone languages of Africa, Mesoamerica and certain languages of the Indosphere (Henderson 1965, 1967; Ratliff 1992). Compared with lexical tone, grammatical tone is a fringe topic in MSEA and grammatical alternations of register are entirely undocumented.

2.2 The Syllable and the Phonological Word in MSEA

A monosyllabic phonological or prosodic word shape is widespread in MSEA, particularly in its northern reaches, but it is actually the *process of monosyllabicization* or *syllable reduction* which is ubiquitous in the MSEA language contact area. Over the past three millennia and continuing to this day, there has been a general reduction in the shape of lexical morphemes across MSEA languages from iambic disyllables to monosyllables (Matisoff 1973, Michaud 2012), with a continuum of intermediate stages being identifiable (Huffman 1972, Thomas 1992, Michaud 2012, Butler 2015, Pittayaporn 2015, Brunelle, Kirby, Michaud & Watkins 2020). Following Matisoff (1973), languages in this intermediate stage between iambic disyllabicity and monosyllabicity are said to employ the *sesquisyllable* (literally, a syllable and a half). The penult, generally referred to as either the *presyllable* or *minor syllable* in the MSEA context, is prosodically non-prominent, being derived from the penult of a historical iambic disyllable, and has a relatively restricted inventory of permissible phonemes in comparison with the second syllable or *main syllable*. In some languages, the presyllable rime is structurally deficient vis-à-vis the main syllable rime, permitting either a vowel segment or a coda consonant segment to stand in the presyllable rime, but never both at the same time. The following examples are taken from the Pacoh language (< Katuic < Austroasiatic):[6]

cv-	/kaɟaː^{L}/	[kaˈɟɜː]	*crab*	/tupat^{H}/	[tuˈpat]	*six*
cc-	/krnaː^{H}/	[kᵊrˈnaː]~[kr̩ˈnaː]	*road*	/tmpraːŋ^{H}/	[tᵊmˈpraːŋ]~[tm̩ˈpraːŋ]	*crossbow*

In other languages, no underlying syllable rime needs to be postulated for the presyllable at all, as the appearance of a short vocalic transition from the presyllable to the main syllable can be described using insertion rules. In such cases, the presyllable is reduced to a single segmental consonant phoneme and its accompanying sub-phonemic, epenthetic vocoid. The following examples are taken from the Kuy language (< Katuic < Austroasiatic):[7]

/cŋɛːt^{H} /	[cᵊŋɛːt]	*cold*	/lmiːt^{L}/	[lᵊmi̤ːt]	*turmeric*
/ktɒːt^{H}/	[kᵊtɒːt]	*wart*	/smoːc^{H}/	[sᵊmoːc]	*ant*

Compelling evidence for the MSEA syllable reduction process is found in the Chamic languages, a sub-group of the Malayic languages of Island Southeast Asia. Disyllabic phonological words are typical of Malayic languages, but the Chamic languages experienced a significant reduction in permissible phonological word shapes after arriving on the shores of MSEA. This shift was so complete that modern Chamic languages have maximally sesquisyllabic or, in some cases, even monosyllabic phonological word templates today (Thurgood 1999, Thurgood & Li 2007, Brunelle 2004).

Syllable reduction and the MSEA sesquisyllable are not core concerns of this thesis. However, for our purposes, it is important to clarify that in languages that allow for sesquisyllabic word structure, the presyllable is rarely if ever found to carry a phonological tone or register specification of its own, separate from that of the main syllable.[8] I know of no examples of such a language. As a result, tone and register languages in this region, including those which are not strictly monosyllabic, have in common a *1:1 ratio of phonological word to suprasegment*. In other words,

[6] Pacoh lexical data from Watson et al. (2013)
[7] Kuy lexical data from Srivises (1978)
[8] Note, however, that in some cases, the surface realization of presyllable tone may be conditioned by main syllable tone. For example, in certain dialects of the Khmu language (< Khmuic < Austroasiatic), there is a pitch dissimilation rule, whereby main syllable /high tone/ conditions [low pitch] on presyllables in sesquisyllabic words and /low tone/ conditions presyllable [high pitch] (Svantesson 1983).

underlying tone and register specifications are culminative (Hyman 2006) in both the MSEA monosyllable and in the sesquisyllable; only one may occur per word.

2.3 Synchronic Tone & Register in MSEA

As has been established in the previous section, lexical contrast is upheld in the majority of MSEA languages through a combination of segmental and suprasegmental contrasts. In such languages, phonological words are made up of both consonant and vowel segments and contrastive suprasegmental units in the form of *tones* or *registers*. In this section, a general overview of MSEA tones (Section 2.3.1) and registers (Section 2.3.2) in synchrony is presented, followed by a comparison and disambiguation of the two (Section 2.3.3).

2.3.1 Tone

The human vocal apparatus is capable of manipulating the fundamental frequency (F0) of any voiced sound that it produces, and listeners perceive differences in the F0 of speech sounds as *vocal pitch* (Yip 2002). Distinctive patterns of vocal pitch are universally employed in spoken human languages, but they are used to communicate different kinds of information in different languages. In many languages, these differential pitch patterns apply only at the post-lexical level, conveying information about speaker attitudes (intonation) or information structure, among other possibilities. In other languages, differential pitch patterns may also be employed in the lexical phonology to mark lexical and/or grammatical contrasts. This particular use of vocal pitch is what is meant by the term *tone*.

Hyman (2001, 2011) proposes the following well-reasoned definition of a tone language:

> **Tone Language:** *A language in which an indication of pitch enters into the lexical realization of at least some morphemes*

Hyman's definition restricts tone languages to only those which include vocal pitch specifications at the lexical level and, thereby, excludes intonation, focus and other post-lexical implementations of contrastive pitch as qualificatory criteria for a tone language. In any tone language, tones must be tethered to certain segmental units which are meaningful in the phonology of the language in question, so that the tone and the segmental unit may be temporally aligned. This unit, the *tone bearing unit* (TBU) of a language, could be one of several possible structural units, such as a segment, a syllable, a word, or a mora, according to the phonology of the tone language in question. Hyman's definition avoids referencing a specific TBU and simply posits that pitch specifications must be carried on morphemes. In most cases, these morphemes will be comprised of one or more TBUs and one or more pitch specifications (i.e. tones). In other cases, a pitch specification without any accompanying segmental information may itself constitute a morpheme, as is the case in grammatically meaningful tone alternations. These tonal alternations or *floating tones* do not come pre-anchored to any TBU; rather, they become attracted to TBUs on other morphemes. Hyman further specifies that it is not required that all of a tone language's lexical morphemes carry tonal specifications. Some morphemes may be toneless, but as long as "an indication of pitch" is carried on a subset of a language's morphemes, that language is, by this definition, tonal.

The distribution and scope of tonal contrasts vary significantly from language to language. In some pre-tonal or marginally tonal languages, pitch may be used as one cue in a bundle of phonetic cues associated with a segmental contrast. For example, an exaggeration of the natural pitch-depressing effect associated with voiced stop onsets may lead to a situation in which lower and higher pitch levels become reanalyzed as predictable, if not obligatory, cues associated with voiced and voiceless stops, respectively, in the syllable onset position (Hombert et al. 1979). In other languages, tone may not covary predictably with any segmental properties.

In the SPE tradition, tone was treated as a segmental property, namely, a laryngeal-node feature of vowel nuclei (Chomsky & Halle 1968). This framework applied reasonably well for some tone languages but proved inadequate for others. Analyzing tone as a property of segmental phonemes fails to account for tone's propensity to affect other tones at distance across syllable and even word boundaries in some tone languages, and for individual tones' capacity to move from one TBU to another in different morphosyntactic environments (Hyman 2011). The need for a model which could describe such complex tonal interactions inspired the development of *Autosegmental*

Theory, which posits that tonal contrasts are operative on a separate level from segments in the underlying representation: the *suprasegmental* tier (Goldsmith 1976, 1990). Tones then become attached to TBUs following regular, language-specific rules, all of which can be captured by linguists to describe complex morphotonologies.

Intermediate between intrinsic pitch perturbations conditioned by segmental features and strongly autosegmental tonal systems, we find the tonal pattern of MSEA languages. Here, tone is primarily a tool of lexical differentiation; however, intonational (Brunelle & Kirby 2016, 199-200; Enfield 2019, 82-84) and grammatical (Henderson 1965, 1967; Ratliff 1992, Chen 2000) applications of pitch do coexist alongside lexical tones.

2.3.1.1 Phonetics of Tone

Hyman's definition of a tone language is predicated on the phonological implementation of pitch. Differences of fundamental frequency do seem to be, impressionistically at least, the "primary" phonetic correlate of tonal contrasts in MSEA and some of the best-known and most-studied languages of the region may rightly be described this way (i.e. Mandarin Chinese and Standard/Central Thai). However, MSEA languages typically employ bundles of cues to uphold tonal contrasts (Bradley 1982, Mazaudon & Michaud 2008, Brunelle & Kirby 2016, Tạ 2021). Three prime examples of this phenomenon, as highlighted by Brunelle & Kirby (2016) are Northern Vietnamese (Brunelle 2009b), Black Miao (Kuang 2013) and Burmese (Watkins 2001, Gruber 2011). Another good example is the White Hmong language (< Hmongic < Hmong-Mien), the tonal inventory of which is presented in Table 4.

Table 4: *White Hmong tone inventory*[9]

toneme	orthography	phonetic
/high/	<pob> *ball-like*	[pŏ^{55}]
/mid/	<po> *spleen*	[po^{33}]
/low/	<pos> *thorn*	[po^{22}]
/high-falling/	<poj> *female*	[po^{52}]
/mid-rising/	<pov> *to throw*	[po^{24}]
/low-falling/	<pom> *to see*	[pŏ̰^{21}]
/mid-low/	<pog> *grandmother*	[po̤^{42}]

The phonetic transcriptions in Table 4 show a different characteristic pitch pattern for each tone, but note that (1) some of these pitch patterns are very similar and (2) although each of the tones is named with reference to pitch here, pitch is not the only phonetic property which plays a role in differentiating White Hmong tones. Esposito's (2012) study of this language found that differences of both duration and voice quality work together with differences of pitch to uphold tonal contrast in White Hmong. The high tone and the low-falling tone are found to be much shorter than the other five to a statistically significant degree. Furthermore, two of the tones, the low-falling tone and the mid-low tone, are characterized by non-modal voice qualities: creaky voice and breathy voice, respectively. Esposito shows how, for female speakers, the F0 patterns of high-falling and low-falling tones are merging, leaving voice quality as the primary cue upholding the contrast between the two. This illustrates clearly how voice quality, duration and pitch can be amalgamated into the higher order phonological category of tone.

A relatively early publication which addresses this issue is a volume edited by Bradley (1982). Here, he introduces the term *tonation* as a portmanteau of tone and phonation type to highlight the fact that tonal contrast in MSEA typically involves phonetic cues beyond just pitch. The term tonation has not made its way into common usage, but the perspective taken in the following quote from Bradley's (1982, vi) introduction to the volume certainly has become the consensus view:

[9] The White Hmong example presented here is based on the analyses of Smalley (1976) and Ratliff (1992) as reported in Esposito (2012).

"The authors have not made the usual, incorrect assumption that 'tone' systems in this area have fundamental frequency, perceived as pitch and contour, as the only parameter in their realization. Rather, they have also considered such other parameters as duration, intensity, vowel quality, and voice quality. The 'tones' are regarded as a system, each member of which has a complex of parameters involved in its production. While fundamental frequency is a very prominent characteristic, other characteristics may be just as much a part of the realization of the 'tone'."

2.3.1.2 Phonology of Tone

The widespread restriction of permissible word shape to mono- or sesquisyllables only among MSEA languages (see Section 1.5) plays a significant role in influencing the typological profile of tone in region. It would not be incorrect to posit that heavy syllables generally serve as TBUs here, but for languages in which the phonological / prosodic word may contain no more than one heavy syllable, the TBU may just as well be analyzed as the phonological word itself.[10] Matisoff (2000), in typologizing different tone languages across the Tibeto-Burman family, proposes the term *omnisyllabic* to describe tone languages such as these, which are typical of, for example, the Lolo-Burmese branch of Tibeto-Burman. In an omnisyllabic language, there is no structural differentiation between the TBU, the syllable and the phonological word.

In addition to the tonal patterns found in omnisyllabic languages, one encounters other tonal patterns among the Tibeto-Burman languages as well; and some of these are quite different from the omnisyllabic type (cf. Evans's (2009) proposed Himalayan tone typology). These Tibeto-Burman languages exhibit differences in tonal behavior in large part because they permit more expansive word shapes (greater than mono- / sesquisyllabic) and because their morphology is more complex. As they lay outside of the MSEA contact area, these languages are not addressed in this thesis.

Unlike in, for example, Otomanguean or Niger-Congo tone languages, we typically find little justification for breaking down contour tones into sequences of discrete high, mid or low tone targets in MSEA. This is because the underlying tones rarely dissociate from their underlying segmental TBUs to spread over other TBUs here.[11] Even when tones on adjacent TBUs do affect one another, the effects are typically paradigmatic, with one lexical tone being substituted for another lexical tone. This demonstrates the general indivisibility of Sinospheric tones into two or more pitch targets that can be shifted across TBU boundaries. A falling tone in a prototypical Sinospheric tone language is simply that – in the absence of tone spreading or morphotonological processes, there is generally no motivation for positing an underlying High Tone – Low Tone sequence.[12]

We may draw examples of paradigmatic tonal interactions across syllable TBUs from the White Hmong language, the tone inventory of which was already introduced above in Table 4. The examples in Table 5 are from Ratliff (1992), who demonstrates that in certain collocations, a preceding high or high-falling tone triggers a change in the tone of the following word. These collocations are frozen relics of a historically productive, syntactically conditioned tone sandhi process; the altered tones are now lexicalized in these particular collocations, but the pattern of tone interaction is clear with reference to the reconstructed tones of Proto-Hmongic (Ratliff 2010).

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[10] Note that lexical words may comprise more than one phonological word due to compounding. As such, lexical words may contain more than one TBU and, therefore, more than one tone specification, but phonological words are restricted to just one.

[11] There are exceptions to this generalization, especially among the more complicated tone sandhi processes found in the Mandarin and Min subgroups of Sinitic. The Southern Min dialect Xiamen is a particularly notable example (Chen 1987, 2000).

[12] Note, however, that while this is true for omnisyllabic languages in MSEA, this generalization does not necessarily hold true for languages in which the mora, not the syllable, may be analyzed to be the TBU (cf. Standard Thai (Morén & Zsiga 2006)).

Table 5: *White Hmong paradigmatic tone interactions (historical tone sandhi)*

Underlying Tone	Sandhi Alteration	Unaltered Word	Altered Word in Collocation
***A1** < b > *high*	*no change*	-	-
***B1** < v > *mid-rising*	***C1** < - > *mid*	< tschauv > *ash*	< cub tschau > *fireplace*
***C1** < - > *mid*	***D1** < s > *low*	< pa > *breath*	< caj pas > *throat*
***D1** < s > *low*	*no change*	-	-
***A2** < j > *high-falling*	***C2** < g > *mid-low*	< ntsej > *ear*	< kauj ntseg > *earring*
***B2** < s > *low*	***C2** < g > *mid-low*	< txias > *cold*	< dej txiag > *cold water*
***C2** < g > *mid-low*	*no change*	-	-
***D2** < m > *low-falling*	***C2** < g > *mid-low*	< twm > *buffalo*	< kub twg > *buffalo horn*

Tone sandhi like that of White Hmong, in which a tone carried on one syllable/word interacts with a tone on another adjacent syllable/word triggering alternations, is not uncommon among MSEA tone languages. In these languages, a suprasegmental tier is helpful for modeling phonological effects at a distance, similar to, for example, vowel harmony processes. However, in other MSEA tone languages that lack sandhi effects or morphotonological variations, the utility of the suprasegmental tier is called into question. In languages such as these, there is no obvious need for positing a suprasegmental tonal tier at all. Because each successive tone simply links to each successive monosyllable (i.e. omnisyllabicity), an autosegmental approach proves to be rather unenlightening. The fact is that in such languages, tones simply do not behave in a "semi-autonomous" manner in relation to TBUs. This is a particular type of lexical tone contrast, and it is common among the tone languages of MSEA.

2.3.2 Register

The term *register* is used to describe various natural phenomena in linguistics, speech pathology and vocal pedagogy. There is no established definition of the term and different researchers have used the term differently. For some, phonological register may be used to refer to any suprasegmental contrast for which differential voice quality is considered the primary phonetic cue. Others are less inclusive, constraining register to only those voice quality-based contrasts which are cognate with the historical voicing of onset consonants. Some use the term register to refer to any tonal system in which differences of pitch and of voice quality work in tandem to mark tonal contrasts (i.e. a register-tone system). Still others use register to refer to a particular type of tone language, in which only non-contour tones are analyzed underlyingly, and contour tones constitute a possible surface output. Among the MSEA tone languages with large tone inventories, the term is sometimes used divide a language's tone inventory into a higher register and a lower register, where tones with similar contours are arranged in pairs: one relatively high-pitched and one relatively low-pitched. We may take Cantonese as an example. Table 6 shows the reflexes of the four Middle Chinese tone categories in modern Cantonese (Lee 1993, 18). The tones associated with historically voiceless onsets are produced in a globally higher *pitch register* than the tones associated with historically voiced onsets.

Table 6: *High and low pitch registers in Cantonese*[13]

	A** ***ping **"even"**	***B** ***shang*** **"ascending"**	***C** ***qu*** **"departing"**	***D** ***ru*** **"entering"**	
***voiceless onset** ***yin* "upper"**	53~55	35	33	55	33
***voiced onset** ***yang* "lower"**	21~22	24	22	22	

This Cantonese-style pitch register among historically cognate tones does not represent what is meant by a *register contrast* in this thesis. The term register here is not used to refer to a subset of tones within a larger tone inventory, but, rather, to refer to a particular subcategory of suprasegmental contrast encountered in MSEA. Brunelle

[13] There is a secondary split in the *D tone category conditioned by vowel length, which is not relevant to this discussion.

& Kirby (2016) define register as, “the redundant use of pitch, voice quality, vowel quality, and durational differences to distinguish (typically two) contrastive categories.”

Examples of this type of suprasegmental contrast are restricted to two of MSEA’s language families: Austroasiatic and Austronesian. In the Austroasiatic family, register contrasts are encountered in all major branches except for those which lay outside of the MSEA linguistic convergence area (i.e. Munda, Khasian and Nicobaric). We will look at many instantiations of the register phenomenon from Austroasiatic languages throughout this thesis. The Austronesian register languages are restricted to the Chamic languages (Friberg & Hor 1977; Lee 1977; Edmondson & Gregerson 1993; Thurgood 1997, 1999, 2003; Brunelle 2005a, 2005b 2009a, 2012; Brunelle, Tạ, Kirby & Đinh 2019, 2020), Javanese (Fagan 1988, Hayword et al. 1994, Thurgood 2004, Brunelle 2010, Perwitasari et al. 2017), Sundanese (Kulikov 2010, Perwitasari et al. 2017) and Madurese (Misnadin 2016, Misnadin & Kirby 2020).[14]

2.3.2.1 Phonetics of Register

The phonetic realization of register is not uniform; it may exhibit variability across time, between languages or dialects, between speakers of the same language and even within the speech patterns of an individual speaker. While differential laryngeal tension is typically considered the fundamental phonetic difference between the two registers, more accurately, registers are two dichotomous bundles of naturally covarying laryngeal and oral articulations (Henderson 1952, Matisoff 1973, Gregerson 1976, Bradley 1982, Brunelle & Kirby 2016). In registrogenesis, etymologically voiceless onsets are associated with a *high register*, characterized by relative laryngeal tension while voiced onsets are associated with a *low register*, marked by relative laryngeal laxness.[15] The phonetic cues associated with high and low register are summarized in Table 7. It is important to recognize that different register languages and even different speakers of the same language may employ different subsets of these cues, and the relative prominence of individual cues employed may differ as well.

Table 7: *Phonetic correlates of high and low register*

	{vl -} > High Register	**{vd-} > Low Register**
Voice Quality:	*Tense / Modal*	*Lax / Breathy*
Vocal Pitch:	*Higher*	*Lower*
Vowel Quality:	*More open*	*Closer*
Tongue Root Position:	*Retracted*	*Advanced*
Larynx Position	*Higher*	*Lower*
Onset Stop Phonation:	*Shorter VOT lag*	*Longer VOT lag*

As an example of register in context, see the examples in Table 8, which are based on Brunelle’s (2005b) description of register in Eastern Cham (< Chamic < Austronesian). We see that the two registers are accompanied by phonetic differences of pitch, voice quality, vowel quality and stop VOT in this language.

Table 8: *Register in Eastern Cham*[16]

register	**phonemic**	**phonetic**
/high/	/pa^{H}/ *to cross*	[paː^{44}]
/low/	/pa^{L}/ *to carry*	[pʿɜ̤ː^{22}]
/high/	/păʔ^{H}/ *at*	[păʔ^{44}]
/low/	/păʔ^{L}/ *full*	[pʿɜ̤̆ʔ^{22}]
/high/	/paʔ^{H}/ *four*	[paʔ^{44}]
/low/	/paʔ^{L}/ *to take a walk*	[pʿɜ̤ʔ^{22}]

[14] Note that the situation in modern Madurese reflects a historical register contrast which has since been restructured (Misnadin 2016).

[15] Labels other than (high - low) have also been used in the literature on register, including (tense - lax), (first - second), (head - chest) and (retracted tongue root - advanced tongue root).

[16] Note that high register and low register are transcribed with ^{H} and ^{L} superscripts here and throughout the thesis and [ʿ] indicates light aspiration, a relatively short VOT lag.

The phonetic correlate most commonly associated with phonological register is voice quality. Voice quality is a complex articulatory phenomenon involving an array of chiefly laryngeal co-articulations which conspire to produce a variety of acoustic cues. Historically, voice quality was conceptualized as a continuum of glottal tension ranging from an open state that is characterized by fully separated, abducted glottal folds (i.e. voicelessness or whisper) to lightly adducted state with regularly vibrating glottal folds (i.e. modal voicing) to a state with tightly adducted glottal folds (i.e. glottal closure) with various other intermediary states between these stable points also being relevant in some cases (Gordon & Ladefoged 2001). Subsequent work has made it clear that the glottal folds are only one of several articulatory structures involved in the production of voice quality and that many more subtle distinctions are relevant (Edmondson & Esling 2006).

The characterization of register laid out in Table 7 represents that of a prototypical register language. In these languages, which will be referred to as *lax-marked register* languages here, the low register tends to be realized with a marked, breathy voice quality, while the high register is realized with an unmarked, modal voice quality. However, there are at least two other subcategories of register, as well, which implement voice quality differently. There are also *tense-marked register* languages, in which it is the low register that is characterized by unmarked modal phonation while the high register is accompanied by marked laryngealization or creak.[17] There are also languages which exhibit what we might call a *complex register* or *double register*, in which four registers are contrastive: two high registers and two low registers. In the two high registers, we have a register marked for modal voice and a register marked for creaky voice. In the two low registers we have a register marked for breathy voice and a register, in which a breathy voiced early phase is followed by a laryngealized later phase.[18] Tense-marked register and complex/double register are discussed in detail in Section 4.10.

Pitch typically co-varies with register, but unlike in tonal contrasts, differences in pitch are not often the most prominent cues to a register contrast. That being said, pitch-prominent register languages are encountered in MSEA, especially among the geographically northern Austroasiatic register languages from the Palaungic and Khmuic branches.[19] The suprasegmental contrasts of these languages are difficult to classify as they blur the line between a tone language and a register language, but they will be considered register languages here (see Section 4.3.3).

Low register is associated with historically voiced stop onsets (*daː > /taː^{L}/) and high register with historically voiceless onsets (*taː > /taː^{H}/). Consonant voicing requires the maintenance of constant vocal fold vibration throughout the duration of a consonant's articulation. This vocal fold vibration is achieved by passing an uninterrupted flow of pulmonic air through the adducted vocal folds. For the pulmonic airflow to remain constant, a transglottal pressure differential must be maintained; in other words, air pressure must rapidly build up behind the adducted vocal folds in the subglottal cavity, while the air pressure above the vocal folds in the supraglottal cavity remains relatively low. As a result of this air pressure differential, the pressurized air in the subglottal cavity pushes the vocal folds apart and equilibrium is restored as the excess air escapes into the supraglottal cavity. As equilibrium is restored, the glottal folds are able to adduct once more and the next cycle begins.

For most natural classes of consonants, maintenance of the transglottal pressure differential is unproblematic. So long as a pathway remains by which air may escape the vocal tract through the oral cavity or the nasal cavity, air pressure in the supraglottal cavity will remain relatively low. As a result, voicing for sonorant and fricative consonants may be maintained without difficulty. However, vocal fold vibration becomes impossible to maintain when the oral occlusion accompanying a non-nasal stop or affricate consonant obstructs the pulmonic airflow. When this happens, air pressure in the supraglottal cavity increases rapidly, because the pulmonic air is trapped with nowhere to go. As a result, supraglottal air pressure approaches equilibrium with subglottal air pressure and the transglottal pressure

[17] e.g. Sedang (< Bahnaric < Austroasiatic) (Smith 1968, 1975; Smith & Sidwell 2015) and Ta'oiq (< Katuic < Austroasiatic) (Ferlus 1974a; Diffloth 1989; Gehrmann 2015, 2019)

[18] E.g. Chong (< Pearic < Austroasiatic) (Huffman 1985a; L-Thongkum 1991; Edmondson 1996; DiCanio 2009)

[19] E.g. certain varieties of Khmu (< Khmuic < Austroasiatic) (Svantesson 1983; Premsrirat 1999, 2001, 2004; Svantesson & House 2006; Abramson et al. 2007; Kirby 2021), certain varieties of Mon (< Monic < Austroasiatic) (Abramson et al. 2015), Wa (< Palaungic < Austroasiatic) (Diffloth 1980, Watkins 2002), and Lamet (< Palaungic < Austroasiatic) (Mitani 1965, Conver 1999)

differential is neutralized. In the absence of a pressure differential, airflow through the vocal folds slows rapidly and, by mechanical necessity, halts completely, putting an end to stop voicing.

The difficulty of maintaining stop voicing, known as the *aerodynamic voicing constraint* (Ohala 1983, 2011), poses a challenge for the phonological implementation of voicing on stop consonants. In order to enhance the perceptibility of underlyingly voiced stops with respect to their voiceless counterparts, voiced stops are typically accompanied by additional articulatory gestures which may generate additional auditory cues (Keyser & Stevens 2006). Larynx lowering is one such coarticulatory gesture which often accompanies voiced stops. A lowered larynx induces the slackening of both the vocal folds and the vocal tract walls and increases the volume of the pharyngeal cavity, a sub-structure of the supraglottal cavity. A larger pharyngeal cavity volume facilitates the maintenance of vocal fold vibration by increasing the amount of time it takes for air pressure in the supraglottal cavity to increase to the point that voicing must cease. Tongue root advancement is another such gesture, which, like larynx lowering, serves to increase the volume of the pharyngeal cavity. In addition, opening the velopharyngeal port to release supraglottal air pressure is another strategy to enhance stop voicing perceptibility, as nasal voicing is uninhibited (cf. discussion in Keyser & Stevens 2006, p. 40-41).

Some MSEA languages have adopted the nasalization strategy with the result that /voiced/ stops are consistently [prenaslized]. More often, however, larynx lowering and/or tongue root advancement has been the preferred strategy. We may infer this because the very co-articulations which we would expect from larynx lowering and tongue root advancement, including lower pitch, breathier voice quality and closer vowel quality, are all associated with low register and low register is associated with historically voiced stop onsets. The picture that emerges is that a language may exaggerate one or more of these co-articulations associated with onset voicing, larynx lowering and tongue root advancement to the point that the co-articulations themselves may supplant onset voicing as the primary cues to the historical onset voicing contrast.[20] The result is the devoicing of the *voiced stops with no loss of contrast. In the wake of this devoicing, such a language is left with phonologized register contrast.

However, devoicing of stop onsets does not necessarily lead to the full, phonetic merger of the newly devoiced stops with the historically voiceless stops. In fact, devoiced stops very frequently have longer VOT than reflexes of *voiceless stops in a register context, and this state of affairs may persist. Eventually, this VOT differential disappears as the register contrast matures and changes into new contrasts of tone or vowel quality. As Huffman (1976) puts it, these languages have "undergone complete merger, both structural and phonetic, of the original voiceless and voiced stops." Less commonly, the VOT differential becomes more pronounced over time, to the point that the devoiced stops merge not with reflexes of the *voiceless series, but with reflexes of a *voiceless aspirated series, in cases where such a series was already present. Notable examples of this include various Tai languages, including Siamese, Southern Thai, Lao, Phuan, Nyo, Phu Thai (< Southwestern Tai), Leiping (< Central Tai) and Saek (< Northern Tai) (Pittayaporn 2009).[21] This aspiration of devoiced stops in the low register is not unique to Tai. Similar cases are documented in Austroasiatic languages including Kuay (< Katuic), Nya Kur (< Monic), certain Waic languages (< Palaungic), certain Lamet dialects (< Palaungic) and certain Khmu dialects (< Khmuic) (Haudricourt 1965; Diffloth 1980, 1982b, 1984; Ferlus 1979; Gehrmann 2016; Sun 2018). Even Mandarin Chinese shows an unusual split in the reflexes of the Middle Chinese *voiced stops, whereby they merged with *aspirated stops in words with the historical A tone but merged with *voiceless stops elsewhere (Pulleyblank 1978).

The fact that devoiced stops tend to "leap-frog" over etymologically voiceless stops in terms of VOT lag is, of course, unexpected and demands an explanation. This phenomenon has yet to be systematically investigated, but the following three hypotheses bear mentioning:[22]

[20] Because these co-articulations are, in a sense, "easier" to articulate than the voiced obstruents with which they are associated, they offer a way of circumventing the aerodynamic voicing constraint. The obstruent voicing is, of course, under no obligation to disappear and we have contemporary examples of low register features co-existing alongside obstruent pre-voicing (cf. Chru (Brunelle, Tạ, Kirby & Đinh 2020) and Chrau (Tạ et al. 2019)), but crosslinguistically, register cues have more often won out and supplanted the onset voicing cues over time in the languages of MSEA.

[21] Note that all of these languages, with the exception of Leiping, are more or less geographically contiguous on the south end of the Tai geographic range. The aspiration of devoiced stops can be seen as an areal phenomenon in the south but the Leiping development is a separate, parallel innovation. (Leiping is spoken in southern China)

[22] Note that these three hypotheses are not necessarily mutually exclusive.

(1) Breathiness > VOT Lag: Breathy vowels are associated with a VOT lag and so, in cases where registrogenesis results in extrinsic differences of voice quality (as is prototypically the case), the devoiced stops would develop longer VOT in their phonetic environment preceding breathy vowels. There are counterexamples such as Chru (< Chamic < Austronesian), however, where breathy voice quality is not a reliable correlate of low register and yet a small but measureable VOT lag is nevertheless detectable for devoiced stops (Brunelle, Tạ, Kirby & Đinh 2020).

(2) ATR > VOT Lag: Pharyngeal expansion by tongue root advancement (associated with stop prevoicing) pulls on the arytenoid cartilage, pulling the vocal folds apart slightly (Kingston et al. 1997).

(3) Subglottal Air Pressure Buildup > VOT Lag: Pharyngeal expansion by larynx lowering (associated with stop prevoicing) increases subglottal air pressure, which is released in a short burst at stop release (Ferlus 1979; Thurgood 2002, 2007).

2.3.2.2 Phonology of Register

In many cases, determining whether register is a segmental or a suprasegmental contrast is not a straightforward issue. The prototypical point of origin for a register contrast is a historical onset voicing contrast, but it is not clear what criteria might be used to determine when an onset voicing contrast has completed a transition from a segmental contrast associated with onset consonants to a suprasegmental contrast.[23] There is clearly an intermediate period when onset voicing differences and differences in register features both occur in the same language or in the same speaker (cf. recent work on Chru (< Chamic < Austronesian) (Brunelle, Tạ, Kirby & Đinh 2020) and Chrau (< Bahnaric < Austroasiatic) (Tạ et al. 2019)). Such a language "straddles the line" between segmental onset voicing contrast and suprasegmental register contrast.

In addition to overlapping with onset voicing contrast, register may also overlap with vowel quality contrasts. The differences in vowel height which often accompany a register contrast may become exaggerated and trigger vowel splits in a language (see Sections 2.4.2 and 3.2.1). Conversely, historical vowel quality contrasts can become reanalyzed as register contrasts (see Sections 2.5.2 and 4.4). As a result, register and vowel quality contrast may overlap at either the inception of a new register contrast or at the point where the register contrast breaks down and restructures into vowel quality contrasts. At either point, it becomes difficult to definitively draw a line between segmental vowel quality contrasts and suprasegmental register contrasts.

While it is not always possible to determine what register *is* in the synchronic phonology of a language, the role that register is playing diachronically in these situations is easily recognizable. Furthermore, this issue is not unique to register. Tones also have their origins in historically segmental contrasts in MSEA and, therefore, similar periods of overlap between segmental and suprasegmental contrasts are found among MSEA tone languages as well.

2.3.2.3 Parallels to Register Outside of the Sinosphere

While the register phenomenon in particular is unique to MSEA and a few Austronesian languages in Insular SEA, the interactions between naturally co-varying phonetic cues which underlie register are not. The concept of voiced *depressor consonants* is fundamental to our understanding the synchrony and diachrony of many African tone systems (cf. Michaud & Sands's (2020, 10-15) recent overview of this topic). Elsewhere in the world, non-tonal languages have also been shown to shift from an onset voicing contrast to a pitch-primary realization of that contrast. Two recent, real-time descriptions of this shift in process include Afrikaans (Coetzee et al. 2018) and Central Malagasy (Howe 2017).

There are also languages outside of MSEA, which exhibit a familiar-looking, binary phonological opposition involving characteristic differences of vowel height and laryngeal tension. In these languages, pairs of vowels of similar vowel quality are phonologically specified not for low or high register, but for *advanced tongue root* (+ATR) or *retracted tongue root* (-ATR). This phenomenon, *ATR harmony*, requires that all surface vowels in a single morphological word must share the same ATR specification. If and when two morphemes of differing ATR

[23] The behavior of register features in word games have been proposed as one promising piece of evidence (Svantesson 1983, Brunelle 2005a)

specifications are concatenated, a language-specific phonological process obtains which results in vowel mutations that bring all of the vowels in the morphological word under a uniform ATR specification in the surface realization.

In the examples from the Niger-Congo language Igbo presented in Table 9 (Archangeli & Pulleyblank 1994), observe that the mid back vowel prefix appears as the +ATR vowel [ó] when appended to a +ATR verb root but as the –ATR vowel [ɔ́] when attached to a –ATR verb root. Furthermore, the rhotic onset suffix carries a simple copy of the root vowel, which is allophonically conditioned to carry the same ATR setting as the verb root.

Table 9: *ATR harmony in Igbo (examples)*

Verb Root +ATR		**Affixes +ATR**		**Verb Root -ATR**		**Affixes -ATR**	
/rì/	*to eat*	[ó-rì-rì]	*he ate*	/pè̙/	*to carve*	[ɔ́-pè̙-rè̙]	*he carved*
/mɛ̀/	*to do*	[ó-mɛ̀-rɛ̀]	*he did*	/sà/	*to wash*	[ɔ́-sà-rà]	*he washed*
/zò/	*to do*	[ó-zò-rò]	*he did*	/dɔ̀/	*to pull*	[ɔ́-dɔ̀-rɔ̀]	*he pulled*
/gbù/	*to kill*	[ó-gbù-rù]	*he killed*	/pʊ̀/	*to buy*	[ɔ́-pʊ̀-rʊ̀]	*he bought*

Vowel pairs which differ in their ATR harmony specification are characterized by paradigmatic differences of vowel height. +ATR vowels are generally articulated with a somewhat closer vowel quality relative to their –ATR counterparts. The Shilluk (< Western Nilotic) vowel inventory in Table 10 exemplifies the vocalism of a prototypical, symmetrical, 10-vowel ATR harmony language of the Nilotic branch (Remijsen et al. 2011). The ten vowels are arranged in five pairs with the –ATR vowels to the left and the +ATR vowels to the right. This phonemic transcription system uses differences of vowel quality to differentiate the ATR vowel pairs rather than the ATR subscript diacritic of the IPA, as is common.[24]

Table 10: *Shilluk vowel inventory*

/	ɪ	i		ʊ	u	
	ɛ	e		ɔ	o	
			a ʌ			/

Parallels to register continue with another commonly co-varying cue of ATR harmony contrasts: voice quality. Differential voice quality may be utilized as a reinforcing auditory cue to the ATR harmony contrast, with the +ATR vowels being marked for breathiness or laxer-than-modal phonation and –ATR vowels being marked for laryngealization or tenser-than-modal phonation. There has been experimental confirmation of this phenomenon in some languages, such as Maa (Guion et al. 2004), but phonetic studies of other languages have not been able to demonstrate a reliably co-varying relationship between voice quality and ATR harmony (cf. discussion in Casali (2011, 510-511)).

Differential tongue root position is generally accepted as the articulatory explanation for the co-articulation of vowel height and voice quality differences in ATR harmony languages (Pike 1967, Ladefoged 1964). As the binary phonological contrast in ATR harmony languages resembles a binary register contrast in many respects, this estalishes a precedent for and lends credence to the position presented in the previous section that the articulatory gestures underlying MSEA register are likewise differences in tongue root position with likely reinforcement from differential larynx height positions. While ATR harmony and register are also different in certain ways,[25] we may well hypothesize that ATR harmony languages and register languages are both drawing on the same suite of naturally co-varying phonetic cues associated with the expansion or reduction of supraglottal cavity volume, as Gregerson (1976, 1984) has argued. The striking parallelism between the ATR pairs of Shilluk and the register pairs of Rengao (< Bahnaric < Austroasiatic) in Table 11 serve to illustrate just how similar an effect ATR harmony and register can have on the vowel inventory of a language.

[24] Shilluk also contrasts three vowel duration categories which are not represented here.

[25] Allomorphic variation based on vowel harmony, for example, is irrelevant in MSEA for reasons of grammatical and word shape typology. Furthermore, pitch tends to operate independent of ATR harmony at the phonological level in tonal ATR harmony languages of Africa, while pitch is prototypically a co-varying property of register in MSEA.

Table 11: *Comparison of Rengao (register) and Shilluk (ATR harmony) vowel realizations*

Vowel Phoneme	Rengao High Reg.	Shilluk -ATR	Rengao Low Reg.	Shilluk +ATR
/i/	[ei]	[ɪ]	[i]	[i]
/e/	[ɛ]	[ɛ]	[e]	[e]
/a/	[a]	[a]	[ə]	[ʌ]
/u/	[ou]	[ʊ]	[u]	[u]
/o/	[ɔ]	[ɔ]	[o]	[o]

2.3.3 Similarities and Differences between Tone & Register

We may summarize and conclude this brief introduction to tone and register in MSEA by comparing and contrasting the two. It should be clear, having read the above, that there is significant overlap between tone and register in both phonetic and phonological perspective. On that point, the following quote from Brunelle & Kirby (2016, 192) is worth reproducing here in full:

> *"…although much literature, including the present work, makes extensive use of descriptive shortcuts such as* tone *and* register*, it must be emphasized that these are labels of convenience, and do not correspond to meaningful discrete categories. Rather than trying to group languages based on arbitrary assessments of the importance of individual phonetic properties, we would like to suggest that a more fruitful avenue of research is to see different systems as the outcome of multiple, overlapping articulatory settings, the acoustic consequences of which are perceived in a multidimensional phonetic space."*

In synchronic phonological / distributional terms, there is no obvious difference between tone and register. They are the same thing: lexically contrastive, suprasegmental phonemes. In terms of phonetics, tone and register contrasts are upheld via a largely overlapping suite of phonetic cues. While there is a general sense that pitch is somehow "primary" among the cues related to a tone contrast and that voice quality somehow plays the most important role in distinguishing register contrasts, this proves to be a difficult rubric for disambiguating tonal languages from a registral ones (Mazaudon & Michaud 2008, Tạ 2021). As Brunelle & Kirby say, such criteria can only introduce an *arbitrary* distinction. Moreover, such a distinction is entirely unhelpful when trying to classify pitch-prominent "register" languages (e.g. Northern/Western Khmu (Svantesson & House 2006; Abramson et al. 2007)) or voice quality-prominent "tone" languages (e.g. Burmese (Gruber 2011)).

While there may be no clear line of demarcation between tone and register and while it seems to be the case that a continuum exists between the two, there are, nevertheless, notable differences between what we might call prototypical tone and prototypical register in MSEA. These are summarized in Table 12.

Table 12: *Prototypical properties of tone and register in MSEA*

	Tone	Register
Pitch Cues:	*typically*	*often*
Voice Quality Cues:	*often*	*typically*
Vowel Quality Cues:	*almost never*[26]	*often*
Phoneme Inventory:	*typically more than two*	*typically two*
Grammatical:	*occasionally*	*unattested*
Sandhi /Autosegmentality:	*occasionally*	*unattested*

This section has provided an introduction to tone and register in synchrony. We have seen that they have a great deal in common in terms of phonetics and phonology and that, while they can be sub-categorized under the

[26] Note, however, the exceedingly rare example of vowel quality ramifications of onset stop devoicing in a tonal language described for the Hmongic language Zongdi (Wang 1994, Wang & Mao 1995, Ratliff 2010) (see Section 3.3.1). In this language, vowels in words of tone categories B2 and C2 have undergone vowel raising, while vowels in words from the A2 and D2 categories are unchanged. This indicates that a low register vowel raising effect was operative at some point in the past.

larger heading of suprasegmental contrast based on properties that *tend* to differentiate them, it is difficult to draw a clear line between them. In the next section, we shift our attention to the historical phonological processes which produce tone and register contrast in MSEA languages. It will be shown that, similar as they are in synchrony, the similarity between tone and register in diachrony is even greater.

2.4 Tone & Register Origins in MSEA

2.4.1 Tonogenesis

2.4.1.1 Haudricourt's Model

Credit for the development of the traditional model for tonogenesis in Southeast Asia goes to Haudricourt (1954, 1961, 1965), who built on the work of Maspero (1911, 1912). By about a century ago, it was well established that tonality was the norm in MSEA and that three of the major tone languages of the region, Chinese, Thai and Vietnamese, shared a striking parallelism in the historical development of their tone inventories. Hmong-Mien languages were later found to share in this parallelism as well. In all of these cases, it was proposed that an original, three-way tone contrast in sonorant-final syllables (i.e. syllables ending in a vowel or sonorant coda consonant) had been split into a six-way tone contrast by the transphonologization of historical onset voicing contrasts. Voiced stops devoiced and merged with originally voiceless stops and voiceless sonorants became voiced, merging with originally voiced sonorants, but the historical onset voicing contrast was preserved in the form of a *tone split*. The tone split caused a doubling of the tone inventory into a high series associated with the historically voiceless onsets and a low series associated with the historically voiced onsets. The high and low series are so named because of their effect on the original tone inventory, resulting in relatively higher-pitched reflexes of the original tones in the high register and relatively lower-pitched reflexes in the low register. This effect can be observed directly in various modern languages (cf. Cantonese in Table 6 above and many other illustrative examples in Haudricourt (1961)).

The resulting tone inventory is typically schematized as a *tone box* (see Table 13), with the three proposed "original" tones in sonorant-final syllables, named A, B and C, and a fourth, non-contrastive tone in syllables closed by an oral stop, named D. The tone split is reflected in the numbers 1 (historically voiceless onset) and 2 (historically voiced onset).

Table 13: *Conventional tone box for Haudricourtian tonogenesis*

	A	**B**	**C**	**D**
1	A1	B1	C1	D1
2	A2	B2	C2	D2

In addition to this developmental parallelism, it was discovered that there are quite regular correspondences of tonal category in cognate etyma across the major language families (see Table 14) (Haudricourt 1954). Matisoff (2001) later coined the term *Sinospheric Tonbund* to refer to this tone category correspondence across many languages of Sinospheric MSEA. Because the regular correspondence of phonemes in cognate etyma across languages typically evinces genetic relatedness, the obvious question was raised: *did all of the Southeast Asian language families inherit their tones from a common ancestor* (cf. Maspero 1912)? The answer to this question has been clearly demonstrated to be "no", because, aside from these tonal correspondences, there is no basis for claiming the relatedness or unrelatedness of any of the major language families of MSEA, with the exception of Austronesian and Tai (Benedict 1942, 1990b; Ostapirat 2005). The comparative method is simply unable to provide insights beyond a certain time-depth, and, so, if any of the other major language families of MSEA are ultimately of the same genetic stock, the evidence needed to demonstrate that fact is unrecoverable by contemporary investigative methods.

Table 14: *Tone category correspondences across the Sinospheric Tonbund* [27]

Vietnamese	Sinitic	Hmong-Mien	Tai
A (ngang-huyền)	A (平 píng *level*)	A	A (unmarked)
B (sắc-nặng)	B (上 shǎng *rising*)	B	C (mai tho)
C (hỏi-ngã)	C (去 qù *departing*)	C	B (mai ek)
D (sắc-nặng)	D (入 rù *entering*)	D	D (unmarked)

Since the explanation for the regularity of tonal correspondences could not be established as being the result of mutual genetic inheritance, another hypothesis, one which could be tested empirically, was that these correspondences were the result of lexical borrowing. This raised new issues. Assuming that all of the languages in question were tonal at the time of borrowing and given that much of this cognate vocabulary was borrowed from Sinitic into the other families over long periods of contact, during which time the phonetic realizations of the individual tones of all languages involved would have been constantly evolving, how did the correspondences remain so regular? In addition, dissimilar patterns of tone splits and mergers would have been happening inside each language, further obscuring the connections between the tone categories across the languages.

As Ratliff (2010, 185-192) discusses, when a tonal language borrows a word from another tonal language, the tone that is assigned to the borrowed word in the target language will either be assigned on the basis of its phonetic similarity to the word's tone in the source language (Chamberlain 1972, Ying 1972, L-Thongkum 1997) or it will be assigned to a predetermined *loan tone* category, to which all or most loan words in the language are assigned (Matisoff 2001). What the borrowing tone language will *not* do is borrow the entire historical tonology of the source tone language and situate the borrowed word in the appropriate historical tone category which is equivalent to the historical tone category in the source language. This is obviously impossible, as the information required to do this would not be available to speakers of the target language. If we apply this same principle then to the Sinospheric Tonbund, we can only conclude that the languages in question did not actually borrow tone categories directly from one another.

Haudricourt's insight was that these correspondences between historical tone categories do not reflect the borrowing of tones at all, but rather the borrowing of words with analogous phonetic conditioning environments of tonogenetic potential at a stage predating tonogenesis. Haudricourt proposed that all six of the basic tone categories in Sinospheric Tonbund languages developed out of originally segmental contrasts. It was already established in Haudricourt's time that segmental onset voicing contrasts gave rise to suprasegmental tone contrasts via tone splits, but the origins of the A, B and C tone categories were not yet known. Haudricourt produced evidence that these three categories were also of historically segmental origin, being associated with differential laryngeal settings of codas. Although this laryngeal complexity is absent today from codas in languages of the Sinospheric Tonbund, they must still have been present during the period when many of the more ancient lexical borrowings between Sinospheric Tonbund languages were taking place. Analogous patterns of tonogenesis then applied separately and at different times in different languages of the Tonbund with the result that the historically cognate conditioning environments developed into historically cognate tone categories.

Evidence supporting Haudricourt's model came from various sources. The key to unlocking the segmental origins of the A, B and C tones was to compare tonally innovative Vietnamese with its more conservative cousin languages from the Austroasiatic family.[28] Haudricourt hypothesized that Vietnamese tones A, B and C correspond to words with differing patterns of coda phonation elsewhere in Austroasiatic and subsequent work on Vietnamese's

[27] Note that, in a historiographic quirk, the designation of tone categories B and C in the literature on Tai languages correspond to tone C and B, respectively, in other language families. Also, *unmarked*, *mai ek* and *mai tho* refer to the graphemic indications of tone found in Tai orthographies, such as the national orthographies of Thailand and Laos.

[28] Note that Maspero deserves more credit than he usual gets for this discovery. As Haudricourt (1954) states, Maspero (1912, 102) had already pointed to a possible correspondence between Vietnamese tone C and coda fricatives in wider Austroastiatic.

lesser-known sibling languages in the Vietic branch of Austroasiatic has further validated this hypothesis (see Section 2.4.1.2). The simplification of laryngeal complexity on segmental codas coincided with the development of the A, B and C tones in Vietnamese. Words with voiced sonorant codas developed tone A, while glottalized rimes (i.e. those ending in a glottal stop *ʔ or a glottalized sonorant coda such as *m^{ʔ} or *l^{ʔ}) developed tone B and words with voiceless fricative codas (i.e. those ending in *s, *h or a voiceless sonorant coda such as *m^{h} or *l^{h}) developed tone C. As for tone D, Vietnamese still retains final oral stops inherited from Proto-Austroasiatic, making the origin of the D tone abundantly clear.

Table 15 summarizes Haudricourt's conception of Vietnamese tonogenesis. There are additional issues which Haudricourt was not aware of at the time (cf. Cage 1985; Thurgood 2002, 2007), but the fundamental principles expressed in Table 15 apply not just for Vietnamese, but for the entire Sinospheric Tonbund (Matisoff 1973).

Table 15: *The segmental origins of tones in the Sinospheric Tonbund*

		A *sonorant coda*	**B** *glottalized coda*	**C** *fricative coda*	**D** *oral stop coda*
1	***vl onset**	A1	B1	C1	D1
2	***vd onset**	A2	B2	C2	D2

It is now widely accepted that the tonogenetic pattern evident in Vietnamese was shared with languages in the Sinitic, Tai and Hmong-Mien families. Old Chinese, for example, is reconstructed as a pre-tonal language with additional coda complexity based in large part on the evidence from Vietnamese and other Austroasiatic languages (Pulleyblank 1962, 1972-73; Baxter 1992, Baxter & Sagart 2014). Furthermore, the ABCD tone categories are universally split by onset voicing contrasts in Sinospheric Tonbund languages.[29] Once again, Austroasiatic provides good contemporary evidence that historical voicing differences are the source for these splits, since the words with voiceless stop onsets and tones from the low series in Vietnamese correspond to words with voiced stop onsets in other Austroasiatic languages. Further confirmation for the hypothesis that voiced stops conditioned the emergence of the low tone series comes from Min Chinese dialects. In Min, a phonation difference between historically voiced and voiceless stops is retained, as they have become breathy voiced and voiceless stops, respectively. Another telling piece of evidence comes from the Indic-based Siamese orthography that was developed in the 12th century C.E. In this iteration on the script, glyphs which are associated with voiced stop phonemes in Indic scripts are used to represent the now-voiceless stops in the onsets of Siamese words with low series tones.

The voicing of other natural classes of onsets had similar ramifications for tone inventory splits. A contrast existed between voiced and voiceless sonorant onsets in Old Chinese (Baxter & Sagart 2014), Proto-Tai (Pittayaporn 2009), Proto-Hmong-Mien (Ratliff 2010) and pre-Vietnamese (Haudricourt 1954). The voiced and voiceless sonorants conditioned the same tone split as the voiced and voiceless stops, and the voiceless sonorants subsequently merged into the voiced sonorants. There is suggestive evidence that, in languages with laryngeal contrasts on sonorant onsets, tone tends to become phonemicized in words with sonorant onsets first, *before* tone emerges in words with stop onsets. Evidence in support of this hypothesis comes from two Tai languages, Dai Tho (L-Thongkum 1997) and Cao Bằng Tai (Haudricourt 1961, Pittayaporn & Kirby 2017), from two Tibeto-Burman languages, Tibetan (Mazaudon 1977) and Kurtöp (Hyslop 2009) and from one Austroasiatic language, Khmu (Kirby 2021). Haudricourt (1961) lists a counterexample from the Kam-Sui languages, in which sonorant onset voicing is retained even as voiced stops have devoiced, splitting the language's A, B and C tones, but, by and large, the pattern holds.

In summary, the explanation for the cross-phylum tonal correspondences in the Sinospheric Tonbund is not found in the borrowing of tones, but rather in the borrowing of words at a time before tonogenesis had even begun. Parallel tonogenetic processes subsequently obtained across genetically unrelated MSEA languages, carrying over the older segmental contrasts into suprasegmental contrasts. The resulting suprasegmental contrasts, having been conditioned by historically cognate segmental contrasts, retained their cognacy and their regular correspondence

[29] One possible exception to this is the Fuyuan variety of West Hmongic, which preserves no tonal reflexes of onset phonation (Wang 1994, Wang & Mao 1995, Ratliff 2010). See discussion in Section 5.2.3.

across the Tonbund. To take a concrete example, the Old Chinese word for *basin*, which is reconstructed by Baxter & Sagart (2014) *ʔ^{ʕ}aŋ-s would have been borrowed with either its OC-reconstructed complex coda *ŋs intact or, more likely, with the two segments fused into a voiceless or post-aspirated nasal coda *ŋ^{h} in pre-Proto-Tai and pre-Vietnamese. The coda voicelessness would then have been transphonologized into what became the Proto-Tai B tone (*ʔaːŋ^{B}) and the Vietnamese C tone (<ẳng> /ʔaːŋ^{C1}/), as both of those languages experienced parallel but separate tonogenetic events.[30]

2.4.1.2 Tonogenesis in Vietic

To illustrate Haudricourt's tonogenetic model, we can do no better than to review Vietnamese tonogenesis in closer detail. Haudricourt (1954) developed his model based on Vietnamese evidence, but he did so without reference to the other languages of the Vietic branch, as they were not yet sufficiently documented in his time. Subsequent work on historical Vietic phonology, primarily that of Ferlus (1975, 1982, 1991, 1992b, 1992c, 1996, 1997, 1998b, 2004, 2005, 2007), has only served to confirm Haudricourt's hypothesis. Here we will briefly review Vietnamese and two other Vietic languages, Kri and Rục, to provide a concrete example of classical, Haudricourtian tonogenesis.

The Kri language of Laos is not a tone language; it is a register language (Enfield & Diffloth 2009). Kri's conservatism offers us a glimpse at what pre-tonal Vietnamese would have looked like. Vietnamese's A, B and C tones originated as different Pre-Vietnamese coda phonation types, as described above, and these three coda phonation types remain contrastive in modern Kri. The contrast is reduced to a two-way contrast among Kri nasal codas, which never occur voiceless / post-aspirated, but for open syllables, semivowel glide codas and liquid codas, there is a three-way contrast of coda phonation. Examples provided by Enfield & Diffloth (2009) are presented in Table 16.

Table 16: *Examples of laryngeal contrast on Kri codas*

Plain Voiced (=A)	Glottalized (=B)	Voiceless (=C)
/ʐɑː^{H}/ '*turtle*'	/ʐɑː^{ʔH}/ '*pig basket*'	/ʐɑː^{hH}/ '*dry*'
/camaːl^{H}/ '*shiny*'	/ʔumaːl^{ʔH}/ '*to hunt*'	/ɗal^{hH}/ '*to bounce*'
/kaʋər^{H}/ '*stir*'	/kaʋar^{ʔL}/ '*embrace*'	/tar^{hH}/ '*to run out of space*'
/tɔːj^{L}/ '*tail*'	/tɔːj^{ʔL}/ '*bowl*'	/tɔːj^{hL}/ '*follow*'
/carɛːw^{H}/ '*green*'	/sarɛːw^{ʔH}/ '*to raise/feed*'	/ɓlɛːw^{hH}/ '*four-eyed turtle*'
/jaːm^{L}/ '*sugar cane*'	/jaːm^{ʔL}/ '*to cry*'	-
/kaːn^{H}/ '*oversize*'	/kaːn^{ʔH}/ '*to hunt by night*'	-
/ɓuːɲ^{L}/ '*dust*'	/puːɲ^{ʔL}/ '*tree sp.*'	-
/cɑŋ^{H}/ '*tree sp.*'	/cɑŋ^{ʔH}/ '*salty*'	-

It should be noted that, while Kri has not undergone Vietnamese-style tonogenesis, Kri and Vietnamese do have in common the reanalysis of onset voicing contrast as a suprasegmental contrast. In Vietnamese, this resulted in the tone split, but, in Kri, it resulted in a register contrast. Enfield & Diffloth (2009) report that Kri register is cued by differences of voice quality and vowel height, as summarized in Table 17, where high register allophones are colored red and low register allophones are blue.

[30] Proto-Tai reconstruction from Pittayaporn (2009)

Table 17: *Register-conditioned allophones of Kri vowel phonemes*[31]

/ia/ - [i̤a]	/ɨa/ - [ɨ̤a]	/ua/ - [ṳa]			
/iː/ [ᵉɪː] [i̤ː]	/ɨː/ [ᵊɪ̵ː] [ɨ̤ː]	/uː/ [ᵒʊː] [ṳː]	/i/ [ᵉɪ] [i̤]	/ɨ/ [ə] [ɨ̤]	/u/ [o] [ṳ]
/eː/ [ᵋeː] [ɪ̤ː]	/əː/ [əː] [ɪ̵̤ː]	/oː/ [ɔː] [ʊ̤ː]	- - -	- - -	- - -
/ɛː/ [ɛː] [ɛ̤ː]	/aː/ [aː] [ᵊa̤ː]	/ɔː/ [ɑː] [ᵒɔ̤ː]	/ɛ/ [ɛ] [ɛ̤]	/a/ [a] [ᵊa̤]	/ɔ/ [ɑ] [ᵒɔ̤]

The Rục language of Vietnam represents a stage in the tonogenetic process intermediate between conservative Kri and innovative Vietnamese. Rục's tone inventory was first described impressionistically by Nguyễn Văn Lợi (1993), and a follow-up acoustic phonetic study by Tạ (2020, 2021) has filled in many details. Rục has four phonemic tones, as presented in Table 18, which correspond to the expected historical conditioning categories. Breathiness and closer vowel quality are both associated with the low series tones. This is especially noticeable for /aː/ vowels in the low series tones, which are diphthongized to [ᵊa̤ː]. The B tones retain glottalization at syllable offset as one of their phonetic cues, as modern Vietnamese B tones sắc and nặng often do (depending on the dialect). The low register tones also condition a slightly longer voicing lag for voiceless stop onsets.

Table 18: *The four-tone inventory of Rục*[32]

	A sonorant coda		**B glottalized coda**	
***vl onsets**	/ta^{A1}/	[taː^{53}]	/ta^{B1}/	[ta^{ʔ34}]
***vd onset**	/ta^{A2}/	[tˁᵊa̤ː^{32}]	/ta^{B2}/	[tˁᵊa̤^{ʔ31}]

Missing from Table 18 is the expected tone C. Voiceless sonorant codas are still retained in contemporary Rục, and Tạ analyzes tones [C1] and [C2] as allotones of tones /A1/ and /A2/, conditioned by the presence of such codas. The C tones are both realized with a mid-level [44] pitch.

Table 19 summarizes the progression of tonogenesis across Vietic using Kri, Rục and Vietnamese as examples. We see that Kri retains fricative and glottal stop codas, Rục retains fricative codas but has restructured the *ʔ coda into a tone which is contrastive with open syllables, and Vietnamese has restructured both *ʔ and *H codas into tones.

Table 19: *Emergent tonality across the Vietic languages*

		A *sonorant coda*	**B** *glottalized coda*	**C** *fricative coda*		
		V(N)^{H}	Vʔ^{H}	VH^{H}	**Kri**	/^{H}/
1	***vl onset**	V(N)^{A1}	Vʔ^{B1}	VH$^{A1\ [C1]}$	**Rục**	/^{A1}/, /^{B1}/
		V(N)^{A1}	Vʔ^{B1}	VH^{C1}	**Vietnamese**	/^{A1}, /^{B1}/, /^{C1}/
		V(N)^{L}	Vʔ^{L}	VH^{L}	**Kri**	/^{L}/
2	***vd onset**	V(N)^{A2}	Vʔ^{B2}	VH$^{A2\ [C2]}$	**Rục**	/^{A2}/, /^{B2}/
		V(N)^{A2}	Vʔ^{B2}	VH^{C2}	**Vietnamese**	/^{A2}/, /^{B2}/, /^{C2}/

[31] Register contrast is neutralized among the diphthongs, where only low register occurs.

[32] Note that hypothetical /ta/ words are used here to illustrate the phonetic realization of Rục tones. The phonetic realizations are based on Tạ's description of the effects of register.

2.4.2 Registrogenesis

2.4.2.1 Huffman's Model

The register phenomenon was first introduced by Henderson (1952) in her work on Khmer phonology and the concept was also applied to the Mon language early on (Shorto 1962). In the 1970's, linguist Franklin Huffman documented many Austroasiatic languages of Thailand and its neighboring countries, many of which happened to be register languages.[33] Huffman combined the insights that he gained from his work on register in these lesser-known or previously undocumented Austroasiatic languages with his expert knowledge of Khmer phonology and orthography to develop a general model of register formation and evolution. Although modern Khmer is a post-registral language, this model is often referred to as the *Khmer Model* of registrogenesis, because it lays out a pathway by which a conservative language without register may become registral and subsequently lose register after it conditions innovative vowel splits, as has happened in Khmer. Huffman's (1976, 1985b) contributions, alongside those of Ferlus (1979), constituted a significant step forward in modeling suprasegmental sound change in MSEA.

Huffman's model of registrogenesis is broken down into four stages, as summarized in Table 20 below. Languages at the first stage are not registral at all, as onset voicing contrasts are retained. Languages at stage two are in a transitional period, as they begin to employ additional cues from the register bundle extrinsically, either in addition to or in place of onset voicing cues (cf. discussion in Section 2.3.2.1). If a language is at stage three, historical onset voicing differences have been entirely replaced by cues from the register bundle and the two registers are integrated as suprasegmental contrasts. Finally, for languages at the last stage, register-conditioned differences of vowel height between the members of register vowel pairs have progressed to the point that splits in the language's vocalism occur and the former suprasegmental register contrast is transphonologized into many new segmental vowel quality contrasts (see Table 22 below for an example from Standard Khmer). This process is generally referred to as *vocalic restructuring* in register studies. Other register cues (e.g. voice quality, pitch, VOT differences) eventually fade away, as the historical, register-conditioned allophones become reanalyzed by speakers as separate vowel phonemes differentiated by vowel quality. The full phonetic merger of *voiced and *voiceless stops may follow, completing the process of /segmental onset voicing/ > /suprasegmental register/ > /segmental vowel quality/ contrast.

Table 20: *Huffman's (1976) model of registrogenesis*

Stage	Hypothetical Example	Description
1. Conservative	/baː/ [baː] /paː/ [paː]	Preserves consonant voicing contrast phonetically and phonologically
2. Transitional	/baː/ [pˁᵊa̤ː˧˨] /paː/ [paː˦]	Preserves consonant voicing contrast phonologically and adds redundant register cues to reinforce the contrast.
3. Register	/paː^{H}/ [pˁᵊa̤ː˧˨] /paː^{L}/ [paː˦]	Consonant voicing contrast is transphonologized to a register contrast as onset voicing differences become unreliable and the bundle of register cues takes responsibility for cueing the contrast.
4. Restructured	/pɨa/ [pᵊaː] /paː/ [paː]	Register contrast breaks down due to vocalic restructuring. Phonemic vowel splits result. Other register cues fade away and the full phonetic merger of *vd/*vl onsets is achieved.

Huffman also discusses the development of register in words with onsets other than *vd stops or *vl stops. Huffman lays out a scenario whereby languages with laryngeally complex onsets such as voiceless sonorants and/or preglottalized sonorants may transphonologize the contrast between these complex sonorants and plain voiced sonorants into a register contrast along the same lines as the *vd/*vl stops. This certainly happens in Austroasiatic, but Huffman errs in projecting contrasts of *vl/*vd/*glottalized sonorants back to Proto-Austroasiatic (cf. introduction

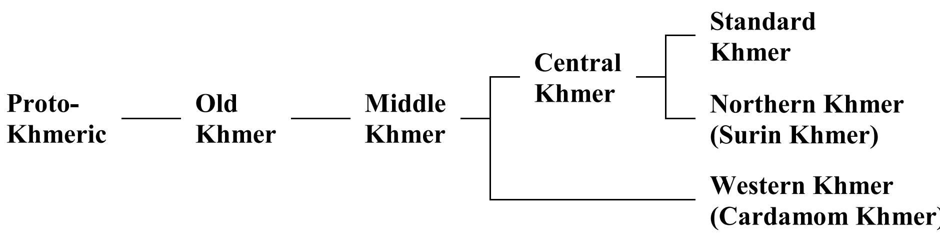
[33] See the Huffman Papers (http://sealang.net/archives/huffman/) and the Huffman Katuic Audio Archive (http://sealang.net/archives/huffman2/) on sealang.net, where much of this valuable data and analysis is archived.

to Proto-Austroasiatic in Section 4.2). Only certain branches and certain languages had developed such contrasts when they began to undergo registrogenesis. In languages where only plain voiced sonorant onsets are found, register will either fail to phonologize in environments other than following *vd and *vl stops or it will phonologize with low register features developing after voiced sonorant onsets as was the case in Khmer.

2.4.2.2 Registrogenesis in Khmer

To exemplify Huffman's Khmer Model of registrogenesis, we need look no farther than the model's namesake. The Khmeric branch of Austroasiatic may be divided into three closely related languages, all descended from the Middle Khmer language spoken in post-Angkorian Cambodia (14^{th} - 18^{th} centuries CE). Ferlus (1992a) proposes that Standard Khmer of modern Cambodia and the Norther Khmer (or Surin Khmer) of modern Thailand share common descent from an intermediate Central Khmer node. The Western Khmer (or Cardamom Khmer) spoken in the mountainous borderland between western Cambodia and Thailand constitutes a separate lineage, directly descended from Middle Khmer (see Figure 1).

Figure 1: *From Proto-Khmeric to modern languages (Ferlus 1992a)*



In Henderson's (1952) pioneering work on Khmer phonology, she describes the *first register* (i.e. high register) as being characterized by normal voice quality and relatively higher pitch while the *second register* (i.e. low register) imparts relatively low pitch and "a deep, rather breathy or 'sepulchral' voice, pronounced with lowering of the larynx and frequently accompanied by a certain dilation of the nostrils". Henderson's description of a register contrast is consistent with what we find in many contemporary register languages and her work greatly influenced subsequent thinking on the phenomenon. However, we should note that Henderson later retracted her analysis of modern standard Khmer as a register language, explaining that the Khmer speaker with whom she worked was affecting an artificial, archaic reading pronunciation of the two registers (Wayland & Jongman 2002).[34] Instead, she concluded, in keeping with the analysis of Huffman and others, that Khmer is at a post-registral stage, in which register has conditioned vowel splits and faded.

The fact that register has played a role in the history of Khmer was never in doubt, however. The Khmer orthography serves as a time capsule of sorts, representing and preserving a pre-registral stage of the language. Comparing the Khmer orthography with the patterns of development of vowels in modern Khmer dialects reveals the role that differences in onset phonation have played in conditioning vowel splits. This analysis is well justified, given the overwhelming amount of extra-Khmer evidence in support of a onset voicing > register > vowel split progression (Ferlus 1979; Huffman 1976, 1985b; Diffloth 1980, 1982a, 1982b, 1984; Thurgood 1997, 1999, 2003; Gehrmann 2016). In addition, it has been subsequently documented that at least one dialect of Khmer, Chanthaburi Khmer, conservatively employs differential voice quality among historical register vowel pairs: an enduring example of register contrast within the modern Khmer language community (Wayland 1997, Wayland & Jongman 2001).

As a post-registral language with a vowel inventory that has been essentially doubled, the vowel inventory of modern Standard Khmer is complex and subject to interpretation. In addition, some of the specifics differ from dialect to dialect. The inventory presented in Table 21 below is based on that of Bisang (2015), whose own analysis was is a synthesis of Jacob's (1968), Huffman's (1967), Ehrman's (1972) and Haiman's (2011). The inventory of long vowels, short vowels and three centering diphthongs (/iə ɨə uə/) is unremarkable for an Austroasiatic language;

[34] Wayland & Jongman are reporting personal communication with Gérard Diffloth here.

however, the seven additional rising diphthongs are atypical and represent a legacy of the historical high register's propensity to induce onset lowering.

Table 21: *Modern Standard Khmer vocalism (adapted from Bisang 2015)*[35]

/	iə	ɨə	uə							
	iː	ɨː	uː	i	ɨ	u				
	eː	əː	oː	e	ə	o		əɨ		
	ɛː	-	ɔː	-	-	-	ɛə	aɨ	ɔə	
		aː	ɑː		a	ɑ	ae	aə	ao	/

While register no longer a part of the phonology of Standard Khmer, it remains a psycholinguistic reality for literate speakers of Khmer on account of the language's aforementioned conservative orthography. The orthography, which reflects Middle Khmer phonology, continues to encode the historical register pairs, as both members of such pairs are written using the same vowel grapheme (see Table 22).

The Standard Khmer vowel phoneme inventory is quite a bit larger than the vowel grapheme inventory. Orthographic Khmer has just nine long vowel graphemes, five short vowel graphemes and three diphthong graphemes. Other graphemes exist as well but they have more specialized purposes (e.g. marking certain vowel+coda combinations, certain onset+coda combinations, etc.). A further conservative aspect of the Khmer orthography is its retention of consonant graphemes which reflect Middle Khmer voicing contrasts. Because the Standard Khmer orthography still largely represents Middle Khmer phonology, there are two different modern vowel quality readings for almost every orthographic vowel and the correct reading of a vowel grapheme requires that one know the historical voicing value of the onset and the reading pronunciation that it imparts to that particular vowel grapheme.[36]

Table 22 demonstrates the Standard Khmer orthographic representation of vowels (in IPA romanization) and how it relates to the Standard Khmer phonological vowel inventory. High register reflexes are in red and low register in blue. The phonological forms correspond to those presented in Table 21 above. Note that the vowel development is slightly simplified here for the purpose illustration, but those who are interested in a greater level of detail should consult Ferlus (1992a).

Table 22: *Orthography and phonology for Standard Khmer vowels*

< iə > /iə/ /iə/	< ɨə > /ɨə/ /ɨə/	< uə > /uə/ /uə/				
< iː > /eː/ /iː/	< ɨː > /əː/ /ɨː/	< uː > /oː/ /uː/		< i > /ə/ /ɨ/	< ɨ > /ə/ /ɨ/	< u > /o/ /u/
< eː > /eː/ /eː/	< əː > /aə/ /əː/	< oː > /ao/ /oː/				
< ɛː > /ae/ /ɛː/	< aː > /aː/ /iə/	< ɔː > /ɒː/ /ɔː/			< a > /a/ /ɛə/	< ɔ > /ɒ/ /ɔə/

We see that almost every vowel grapheme has two readings according to which historical register is associated with a given word. Exceptions include the diphthong series /iə ɨə uə/ and one long monophthong, /eː/, where the historical register contrast did not result in a phonemic vowel quality split. The pattern of vowel quality change among these historical register pairs are entirely typical in the context of MSEA register languages, with characteristic vowel raising in the low register open vowels and vowel lowering in the high register vowels (Huffman 1985b).

The Northern Khmer dialect is also post-registral in its vocalism. Table 23 presents the synchronic Northern Khmer vowel inventory using the transcription system of Chantrupanth & Phromjakgarin (1978). Vowels associated with the historical high register are colored red and blue-colored vowels are historically low register. Vowels that do

[35] This inventory is presented to facilitate the current discussion, acknowledging that other valid interpretations could also serve.
[36] Note that Standard Khmer orthography does not perfectly represent the vowels of Middle Khmer (Ferlus 1992a), but the correspondence is regular enough to illustrate the broader point here.

not descend directly from Middle Khmer are listed in parentheses. These were introduced through loans, expressive/ideophonic neologisms (cf. Diffloth 2001) or other minor irregular developments to promote symmetry in the vocalic inventory.

Table 23: *Modern Northern Khmer vocalism Chantrupanth & Phromjakgarin (1978)*

/	iːa	ɨːa	uːa	ia	ɨa	ua	
	iː	ɨː	uː	i	ɨ	u	
	ɪː	ᵻː	ʊː	(ɪ)	(ᵻ)	ʊ	
	eː	əː	oː	(e)	(ə)	(o)	
	ɛː	ɜː	ɔː	(ɛ)	ɜ	(ɔ)	
		aː	ɒː		a	ɒ	/

In Table 24, these same Northern Khmer vowels are arranged in their historical register pairs with reference to Khmer orthography to facilitate comparison with Standard Khmer (cf. Table 22 above). Note that the Middle Khmer diphthongs are all monophthongized to near-close vowels in low register and are merged with the low register reflexes of the historical mid vowels in the case of /ɪː/ and /ʊː/.

Table 24: *Orthography and phonology for Northern Khmer vowels*

<iə> /ɪː/ /ɪː/	<ɨə> /ᵻː/ /ᵻː/	<uə> /ʊː/ /ʊː/			
<iː> /eː/ /iː/	<ɨː> /əː/ /ɨː/	<uː> /oː/ /uː/	<i> /ɜ/ /ɨ/	<ɨ> /ɜ/ /ɨ/	<u> /ɔ/ /u/
<eː> /ɛː/ /ɪː/	<əː> /ɜː/ /əː/	<oː> /ɔː/ /ʊː/			
<ɛː> /ɛː/ /eː/	<aː> /aː/ /iːa/	<ɔː> /ɒː/ /uːa/		<a> /a/ /ɨa~ia/	<ɔ> /ɒ/ /ua~ʊ/

If we compare the development of the Middle Khmer vowels under the influence of register across both Standard Khmer and Northern Khmer, we find that in every case where register has triggered a vowel split, the resulting split involves a change in vowel height whereby the high register reflex is more open than the low register reflex. We can compare this state of affairs with that of a modern register language: the Suay language (< Katuic) of southern Laos. Table 22 shows the Suay long vowel phonemes and the effect of register on vowel quality (Ferlus 1971a, Huffman 1971, Gehrmann & Kirby 2019).

Table 25: *Allophonic realization of Suay vowel phonemes in high (red) and low (blue) register*

/iː/ [iː] [i̤ː]	/ɨː/ [ɨː] [ɨ̤ː]	/uː/ [uː] [ṳː]
/eː/ [eː] [ⁱe̤ː]	/əː/ [əː] [ᶤə̤ː]	/oː/ [oː] [ᵘo̤ː]
/ɛː/ [ɛː] [ᵉɛ̤ː]	/aː/ [aː] [ᵊa̤ː]	/ɔː/ [ɔː] [ᵒɔ̤ː]

The pattern of vowel height restructuring among register vowel pairs in Suay resembles that of Khmer, in that when allophonic vowel quality differences are conditioned by register, the high register vowels are more open than the low register vowels. Unlike Khmer, however, the high register vowels have not lowered in Suay. Rather, all low register vowels which are able to raise, which is to say all vowels save those of the close vowel series, do so. Furthermore, because Suay is a synchronic register language, as opposed to a historically registral language like Khmer, a bundle of register cues remains in place to cue the register contrast in Suay. Gehrmann & Kirby (2019) show that low register is characterized by slightly longer voiceless stop onset VOT and higher spectral tilt measures (breathier voice quality) on average. No reliable difference of F0 was measured. In the register language Suay, then, we can say that the register contrast is upheld by a combination of differences in vowel quality, voice quality and voiceless stop VOT.

By comparing the phonologies of pre-registral Middle Khmer (as generally preserved in the Khmer orthography), contemporary registral Suay and post-registral Standard and Northern Khmer, we get a picture of the entire registrogenetic life cycle, as modeled by Huffman (1976, 1985b). Onset voicing contrasts (as in Middle Khmer) first become transphonologized to a register contrast (as in modern Suay), which utilizes differences in a bundle of naturally co-varying phonetic properties to cue each register. Eventually, one of those register cues, differences in vowel height, becomes exaggerated, and the register contrast becomes reanalyzed as a vowel quality contrast, coincident with the loss of other cues from the register bundle (as in modern Standard and Northern Khmer).

2.5 Beyond the Conventional Models

In Section 2.4, we have briefly reviewed the conventional models of tonogenesis and registrogenesis for MSEA languages. The validity of these models has been independently confirmed time and again, as they accurately predict the evolution of most of the region's tone languages and many of the region's register language. Or, perhaps more to the point, they accurately predict the evolution of tone and register in the region's best known and most studied languages: languages with national status and regional prestige, including Vietnamese, Khmer, Thai and Lao, and historically influential languages with written traditions, such as Mon and Cham. Because of the bias towards the better-studied languages of MSEA in the conventional models, the actual diversity of tono-/registrogenetic pathways is overlooked and underappreciated outside of specialist circles. A criticism that may rightly be levied against our received models is that they are insufficiently broad to account for the emergence and evolution of tone and register in many lesser-known and understudied languages.

As was established above, Haudricourtian tonogenesis involves the transphonologization of two types of segmental contrast, onset phonation and coda phonation, as suprasegmental contrasts of tone. According to Huffman's model, registrogenesis involves the transphonologization of just one type of segmental contrast: onset phonation. Between them, then, the received models are sensitive to only two types of segmental > suprasegmental sound change. However, at least two further types of segmental contrast have been documented as conditioning the emergence of suprasegmental contrast in MSEA, namely, *vowel length* and *vowel height* (Diffloth 1982b; Svantesson 1989; Sidwell 2015b; Gehrmann 2015, 2016, 2019). We will explore these in greater detail in Chapter 4, but in order to establish the fact there are suprasegmental sound change pathways which fall outside of our received models, four case studies will be presented here.

We begin with examples of tonogenesis and registrogenesis that have no overlap with the conventional models. First, in Sections 2.5.1, an example of tonogenesis under conditioning from vowel length is presented, looking at the Hu language. Then, in Section 2.5.2, it will be shown that register in Rengao corresponds not to onset phonation contrasts in other Bahnaric languages, but to vowel height contrasts. Two further case studies are then presented which overlap with the conventional models but are nevertheless outside of their explanatory scope. In Section 2.5.3, it is shown how the development of tone in the Muak Sa'ak language was conditioned not by the expected combination of onset phonation and coda phonation, but by a combination of vowel length and coda phonation. Finally in Section 2.5.4, we explore a case of registrogenesis conditioned not only by onset phonation, but by a combination of onset phonation and vowel height in the Kriang language.

2.5.1 Tonogenesis via Vowel Length in Hu

Hu is one of the Angkuic languages in the Palaungic branch of Austroasiatic, which are spoken in an area straddling the border between Shan State, Myanmar and Yunnan province, China. Angkuic languages are notable for two interrelated phonological innovations related to onset voicing and tonogenesis. Proto-Angkuic (pAngkuic) underwent a so-called *Germanic Shift* in its stop onset series (Haudricourt 1965), meaning that *voiced stops have devoiced to become pAngkuic *voiceless stops, while *voiceless stops have shifted to become pAngkuic *voiceless aspirated stops. This shift in onset stop phonation in the Angkuic languages, which is atypical of MSEA languages, precludes the possibility of one of the perennial processes of segmental > suprasegmental sound change: the transphonologization of stop onset voicing.

Nevertheless, Angkuic languages are tonal today, following unorthodox tonogenetic pathways involving the transphonologization of vowel length contrast as tone. The situation in Angkuic tonogenesis is neatly summarized by Sidwell (2015b) who draws on the available analyses of Hu, U and Muak Sa'ak (Svantesson 1988, 1989, 1991; Hall 2010). Tonogenesis in Muak Sa'ak and U will be reviewed below, but we begin here with the Hu language, the toneme inventory of which is the simplest among the Angkuic languages.

In Hu, pPalaungic vowel duration contrast was transphonologized into a tone contrast, with *short vowels conditioning a high tone and *long vowels a low tone. Table 26 is a reproduction of a table summarizing the results of a small acoustic study, investigating the F0 and duration correlates of tone in Hu (Svantesson 1991). We see that vowels in low tone words (grave accent) continue to be produced with longer duration than vowels in high tone words (acute accent). As demonstrated by the first tokens of /páp/ and /kʰàp/, duration may overlap between the two tones in words with comparable codas, but pitch overlap was not encountered. Svantesson interprets this as evidence that Hu is a tone language with unreliable, allophonic differences of vowel duration.

Table 26: *Average F0 and duration for Hu tone (Svantesson 1991)*

	High Tone				Low Tone		
	Token	**Avg F0 (Hz)**	**Duration (ms)**		**Token**	**Avg F0 (Hz)**	**Duration (ms)**
jám	1	269	130	**jàm**	1	214	200
	2	247	135		2	215	175
	3	263	120		3	215	225
	4	263	120		-	-	-
	Avg	**260**	**126**		**Avg**	**215**	**200**
páp	1	253	115	**kʰàp**	1	204	115
	2	249	95		2	203	130
	3	242	95		3	208	115
	Avg	**248**	**102**		**Avg**	**205**	**120**
kák	1	253	100	**ʔàk**	1	205	180
	2	252	130		2	201	205
	3	258	120		3	201	180
	Avg	**254**	**117**		**Avg**	**202**	**188**

Svantesson provides clear examples comparing tonal Hu to registral Lamet, a conservative Palaungic language that preserves pPalaungic vowel length contrast. A small sample of these correspondences is presented in Table 27.

Table 27: *Examples of vowel length desegmentalization in Hu (Svantesson 1991)*

	Hu	**Lamet**			**Hu**	**Lamet**	
***short**	jám	yam^{L}	*to die*	***long**	jàm	jaːm^{L}	*to cry*
	paθán	pʰan^{H}	*five*		lèk	liːk^{L}	*pig*
	méɲ	krmɨɲ^{L}	*star*		ʔɔ̀m	ʔoːm^{H}	*water*
	ncɛ́n	kcɛn^{L}	*heavy*		nasɔ̀k	joːk^{H}	*ear*

Svantesson raises two exceptions to this vowel length > tone correspondence. In syllables ending in *ʔ, vowel length appears to have been neutralized to short at a time predating Hu tonogenesis, as all words with coda glottal stops carry high tone. Words with close vowels are also almost invariably in high tone, which Svantesson similarly explains as the result of a vowel length neutralization to short in historical close vowels. This latter hypothesis is supported by evidence from another Angkuic language, Muak Sa'ak, where we find vowel length neutralization to short among the close vowels (Hall 2010).

One wonders if the length neutralization in close vowels is entirely unrelated to the tonal development here, since close vowels are produced with relatively higher pitch naturally (i.e. higher intrinsic F0 (iF0)). If vowel length contrast had not been neutralized before tonogenesis began in Hu and phonologically long close vowels persisted into the incipiently tonal period, two opposite influences would have been in competition to affect the pitch patterns associated with those long close vowels. Their long duration would have encouraged an F0-lowering effect, but this would have been in conflict with the natural F0-raising effect of their close vowel iF0. It is conceivable that the F0-raising affect could have won out in this scenario, influencing the eventual merger of short, high tone close vowels and long, low (but raised via iF0) tone close vowels.

These issues aside, the role played by historical vowel length contrast in the origin of tonal contrasts in Hu is abundantly clear. A simple, binary, suprasegmental contrast of low and high tone was innovated not under conditioning from voiced and voiceless onsets, respectively, as we would expect from comparable two-term suprasegmental contrasts that straddle the border between register and tone in other Palaungic languages (see Section 4.3.3), but rather under conditioning from long and short vowels, respectively. Further discussion on the phonetic motivations underlying such a process will be offered below in Section 4.5.

2.5.2 Registrogenesis via Vowel Height in Rengao

The North Bahnaric languages of Vietnam's central highlands are predominantly register languages. Smith's (1972) early comparative work on North Bahnaric identified the non-correspondence of North Bahnaric register with historical onset voicing contrasts. In his search for an explanation for this state of affairs, Smith pointed out that register in North Bahnaric does correspond quite regularly with vowel height in the Central Bahnaric language, Bahnar.[37] Smith ultimately dismissed historical vowel height as the conditioning environment underpinning North Bahnaric registrogenesis, as this was an unprecedented sound change process and the conventional wisdom at the time was that register catalyzes vowel height differences, not the other way around.

In the following decade, another example of apparently vowel height-conditioned registrogenesis was produced in the Katuic language Pacoh (Diffloth 1982b). Sidwell (2002b, 2011, 2015b) eventually took up and continued Smith's work on Proto-North Bahnaric (pNorth Bahnaric) reconstruction and produced clear evidence supporting the hypothesis that historical vowel height contrasts were indeed the source of modern North Bahnaric register contrasts.

In this section we will look at the correspondence between register in a North Bahnaric language, Rengao, and vowel height in the non-registral Central Bahnaric language Bahnar. Gregerson's (1976) analysis of Rengao vocalism and the effect of register on each vowel phoneme is presented in Table 28.

Table 28: *Conditioned variation in Rengao vowels in high (red) & low (blue) registers*

/iː/		/uː/	/i/		/u/
[ei] [i̤ː]		[ou] [ṳː]	[ɪ] [i̤]		[ʊ] [ṳ]
/eː/	/aː/	/oː/	/e/	/a/	/o/
[ɛː] [e̤ː]	[aː] [ə̤ː]	[ɔː] [o̤ː]	[ɛ] [e̤]	[a] [ə̤]	[ɔ] [o̤]

Sidwell (2011) reconstructs the vocalism of pNorth Bahnaric as presented in Table 29.

Table 29: *Proto-North Bahnaric vocalism (Sidwell 2011)*

ia		ua			
iː		uː	i		u
eː		oː	e	ə	o
ɛː	aː	ɔː	ɛ	a	ɔ

pNorth Bahnaric vowel quality contrasts have been transphonologized into register contrasts along the same general pattern from language to language across North Bahnaric with only minor differences in the details. As Sidwell (2015b) discusses, historically open vowels are the source of high register vowels in the modern languages and

[37] Smith actually considered Bahnar to be a North Bahnaric language at the time, but today it is recognized as Central Bahnaric (Sidwell 2009, 2021).

historically close vowels are the source of the low register vowels. The diphthongs *ia and *ua followed the open vowels, conditioning high register. The mid vowels, as they are currently reconstructed, were unexpectedly variable when it comes to register assignment. Sidwell's pNorth Bahnaric *e: and *ə are associated with low register while his pNorth Bahnaric *o: is associated with high register.

Table 30 presents examples of cognate etyma between Rengao and Bahnar. Because Bahnar retains conservative reflexes of most Proto-Bahnaric (pBahnaric) vowels, a comparison of Bahnar and Rengao reveals that the origins of certain Rengao register vowel pairs are found in historical vowel quality contrasts. pBahnaric open vowels *ɛ:, *ɔ, *ɔ: and *a have raised while maintaining their association with high register to become high register counterparts to pBahnaric non-open vowels *i:, *u, *u: and *ə, respectively, before certain coda consonants.

Table 30: *Evidence for the origin of Rengao register contrasts in historical vowel height contrasts*

Bahnar		**Rengao**		**Bahnar**		**Rengao**	
pBahnaric *ɛ:-				**pBahnaric *i:-**			
babɛ:	*goat*	babi:^{H}	*goat*	bri:	*woods*	bri:^{L}	*wild (forest)*
r̥ɛ:	*rattan*	ri:^{H}	*rattan*	ɟri:	*banyan tree*	ɟri:^{L}	*banyan tree*
kanɛ:	*rat*	kani:^{H}	*rat*	si:	*louse*	ci:^{L}	*louse*
ʔakɛ:	*horn*	ki:^{H}	*antlers*	ti:	*hand*	ti:^{L}	*hand*
pBahnaric *ɔh				**pBahnaric *uh**			
dasɔh	*lungs*	katsuh^{H}	*lungs*	kuh	*salute*	kuh^{L}	*worship*
ɟɔh	*peck*	ɟuh^{H}	*peck*	muh	*nose*	muh^{L}	*nose*
kaɗɔh	*bark (tree)*	kaduh^{H}	*rind*	truh	*arrive*	truh^{L}	*arrive*
kasɔh	*spit*	cuh^{H}	*to spit*	ʔadruh	*girl*	hadruh^{L}	*girl*
sɔh	*light a fire*	cuh^{H}	*kindle*	danuh	*poor*	danuh^{L}	*poor*
pBahnaric *ɔ:ŋ				**pBahnaric *u:ŋ**			
ʔɔ:ŋ	*bee*	ʔo:ŋ^{H}	*wasp*	tu:ŋ	*carry on shoulder*	to:ŋ^{L}	*carry*
ˀlɔ:ŋ	*tree*	lo:ŋ^{H}	*wood*	ku:ŋ	*ladder*	go:ŋ^{L}	*stairs*
bɔ:ŋ	*casket*	bo:ŋ^{H}	*coffin*	su:ŋ	*axe*	co:ŋ^{L}	*axe*
gɔ:ŋ	*beat gong*	go:ŋ^{H}	*gong*	ˀju:ŋ	*stand up*	jo:ŋ^{L} dəŋ^{L}	*sit up*
pBahnaric *a				**pBahnaric *ə**			
nam	*go*	nam^{H}	*go*	kaˀnəm	*under*	kaˀnam^{L}	*under*
paɗam	*five*	padam^{H}	*five*	hatəp	*dig hole*	tanap^{L}	*bury*
kap	*bite*	kap^{H} bər^{L}	*shut mouth*	ləp	*flood*	klap^{L}	*cover*
ʔakan	*woman*	kan^{H}	*female*	bət	*make a dam*	bat^{L}	*dam*
panar	*wing*	manar^{H}	*wing*	kət	*to tie animals*	kat^{L}	*tie up*
mat	*eye*	mat^{H}	*eye*	ʔət	*hold breath*	ʔat^{L}	*stop breathing*
ɟraŋ	*house post*	ɟraŋ^{H}	*post*	glək	*drown*	glak^{L}	*drown*
maŋ	*night*	maŋ^{H}	*night*	katəŋ	*hear*	taŋ^{L}	*hear*
praŋ	*clear sky*	praŋ^{H}	*end of rain*	məŋ	*listen*	tamaŋ^{L}	*listen*
taŋ	*bitter*	tsaŋ^{H}	*bitter*	parəŋ	*strive to do*	raŋ^{L}	*hold*
taɓaŋ	*bamboo shoots*	tabaŋ^{H}	*sprout*	tadəŋ	*warp*	daŋ^{L}	*approximately*

Comparable examples of this kind of register formation may be drawn from all registral North Bahnaric languages (see further discussion in Section 4.4.2), but the examples from Rengao in Table 25 suffice to introduce this particular register formation process. In short, high and low registers were innovated in Rengao not via the transphonologization of voiceless and voiced onsets as expected, but via the transphonologization of historical vowel height contrasts.

2.5.3 Tonogenesis via Vowel Length and Coda Phonation in Muak Sa'ak

Muak Sa'ak is a sister language to Hu in the Angkuic sub-branch of Palaungic (see Hu discussion above in Section 2.5.1). Hu has only two tones, but Muak Sa'ak has an inventory of three phonemic tones: a low tone /1/, a checked tone /2/ with two allotones ([highˀ] and [fallingˀ]) and a falling tone /3/ (Hall 2010). As the [fallingˀ] allotone of tone /2/ is associated with loan words exclusively, we need only concern ourselves with the [highˀ] allotone here.

Unlike Hu, Muak Sa'ak tonogenesis was conditioned by both vowel length and coda phonation. Also unlike Hu, vowel length contrast has not been neutralized and reanalyzed as a phonological cue to tonal contrast in Muak Sa'ak. Hall shows that the falling tone is associated with sonorant-final syllables and that, in this environment, vowel length does not affect tone assignment. This is demonstrated by comparing Hall's (2010) Muak Sa'ak data with Sidwell's (2015c) Proto-Palaungic (pPalaungic) reconstruction (see Table 31). This data reveals that Muak Sa'ak has falling tone /3/ on sonorant-final syllables irrespective of historical vowel length.

Table 31: *Muak Sa'ak falling tone in sonorant-final words irrespective of vowel length*

	Muak Sa'ak	**pPalaungic**			**Muak Sa'ak**	**pPalaungic**	
***long**	jaːm^{3}	*jaːm	*to weep*	***short**	jam^{3}	*jam	*to die*
	kaːŋ^{3}	*gaːŋ	*house*		rim^{3}	*rim	*village*
	tian^{3}	*ɗiəm	*low*		pil^{3}	*ɓiːl	*forget*
	kʰuan^{3}	*kɔːn	*child*		laŋ^{3}	*laŋ	*black*
	maːl^{3}	*ˀmaːr	*swidden field*		k.tɤl^{3}	*kəɗəl	*belly*
	ŋaːj^{3}	*ˀŋaːj	*eye*		k.tʰuŋ^{3}	*cətuŋ	*drum*

In words with non-sonorant codas, long vowels are associated with low tone /1/ and short vowels with the high checked tone /2/. We see this clearly in words with oral stop codas, as in Table 32.

Table 32: *Muak Sa'ak tone in oral stop-final words is sensitive to historical vowel length*

	Muak Sa'ak	**pPalaungic**			**Muak Sa'ak**	**pPalaungic**	
***long**	tʰaːk^{1}	*-taːk	*tongue*	***short**	kak^{2}	*gak	*to bite*
	kʰaːp^{1}	*kaːp	*chin*		cʰak^{2}	*ɟak	*seed*
	leːk^{1}	*-leːk	*pig*		kʰap^{2}	*kap	*enough*
	ʔuat^{1}	*ʔɔːt	*wipe*		kɔp^{2}	*kɔp	*to cover*
	p.saːc^{1}	*-saːc	*sand*		pɛk^{2}	*ɓəc	*to spit*
	ʔaːp^{1}	*haːp	*to yawn*		t.wɤc^{2}	*ʋəc	*to harvest*

It appears that vowel length contrast was neutralized to long in words ending in voiceless fricatives *h or *s before tonogenesis began in Muak Sa'ak, as evidenced by the fact that reflexes of such words are found with low tone /1/ today. Note that the segmental codas have since been deleted, resulting in open syllables and the loss of vowel length contrast in these words (see Table 33).

Table 33: *Muak Sa'ak tone in voiceless fricative-final words are not sensitive to historical vowel length*

	Muak Sa'ak	**pPalaungic**			**Muak Sa'ak**	**pPalaungic**	
***long**	tʰiː^{1}	*tiːs	*mushroom*	***short**	pʰeː^{1}	*pɛh	*to pick, gather*
	kʰreːj^{1}	*kreːs	*bear*		waː^{1}	*ʋah	*wide*
	k.jeː^{1}	*riɛs	*root*		raj^{1}	*ras	*to choose*
	cʰeː^{1}	*ɟiɛs	*to tear*		cʰeː^{1}	*kətas	*charcoal*

Vowel length also seems to have been neutralized in words with glottal stop codas in a period pre-dating Muak Sa'ak tonogenesis. In this case, modern reflexes of *ʔ-final words are found in the checked tone /2/ today, the same tone that is associated with short vowels in oral-stop final syllables. This indicates that vowel length was neutralized to short before *ʔ in Muak Sa'ak (cf. parallel development in Hu, described above in Section 2.5.1).

Table 34: *Muak Sa'ak tone in glottal stop-final words are not sensitive to historical vowel length*

	Muak Sa'ak	**pPalaungic**			**Muak Sa'ak**	**pPalaungic**	
***long**	cʰɔ^{2}	*cɔːʔ	*dog*	***short**	kʰa^{2}	*kaʔ	*fish*
	tʰi^{2}	*tiːʔ	*hand, arm*		pri^{2}	*breʔ	*maggot*
	s.mo^{2}	*cəmoːʔ	*stone*		pʰri^{2}	*pliʔ	*fruit*
	t.lu^{2}	*bluːʔ	*thigh*		t.pra^{2}	*-raʔ	*steal*

Muak Sa'ak tonogenesis is summarized in Table 35. If we compare this tone box to the tone box for Haudricourtian tonogenesis (cf. Table 15 above), we see that one need only swap out onset voicing in the row headers for vowel length in order to produce a suitable schematic for Muak Sa'ak. The coda phonation categories across the column headers remain the same.

Table 35: *Tonogenesis in Muak Sa'ak*

		A ***sonorant coda***	**B** ***glottalized coda***	**C** ***fricative coda***	**D** ***oral stop coda***
1	***V̆**	V̆N³	V̆²	V:¹	V̆T²
2	***V**:	V:N³			V:T¹

Note that, according to the pattern of development presented in Table 35, tone does not appear to actually be contrastive in Muak Sa'ak. All three tones appear to be in complementary distribution, given that pPalaungic vowel length contrast is retained in Muak Sa'ak. However, as Hall (2010) points out throughout her thesis, Muak Sa'ak is replete with loan words from tonal Tai languages, primarily Shan and Tai Lue, which have served to fill in many of the gaps implied by the tone box in Table 35.

2.5.4 Registrogenesis via Vowel Height and Onset Phonation in Kriang

We have already seen examples above of languages which developed register either via the reanalysis of onset voicing contrasts (i.e. Khmer and Suay, cf. Section 2.4.2.2) or under conditioning from historical vowel height contrasts (i.e. Rengao, cf. Section 2.5.2). In this section, we will introduce Kriang (< Katuic < Austroasiatic), a language with a pattern of register that was sensitive to both of these conditioning environments.

Table 36 presents Gehrmann's (2017) analysis of the vocalic inventory of Tha Taeng dialect of Kriang. Register bifurcates the vowel inventory of this language, but there are three gaps: high register /eᴴ/ and low register /ɛ:ᴸ/ or /ɛᴸ/ do not occur in the data.

Table 36: *Register-conditioned allophonic variation in Kriang Tha Taeng vocalism*

/ia/		/ɨa/		/ua/							
[i̟:ᵃ]	[i̤:ᵃ]	[ɨ̟:ᵃ]	[ɨ̤:ᵃ]	[u̟:ᵃ]	[ṳ:ᵃ]						
/i:/		/ɨ:/		/u:/		/i/		/ɨ/		/u/	
[i̟:]	[i̤:]	[ɨ̟:]	[ɨ̤:]	[u̟:]	[ṳ:]	[i̟]	[i̤]	[ɨ̟]	[ɨ̤]	[u̟]	[ṳ]
/e:/		/ə:/		/o:/		/e/		/ə/		/o/	
[e:]	[ⁱe̤:]	[ɜ:]	[ᶤɜ̤:]	[o:]	[ᵘo̤:]	-	[ⁱe̤]	[ɜ]	[ᶤɜ̤]	[o]	[ᵘo̤]
/ɛ:/		/a:/		/ɔ:/		/ɛ/		/a/		/ɔ/	
[ɛ:]	-	[a:]	[ᶤa̤:]	[ɔ:]	[ᵘɔ̤:]	[ɛ]	-	[a]	[ᶤa̤]	[ɔ]	[ᵘɔ̤]

At first glance, Kriang register would appear to have developed largely as expected in terms of the Khmer model. Voiced stops conditioned the low register and voiceless stops conditioned the high register. As for other natural classes of onsets, Huffman's model predicts that vowels following any voiceless onsets, i.e. the Proto-Katuic (pKatuic) implosives (*ɓ *ɗ *ʄ), glottals (*h *ʔ) and fricative (*s), will be in high register[38] and vowels following other voiced onsets, i.e. the pKatuic nasals (*m *n *ɲ *ŋ), liquids (*r *l) and semivowel glides (*j *w) will be in low register. In other words, the Khmer model predicts that onsets will be classifiable into just two categories based on shared behavior in conditioning the emergence of register. However, this two-series model is insufficient to describe the distribution of modern Kriang register. Instead, the pKatuic onsets must be divided into three series and the effect of historical

[38] The glottal consonants, which are neither voiced nor voiceless, pattern with the voiceless stops in Khmer and many other register languages. The implosives are partially voiced, but the glottal construction which accompanies them leads them to pattern with the glottal stop rather than the voiced stops for the purposes of register assignment, generally.

vowel height must be taken into account. The first onset series may be called the *low series*, as it invariably conditions low register. The low series includes reflexes of the pKatuic voiced stops *b *d *ɟ *g and two additional palatal consonants, *ʄ *j. The second onset series, the *high series*, always conditions high register and includes reflexes of the pKatuic voiceless stops *p *t *c *k and the fricative *s. The remaining onsets, including the voiced sonorants, implosives and glottal consonants, fall into a *middle series*, which conditions high register for open vowels and low register for non-open vowels. Kriang's atypical pattern of register formation is summarized in Table 37.

Table 37: *Desegmentalization box for Kriang Tha Taeng*

High Series	**p *t *c *k *s*	*High Register*	*High Register*
Middle Series	**m *n *ɲ *ŋ *r *l *w *ɓ *ɗ *ʔ *h*	*Low Register*	*High Register*
Low Series	**b *d *ɟ *g *ʄ *j*	*Low Register*	*Low Register*
		Non-Open Vowels	**Open Vowels**

Examples demonstrating the role of vowel height in conditioning register for words with middle series onsets are presented in Table 38. These examples are all monosyllables, but sesquisyllables follow the same rules with the exception that sonorants in the main syllable onset are permeable to the register conditioning effects of presyllable onsets (e.g. /ŋa:j^{H}/ 'who' < *ŋa:j; /caŋa:j^{L}/ 'far' < *ɟaŋa:j).

Table 38: *Examples of register assignment by vowel height with middle series onsets in Kriang Tha Taeng*

	***Sonorants**		***Glottals**		***Implosives**	
Diphthongs	lɨaj^{L}	*saw*	hual^{L}	*steam*	ɓuac^{L}	*wash face*
	riah^{L}	*root*	ʔual^{L}	*choke*	ɗual^{L}	*carry over shoulder*
Close Vowels	lu:t^{L}	*flood*	hu:l^{L}	*singe*	ɗu:ɲ^{L}	*long time*
	lɨ:ŋ^{L}	*galangal*	hɨ:t^{L}	*tobacco*	ɗu:p^{L}	*below*
	ru:s^{L}	*k.o. forest*	ʔu:s^{L}	*fire*		
	mi:t^{L}	*vulture*	ʔu:t^{L}	*coucal*		
Mid Vowels	lo:s^{L}	*wrong*	ho:r^{L}	*roast*	ɓo:c^{L}	*tapered*
	lə:n^{L}	*swallow*	hə:m^{L}	*bathe*	ɓo:l^{L}	*drunk*
	rət^{L}	*fasten*	ho:t^{L}	*'to blow'*	ɗo:m^{L}	*ripe*
	mo:t^{L}	*enter*			ɗə:ʔ^{L}	*put away*
Open Vowels	lɔ:m^{H}	*liver*	hɔ:ŋ^{H}	*bee*	ɓɔ:^{H}	*rain*
	rɔ:c^{H}	*intestines*	ha:m^{H}	*blood*	ɓa:r^{H}	*two*
	ra:k^{H}	*yellow*	ʔɔ:c^{H}	*thin*	ɗɔ:j^{H}	*little finger*
	ma:n^{H}	*mold, form*	ʔɔ:t^{H}	*scratch*	ɗa:ʔ^{H}	*water*

The pattern of register assignment found in words with middle series onsets indicates that there is a preferred, default register for each vowel height series in Kriang. This resembles the register formation pattern of Rengao, where different vowel height series became associated with high or low register features before vowel shifts triggered the phonemicization of register. In the Kriang case, however, there is no evidence of vowel height differences being reanalyzed as register differences as per the North Bahnaric model. Rather, register contrasts were clearly innovated in Kriang following the *voiced and *voiceless stops (e.g. Kriang /pi:h^{H}/ 'to sweep and /pi:h^{L}/ 'poison' from pKatuic *pɨas and *bi:h, respectively)[39] and vowel height merely complicated the assignment of register following other natural classes of onset.

[39] pKatuic reconstructions are the author's own (Gehrmann 2021b).

2.6 Summary

In this chapter, a broad overview of suprasegmental contrast in MSEA was presented and the pathways by which segmental contrasts are reanalyzed as tones and registers in languages of the region were introduced. While the received models of tonogenesis and registrogenesis accurately describe tone and register origins in many languages, it has been demonstrated here via examples from Hu, Rengao, Muak Sa'ak and Kriang that those models are unable to describe the evolution of tone and register in other MSEA languages.

While it is necessary to recognize the real phonetic and phonological differences between tone languages and register languages *in synchrony* (see discussion Section 2.3.3), it is clear that *diachronic* processes which underlie the classical tonogenesis and registrogenesis are not necessarily different in kind, as they both involve the transfer of segmental complexity to suprasegmental complexity. Furthermore, the segmental > suprasegmental sound change pathways inherent in conventional tonogenesis and registrogenesis (i.e. the transphonologization of onset phonation and coda phonation as suprasegmental phonemes) are not unique or special among the other pathways found in the region. They receive outsized attention because they are more frequently encountered among MSEA languages and because they are characteristic of the phonological histories of some of the region's more widely spoken and well-studied languages.

Given that Haudricourtian tonogenesis and Huffmanian registrogenesis are insufficient to account for the broader array of identified tonogenetic and registrogenetic mechanisms in MSEA, and given that the sound change pathways upon which the models are founded are but two such pathways in a broader ecosystem of sound change processes with tono-/registrogenetic potential, I propose that a resynthesis and an expansion of our classical models is overdue. To that end, the concept of *desegmentalization* is proposed in Chapter 2, which integrates conventional tonogenesis, conventional registrogenesis and other developmental pathways under a common framework.

3 Desegmentalization

In Chapter 2, it was demonstrated, with reference to various modern Austroasiatic languages, how four types of segmental contrast have tono-/registrogenetic potential in languages of the MSEA language contact area: *onset phonation*, *vowel height*, *vowel length* and *coda phonation*. It was further demonstrated how the historical shift of vowel length contrasts and vowel height contrasts to suprasegmental contrasts falls outside the explanatory scope of the received models of tonogenesis and registrogenesis. Another issue is the models' insufficiency to describe any combination of segmental > suprasegmental sound change processes other than the combination of onset phonation + coda phonation (i.e. Haudricourtian tonogenesis).

The purpose of this chapter is to propose a broader framework for the modeling of segmental > suprasegmental sound change in MSEA: *desegmentalization*. In Section 3.1, the conceptual inspiration for desegmentalization is introduced, namely, Dockum's (2019) *desegmental phonology*. Desegmentalization itself is then introduced in Section 3.2, along with examples and discussion on how it relates to broader topics in sound change. Thereafter, new terminological and schematic tools for the crosslinguistic study of desegmental sound change are introduced in Section 3.3, and an elaboration on the standard tone box is proposed in Section 3.4, which is designed to schematize both tonogenesis and registrogenesis right across the language families of MSEA: the *desegmentalization box*.

3.1 Desegmental Phonology

Desegmental phonology is an overarching conceptual framework, designed to cover conventional tonogenesis, conventional registrogenesis, and many other sound change processes which likewise involve the phonemicization of suprasegmental contrasts. This model emphasizes a "diachronic unity" which underlies all such processes. Dockum (2019, 96), who first proposed the concept of desegmental phonology, characterizes this unity as follows:

> *"The diachronic unity of tone and register can be stated simply: both represent a transfer of phonemic complexity from segments onto suprasegments—a rebalancing of functional load. This close kinship highlights the need to recognize them as a meaningful subset of the suprasegmental domain."*

Dockum proposes the term *desegmental phoneme* to cover this "meaningful subset of the suprasegmental domain" in diachronic perspective; in synchrony, desegmental phonemes are simply contrastive tones and registers. Dockum defines the desegmental phoneme as follows:

> *"***Desegmental phoneme***: a lexically contrastive suprasegmental feature that historically derives from a segmental contrast."*

Crucially, as the *de-* prefix (lit. *from*) implies, desegmental phonology is definitionally linked to a change of category. It is designed for the purpose of comparing cognate segmental and suprasegmental contrasts across languages, in order to better model their origins and subsequent evolutionary trajectories. Dockum (2019) proposes the desegmental phoneme as a practical concept for historical tonology in response to a perceived dismissiveness of historical linguists in some corners towards tones as comparable units across languages.

The relationships which may exist between desegmental phonemes across different languages fall into three broad categories: those which are *historically cognate* (i.e. derived from *shared* innovations), those which are *historically analogous* (i.e. derived from non-cognate but *parallel* innovations) and those which are simply unrelated. Historically cognate desegmental phonemes are found in genetically related languages which have retained proto-language desegmental phonemes by mutual inheritance from a common ancestor language (e.g. *Tone A > Language 1 /A/, Language 2 /A/). Historically analogous desegmental phonemes are innovated independently across languages via parallel sound change mechanisms, such that the desegmental phonemes themselves are not historically cognate, but their phonological conditioning environments may be (e.g. *daʔ > Language 1 /da^2/, Language 2 /ta^4/). That being said, for desegmental phonemes to be historically analogous, it is not actually relevant whether the languages in question are genetically related or not; so long as an equivalent desegmental sound change occurs in two or more languages affecting the same segmental source material, the resulting desegmental phonemes are analogous. Unrelated desegmental phonemes are any other desegmental phonemes which do not meet the criteria to be historically cognate or historically analogous.

Whether a given desegmental phoneme is historically cognate or historically analogous across two or more languages, there is potential for a great deal of fluctuation in (1) the phonetic realization of the related desegmental phonemes and in (2) the patterns of merger or split, in which they may or may not take part.[40] These developments appear quite chaotic, to the extent that attempts to model the evolution of tones in terms of identifiably natural sound change patterns have met with surprisingly little success (cf. Campbell 2021 for a recent overview of the situation). It is generally accepted that our understanding of the evolution of tonal contrasts lags far behind our understanding of sound change in segmental phonology. While not being predictable, segmental sound changes tend to proceed along the well-worn developmental pathways that we call natural phonological processes. The discipline of historical and comparative phonology has made great progress in identifying and testing these natural processes to ensure that they are indeed natural (i.e. phonetically motivated and plausible), that they recur frequently in unrelated languages and that they are broadly explanatory. When it comes to tonal evolution, however, it is a fact that linguistics has not yet developed an "equivalent body of received wisdom for sound change" (Dockum 2019, 92) and it is not at all clear at this point that such a body of wisdom will be forthcoming at all.[41]

In order to make progress in this area, Dockum suggests setting aside synchronic tones with their variable phonetic forms and as-yet-unmodeled proclivities for split and merger. Instead, what is needed are (1) an appropriate *object of comparison* for comparative work on tone and (2) the ability to *evaluate specific tone changes* with the goal of discovering their origins. Dockum puts forward a *tonal comparative method* to address these needs, within which the desegmental phoneme is the proposed object of comparison. Dockum's way forward insists upon the comparison of historical tone categories rather than synchronic tones. Consequently, the phonetic properties of the synchronic tones are de-emphasized, and the *historical conditioning environments* that produced those tones are taken as the main point of comparison.[42]

Although natural sound change related to tone remains a relatively underdeveloped line of inquiry in historical phonology, there is reason to be optimistic that progress in this area is possible. While the straightforward comparison of the phonetic properties of synchronic tones in cognate etyma has failed to produce results using the traditional tools of the comparative method, it does not necessarily follow that tone change is random. In all likelihood natural tone change processes will be identifiable in the future, but only when the many complex interactions that influence tone change are better understood and properly modelled. These interactions include issues of linguistic typology at the top level (e.g. word/syllable shape and grammatical profile), the size of the synchronic tone inventory, the phonetic cues associated with the synchronic tone inventory and the various historical conditioning environments which produced the tone inventory. The chief purpose of this thesis is to make a contribution to the latter topic: a better understanding of what kinds of historical conditioning environments tend to produce tone and register in MSEA.

3.2 Desegmentalization

If we adopt the desegmental paradigm and apply it to suprasegmental sound change in MSEA, it becomes possible to construct an overarching umbrella, under which the conventional models of tonogenesis and registrogenesis may be consolidated alongside any number of other desegmental sound change processes. From this perspective, we may deconstruct tonogenesis and registrogenesis as particular packages or combinations of

[40] This is an issue that affects tones more than registers, as register contrasts are prototypically binary, whereas tone inventories are usually larger.
[41] See, however, Yang & Xu (2019) for a summary of promising advances in this area of research.
[42] A slightly different but complementary line of inquiry is pursued by Krekoski (2017), who analyzes emergent contrastive features of tone inventories across the Sinitic languages. He shows convincingly that a simple comparison of the synchronic phonetic cues of tones across these languages can be very misleading, and may lead one to miss the crucial insights gained by controlling for tone category cognacy.

desegmental sound change processes, as demonstrated in Chapter 1. We may also recast what are otherwise conceived of as *unorthodox* or *atypical* examples of tonogenesis or registrogenesis (see Section 2.5) as perfectly conventional examples of segmental > suprasegmental sound change. The only differences between the unorthodox examples and the orthodox ones are (1) the particular desegmental sound changes (or combinations thereof) that are employed, (2) the relative frequency with which they occur across MSEA languages and (3) the profile of the languages in which they occur, which is directly related to how often the phenomena have been reported and studied.

I propose the term *desegmentalization* for the process by which desegmental phonemes emerge out of one or more historically segmental contrasts. While the proposal of new jargon such as this should be considered a measure of last resort, I believe that the introduction of a term for this concept is justified. This term allows us to avoid two unwieldly and unhelpful facets of the terms tonogenesis and registrogenesis: their overspecificity when used in specific reference to the models proposed by Haudricourt and Huffman and their bifurcation of desegmental sound change into two distinct sub-categories, which are much more meaningfully distinct in synchrony than they are in diachrony. It must be stressed, however, that I do not propose desegmentalization as a term which should replace tonogenesis and registrogenesis. Rather, the concept of desegmentalization constitutes a superior node above Haudricourtian tonogenesis and Huffmanian registrogenesis within a broader ecology of sound change typology. Other models may then be situated under the canopy of desegmentalization as siblings to these two received models. Identifying and describing these sub-categories of desegmental sound change is the goal of Chapter 4 in this thesis.

3.2.1 Transphonologizational Desegmentalization

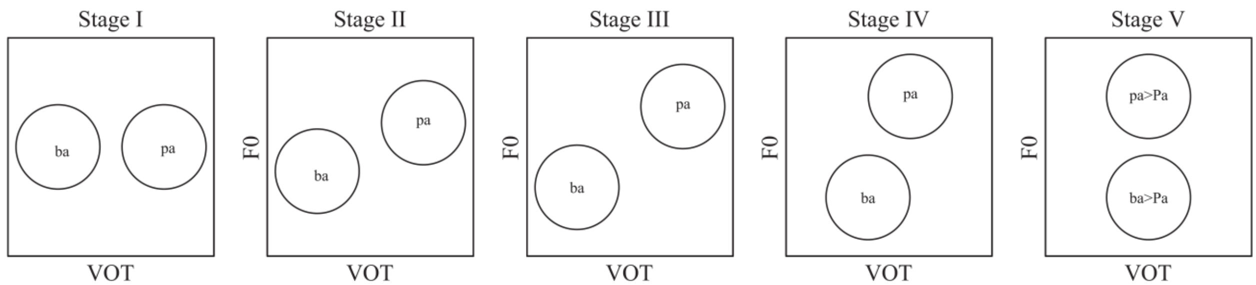
Desegmentalization is often transphonologizational and, indeed, onset voicing desegmentalization is a classic example of transphonologization (Haudricourt 1965, Hagège & Haudricourt 1978, Hyman 1976). We may speak of desegmentalization as being transphonologizational when it involves a simple shift in the cues that uphold a historical contrast. Hyman (1976) proposes a three-stage model for this process as summarized in Figure 2, in which a phonemic contrast is preserved, even as the phonetic cues associated with the contrast are shifted. Figure 2 presents an example, in which segmental onset voicing cues shift to suprasegmental pitch cues. In Stage 1, there is a small phonetic variation in F0 at stop release between voiced and voiceless stop onsets, which is *intrinsic* (i.e. automatic and not speaker-controlled). By Stage 2, the difference in F0 at stop release has increased to the point that it is now exaggerated beyond what could be considered natural phonetic variation conditioned by onset voicing. At this point, F0 has become *phonologized* as one of the *extrinsic* (i.e. non-automatic and speaker-controlled) cues to the language's stop voicing contrast, and it works in tandem with differences in VOT to uphold the contrast. Finally, at Stage 3, the F0 differences are *phonemicized* if the stop VOT cues fade, leaving differing pitch patterns as the only phonetic difference between reflexes of *pa and *ba. In desegmental terms, then, Hyman's example may be summarized as the desegmentalization of onset stop voicing contrast, resulting in two innovative desegmental phonemes and the neutralization of the historically segmental contrast of onset stop voicing. The innovative desegmental phonemes in this example would likely be classified as tones in synchronic phonological terms, given their reliance on pitch cues, through the line between tone and register in this particular scenario is difficult to define (see Section 4.3).

Figure 2: *A model for transphonologization (Hyman 1976)*

Stage 1				Stage 2				Stage 3
intrinsic F0	>	*phonologized*	>	***extrinsic F0***	>	*phonemicized*	>	***phonemic F0***
/pa/ [pa˦]				/pa/ [pa˦]				/pa/ [pa˦]
/ba/ [ba˧]				/ba/ [ba˩˧]				/pa/ [pa˩˧]
VOT contrast				***hybrid***				***F0 contrast***

Kang (2014), drawing on a model of suprasegmental sound change proposed by Maran (1973), provides a useful illustration of the transphonologization of onset voicing contrast as F0 contrast. Kang's visualization of the process is reproduced in Figure 3. The process is stretched out into five stages here. Stage I would be Stage 1 in Hyman's model; a stage at which intrinsic phonetic differences of F0 are small. Kang's Stage II would then fall between Hyman's Stage 1 and Stage 2, with F0 differences beginning to be exaggerated and moving towards phonologization. Thereafter, a cue-redundant, hybrid contrast involving the extrinsic manipulation of both VOT and F0 emerges, as F0 difference is unquestionably phonologized in Stage III (cf. Hyman's Stage 2). The language experiences a reduction in the degree of phonetic VOT difference between /p/ and /b/ at Stage IV, indicating an increasing reliance on F0 in the maintenance of this particular contrast. Finally, VOT difference is eliminated altogether and F0 differences are phonemicized in Stage V (cf. Hyman's Stage 3). This model involves the transphonologization of onset voicing as pitch/tone but the principle is broadly applicable and may be applied in modeling any transphonologizational sound change involving a binary contrast.

Figure 3: *Kang's (2014) five-stage model of transphonologization*



Kang's model is conceptually equivalent to Hyman's, the only difference being the level of granularity inherent in each model; Kang includes two extra stages, which make her model more "comprehensive", in a sense. However, while the visualizations accompanying each of these models in Figures 2 and 3 give the appearance of sound change process with identifiable benchmarks in the form of discrete stages, this is not actually the kind of sound change that is being modeled here, as both Hyman and Kang recognize. Rather, desegmentalization is an example of a regular and continuous phonetic change (i.e. *neogrammarian* change, cf. discussion on phonetic change in *amphichronic phonology* in Bermúdez-Otero (2015)), affecting the phonetic realization of existing contrasts in the language. It is typically possible to discern a clear difference between the start point (segmental contrast) and end point (suprasegmental contrast) of desegmentalization, but while the process is ongoing, it is not possible to draw a clear and meaningful distinction between intrinsic and extrinsic variation, or between phonologization and phonemicization. The phonetic changes are gradual, and the kinds of tests which may be employed to demonstrate the phonologization of a non-phonemic cue (i.e. reliance on said cues for rules in a language's lexical phonology or morphophonology) are almost always lacking in languages of the MSEA type. As a consequence, the labels supplied for the contrasts discussed in work on MSEA phonology, including here in this thesis, are generally applied impressionistically by the researcher; not necessarily out of any biases, implicit or explicit, but out of necessity, given the lack of a clear-cut rubric, by which of the phonological status of a given cue may be determined.

Hyman and Kang both use an example of desegmental transphonologization (onset voicing > pitch) in their models, but transphonologization is not definitionally restricted to segmental > suprasegmental shifts. We may compare Hyman's example to familiar examples from the segmental domain. Germanic *umlaut*, by which non-front vowels were fronted by a vowel harmony process when followed by a front vowel in the following syllable, is a prime example. Subsequent reduction or deletion of the historically front vowel resulted in the loss of the conditioning environment, but the conditioned change in the modified vowel - formerly allophonic and predictable, now phonemic and unpredictable - remained to maintain the contrast. We see this in Old English /muːs/ *mouse* and /myːs/ *mice*. The vocalic contrast between /u/ and /y/ that differentiates this minimal pair is the result of the transphonologization of an earlier contrast involving the presence or absence of a front vowel in a suffix (i.e. Proto-Germanic *muːs *mouse* and *muːs-iz *mouse-PL*). This process may be summarized using Hyman's three-stage model as presented in Figure 4.

Figure 4: *Transphonologization in Germanic* umlaut

Stage 1	Stage 2	Stage 3
intrinsic fronting	***extrinsic fronting***	***phonemic fronting***
/mus/ [mus]	/mus/ [mus]	/mus/ [mus]
/mus-iz/ [muʲsiz]	/mus-iz/ [mysiz]	/mys/ [mys]
suffixal morphology	***hybrid***	***apophonic morphology***

To take a contemporary example from modern English, we may look to the effect of coda consonant voicing on vowel duration. Differences in coda voicing condition allophonic variations of vowel length in English, such that minimal pair /bɛt/ *bet* and /bɛd/ *bed* is realized as something like [bɛt] and [bɛːd], respectively (Chen 1970, Purnell et al. 2005). Consequently, we may situate coda voicing contrast at Hyman's Stage 2 in contemporary English, as it is a hybrid contrast relying on not just coda phonation, but also on vowel length. If we project into a hypothetical future, in which English loses coda voicing contrast as has happened in other Germanic languages, we can imagine a scenario, in which coda voicing contrast in /bɛt/ and /bɛd/ would be transphonologized into vowel length contrasts: /bɛt/ and /bɛːt/, respectively. Figure 5 models this process, including a hypothetical future vowel length contrast for English in Stage 3.

Figure 5: *Potential for the transphonologization of English coda voicing > vowel length*

Historical Stage 1	Contemporary Stage 2	Hypothetical Stage 3
intrinsic duration	***extrinsic duration***	***phonemic duration***
/bɛt/ [bɛt]	/bɛt/ [bɛt]	/bɛt/ [bɛt]
/bɛd/ [bɛˑd]	/bɛd/ [bɛːd]	/bɛːt/ [bɛːt]
VOT contrast	***hybrid***	***duration contrast***

Returning now to desegmentalization in MSEA, three varieties of simple desegmentalization are documented among the Austroasiatic languages (see Section 4.1): onset phonation, vowel height and vowel length. Beginning with the latter, the desegmentalization of vowel length as tone in Hu (see Section 2.5.1) is transphonologizational and, based on the description given by Svantesson (1991), straightforwardly modeled using Hyman's three stages (see Figure 6). However, given the persistent difference of both vowel length and pitch in modern Hu, it would perhaps be more accurate to place Hu vowel length desegmentalization at a stage equivalent to Kang's Stage IV, where differences of the historical duration cue persist, but are in the process of being marginalized (i.e. becoming less reliable) as the innovative pitch cue is emphasized (i.e. becomes more reliable).

Figure 6: *Vowel length desegmentalization in Hu*

Stage 1	Stage 2	Stage 3
intrinsic F0	***extrinsic F0***	***phonemic F0***
/jaːm/ [jaːm˧˨]	/jaːm/ [jaːm˧]	/jàm/ [jam˧]
/jam/ [jam˦]	/jam/ [jam˦]	/jám/ [jam˦]
duration contrast	***hybrid***	***F0 contrast***

The desegmentalization of vowel height, as in Rengao (see Section 2.5.2) could also be modelled using Hyman's three stages, although, at this point, I have not encountered a language which has developed register in this way and then demonstrably restructured that register contrast into something else.[43] Consequently, while it is

[43] One language, Stieng (< Bahnaric), may have restructured a vowel height-conditioned register contrast to a tonal contrast, but the situation in Stieng is complicated by the devoicing of onset stops resulting in what appears to be a double register contrast (see

hypothetically possible that register conditioned by vowel height desegmentalization could lead to a pitch-primary contrast as in Hu (duration > hybrid duration/F0 > F0), for example, we have no actual examples of such a language reaching a third stage (e.g. hypothetically: F1 > hybrid register (F1/F0/voice quality) > F0).

The desegmentalization of onset voicing is more complicated. We have already seen onset voicing desegmentalization modeled in Hyman's and Kang's examples, both resulting in the phonemicization of pitch contrasts, but this is not the only possible outcome. In the introduction to Khmer-model registrogenesis in Section 2.4.2, it was demonstrated how historical onset voicing contrasts may alternatively be transphonologized into vowel quality contrasts. As a concrete example, we may take Middle Khmer *k and *g in *kɔːŋ *bracelet* and *gɔːŋ *gong* and their modern Khmer reflexes of /kɒːŋ/ and /kɔːŋ/, respectively. In this example, onset voicing has been transphonologized into a phonemic F1 contrast rather than an F0 contrast. Once again, we can use Hyman's three-stage model to summarize these developments, as shown in Figure 7.

Figure 7: *Onset voicing desegmentalization in Khmer (oversimplified)*

Stage 1	**Stage 2**	**Stage 3**
intrinsic F1	***extrinsic F1***	***phonemic F1***
/kɔːŋ/ [kᵓɔːŋ]	/kɔːŋ/ [kɒːŋ]	/kɑːŋ/ [kɑːŋ]
/gɔːŋ/ [gɔːŋ]	/gɔːŋ/ [gɔːŋ]	/kɔːŋ/ [kɔːŋ]
VOT contrast	***hybrid***	***F1 contrast***

We can be sure, however, based on the progression of register development documented among contemporary register languages, that Figure 7 oversimplifies the phonetics of this process. If we attempt to reconcile Hyman's model with Huffman's model of registrogenesis (cf. Section 2.4.2.1), Hyman's Stage 2 would align best with Huffman's Stage 3: his *Register* stage. However, whereas Hyman's model involves just two phonetic dimensions - one historical cue and one innovative cue - a register contrast is phonetically multifaceted. In registrogenesis, the historical phonetic cue of onset voicing does not just shift in one dimension; it shifts in multiple dimensions at the same time, being translated into a package of interrelated cues which may include any combination of pitch, vowel quality, voice quality and onset VOT (i.e. the register bundle discussed in Section 2.3.2).

Among these, onset VOT serves as the historical contrast which is gradually marginalized in favor of other cues. The innovative cues include some combination of pitch, voice quality and vowel quality, any of which would be candidates for eventual phonemicization. Figure 8 presents my own recasting of Huffman's (1976) registrogenetic model in transphonologizational terminology, and expands it to more explicitly model the alternative F0 phonemicization outcome.[44] The four primary phonetic dimensions of register are represented here, making this a more complicated visualization than those in the figures above. The historical contrast of VOT is represented as phonemic in Stage 1 "Conservative", with intrinsic variation of the other three cues. Stage 2 "Transitional" continues the phonemic VOT contrast, though sporadic, non-obligatory devoicing of *b will begin to occur during this stage. One or more of the other three cues will have become extrinsic at this point resulting in a hybrid contrast involving both VOT and at least one other cue. At Stage 3 "Register", register has become phonemicized as historical VOT contrast breaks down at the phonetic level, with the result that differences of onset voicing are no longer reliable correlates to the contrast. In the example syllables used in Figure 8, we see that the voicing distinction between reflexes of onset sonorants *ʰm and *m is now lost and reflexes of *b are now mostly, if not fully, phonetically overlapping with reflexes of voiceless *p. One or more of the other three register cues uphold the new register contrast. Finally, at Stage 4, the process completes with either F1 or F0 becoming phonemic and full phonetic merger of the other cues. While there are also what might be called voice quality-primary register languages, which might be described as languages in which a historical register contrast has been transphonologized into a contrast of /voice quality/ without

discussion in Section 4.10). In any case, further investigation of Stieng is needed to clarify the desegmentalization processes that are at play in this language.

[44] In Huffman's (1976) first article presenting his model for registrogenesis, he does not include pitch-primary outcomes, but he does mention them in a subsequent paper on registrogenetic theory (Huffman 1985b).

the other expected register cues (see Section 4.3.1), there are few examples of such languages and the role of voice quality in these languages has not been extensively investigated. For this reason, only F1-primary and F0-primary outcomes are presented for Stage 4 in Figure 8. Nevertheless, the possibility that voice quality-primary outcomes should also be overtly modeled here is acknowledged.

Figure 8: *Huffman's (1976) model of registrogenesis in transphonologizational perspective*

	Stage 1 **"Conservative"**		**Stage 2** **"Transitional"**		**Stage 3** **"Register"**	**Stage 4** **"Restructured"**		
	VOT contrast		***hybrid***		***register contrast***	***F1 contrast***	***or***	***F0 contrast***
	/pa/ /ʰma/ /ba/ /ma/		/pa/ /ʰma/ /ba/ /ma/		/pa^{H}/ /ma^{H}/ /pa^{L}/ /ma^{L}/	/pa/ /ma/ /pɨa/ /mɨa/		/pá/ /má/ /pà/ /mà/
VOT	***phonemic***		***phonemic***		*merged*	*merged*		*merged*
	[pa] [ʰma] **[ba] [ma]**		**[pa] [ʰma]** **[ba]~[pˁa] [ma]**		[pa] [ma] [pˁa]~[pa] [ma]	[pa] [ma] [pɨa] [mɨa]		[pà] [má] [pá] [mà]
Voice Quality	*intrinsic*	- - Any Combination - -	*extrinsic*	- - Any Combination - -	*extrinsic*	*merged*		*merged*
	[pa] [ʰma] [ba] [ma]		[pa] [ʰma] [ba̤] [ma̤]		[pa] [ma] [pa̤] [ma̤]	[pa] [ma] [pɨa] [mɨa]		[pà] [má] [pá] [mà]
F1	*intrinsic*		*extrinsic*		*extrinsic*	***phonemic***		*merged*
	[pa] [ʰma] [ba] [ma]		[pa] [ʰma] [bᵊa] [mᵊa]		[pa] [ma] [pᵊa] [mᵊa]	**[pa] [ma]** **[pɨa] [mɨa]**		[pà] [má] [pá] [mà]
F0	*intrinsic*		*extrinsic*		*extrinsic*	*merged*		***phonemic***
	[pa] [ʰma] [ba] [ma]		[pa˦] [ʰma˦] [ba˩˧] [ma˩˧]		[pa˦] [ma˦] [pa˩˧] [ma˩˧]	[pa] [ma] [pɨa] [mɨa]		**[pà] [má]** **[pá] [mà]**

The progression mapped out in Figure 8 emphasizes the gradual nature of onset voicing desegmentalization through the registrogenetic life cycle. As we trace the organization of the relevant phonetic properties from stage to stage, we find that periods of overlap and cue-redundancy facilitate the transition from an originally segmental VOT contrast, through a hybrid register phase to an ultimate resolution in the innovation of pitch or vowel quality contrasts. Matisoff (1991), inspired by cue-redundant sound change processes in MSEA such as those described above, coined the term *cheshirization*, which evokes images of the vanishing cat from *Alice in Wonderland*. The Cheshire Cat slowly disappears in the story, but leaves behind a grinning mouth that persists for some time after the rest of the cat's body has already gone. Similarly, the phonetic distinctions which upheld an originally segmental contrast may persist for some time after the desegmentalization of that contrast, before ultimately disappearing and, thereby, completing the transphonologization process. We see this exemplified in the persistence of VOT differences up until Stage 4 in Figure 8.

No examples of complex desegmentalization processes, combining more than one type of segmental conditioning environment, have been discussed here. While transphonologization is indeed involved in many of these, the interaction between multiple desegmentalization processes complicates the model significantly, introducing questions about the relative chronology versus simultaneity of the discrete desegmentalization processes involved. These issues are not easily resolved. We will look at each of the sub-types of complex desegmentalization in context in Chapter 4 and discuss issues of modeling complex desegmentalization in Chapter 5.

3.2.2 Non-Transphonologizational Desegmentalization

Desegmentalization is not always transphonologizational, as "phonologization need not imply transphonologization." (Hyman 2013, 9); sometimes, the cat's smile just never leaves. The *de-* in desegmental is not meant in the sense of *undoing, removing,* but rather in its more literal, Latinate sense of *from, off.* We can make an analogy to a denominal verb, the existence of which does not imply erasure of the noun from which it was derived from the lexicon (Dockum, personal communication). Desegmentalization similarly does not necessarily presuppose neutralization of the historical segmental contrast that triggered the process, even if such neutralization is the prototypical outcome.

3.2.2.1 Desegmentalization in Non-Contrastive Environments

First, let us consider what happens when a targeted segmental contrast is neutralized in certain environments. To take a hypothetical example, consider a language with onset voicing contrast. In this language onset voicing is contrastive among the oral stop onsets (i.e. /p/ vs. /b/) but non-contrastive among the sonorant onsets, which are exclusively voiced (i.e. /m/ only). If this language undergoes onset voicing desegmentalization with the result that *pa *ba/ > /pá pà/, how should *ma develop? If the phonologization of tone in this scenario is purely driven by natural phonetic variations, then we can explain the innovated pitch differences with reference to the differential effect that voiceless *p and voiced *b have on F0; but what effect should *m have on F0 in the absence of a voiceless counterpart *^{h}m to react against? We might expect no effect following voiced sonorant *m in this case. Or, we can take a different approach and posit that phonemic /voicing/ has co-opted phonetic [pitch] as an associated correlate, in which case we would expect the pattern of F0 development after *m to follow the pattern after its voiced oral stop counterpart *b (cf. discussion in Hyman 2013, 9-16).

In fact, there is support for both of these outcomes among the MSEA register languages. Here, we will draw examples from among the dialects of the Kuay language (< West Katuic < Katuic < Austroasiatic). In Proto-Katuic, as in the hypothetical scenario above, onset voicing was only contrastive among oral stops. Proto-Katuic did have a full inventory of sonorant onsets, but voicing was non-contrastive among the sonorants; they were all voiced.

In the *Suay* variety of Kuay, onset voicing desegmentalization has taken place in words with historical *voiced and *voiceless oral stop onsets, some examples of which are presented in Table 39. Gehrmann & Kirby (2019) show that differences in stop VOT and vowel height are the reliable correlates of the register contrast in Suay, along with a comparatively smaller difference of voice quality. However, the pattern of register features in words with historical *voiced sonorant onsets does not follow the low register pattern associated with *voiced stop onsets. The clearly extrinsic, low register vowel raising effect found in words with etymologically *voiced stop onsets is not found in words with etymologically *voiced sonorant onsets.[45] Words with sonorant onsets are on average breathier in Suay than words with *voiceless stop onsets, patterning with low register words, but it is unclear whether this rather weak trend rises to the level of extrinsic variation or what degree of salience this variation in voice quality might carry for speakers.[46]

Table 39: *Examples illustrating the desegmentalization of stop onset voicing in Suay*[47]

Proto-Katuic		Suay	Proto-Katuic		Suay
*prɒːk	*squirrel*	/prɔːk^{H}/	*brah	*sky*	/prah^{L}/
*tuɔm	*to wrap*	/tuam^{H}/	*duɔk	*boat*	/tuaʔ^{L}/
*coː	*to return home*	/cuː^{H}/	*ɟriː	*banyan tree*	/craj^{L}/
*kɒːn	*child*	/kɔːn^{H}/	*gɒːŋ	*gong*	/kɔːŋ^{L}/

In Suay, then, we have a clear transphonologization of the historical onset voicing contrast following *voiced and *voiceless stops, which has introduced a register contrast that is upheld by marked differences of vowel height and slight differences of VOT and voice quality. The *voiced sonorants, however, have not patterned with the *voiced stops in conditioning these low register cues. As a result, because words with *voiced sonorant onsets do not condition a low register, the contrastive property of /voice/ has not been generally desegmentalized in Suay. Rather, the environment in which /voice/ has desegmentalized to /register/ is restricted to the environment following *voiced and *voiceless oral stops. Words with any other type of historical onset, including the *voiced sonorants, must consequently be analyzed either as (1) being in the high register because vowel raising is absent or (2) be analyzed as register-less words.

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[45] cf. Table 25 for a summary of the effect of register on vowel height in Suay.

[46] It is unclear in general where to draw a line between intrinsic and extrinsic variation in marginal cases (cf. discussion in Hyman 2013).

[47] Suay data comes from Ferlus (1974b). pKatuic lexical reconstructions are the author’s (Gehrmann 2021b).

In a different Kuay variety, *Kuy*, the desegmentalization of /voice/ to /register/ did extend to words with *sonorant onsets; all words with Proto-Katuic *voiced sonorant and *voiced stop onsets developed low register in the Kuy dialect, as cued by raised vowel height, breathier voice quality and lower pitch (Gehrmann & Kirby 2019). Because Proto-Katuic had no voiceless sonorants, there is no register contrast among native etyma with sonorant onsets. However, a register contrast has been subsequently innovated in this environment with the integration of loan words from local varieties of Khmer and Lao. This is exemplified in the comparison of voiced sonorant-initial words of Katuic origin and Lao origin presented in Table 40.

Table 40: *Examples illustrating the phonologization of register after voiced sonorant onsets in Kuy*[48]

Lao[49]		**Kuy**	**Proto-Katuic**		**Kuy**
/laːn/	*million*	/laːn^H/	*lɒːm	*liver*	/luam^L/
/mɔː/	*shaman*	/mɒː^H/	*mɔːt	*to mold*	/muat^L/
/nat/	*to make an appointment*	/nat^H/	*nak	*person (clf.)*	/naʔ^L/
/haːn/ (< *raːn)	*shop*	/raːn^H/	*raːc	*grasshopper*	/riac^L/

We see that the non-contrastiveness of voice in sonorant onsets in Proto-Katuic was translated into Suay and Kuy's register contrast. Just as voicing contrast was neutralized in this environment in Proto-Katuic, so was the contrast neutralized in this same environment among native Katuic etyma in Suay and Kuy. A more conservative stage is found in Suay, where the register contrast remains neutralized for all words with sonorant onsets and overt low register cues are missing in this environment. Kuy has been more innovative. Voicing was in fact desegmentalized for words with Proto-Katuic voiced sonorant onsets, but this desegmentalization was non-transphonologizational. Register was only phonemicized in words with sonorant onsets following the integration of loan words with sonorant onsets, which came in in high register rather than low.[50] Table 41 summarizes this process with hypothetical syllables, based on the pattern presented for Kuy in Table 40.

Table 41: *Register contrast introduced after sonorants via loans (a historically non-contrastive environment)*

***pa**	>	/pa^H/	/pʰa^L/	<	***ba**
loan	>	/ma^H/	/ma^L/	<	***ma**

Vowel length desegmentalization in Hu also involved an instance of non-transphonologizational desegmentalization related to a non-contrastive environment. It was mentioned in Section 1.8.1 that native Palaungic words with coda glottal stop are universally in high tone in Hu and that this state of affairs is explained by the apparent neutralization of vowel length contrast in words with glottal stop codas in Hu at a stage preceding the desegmentalization of vowel length. The non-contrastiveness of vowel length contrast in this environment was carried over into Hu's tonal contrast, with the effect that all glottal stop-final words in modern Hu are found with high tone. The implication is that vowels preceding *ʔ were more similar in duration to short vowels than long vowels in early Hu.

These examples from Kuay and Hu demonstrate that environmentally specified neutralizations of contrast from the segmental domain are preserved in the suprasegmental domain when a segmental contrast is desegmentalized. We have also seen how phonemic contrast may be subsequently introduced to the historically non-contrastive environments after desegmentalization has occurred if an outside source fills in the gap, as loan words have done in the Kuy dialect of Kuay.

[48] Kuy data comes from Srivises (1978). pKatuic lexical reconstructions are the author's (Gehrmann 2021b).
[49] The proper phonological representation for Lao words should include an indication of tone, however, because Kuy does not borrow tone categories when it borrows from Lao, the Lao tones are excluded here. Also, note the historical shift from *r > /h/ in the word for shop is a regular development in Lao.
[50] High register is the "loan tone category" (see Section 2.4.1.1) for conventional, lax-marked register languages.

3.2.2.2 Desegmentalization without the Loss of Segmental Contrast

In this section, examples of desegmentalization without the loss of segmental contrast will be introduced. In these examples, the historical segmental contrast conditions a change in the distribution of desegmental phonemes, but subsequently fails to neutralize. The transphonologization process is therefore incomplete in these instances.

We begin by returning to the Kuy dialect of Kuay. In this dialect, VOT differences in the reflexes of *voiced and *voiceless stop onsets are quite pronounced. In the high register, there is a contrast between voiceless onsets and voiceless aspirated onsets, the latter of which are present in foreign loan words almost exclusively. In the low register, the aspiration contrast is neutralized and the VOT of voiceless stop onsets in this series is phonetically similar to that of voiceless aspirated onsets in the high register. Table 42 summarizes this state of affairs.

Table 42: *The distribution of onset phonation and register in modern Kuy*

***pa**	>	/pa^{H}/	/p^{h}a^{L}/	<	***ba**
		-	/p^{h}a^{H}/	<	***loans***

Gehrmann & Kirby (2019) found this same significant VOT lag among reflexes of *voiced stops in the Kuy dialect as spoken in Surin province, Thailand. Srivises (1978), furthermore, reports that, in a perception test in which respondents were asked to choose between voiceless or voiceless aspirated graphemes from the Thai orthography to render native Kuy words, respondents chose Thai consonant graphemes representing voiceless aspirated stops for low register words 90% of the time.[51]

From this, we may deduce that the phonetic distance between reflexes of *voiced and *voiceless stops in Kuy is not shrinking as expected. The *voiced stops have devoiced in conjunction with register formation, but are now increasing in VOT lag such that they are approaching merger with the voiceless aspirated stop series rather than the voiceless one (cf. discussion on the aspiration of devoiced stops in Section 2.3.2). As a result, hypothetical historical syllables *pa and *ba have become /pa^{H}/ and /p^{h}a^{L}/ and these syllables, which were formerly differentiated by just one phonemic contrast, VOT, are now doubly differentiated by both register and VOT, differences in the phonetics of the VOT contrast notwithstanding. It is clear that desegmentalization has occurred here (*voicing > /register/) but the transphonologization of the onset voicing is incomplete, as reflexes of *p and *b remain distinct both phonetically and phonemically. And yet, if we turn our attention to a different historical onset phonation contrast in Kuy, the contrast between *voiceless aspirated and *voiced stops, this contrast was desegmentalized in a transphonologizational way. The hypothetical syllables *ba and *p^{h}a have become /p^{h}a^{L}/ /p^{h}a^{H}/, complete with desegmental register contrast and the phonetic coalescence of the onsets. Figure 9 summarizes these developments in Kuy.

Figure 9: *Onset phonation desegmentalization in Kuy is only partly transphonologizational*

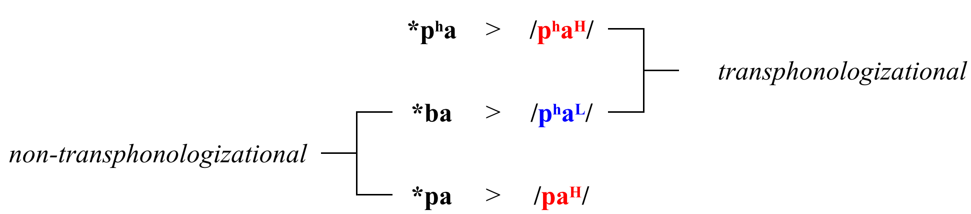


Figure 9 views Kuy onset phonation desegmentalization as a single process, but two separate processes are actually at play here, which must be chronologically ordered. First, *voice was transphonologized as /register/ and then /low register/ conditioned VOT lengthening in stops, such that reflexes of *voiced stops went through the following progression: *ba > /pa^{L}/ [pʿ] > /p^{h}a^{L}/ [p^{h}]. The model of registrogenesis proposed in Figure 8 above predicts

[51] In addition, respondents were also asked to choose stop graphemes for high register words with voiceless stop onsets and high register words with voiceless aspirated stop onsets. In those cases, they chose the appropriate graphemes from the Thai orthography 100% of the time.

that differences of onset voicing between *voiced and *voiceless stops will reduce leading to phonemic merger, but, while this is what most often happens, there is another option. The reflexes of the *voiced stops can merge with the reflexes of the *voiceless aspirated stop series instead with the same effect. In both cases, register is phonemicized and desegmental phoneme complexity is increased as onset contrasts are neutralized and segmental phoneme complexity is decreased.

In summary then, it is somewhat misleading to say that onset phonation has been transphonologized in Kuy without further elaboration. Because Kuy previously had a three-way onset phonation contrasts among its stops, strictly speaking, each of the three phonation types would have needed to condition a separate, unique desegmental phoneme and the historical three-way phonation contrast on the stops would have had to be neutralized in order for that to be accurate (i.e. *p^{h}a *pa *ba > /pa^1 pa^2 pa^3/). This did not happen. Rather, onset voicing desegmentalized first (i.e. *p^{h}a *pa *ba > *p^{h}a^H *pa^L *pa^H) and then a phonetic shift in voiceless stop onsets conditioned by register led to the aspiration of those stops and their merger with the etymological aspirates (i.e. *p^{h}a^H *pa^L > *p^{h}a^H *p^{h}a^L).

A three-way transphonologizational desegmentalization is possible, however. In the Yingla Va language (< Waic < Palaungic < Austroasiatic), a historical three-way onset phonation contrast among nasal stop onsets conditioned the emergence of three desegmental phonemes, which Sun (2018) characterizes as tones. In modern Yingla Va, all three Proto-Waic nasal types (preapsirated, preglottlized and plain voiced) are merged as plain voiced nasals and the three tones remain to carry on the historical contrast, making this an example of a true, three-way, transphonologizational sound change. The three historical phonation types of Proto-Waic oral stop onsets also conditioned the same three tones, but the reduction of contrast among the three oral stop series was not complete. In fact, the pattern of oral stop development is the same in Yingla Va as we saw in Kuy, as the *voiced series has merged with the *voiceless aspirated series to become the modern /voiceless aspirated/ series. Table 43 summarizes the progression from a three-way phonation contrast among oral and nasal stop onsets reconstructed for Proto-Waic to a modern tonal Yingla Va (Sun 2018).

Table 43: *The desegmentalization of onset phonation contrasts as tone in Yingla Va (Sun 2018)*

Proto-Waic			**Yingla Va**		
*T^h	*^{h}N		T^h	N	+ *high tone*
*T	*^{ʔ}N	>	T	N	+ *mid tone*
*D	*N		T^h	N	+ *low tone*

As with the Kuy example, we must resist the urge to conceive of the combination of sound changes in Table 43 as a single process. Certainly, all three Proto-Waic onset phonation contrasts did not desegmentalize simultaneously across the oral and nasal stops; on the contrary, we would expect that desegmentalization would progress in stages, perhaps beginning among the sonorant onsets as has been documented elsewhere (Pittayaporn & Kirby 2016).

We see here two different types of desegmentalization in the same language. The Proto-Waic three-way phonation contrast among the nasal onsets is faithfully preserved in the modern tones and there is no trace of the old contrast in the contemporary phonetic realization of the nasal onsets (i.e. transphonologization). The Proto-Waic oral stop phonation contrasts are likewise faithfully preserved among the tones, but the historical phonemic onset phonation contrasts are not all neutralized. The phonetic distinction between Proto-Waic *T^h and *D is lost, but both remain phonetically distinct from *T. As a result, the historical segmental contrast between *T^h - *T and *D - *T is upheld in the modern language via a redundant combination of onset phonation and tone. Table 44 summarizes the modern output of Proto-Waic onset phonation contrasts in both segmental and desegmental terms in Yingla Va. The two shaded cells are where we find redundancy between the segmental and suprasegmental phoneme inventories.

Table 44: *Onset phonation desegmentalization in Yingla Va: Onsets & Tones*

	*T^h	*T	*D
***T^h**	-		
***T**	/H/ vs. /M/ /T^h/ vs. /T/	-	
***D**	/H/ vs. /L/ /T^h/	/M/ vs. /L/ /T/ vs. /T^h/	-

	*^{h}N	*^{ʔ}N	*N
***^{h}N**	-		
***^{ʔ}N**	/H/ vs. /M/ /N/	-	
***N**	/H/ vs. /L/ /N/	/M/ vs. /L/ /N/	-

This example from Yingla Va demonstrates the role that redundancy may play in desegmentalization. Desegmentalization begins in redundancy, with the innovative phonetic cues which will eventually give rise to new desegmental contrasts being, at first, merely automatic, conditioned variations (Hyman 1976). The segmental cues and the nascent desegmental cues will co-exist in service of the original segmental contrast until such a time as they are made phonologically distinct by a change in phoneme distribution. In Yingla Va, this change comes in the form of the phonetic coalescence of Proto-Waic *^{h}N, *^{ʔ}N and *N, which promotes the previously conditioned tonal variation to unpredictable tonal contrast. Similarly, the loss of phonetic distinction between *T^h and *D results in the undeniable phonemicization of high and low tone. In all of these cases, the former redundancy between segmental phonetic distinctiveness and suprasegmental phonetic distinctiveness has vanished. The mid tone, formerly predictably conditioned by *T and *^{ʔ}N onsets, was phonemicized when *^{ʔ}N merged phonetically with *^{h}N and *N. As a result, words with *T onset became associated with the *mid tone* desegmental phoneme, but the redundancy of onset phonetic distinction and suprasegmental phonetic distinction was not lost, because reflexes of *T remain phonetically distinct from *T^h and *D.

3.2.3 Desegmentalization: Is It Different?

In Section 3.2.2.1, it was shown how desegmentalization of a segmental contrast may occur even in environments where said segmental distinction is non-contrastive and in Section 3.2.2.2, instances of desegmentalization in which transphonologization was incomplete due to the failure of the historical segmental contrast to neutralize were presented. As a result, it is clear that desegmentalization does not necessarily entail transphonologization. What is common to all instances of desegmentalization that we have seen is *phonemicization:* "changes to phonological representations, whether these result in neutralization of contrasts or not." (Barnes 2006: 16).[52] Moreover, what is specific to desegmentalization is the directionality of the changes to phonological representations. These changes flow in just one direction: from segmental to suprasegmental.

Therefore, the following definition of desegmentalization is proposed:

> **Desegmentalization***: a change in the distribution of a language's suprasegmental phonemes, conditioned by a contrastive property in its segmental phonology*

Before moving forward and fleshing out a desegmentalization as a common framework for MSEA tonogenesis and registrogenesis, it is worth asking the question, "why propose a new term for this?" To be clear, there is a hypothesis behind the concept of desegmentalization, which goes back to an old problem: historical bias toward segmental phonology in study of sound change. As Sidwell (personal communication) puts it, "The neogrammarian insights were segmentalist. Once features are de-anchored from segments they are no longer constrained in the way the syllables constrain segments." The hypothesis, then, is that it is possible, perhaps even likely, that we err in expecting sound change that engenders a change of state from segmental contrast to suprasegmental contrast to adhere to the same patterns and rules that govern segmental sound change. The same goes for sound change that occurs purely on the suprasegmental level. The frustratingly slow progress in identifying well-worn sound change pathways in the

[52] Note that Barnes actually calls this *phonologization* in his framework, but it refers to Hyman's *phonemicization*.

area of tone which would match the much more readily-identified segmental sound change pathways sought by the neogrammarians was already discussed in Section 2.1

This mismatch between segmental and suprasegmental sound change in diachrony echoes and amplifies Hyman's view of the singular place occupied by tone in synchronic phonology: "Tone can do everything that segmental and metrical phonology can do, but the reverse is not true." (Hyman 2011, 198) While the ultimate goal of phonological investigation is to unify synchronic phonology and all types of sound change under a common conceptual framework (Kiparsky 2015), the road to this promised land is built out of smaller conceptual experiments, which model different pieces of the greater jigsaw of phonology. There is some justification, then, for proposing desegmentalization as one such piece of that puzzle. Even if desegmentalization ultimately proves to be an artificial, ad-hoc or unnecessary sub-category under the wider umbrella of sound change, in the present, desegmental phonology offers a clear and useful scope, within which a particular line of investigation may be delimited.

Furthermore, the desegmental paradigm allows one to circumvent conventional tone and register terminology in those cases where it is advantageous to do so. This facilitates higher order comparison of tone and register languages and mitigates against any prejudices or imprecisions inherent in the received terminological toolbox. In what remains of this chapter, an expanded terminological and schematic toolbox is proposed for use in the investigation of desegmental phonology and desegmentalization.

3.3 Desegmental Terminology & Schematic Representation

The table of equivalencies presented in Table 45 shows how the desegmental terminology proposed so far relates to the established terminology related to tone and register.

Table 45: *Table of equivalencies for desegmental terminology*

Cover Term for the Phenomena	**Contrastive Units**	**Diachronic Processes**
Tone	Tones / Tonemes	Tonogenesis
Register	Registers	Registrogenesis
Desegmental Phonology	Desegmental Phonemes	Desegmentalization

It must be stressed here again that the desegmental paradigm and its attendant terminology is not intended as a replacement for tone and register terminology. For all its idiosyncratic application in the literature, the vocabulary surrounding tone and register studies is part of a rich tradition that has arisen organically through the efforts of the many linguists over more than a century; it is our heritage. The purpose of the desegmental terminology proposed here is to add new terminological tools to the phonologist's toolkit. These tools are not meant to replace the existing tools, they are meant to augment the toolkit. Desegmental terminology facilitates cross-linguistic and historical phonological discussion on the topic of tone and register origins and provides a means of avoiding the often misleading categorizations implicit in traditional tone and register terminology. It is appropriate to talk of registrogenesis in the history of the Khmer language and of tonogenesis in Vietnamese historical phonology, but if one wishes to compare and contrast the role that onset devoicing has played in both of these languages and in others, neutral terminology allows one to deconstruct the topic in a straightforward way and discuss the relevant issues with greater clarity and precision.

The concept of historical tone categories and their utility for investigating the history of tone language evolution have already been introduced (see Sections 2.4.1 and 3.1). As we have seen, these tone categories represent historical conditioning environments in the segmental domain. Throughout this thesis we will make constant reference to such environments, as we explore those which are prone to desegmentalize. Consequently, it will be beneficial at this point to establish a standard means of referring to them.

An eight-cell matrix for schematizing tonogenesis in MSEA was introduced in Section 2.4.1 and is reproduced here in Table 46. To review, this tone box combines four contrastive patterns of *coda phonation*, which are listed across the top using the capital letters *A*, *B*, *C* and *D*, and two contrastive patterns of *onset voicing*, which are listed down the left side using the numbers *1* and *2*. Conventionally, but not universally, *A* refers to syllables which end in a voiced sonorant sound (this includes open syllables), *B* refers to syllables ending in a glottal stop or glottalized sonorant, *C* refers to syllables ending in a voiceless fricative or voiceless sonorant, and *D* refers to syllables ending in a voiceless oral stop. As for the numbers, *1* refers to voiceless onsets and *2* to voiced onsets.

Table 46: *A conventional, eight-cell tone box*

		A *sonorant coda*	**B** *glottalized coda*	**C** *fricative coda*	**D** *oral stop coda*
1	***vl onset**	A1	B1	C1	D1
2	***vd onset**	A2	B2	C2	D2

A weakness of this model is that the arbitrary use of alphanumeric symbols obscures relevant, established facts about what these historical conditioning environments actually were in the past. Furthermore, the alphanumeric symbols are so abstract that their meaning has not even been fully standardized across the various language families of the region. The B and C categories, which refer to historically glottalized and voiceless codas, respectively outside of Kra-Dai, have their meanings reversed within the Kra-Dai tradition. As a result, the B tones of Middle Chinese, Vietnamese and Hmongic languages correspond confusingly with the C tones of Kra-Dai languages. Numeric symbols may be equally problematic if not worse. The Sinitic tradition has generally been to use only numeric symbols 1-10 to represent historical tone categories with odd numbers representing historically voiceless onset categories and even numbers representing historically voiced ones.[53] Gedney's (1972) tone box schema for representing the relevant historical conditioning environments necessary to describe the historical tonology of modern Tai languages upsets the 1, 2 (voiceless, voiced) paradigm by expanding the two onset categories to four. Gedney's first two rows, which are frequently referred to as *1* and *2* in the Tai literature, correspond to *voiceless frication* (e.g. *ʰm *s) and *voiceless unaspirated* (e.g. *p, *t), respectively, while his additional rows 3 and 4 point to *glottalized* (e.g. *ˀb, *ˀd) and *voiced* (e.g. *b, *d). As a result, sometimes category *A2* refers to historically voiced onsets according to the simpler matrix in Table 46 and sometimes category *A2* refers to historically voiceless unaspirated onsets according to Gedney's matrix (see Table 47 below). Further additions to Gedney's four-row schema have been proposed as well (e.g. Liao (2016)).

Given the terminological confusion that has arisen within MSEA historical tonology, we would do well to step back and propose a family-neutral framework here that may be employed to unambiguously schematize the desegmental phonology of any MSEA language. Throughout the rest of this thesis, we will use curly brackets {} as a standard means of referring to a historical conditioning environment relevant for desegmental phonology. These environments are divided into four broad categories: onset phonation, vowel height, vowel length and coda phonation. Categories associated with the syllable onset have a post-script hyphen ({X-}), categories associated with the syllable coda have a pre-script hyphen ({-X}) and categories related to the vocalic nucleus have no hyphen. The following standard desegmental conditioning environments are frequently encountered:

[53] The extra two tones are added to represent a split in the D tone conditioned by vowel length. Consequently, tones 7-10 in the Sinitic tradition are all D tones.

Onset Phonation

{vl-} *voiceless onsets*
{vd-} *voiced onsets*
{asp-} *aspirated onsets (voiceless aspirated stops, voiceless/aspirated sonorants)*
{glot-} *glottalized onsets (glottal stops, glottalized consonants, implosives)*

Vowel Height

{iɨu} *close vowels*

Vowel Duration

{V:} *long vowels*
{V̆} *short vowels*

Coda Phonation

{-son} *voiced sonorant rimes (open syllables, coda sonorants)*
{-ʔ} *glottalized sonorant rimes (glottal stops, glottalized sonorants)*
{-H} *voiceless sonorant/continuant rimes (glottal fricatives, oral fricatives, voiceless sonorants)*
{-T} *stopped rimes (voiceless oral stops)*

3.4 The Desegmentalization Box

For the purposes of representing desegmentalization graphically and in a standardized way, I propose the *desegmentalization box*. As described above, most graphical representations of tonogenetic developments, including Gedney's (1972) influential tone box for Tai languages, array four coda phonation patterns across the top as column headers, often with an additional split in the {-T} column (Gedney's *D* column) for vowel duration categories. Four onset phonation categories are listed on the left, cross-cutting the four coda phonation columns plus the split in the *D* column for a total of twenty possible cells (4 onset categories x 5 coda/duration categories). A version of Gedney's tone box with both his original labels and with labels in the style of a desegmentalization box (in curly brackets) is presented in Table 47.

Table 47: *Gedney's (1972) tone box with desegmentalization box labels*

		{-son}	**{-H}**	**{-ʔ}**	**{V̆ -T}**	**{V: -T}**
	Gedney	**A**	**B**	**C**	**DS**	**DL**
{asp-}	**1**	*A1*	*B1*	*C1*	*DS1*	*DL1*
{vl-}	**2**	*A2*	*B2*	*C2*	*DS2*	*DL2*
{glot-}	**3**	*A3*	*B3*	*C3*	*DS3*	*DL3*
{vd-}	**4**	*A4*	*B4*	*C4*	*DS4*	*DL4*

The desegmentalization box is similar in concept, but desegmentalized contrasts are oriented to the left, underneath or to the right of the matrix according to where in the phonological word the original contrast was found. Cases of progressive desegmentalization from onset contrasts are listed to the left of the box, cases of nuclear desegmentalization from vocalic contrasts are listed below the box and cases of regressive desegmentalization from coda contrasts are listed to the right of the box. The space above the box is reserved for representing pre-existing suprasegmental contrasts, in cases where it is expedient to show them or where the provenance of those contrasts is unknown.

By way of illustration, Table 48 presents Gedney's tone box converted into a desegmentalization box.

Table 48: *Gedney's tone box re-interpreted in the style of a desegmentalization box*

Desegmental Terminology

{asp-}	-	*{asp- -son}*	**{-son}**
{vl-}	-	*{vl- -son}*	
{glot-}	-	*{glot- -son}*	
{vd-}	-	*{vd- -son}*	
{asp-}	-	*{asp- -ʔ}*	**{-ʔ}**
{vl-}	-	*{vl- -ʔ}*	
{glot-}	-	*{glot- -ʔ}*	
{vd-}	-	*{vd- -ʔ}*	
{asp-}	-	*{asp- -H}*	**{-H}**
{vl-}	-	*{vl- -H}*	
{glot-}	-	*{glot- -H}*	
{vd-}	-	*{vd- -H}*	
{asp-}	*{asp- V̌ -T}*	*{asp- V: -T}*	**{-T}**
{vl-}	*{vl- V̌ -T}*	*{vl- V: -T}*	
{glot-}	*{glot- V̌ -T}*	*{glot- V: -T}*	
{vd-}	*{vd- V̌ -T}*	*{vd- V: -T}*	
	{V̌}	**{V:}**	

Gedney's Terminology

1	-	*A1*	**A**
2	-	*A2*	
3	-	*A3*	
4	-	*A4*	
1	-	*C1*	**C**
2	-	*C2*	
3	-	*C3*	
4	-	*C4*	
1	-	*B1*	**B**
2	-	*B2*	
3	-	*B3*	
4	-	*B4*	
1	*DS1*	*DL1*	**D**
2	*DS2*	*DL2*	
3	*DS3*	*DL3*	
4	*DS4*	*DL4*	
	{V̌}	**{V:}**	

As an additional example, a particularly complex desegmentalization box for the U language (< Angkuic < Palaungic < Austroasiatic) of China as described by Svantesson (1988) is presented in Table 49. The four contrastive tones of modern U, high /H/, low /L/, rising /R/ and falling /F/, were developed through multiple, overlapping waves of desegmentalization involving earlier contrasts of onset voicing, vowel duration and coda phonation (discussed further in Section 4.11).

Table 49: *Desegmentalization box for U*

{vl-}	L	F	**{-son}**
{vd-}		H	
	H	L	**{-ʔ}**
		R	**{-T}**
	{V̌}	**{V:}**	

3.5 Summary

The goal of this thesis is to bring the disparate tonogenetic and registrogenetic pathways found among languages of MSEA under the umbrella of desegmentalization. This, in turn, presents a more cohesive and broadly explanatory model for use in the historical phonological investigation of tones and registers here and, perhaps, elsewhere in the world. To that end, here in Chapter 3, we introduced Dockum's (2019) conception of desegmental phonology and began the process of expanding it into a general model for segmental > suprasegmental sound change in MSEA. In Chapter 4, the desegmentalization framework introduced in this chapter will be applied to languages of the Austroasiatic language family, where each documented desegmentalization pathway will be identified and investigated.

4 A Survey of Desegmentalization in Austroasiatic

In Chapter 3, desegmentalization was proposed as a superordinate framework for segmental > suprasegmental sound change in MSEA, under which conventional tonogenesis and registrogenesis represent constituent subcategories. In desegmental perspective, Haudricourtian tonogenesis and Huffmanian registrogenesis are only two of many possible desegmentalization models, each of which may be distinguished according to the particular combination of desegmental sound change processes employed. By way of example, Huffman's Khmer Model of registrogenesis involves just one desegmentalization process, onset voicing desegmentalization, and Haudricourt's Vietnamese Model of tonogenesis combines two processes, onset voicing desegmentalization and coda phonation desegmentalization.

In this chapter, a general survey of desegmentalization in the Austroasiatic language family is presented, in which many additional desegmentalization models are identified. Austroasiatic is a useful laboratory for such an investigation because the segmental origins of desegmental phonemes in this family are generally much easier to demonstrate than those of other MSEA language families. This is due to a number of factors, including the often shallower time depth of the desegmentalization events, the useful witness of conservative (i.e. non-tonal / non-registral) Austroasiatic languages and epigraphic evidence from earlier, pre-registral stages of Mon and Khmer.[54] It is by no means a new idea to probe the historical phonology of Austroasiatic languages for this kind of evidence. Indeed, it was Haudricourt's discovery that Vietnamese tonal contrasts correspond to segmental contrasts in other Austroasiatic languages which led him to his tonogenetic insights a full seven decades ago. Nevertheless, as will be demonstrated below, there is still much more to learn from a careful study of desegmental phonology across this language family.

The focus of Chapter 4 is to categorize and demonstrate the attested desegmentalization models of Austroasiatic. In Chapter 5, we will return to the project's research questions and discuss the implications of what is presented here in this chapter.

4.1 Desegmentalization Processes and Desegmentalization Models

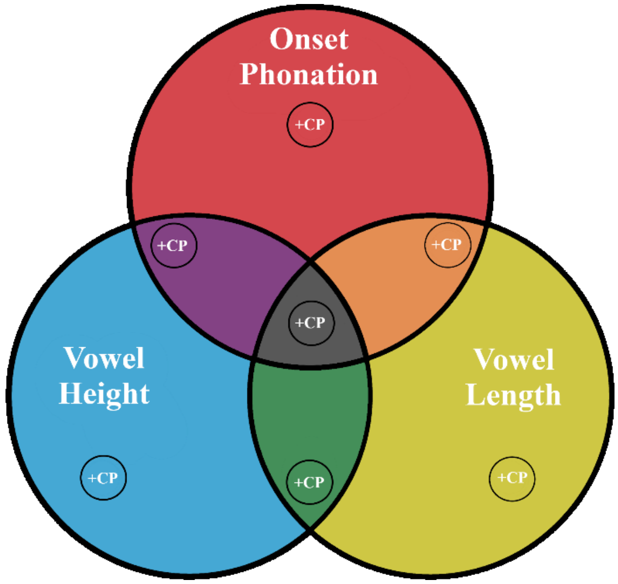
Based on the results of the Austroasiatic desegmentalization survey presented below, there are just four fundamental *desegmentalization processes* which produce desegmental phonology in this language family: *onset phonation desegmentalization (OP)*, *vowel height desegmentalization (VH), vowel length desegmentalization (VL)* and *coda phonation desegmentalization (CP)*. Three of these, OP, VH and VL, may be considered *primary desegmentalization processes*, as there are documented cases where each of these three have occurred on their own in a language. Some examples of primary desegmentalization processes occurring in isolation have already been presented above, including OP in Khmer and Kuay (cf. Sections 2.4.2 & 3.2), VH in Rengao (cf. Section 2.5.2) and VL in Hu (cf. Section 2.5.1). The survey results suggest that the fourth desegmentalization process, CP, may be considered a *secondary desegmentalization process* because, unlike the three primary processes, we have no examples of CP occurring on its own in a language. In other words, no precedent was discovered among the Austroasiatic languages for CP occurring unaccompanied by one of the primary desegmentalization processes. This is a somewhat surprising result, given that it is generally held that CP preceded OP in languages of the Sinospheric Tonbund (i.e. OP split the original tones that had already emerged via CP). This issue and is discussed further in Section 5.2.3 below.

Different formal combinations of desegmentalization processes produce different typological outputs. Before the various models identified in this survey are introduced, an orientation to the various possible combinations of desegmentalization processes is in order. In Figure 10, we present the three primary desegmentalization processes as three large, primary-colored circles. Each of the primary processes may combine with the one secondary process, CP, as represented by the smaller circles labeled +CP. The primary processes may also combine with each other in a language (cf. OP + VH in Kriang, which was introduced above in Section 1.8.4). These are represented by the areas of overlap between the primary-colored circles. Three separate combinations of two primary desegmentalization processes are hypothetically possible, as is the combination of all three. In addition, any combination of the primary

[54] Indic scripts were adapted for Mon and Khmer in the first millennium of the Common Era.

desegmentalization processes could in theory be combined with CP, as represented by the +CP circles in the overlapping areas.

Figure 10: *The desegmentalization diagram*



Thus, the total number of hypothetically possible desegmentalization process combinations is fourteen, but not all of the possible combinations are actually attested in the Austroasiatic survey. Four of the possible combinations were not found. Table 50 offers a text-based presentation of the possible combinations and indicates whether or not they are attested in Austroasiatic.

Table 50: *Summary of desegmentalization process combinations, both attested and unattested*

Simple Desegmentalization Models	**OP**	*Attested*	**Simple Desegmentalization Models with CP**	**OP + CP**	*Attested*
	VH	*Attested*		**VH + CP**	*Attested*
	VL	*Attested*		**VL + CP**	*Attested*
Complex Desegmentalization Models	**OP + VH**	*Attested*	**Complex Desegmentalization Models with CP**	**OP + VH + CP**	*Attested*
	OP + VL	*Unattested*		**OP + VL + CP**	*Attested*
	VH + VL	*Unattested*		**VH + VL + CP**	*Attested*
	OP + VH + VL	*Unattested*		**OP + VH + VL + CP**	*Unattested*

Each combination of desegmentalization processes generates a *desegmentalization model*. Because it is unwieldy to refer to each model with reference to its constituent desegmentalization processes only, each desegmentalization model has been given an informal name for ease of reference. To name them, we have extended the convention of referring to Huffman's model of registrogenesis as the *Khmer Model* and chosen an exemplar language to name each model. Following an introduction to Proto-Austroasiatic phonology, the remainder of this chapter will be organized around introducing and describing each of the ten desegmentalization models, which are summarized in Table 51.

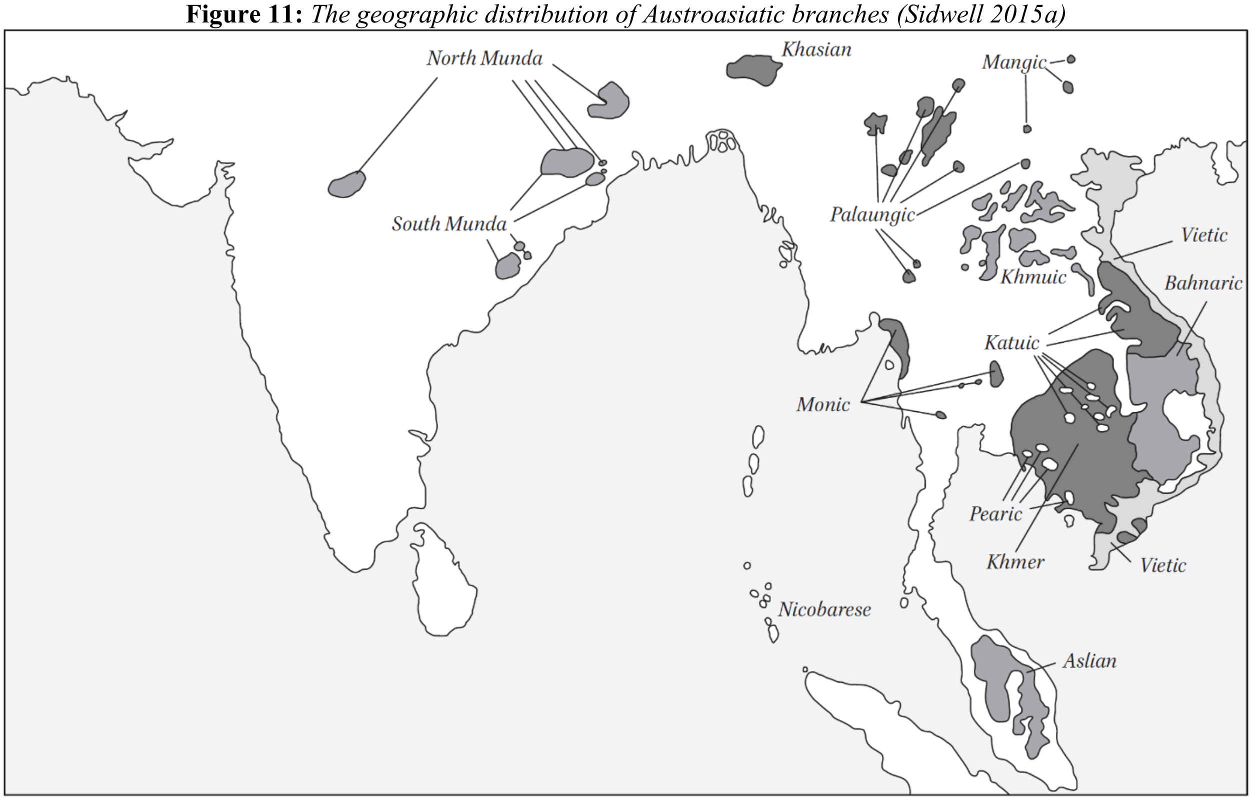
Table 51: *Summary of attested desegmentalization models in Austroasiatic*[55]

Simple Desegmentalization Models	*OP*	**Khmer Model**
	VH	**Rengao Model**
	VL	**Hu Model**
Simple Desegmentalization Models + CP	*OP + CP*	**Vietnamese Model**
	VH + CP	**Jeh Model**
	VL + CP	**Muak Sa'ak Model**
Complex Desegmentalization Models	*OP + VH*	**Kriang Model**
Complex Desegmentalization Models + CP	*OP + VH + CP*	**Chong Model**
	OP + VL + CP	**U Model**
	VH + VL + CP	**Todrah Model**

4.2 Proto-Austroasiatic

The Austroasiatic language family is one of the primary language families of MSEA. Austroasiatic languages are spoken across MSEA and into South Asia and China (see the map in Figure 11).

Figure 11: *The geographic distribution of Austroasiatic branches (Sidwell 2015a)*

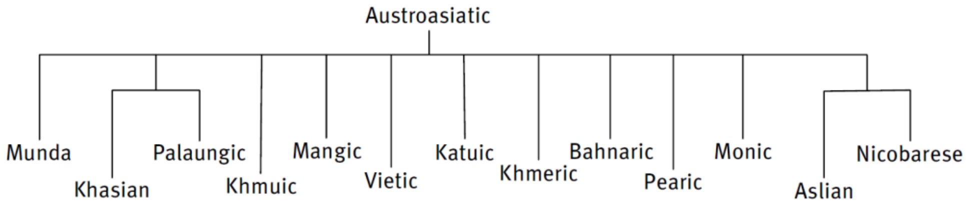


The enumeration of the Austroasiatic branches is nearly settled. Thirteen or fourteen branches are widely recognized, depending on whether one coordinates Mang and the Pakanic languages under one Mangic branch or not (Peiros 2004, Jenny & Sidwell 2015). In the past, it was proposed that Austroasiatic be split into two primary branches, one containing the typologically Indospheric Munda languages spoken in India and Bangladesh and one containing the rest of the branches (Pinnow 1963). This latter branch was referred to as Mon-Khmer, a term which has become virtually synonymous with Austroasiatic today, as this binary split in the family has fallen out of favor. Sidwell (2009, 2015a, 2021) has produced a number of useful summaries of Austroasiatic classification and the classification scheme

[55] See Table 106 below for a list of languages that exemplify each of these models and relevant references

presented in Figure 12 is his. There is evidence to suggest a relationship between Khasian and Palaungic and between Aslian and Nicobarese, but no other proposed nesting relationships are well-supported. As a result, Sidwell proposes a rake-like structure for the Austroasiatic branches.[56]

Figure 12: *Austroasiatic classification (Sidwell 2015a)*



In this section, a brief overview of our current understanding of the Proto-Austroasiatic phoneme inventory is presented. The reconstruction presented here was developed through the pioneering work of Harry Shorto and through the ongoing work of Paul Sidwell, who is building on the foundation laid by Shorto in his comparative dictionary of Austroasiatic (Shorto 2006, Sidwell & Rau 2015). Branch-level and sub-branch level reconstructions will be referred to as *p* + *branch* throughout (e.g. Proto-Katuic = pKatuic) and Proto-Austroasiatic will be referred to as pAustroasiatic.

Sidwell & Rau (2015) reconstruct the phoneme inventory of pAustroasiatic main syllables as demonstrated in Table 52. pAustroasiatic words were either monosyllables of the shape C(M)V(F) (M = medial sonorant, F = final / coda consonant) or disyllables of the shape P(R)CV(F) (P = presyllable onset, R = presyllable rime of *N, *r *l). Because desegmentalization very rarely involves material in the presyllable, we will focus on the main syllable here and throughout this chapter.[57]

Table 52: pAustroasiatic main syllable segmental reconstruction (Sidwell & Rau 2015)

	C					M	V						F				
*	p	t	c	k	ʔ								p	t	c	k	ʔ
	b	d	ɟ	g													
	ɓ	ɗ	(ʄ)				iə		uə								
	m	n	ɲ	ŋ			(ie)		(uo)				m	n	ɲ	ŋ	
	w	l	j			l	iː		uː	i		u	w	l	j		
		r				r	eː	əː	oː	e	ə	o		r			
		s			h	h	ɛː	aː	ɔː	ɛ	a	ɔ		s			h

While pAustroasiatic is currently reconstructed without desegmental phonology, it cannot be entirely ruled out. One proposal has been put forward for a pAustroasiatic creaky-modal contrast (Diffloth 1989), but the current consensus among concerned scholars is that pAustroasiatic was without tones and registers and that, where desegmentalization did occur in Austroasiatic, it occurred independently in the various branches (Sidwell & Rau 2015, 245-247). Let us begin, then, with a brief overview of the pAustroasiatic contrasts which are relevant to the four desegmentalization processes presented above.

Onset Phonation: The pAustroasiatic onset inventory is divisible into three manner of articulation series: stops, sonorants and fricatives. The sonorants and fricatives are without phonation contrast, as only voiced sonorants and voiceless fricatives are reconstructable. While certain modern Austroasiatic languages exhibit phonation contrasts

[56] Sidwell (2021) reports preliminary findings from computational phylogenetic comparison which differ from the rake-like interpretation and support a more nested interpretation of Austroasaitic classification. As Sidwell states, however, these results remain to be corroborated in terms of historical phonological developments.

[57] In cases of onset phonation desegmentalization, a voiced sonorant in the main syllable onset is typically permeable to the conditioning effect of the presyllable onset (e.g. pKatuic *brrɛːk ‘shoulder pole (for carrying smth)’ > Kriang /prreːk^{L}/, but pKatuic *prnɨas ‘broom’ > Kriang /prniːh^{H}/). Otherwise, it is the voicing specification of the main syllable onset that determines tone or register assignment in onset voicing desegmentalization for both monosyllables and sesquisyllables.

for sonorants and a few proto-branch level reconstructions include such contrasts (i.e. pBahnaric, pPalaungic & pPearic), these are secondary developments arising out of the reduction of sesquisyllabic onsets.

Among oral stop onsets, a three-way phonation contrast of voiceless, voiced and implosive is reconstructable. No velar implosive is indicated and the palatal implosive's reconstructability is in question given that it contrasts with pAustroasiatic *ɟ in the Katuic branch only (Sidwell & Rau 2015, 238). Table 53 gives a simplified account of the evolution of pAustroasiatic stop onset phonation contrasts across the Austroasiatic branches based on Sidwell & Rau (2015, p. 240). We see that the *implosive series was already merged into the *voiced series in pKhmuic, pKhmer, pPearic and pAslian. For those branches in which the contrast between the *implosive and *voiced series is preserved at the proto-branch level, subsequent loss of the contrast has often occurred within the branches. For example, among the modern Bahnaric languages, just one language, Bahnar, retains any trace of the old contrast between *implosives and *voiced stops.

Table 53: *Evolution of pAustroasiatic initial stop phonation contrasts in Austroasiatic branches*

<table>
<tr><th>pAustroasiatic</th><th>pMunda</th><th>pKhasian</th><th>pPalaungic</th><th>pKhmuic</th><th>pVietic</th><th>pKatuic</th><th>pBahnaric</th><th>pKhmer</th><th>pPearic</th><th>pMonic</th><th>pAslian</th><th>pNicobaric</th></tr>
<tr><td>voiceless
*p *t *c *k</td><td>vl</td><td>asp</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl</td><td>vl / fric[58]</td></tr>
<tr><td>voiced
*b *d *ɟ *g</td><td rowspan="2">vd</td><td rowspan="2">vd</td><td>vd</td><td rowspan="2">vd</td><td>vd</td><td>vd</td><td>vd</td><td rowspan="2">vd</td><td rowspan="2">vd</td><td>vd</td><td rowspan="2">vd</td><td>vl</td></tr>
<tr><td>implosive
*ɓ *ɗ (*ʄ)</td><td>imp</td><td>imp</td><td>imp</td><td>imp</td><td>imp</td><td>vl / son[59]</td></tr>
</table>

Vowel Height: pAustroasiatic is reconstructed with a vowel inventory that is typical of most modern Austroasiatic languages in MSEA. The monophthong inventory fits in a three-by-three matrix of three vowel height distinctions and three vowel backness distinctions with a gap at the close central position (see Table 52). One series of diphthongs is reconstructed and a more speculative second series is possible. It is no simple matter to trace vowel developments across the Austroasiatic family. Nevertheless, well-informed reconstructions of vocalisms at the proto-branch level are available now for most branches and those will be more relevant to the discussion of vowel height desegmentalization below than the reconstructed pAustroasiatic vocalism.

Vowel Length: Vowel length contrast is reconstructable in every Austroasiatic branch except for the heavily restructured pMunda (Sidwell & Rau 2015, 312) and vowel length contrast is consequently reconstructable for pAustroasiatic as well.

Coda Phonation: We may group the reconstructed coda consonants of pAustroasiatic into four groups according to phonation type: (1) sonorant {-son} (*m *n *ɲ *ŋ *r *l *w *j), (2) glottalized {-ʔ} (*ʔ), (3) voiceless fricative {-H} (*h *s) and (4) stopped {-T} (*p *t *c *k *s). A noteworthy feature of pAustroasiatic is that it did not permit open syllables; therefore, vowel-final syllables are excluded from the inventory of reconstructable {-son} syllables. This ancient state of affairs is attested in Old Mon inscriptions and is preserved even today in languages from three separate branches of Austroasiatic: Khmuic, Palaungic and Aslian (Sidwell & Rau 2015, 242).

There has been certain amount of reorganization within the inherited {-son} and {-ʔ} coda phonation patterns over time and across modern Austroasiatic languages. The {-ʔ} pattern is represented in pAustroasiatic by the glottal stop coda *ʔ for sure and also possibly by glottalized sonorant codas (Shorto 2006), although the latter remain controversial. The pVietic glottalized sonorant codas on which Shorto based their reconstruction in pAustroasiatic are quite likely a regional development under the influence of Old Chinese, which had a robust contrast of plain and

[58] PAA *p *t *c *k > pNicobaric *f *t *s *k (Sidwell 2018)
[59] PAA *ɓ *ɗ > pNicobaric *p *^{d}r (Sidwell 2018)

glottalized sonorant coda consonants (see Section 5.2.4.3). In any event, the pAustroasiatic glottal stop itself is securely reconstructable and it has developed along three broad patterns among Austroasiatic languages.

Pattern 1 – Retention: pKhmuic, pPalaungic and pAslian retained the glottal stop coda and, therewith, a prohibition against open syllables (at least in native etyma).

Pattern 2 – Deletion: In some languages, pAustroasiatic *ʔ has been generally deleted in coda position. In this way, rimes from the {-ʔ} coda phonation set were transferred to the {-son} set and open syllables were introduced in native Austroasiatic etyma. Rime glottalization has often been reintroduced via secondary developments, such as the debuccalization of velar stop codas.

Pattern 3 – Split: In pVietic, we find a curious reorganization of coda glottalization under conditioning that is not currently understood. pVietic retains pAustroasiatic {-ʔ} in some cases but shows open syllables in others. In addition, pVietic retains pAustroasiatic sonorant codas as such in some cases, but shows a glottalized sonorant coda in others. Ferlus (1998a, 2004) has hypothesized that this reorganization of coda glottalization is due to the confounding influence of sesquisyllable collapse (see discussion in Section 5.2.4.3).

Table 54 demonstrates the evolution of the glottal stop coda (*-ʔ) and sonorant codas (*-N) from pAustroasiatic to the reconstructed proto-branch levels.

Table 54: *Evolution of PAustroasiatic *ʔ and sonorant consonant codas in Austroasiatic branches*[60]

pAustroasiatic	**pPalaungic**	**pKhmuic**	**pMonic**	**pAslian**	**pNicobaric**	**pMunda**	**pKhasian**	**pKhmer**	**pPearic**	**pKatuic**	**pBahnaric**	**pVietic**
***-ʔ**	*-ʔ	*-ʔ	*-ʔ	*-ʔ	*-ø	*-ø	*-ø	*-ø	*-ø	*-ø	*-ø	*-ø
												*-ʔ
***-N**	*-N	*-N	*-N	*-N	*-N	*-N	*-N	*-N	*-N	*-N	*-N	*-N
												*-Nˀ

4.3 The Khmer Model (OP)

Now that pAustroasiatic has been introduced, we turn our attention to the main purpose of this chapter: surveying documented instances of desegmentalization among the Austroasiatic languages. We begin with one of the three simple desegmentalization models (those models that involve just one desegmentalization process).

Much has been said about OP already in Chapters 2 and 3. To review, in Section 2.3.2, the phonetics of the register phenomenon (i.e. the register bundle of cues) was introduced along with a discussion about how the high and low registers are associated with historically voiceless and voiced onsets, respectively. An overview of Huffman's model of registrogenesis was then offered in Section 2.4.2, which periodizes the development of register from OP into four distinct stages. In Section 3.2.2.1, we recast Huffman's model with reference to Hyman's (1976) model of onset voicing transphonologization and expanded its output potentialities to include both innovative vowel quality contrasts, as Huffman's original model had it, and innovative pitch contrasts, as in Hyman's examples. Then, in Section 3.2.2.2, an example of tripartite OP was presented from the Va language, in which three different desegmental phonemes were conditioned by three different contrastive onset phonation types.

[60] pMangic is missing from this table because the historical phonology of this branch remains poorly understood (although, cf. discussion on Bolyu in Section 4.6.1).

In general, OP is understood as having three potential outcomes: register, tone or tone split (Haudricourt 1961, 1965; Matisoff 1973). The latter outcome, tone split, occurs when OP is a part of a more complex desegmentalization model, as in Haudricourtian tonogenesis, but the first two, register and tone, are the possible outcomes of OP in a simple desegmentalization model. In this section, we will explore the different configurations and output typologies documented for languages which have undergone OP only.

4.3.1 Register Restructuring: F1, F0 or Both?

Languages which undergo simple OP enter a register stage which mediates an eventual restructuring of onset phonation contrasts in one of two directions: into innovative vowel quality contrasts or into innovative pitch contrasts / tones (see Figure 8 in Section 3.2.1). Much more infrequently, register languages are encountered in which neither F1 nor F0 are reliable register cues, and voice quality differences are demonstrably primary. This is documented in Wa (< Palaungic) (Diffloth 1980, Watkins 2002) and in a variety of Mon in Thailand (Abramson et al. 2015). According to Huffman's (1976) model and, more recently, Thurgood's (2002, 2007), it would be appropriate to consider these languages relatively conservative register languages, having developed the expected voice quality differences but not having restructured in either of the two typical directions. However, because it has become increasingly clear that a stage marked by extrinsic voice quality differences is not necessarily pre-requisite for desegmental developments (Tạ et al. 2019, Brunelle, Tạ, Kirby & Đinh 2020), it is unclear at this time how voice quality-primary register languages such as these are expected to develop. One reasonable hypothesis is that, over time, phonologized differences of vowel quality or pitch will emerge and overtake voice quality, after which point the prototypical register life cycle will pertain. Another possibility is failed secondary split. If the historical onset voicing contrast conditions register-like allophonic variation, in which voice qualify differences are most prominent, but register ultimately fails to phonemicize, the voice quality differences may simply fade over time. They would constitute the last vestiges of the fading onset voicing contrast, as that contrast gradually neutralizes.

Register languages, voice quality-prominent outliers notwithstanding, ultimately drift in one direction or the other: towards F1-prominence or F0-prominence. There is already a name for the process by which OP evolves to introduce register and then resolves into novel vowel quality contrasts: *the Khmer Model*. However, no name is currently given to the Khmer model's fraternal twin, in which OP evolves into register and then resolves into novel pitch-primary tone contrasts. We will, therefore, propose a name for it here, *the Khmu Variant of the Khmer Model*, in reference to the particularly well-known and well-documented instance of this tone formation process in the northern and western dialects of Khmu (< Khmuic).

It is possible for a language to phonemicize both F1 and F0 contrasts out of one and the same historical register contrast, but this is apparently rare. We see indications of this phenomenon in real time in the Kuy dialect of Kuay, where the register contrast has already conditioned vowel quality splits but register contrast persists, cued most prominently now by F0 differences (Gehrmann & Kirby 2019). We find a mature example of this outside of Austroasiatic in the Hmongic language Zongdi. In this language, vowels in words of tone categories B2 and C2 (i.e. {vd- -ʔ} and {vd- -H}, respectively) have undergone vowel raising, while vowels in words from the A2 and D2 (i.e. {vd- -son} and {vd- -T}, respectively) categories are unchanged (Wang 1994, Wang & Mao 1995, Ratliff 2010). This indicates that a low register vowel raising effect was operative at some point in the past, but it was blocked for some reason in the A and D tone categories. However this state of affairs may have arisen, it is clear is that onset phonation contrast has transphonologized in two different directions at the same time in Zongdi, triggering the phonemicization of novel vowel contrasts and novel tone contrasts. This illustrates clearly that the categorical line drawn here between a Khmer Model of desegmentalization and a Khmu Variant of that model is not inviolable. Nevertheless, in typical cases, we expect that languages will tend to desegmentalize OP in one direction or the other.

4.3.2 The Khmer Model Proper

The Khmer Model has received a lot of attention already above and examples from Khmer and Kuay were already highlighted, so we will not repeat that analysis here. It should be noted that it is not necessarily helpful or even possible to label a language which is currently registral as being either on the Khmer Model Proper trajectory or on the trajectory of the Khmu Variant. During the register stage, F1 and F0 cues are commonly both employed as cues to the register contrast and, in these cases, one cannot predict which will ultimately prevail or, indeed, whether both might survive and thrive as innovative phonemic contrasts. We can only confidently label a language as having followed the Khmer Model Proper when F1 has either demonstrably overtaken the other register cues in both reliability of production and perceptual salience or in post-registral languages like Standard Khmer where the vowel splits are complete and register has faded away. There are few such post-registral languages, but another example of a clearly post-registral Khmer Model language is Lawa (< Palaungic) (Diffloth 1980). In addition, Huffman (1985b) proposed three Katuic languages – Bru, Kriang (Ngeq) and Katang – as "candidates" for inclusion in this category. Having personal experience researching all three of these languages (Gehrmann 2016, 2017, 2019), I concur that certain register-conditioned vowel splits have already been accomplished in Bru and Katang, but not in Kriang. However, even in Bru and Katang, vowel splits are not as thoroughgoing in the vocalisms of these Katuic languages as they are in Khmer and Lawa and categorical differences of voice quality clearly remain. Further investigation into the production and perception of register in these languages would be needed to determine the role F1 is currently playing, but, all things considered, I agree with Huffman's suggestion that they are almost assuredly moving through the Khmer Model Proper.

Finally, a fundamental question related to this Khmer Model OP remains to be addressed here. If the Khmer Model is a formulation describing the transphonologization of onset phonation contrasts, a kind of segmental contrast, into vowel quality contrasts, another variety of segmental contrast, are we really justified in considering this particular sound change model a desegmentalization model? Is this not just an example of segmental > segmental sound change? The answer to this question hinges perhaps on another related question: is an intermediary register phase truly necessary for onset phonation contrast to transphonologize into vowel quality contrast? And this leads to yet another conceptual question: is register really *necessarily* a suprasegmental contrast or could it be construed as a segmental contrast instead, bound perhaps to vowels?

While these are big and difficult questions which cannot be comprehensively resolved here and now, let us explore the issue, taking as an example, recent research on Chru. Chru is a very young register language from the Chamic branch of Austronesian spoken in Vietnam. In this language, differences in F1 are the most reliable correlates of the two registers for most speakers, and there is no support for the hypothesis that these F1 differences were developed through intermediate stages where vowel phonation or "breathy release" of devoiced stops were extrinsic or exceptionally prominent/salient (Brunelle, Tạ, Kirby & Đinh 2020). For many speakers recorded in this study, there is free variation among reflexes the historically voiced stops between conservative allophones that preserve closure voicing and innovative allophones which are phonetically devoiced. The authors found that, "with the notable exception of F1, differences in F0, H1*-H2* and CPP are more pronounced when stops are prevoiced than when they are devoiced. We interpret this as evidence that F1 is the primary, obligatory, property of the register contrast, but that other properties can be enhanced in clear speech contexts, where prevoicing is also most likely to be present." (Brunelle, Tạ, Kirby & Đinh 2020, 17). We may infer from this that at an earlier stage, the low register cues of Chru (raised vowels, lowered pitch and breathier voice quality) became phonologized / extrinsic concomitants of stop closure voicing as in Hyman's Stage 2 (see Table 2), and that F0 and voice quality differences remain somehow *mechanically tied* to stop voicing.[61] Meanwhile, F1 differences appear to have broken off from the pack and ascended to something approaching phonemic status. The fact that the F1-lowering effect persists in the low register whether the stop onset is phonetically prevoiced or devoiced would appear to support this assertion.

We may conceptualize the kinds of register contrast that arise in conjunction with simple OP as existing along a continuum, with register contrasts upheld primarily by prototypically segmental phonetic features such as VOT and vowel height on one end and register contrast associated more with prototypically suprasegmental phonetic features, like pitch and voice quality, on the other. Chru register would be placed near the "segmental" pole on this continuum, as the phonological implementation of pitch and voice quality is marginal in this example in comparison to that of VOT and vowel height. *Nevertheless*, differences of pitch and voice quality are there; they are measurable

[61] Note that "mechanically tied" here is not meant to imply intrinsic microvariation; the degree of variability is too great for that. It is simply used to reflect the fact that pitch lowering and laxer voice quality are more reliably present in words produced with prevoiced onsets than in words with devoiced onsets.

and co-vary in the expected manner with historical onset voicing. This particular pattern in the phonological implementation of these particular features aligns exactly with the prototypical instantiation of register, irrespective of the relative prominence of the constituent cues. If it is taken as a given that register is by definition a suprasegmental contrast (as we do in this thesis), then there can be no doubt that even in this very "segmental" example of Khmer Model registrogenesis in Chru, onset voicing has indeed been desegmentalized as a suprasegmental contrast of register.[62] That this register contrast may be rapidly advancing through the Khmer Model progression towards vowel quality splits (a conjecture at this point, though a well-supported one), is immaterial. In the Khmer Model, onset phonation is first transphonologized into register before vowel quality splits are phonemicized and, therefore, the evolution of historical onset phonation contrasts in the Khmer Model qualifies as OP.

4.3.3 The Khmu Variant of the Khmer Model

F0-prominent outcomes for OP have been referred to repeatedly in this thesis, but no natural language examples have been discussed up to this point. Only a few northern Austroasiatic languages are described as having a two-tone inventory developed via OP, including western dialects of Khmu (Svantesson 1983, 1989; Premsrirat 1999, 2001, 2004; Svantesson & House 2006)[63] and certain varieties of two Palaungic languages: Lamet (Mitani 1965, Conver 1999)[64] and Blang/Bulang/Samtao (Diffloth 1980, Zhou & Yan 1983, Li et al. 1986, Svantesson 1989).[65] It is perhaps relevant that all three of these languages are spoken in relative geographic proximity to one another in the area where Laos, Myanmar and Yunnan come together.

In this section, a brief overview of the situation in western Khmu is described. Premsrirat's (1999, 2001, 2004) cross-dialectal survey of the Khmu language offers a clear example of the evolution of F0-prominent register. Svantesson's earlier introduction to the topic divided Khmu into two categories – tonal and non-tonal – but Premsrirat added a third: registral. Phonetic investigation of tonal varieties (Gandour et al. 1978, Svantesson & House 2006, Abramson et al. 2007) and non-tonal varieties (Kirby 2021) have been undertaken, but the registral varieties referenced by Premsrirat remain to be studied.[66]

Premsrirat (2004) compares seven dialects of Khmu. Three of these are non-tonal eastern Khmu varieties which have not undergone OP. The remaining four are western varieties, all of which have undergone OP with differing results. Two of these western varieties are described as registral and two are described as tonal. In all four of the western varieties the *voiced stops have become voiceless, the *voiceless sonorants have become voiced and their former contrast is now reflected in either register or tone. In three out of four varieties, reflexes of *voiced stops have merged with reflexes of *voiceless stops but in the fourth variety, a tonal one, the devoiced stops have become aspirated and remain distinct from the etymologically voiceless stops.

These seven dialects are interpreted by Premsrirat as reflecting a progression of stages in a simple tonogenetic model involving OP only. According to this model, the two register languages represent a transitional stage between the non-tonal and tonal varieties. This matches well with the general model for OP presented in this thesis (see Figure 8 in Section 2.2.1). The pitch contrasts in the tonal varieties represent formerly registral contrasts, in which F0 became

[62] The question of whether register is definitionally suprasegmental is valid but will not be pursued further here, except to say that there is no doubt that register can be conceptualized as having one foot in both worlds: segmental and suprasegmental. One gets the impression that register is perhaps somehow *less suprasegmental* than tone (see Section 2.3.3), but how to quantify such an assertion is not clear.

[63] Note that Svantesson refers to these "western" Khmu varieties as "northern" in his work.

[64] Although other researchers classify Lamet as a conventional register language and do not analyze pitch as being the primary cue for the contrast (Lindell et al. 1978, Ferlus 1979, Charoenma 1982, Svantesson 1989). Whether this is an issue of dialectal variation or differing analyses among researchers is unclear at this time.

[65] Diffloth (1980) calls it tone but remarks that the low tone is sometimes accompanied by breathy voice. Subsequent studies all indicate that Blang/Bumang/Samtao languages typically have a four-way contrast described as a two-way tone contrast crosscut by a two-way register contrast (Paulsen 1992, Harper 2009). Given the relative scarcity of words in low register, Sidwell (2015c) dismisses the proposed register contrast calling breathiness "a concomitant of low tone" instead. Further study is needed.

[66] It should be noted that "tonal" in this context is indistinguishable from the concept of "F0-prominent register". To put it another way, F0-prominent register is an identifiable subtype of tone contrast, which is binary and develops via OP in the same manner as register.

the most prominent cue and then phonemicized. Khmu examples provided by Premsrirat (2004) reproduced here in Table 55.

Table 55: *Examples of Khmu varieites at different stages of tone/register development*

		Non-Tonal	Registral	Tonal (-asp)	Tonal (+asp)
***buːc**	*rice wine*	buːc	puːc^{L}	pùːc	p^{h}ùːc
***puːc**	*to take off clothes*	puːc	puːc^{H}	púːc	púːc
***bok**	*to cut down a tree*	bok	pok^{L}	pòk	p^{h}òk
***pok**	*to take a bite*	pok	pok^{H}	pók	pók
***buːm**	*to chew*	buːm	puːm^{L}	pùːm	p^{h}ùːm
***puːm**	*to fart*	puːm	puːm^{H}	púːm	púːm
***ɟaŋ**	*to weight*	ɟaŋ	caŋ^{L}	càŋ	c^{h}àŋ
***caŋ**	*astringent*	caŋ	caŋ^{H}	cáŋ	cáŋ
***glaːŋ**	*stone*	glaːŋ	klaːŋ^{L}	kàːŋ	k^{h}àːŋ
***klaːŋ**	*eagle*	klaːŋ	klaːŋ^{H}	káːŋ	káːŋ
***ŋɔʔ**	*to fear*	ŋɔʔ	ŋɔʔ^{L}	ŋɔ̀ʔ	ŋɔ̀ʔ
***^{h}ŋɔʔ**	*paddy rice*	^{h}ŋɔʔ	ŋɔʔ^{H}	ŋɔ́ʔ	ŋɔ́ʔ
***waʔ**	*to chase*	waʔ	waʔ^{L}	wàʔ	wàʔ
***^{h}waʔ**	*monkey*	^{h}waʔ	waʔ^{H}	wáʔ	wáʔ
***raːŋ**	*flower*	raːŋ	raːŋ^{L}	ràːŋ	ràːŋ
***^{h}raːŋ**	*tooth*	^{h}raːŋ	raːŋ^{H}	ráːŋ	ráːŋ

4.3.4 The Va Variant of the Khmer Model

Both the Khmer Model Proper and the Khmu Variant involve the desegmentalization of a binary onset phonation contrast between voiced and voiceless onsets. The Yingla Va language, introduced above in Section 3.2.2.2, demonstrates the possibility of the desegmentalization of a trinary onset phonation contrast. Typically, even in a language with more than two contrastive onset phonation types, only two desegmental phonemes will be conditioned. For example, it was shown in Section 3.2.2.2 how *voiceless aspirated stops patterned with the *voiceless stops in Kuy in conditioning the high register rather than conditioning the emergence of a third register. Similarly, in western Khmu, the pKhmuic *glottalized sonorant onsets group with the *voiceless sonorant onsets to condition the high tone and do not condition a third tone (Svantesson 1989). However, Yingla Va is unique among the simple OP languages surveyed here, in that the three way contrast between pWaic *voiceless, *glottalized and *voiced sonorant onsets has been transphonologized into three tones (see Table 43) (Sun 2018).[67]

Since Va tonogenesis has already been introduced above, we will not repeat it here, except to comment that, while three-way OP is quite common in Sinospheric tone languages, where they crosscut tones developed through CP (Haudricourt 1961, Gedney 1972), it would appear that it is a very rare occurrence in simple OP languages. However, as Sun (2018) points out, there is widespread bilingualism with Tai Nuea (< Southwestern Tai < Kradai) in the Yingla Va community and the tone split in Tai Nuea A tones (i.e. {-son}) parallels the Yingla Va tripartite OP pattern exactly. It may well be that bilingualism with Tai Nuea encouraged the otherwise unique and typologically marked trinary OP in Yingla Va. Desegmentalization boxes for both Yingla Va and Tai Nuea are presented in Table 56. The Tai Nuea analysis is based on that of Edmondson & Solnit (1997).

[67] Diffloth (1982a, 1982b) has proposed scenarios whereby implosive stops condition a third register in Kuay and Mon. The Kuay situation is explicable as a secondary OP event whereby *implosives became plain voiced stops before taking part in a second wave of registrogenesis (Gehrmann 2015, 2016; Gehrmann & Kirby 2019), but the Mon situation involves additional complications (see discussion in Section 5.2).

Table 56: *Parallel tripartite OP in Yingla Va and Tai Nuea tone A*

Yingla Va		**Tai Nuea**		
{asp-}	High	**{asp-}**	25	**{-son} "A"**
{vl-}	Mid	**{vl-}**	33	
{glot-}		**{glot-}**		
{vd-}	Low	**{vd-}**	51	

4.4 The Rengao Model (VH)

While there are many examples of languages which have undergone OP in isolation from any other desegmentalization processes, it is comparatively uncommon for a language to undergo VH in isolation. We have already been introduced to such a language in Rengao, which was discussed in Section 2.5.2. In this section, we investigate the development of vowel height-conditioned register in Rengao and other Bahnaric languages to propose the *Rengao Model*. We will review data showing that onset voicing was irrelevant to the development of register contrast in Rengao and its siblings in the North Bahnaric sub-branch and that North Bahnaric register contrasts in fact developed out of historical differences of vowel height. Discussion of the phonetic underpinnings of the *Rengao Model* of registrogenesis are then presented, along with an example of an early-stage Rengao Model language from Sre, a Bahnaric language from the South Bahnaric sub-branch.

4.4.1 Register Distribution in North Bahnaric Languages

In the North Bahnaric sub-branch of Bahnaric, we find a group of languages with binary register contrasts that are phonetically equivalent to Khmer Model register contrasts (Smith 1972; Gregerson 1976, 1984), but not cognate with historical onset voicing. In fact, these North Bahnaric languages retain a robust contrast between voiced and voiceless onsets among both stop onsets and sonorant onsets, all of which were inherited from pNorth Bahnaric (Smith 1972, Sidwell 2015b). And so, the North Bahnaric register contrast did *not* arise to enhance and replace historical onset voicing contrasts as expected; rather, register exists alongside onset voicing contrasts and is an unrelated category in North Bahnaric phonology. A notable exception to this generalization is the Sedang language, which will be discussed under the Chong Model in Section 4.10.

In order to illustrate how North Bahnaric register contrasts are orthogonal to onset voicing and sensitive to vowel height, the lexical data in Tables 57 through 64 are provided. In these tables, reconstructed pBahnaric etyma are presented alongside their modern reflexes in four modern North Bahnaric languages: Rengao, Jeh[68], Halang and Hre. We see that low register is associated with pBahnaric close vowels *i(ː), *ɨ(ː), *u(ː); the mid central vowel *ə(ː); and at least in some cases, the mid front vowel *e(ː). High register is associated with the open vowels *ɛ(ː), *a(ː), *ɔ(ː); the diphthongs *iə, *uə; and the back mid vowel *o(ː) (cf. discussion in Sidwell (2015b)). The pBahnaric lexical reconstructions in Tables 57-64 are Sidwell's (2011) and the North Bahnaric lexical data are extracted from the following sources: Rengao (Gregerson & Gregerson 1977), Jeh (Thông & Gradin 1979), Halang (Cooper & Cooper 1964, 1976) and Hre (Phillips et al. 1961).

[68] The lexical data for Jeh here represents the Northern Jeh variety as described by Gradin (1966). This northern variety is a typical, Rengao Model register language, whereas the Southern Jeh variety described by Gradin constitutes the prototype for the Jeh Model introduced in Section 3.4.2.

Table 57: *Register distribution with pBahnaric *b-*

pBahnaric		Rengao	Jeh	Halang	Hre
*ɓəs	*snake*	bas^{L}	bas^{L}	be:h^{L}	bih^{L}
*ɓuk ~ *buk	*decayed, rotten*	buk^{L}	puk^{L}	buk^{L}	bɔk^{L}
*ɓe:ɹɲ	*full, filled*	biŋ^{L}	biŋ^{L}	bi:ŋ^{L}	biɲ^{L}
*ɓuh	*to roast*	buh^{L}	buh^{L}	bu:h^{L}	buh^{L}
*ɓul	*drunk*	bul^{L}	bol^{L}	bul^{L}	bu^{L}
*bri:	*forest*	bri:^{L}	bri:^{L}	bri:^{L}	bri^{L}
*-bɛ:	*goat*	bəbi:^{H}	bu^{ʔ}bej^{H}	bəbe:^{H}	bubi^{H}
*ba:ʔ	*father*	baʔ^{H}	ba:ʔ^{H}	ba:ʔ^{H}	baʔ^{H}
*ɓɔh	*salt*	boh^{H}	boh^{H}	bo:h^{H}	bɔh^{H}
*ɓa:r	*two*	ba:r^{H}	ba:l^{H}	ba:r^{H}	baj^{ʔH}
*tbɔ:ŋ	*coffin, trough*	bo:ŋ^{H}	bo:ŋ^{H}	buaŋ^{H}	buaŋ^{H}
*bra:j	*thread*	bra:j^{H}	bra:j^{H}	bra:j^{H}	braj^{H}

Table 58: *Register distribution with pBahnaric *p-*

pBahnaric		Rengao	Jeh	Halang	Hre
*plə:m	*leech (land type)*	ple:m^{L}	ple:m^{L}	ple:m^{L}	plem^{L}
*puʔ	*to carry*	puʔ^{L}	po:ʔ^{L}	po:ʔ^{L}	pɔʔ^{L}
*prɨ:t	*banana*	pre:t^{L}	priat^{L}	priət^{L}	pret^{L}
*pah	*split, crack*	pah^{H}	pah^{H}	pa:h^{H}	pah^{H}
*par	*to fly*	par^{H}	par^{H}	par^{H}	par^{H}
*pɛ:	*three*	pi:^{H}	pej^{H}	pe:^{H}	piʔ^{H}
*pa:m	*fishtrap (cylindrical)*	pa:m^{H}	pa:m^{H}	pa:m^{H}	pem^{H}
*paɲ	*to shoot*	peŋ^{H}	peŋ^{H}	peŋ^{H}	pɛɲ^{H}
*pla:	*blade*	pla:^{H}	pla:^{H}	pla:^{H}	pla^{H}
*prɔ:k	*squirrel*	pro:k^{H}	pro:k^{H}	pruak^{H}	pruak^{H}
*pɔ:r	*cooked rice, gruel*	po:r^{H}	po:l^{H}	puar^{H}	pua^{H}
*puəs	*calf, foreleg*	pu:s^{H}	puas^{H}	puəs^{H}	pɔj^{hH}
*puən	*four*	pu:n^{H}	puan^{H}	puən^{H}	pun^{H}

Table 59: *Register distribution with pBahnaric *d-*

pBahnaric		Rengao	Jeh	Halang	Hre
*ɗɨc	*slave, servant*	dik^{L}	di:k^{L}	di:k^{L}	dic^{L}
*ɗu(:)m	*ripe, red*	du:m^{L}	dum^{L}	du:m^{L}	dum^{L}
*dəw	*to run, chase away*	kədaw^{L}	kədaw^{L}	gədo:^{L}	kədaw^{L}
*ɗa:k	*water*	da:k^{H}	da:k^{H}	da:k^{H}	diak^{H}
*ɗac	*only, truly, nearly*	dek^{H}	dek^{H} da:n^{H}	dek^{H}	dɛc^{H}
*ɗok	*monkey*	dok^{H}	dok^{H}	dok^{H}	dɔk^{H}
*-ɗɔ:k	*to hide (something)*	kədo:k^{H}	kədo:k^{H}	gəduak^{H}	kəduak^{H}
*dam	*young male, bachelor*	tədam^{H}	dam^{H} dam^{H}	dam^{H} nel^{H}	rədam^{H}

Table 60: *Register distribution with pBahnaric *t-*

pBahnaric		Rengao	Jeh	Halang	Hre
*-tə:r	*comb of rooster*	tar^{L}	te:l^{L}	te:r^{L}	tɛr^{L}
*tə:l	*to answer*	te:l^{L}	te:l^{L}	te:l^{L}	tew^{L}
*təp ~ *tɨp	*to bury, set in ground*	tənap^{L}	tap^{L}	tap^{L}	hənap^{L}
*ti:	*hand, arm*	ti:^{L}	ti:^{L}	ti:^{L}	ti^{L}
*tu:ŋ	*to carry on shoulder pole*	to:ŋ^{L}	tuaŋ^{L}	hətuəŋ^{L}	tuaŋ^{L}
*ta:p	*to slap*	ta:p^{H}	ta:p^{H}	ta:p^{H}	tep^{H}
*tac	*to sell, trade*	tek^{H}	tek^{H}	tek^{H}	tɛc^{H}
*toʔ	*hot*	tuʔ^{H}	tuʔ^{H}	tu:ʔ^{H}	toʔ^{H}
*ta:m	*yet; in time*	ta:m^{H}	ta:m^{H}	ta:m^{H}	tem^{H}
*ta:ɲ	*to weave (cloth, baskets)*	ta:n^{H}	ta:n^{H}	ta:n^{H}	taŋ^{H}
*tiəŋ	*tail*	ti:ŋ^{H}	te:ŋ^{H}	tiaŋ^{H}	tɛŋ^{H}
*tɔ:ŋ	*handle*	to:ŋ^{H}	to:ŋ^{H}	tuaŋ^{H}	tuaŋ^{H}
*trɔ:m ~ *tro:m	*hole (cavity)*	trom^{H}	tro:m^{H}	truam^{H}	trɔm^{H}

Table 61: *Register distribution with pBahnaric *ɟ-*

pBahnaric		Rengao	Jeh	Halang	Hre
*ɟi:k	*to hoe, cultivate*	ɟe:k^{L}	ɟiak^{L}	ɟiək^{L}	ɟɛc^{L}
*ɟə:ŋ	*foot, leg*	ɟe:ŋ^{L}	ɟo:ŋ^{L}	ɟo:ŋ^{L}	ɟɛŋ^{L}
*ɟil	*barking deer*	ɟil^{L}	ɟel^{L}	ɟil^{L}	ɟiw^{L}
*ɟiʔ	*ache, painful, illness*	ɟiʔ^{L}	ɟiʔ^{L}	ɟi:ʔ^{L}	ɟiʔ^{L}
*ɟu:ʔ	*sour*	ɟoʔ^{L}	ɟuaʔ^{L}	ɟuəʔ^{L}	ɟɔʔ^{L}
*ɟur	*to descend, go down*	ɟu:r^{L}	ɟol^{L}	ɟur^{L}	ɟua^{L}
*ɟɨt	*ten*	ɟat^{L}	ɟat^{L}	ɟat^{L}	ɟat^{L}
*ɟo:r	*to siphon, pour*	ɟo:r^{L}	ɟual^{L}	ɟuər^{L}	(ɟua^{H})
*ɟah	*be able*	ɟah^{H}	ɟah^{H}	ɟa:h^{H}	ɟah^{H}
*ɟuəj	*deer (large)*	ɟo:j^{H}	ɟu:j^{H}	ɟuəj^{H}	ɟɔj^{H}
*ɟoh	*to peck, stab*	ɟuh^{H}	ɟoh^{H}	ɟo:h^{H}	ɟoh^{H}

Table 62: *Register distribution with pBahnaric *c-*

pBahnaric		Rengao	Jeh	Halang	Hre
*cu:ŋ	*axe*	co:ŋ^{L}	cuaŋ^{L}	cuəŋ^{L}	cuaŋ^{L}
*cur	*pig*	cu:r^{L}	col^{L}	cur^{L}	cua^{L}
*ce:$_{2}$m	*bird*	cim^{L}	(cim^{H})	ci:m^{L}	cim^{L}
*ce:$_{2}$n	*cooked*	cin^{L}	cen^{L}	(cen^{H})	ʔəcin^{L}
*coh	*to light, ignite, burn*	cuh^{H}	cuh^{H}	(cu:h^{L})	coh^{H}
*cak	*body*	cak^{H}	cak^{H}	cak^{H}	cak^{H}
*caŋ	*knife, sword*	caŋ^{H} wɛʔ^{H}	caŋ^{H}	caŋ^{H}	caŋ^{H}
*caw	*grandchild*	caw^{H}	caw^{H}	caw^{H}	saw^{H}
*ciəm	*to feed*	cem^{H}	ciam^{H}	ciəm^{H}	cɛm^{H}
*cɔ:j	*to plant, dibble*	co:j^{H}	co:j^{H}	cuaj^{H}	coj^{H}

Table 63: *Register distribution with pBahnaric *g-*

pBahnaric		Rengao	Jeh	Halang	Hre
*gɨl	*head*	gal^{L}	kal^{L}	kal^{L}	gaw^{L}
*gu:ŋ	*ladder, stair*	go:ŋ^{L}	guaŋ^{L}	guəŋ^{L}	guaŋ^{L}
*grɨm ~ *krɨm	*thunder*	gram^{L}	gram^{L}	gəram^{L}	-
*sgɨr	*drum*	həgar^{L}	sigal^{L}	həgar^{L}	-
*rgəj ~ *rgaj	*skillful, clever*	rəgaj^{L}	ləgaj^{L}	rəge:j^{L}	-
*guŋ	*forested land*	guŋ^{L}	-	guŋ^{L}	gɔŋ^{L}
*gəŋ	*post for sacrifice*	-	gaŋ^{L}	gaŋ^{L}	gaŋ^{L}
*griang	*fang*	griaŋ^{H}	driaŋ^{H}	griəŋ^{H}	-
*gɔʔ	*to knock*	-	goʔ^{H}	go:ʔ^{H}	gəgoʔ^{H}
*gar	*seed*	gar^{H}	-	gar^{H}	-
Bahnar /gam/	*black*	gam^{H}	-	-	gam^{H}
Bahnar /gɔ:ŋ/	*gong (large)*	go:ŋ^{H}	go:ŋ^{H}	guaŋ^{H}	-
Bahnar /pəga:ŋ/	*medicine*	pəga:ŋ^{H}	pəga:ŋ^{H}	bəga:ŋ^{H}	-
Bahnar /gɔh/	*clean, empty*	-	goh^{H}	rəgo:h^{H}	gɔh^{H}
pChamic *gan	*cross*	bəgan^{H}	pəgan^{H}	-	-
pChamic *gah	*side, direction*	gah^{H}	-	ga:h^{H}	gah^{H}

Table 64: *Register distribution with pBahnaric *k-*

pBahnaric		Rengao	Jeh	Halang	Hre
*klə:m	*liver*	kle:m^{L}	kle:m^{L}	kle:m^{L}	klem^{L}
*ki(:)t	*frog*	kit^{L}	kiat^{L}	(ki:t^{H})	kɛt^{L}
*kən	*large*	kan^{L}	-	-	kan^{L}
*kruŋ ~ *krəŋ	*knee*	kuŋ^{L} kraŋ^{L}	-	kraŋ^{L}	kukraŋ^{L}
*kət	*to tie up*	kat^{L}	-	-	kat^{L}
*kuj	*to sleep, lie down*	kuj^{L}	-	(ku:j^{H})	kuj^{L}
*ka:	*fish*	ka:^{H}	ka:^{H}	ka:^{H}	ka^{H}
*kal	*to fell (tree)*	ka:l^{H}	ka:l^{H}	kal^{H}	kaw^{H}
*ka:ŋ	*jaw, chin*	ka:ŋ^{H}	ka:ŋ^{H}	ka:ŋ^{H}	kiaŋ^{H}
*kap	*to bite*	kap^{H}	kap^{H}	kap^{H}	kap^{H}
*ke:$_2$ŋ	*edge*	ki:ŋ^{H}	ki:ŋ^{H}	kəni:ŋ^{H}	kɛŋ^{H}
*kla:k	*intestines, belly*	kla:k^{H}	kla:k^{H}	kla:k^{H}	kliak^{H}
*kla:ŋ	*hawk*	kla:ŋ^{H}	kla:ŋ^{H}	kla:ŋ^{H}	kliaŋ^{H}
*kɔ:n	*child*	ko:n^{H}	ko:n^{H}	kuan^{H}	kɔn^{H}
*kɔ:ŋ	*bracelet*	ko:ŋ^{H}	ko:ŋ^{H}	həkuaŋ^{H}	kuaŋ^{H}
*kɔ:p	*turtle (land variety)*	ko:p^{H}	ko:p^{H}	kuap^{H}	kɔp^{H}
*kɔh	*to cut, chop (wood)*	koh^{H}	koh^{H}	ko:h^{H}	kɔh^{H}
*kra(:)p	*stuck together*	kra:p^{H}	kra:p^{H}	kra:p^{H}	krep^{H}
*kraʔ	*old (of persons)*	kraʔ^{H}	-	kra:ʔ^{H}	kraʔ^{H}

4.4.2 The Relationship between Vowel Height and Register

Environmental conditioning from consonants has an effect on the origins, distributions and evolutions of suprasegmental contrasts far more commonly than vowels do. Vowels affect tones so infrequently, in fact, that in the past, it was doubted whether or not vowel-tone interactions even existed at all (Hombert 1977). Many clear examples of such interactions have come to light since, as Becker & Jurgec (2017, 11-14) demonstrate in their useful summary of this issue.

All things being equal, closer vowels naturally have higher F0 than more open vowels (*intrinsic F0*) and this has been suggested as a universal of vowel production (Whalen & Levitt 1995, Maddieson 1997, Chen et al. 2021). The explanation for this may be found in articulatory mechanics, given that a raised tongue body will pull on laryngeal tissues, including the cricothyroid muscle, which is involved in the manipulation of F0 (Ohala 1973, Honda & Fujimura 1991). However, auditory perception may play a role as well, since the low F1 frequencies intrinsic to close vowels approach the bandwidth range in which F0 is found. This may encourage a perceptual integration of low F1 and raised F0 for close vowels, whether universally or only in the phonologies of certain languages (Hoemeke & Diel 1994).

Instances of direct interaction between vowel quality and pitch are uncommon, both worldwide and in MSEA, but the interrelationship between vowel quality and the MSEA register phenomenon is clear. As we have discussed in the context of the Khmer Model, the direction of conditioning is typically from onset phonation to register to vowel height, with low register conditioning vowel raising and high register conditioning vowel lowering. However, we also have examples of a reversal of the conditioning relationship in certain Bahnaric and Katuic languages (Sidwell 2015b; Gehrmann 2015, 2019). In these languages, historical vowel height contrasts have been desegmentalized into register contrasts without conditioning from OP. There are two basic models of registrogenesis then, the Khmer Model (registrogenesis from OP) and the Rengao Model (registrogenesis from VH) (see Table 65).

Table 65: *Two basic models for registrogenesis: the Khmer Model & the Rengao Model*

Khmer Model
(OP > Register)

<table>
<tr><td>{vl-}</td><td colspan="2">high register</td></tr>
<tr><td>{vd-}</td><td colspan="2">low register</td></tr>
<tr><td></td><td>{more open V}</td><td>{closer V}</td></tr>
</table>

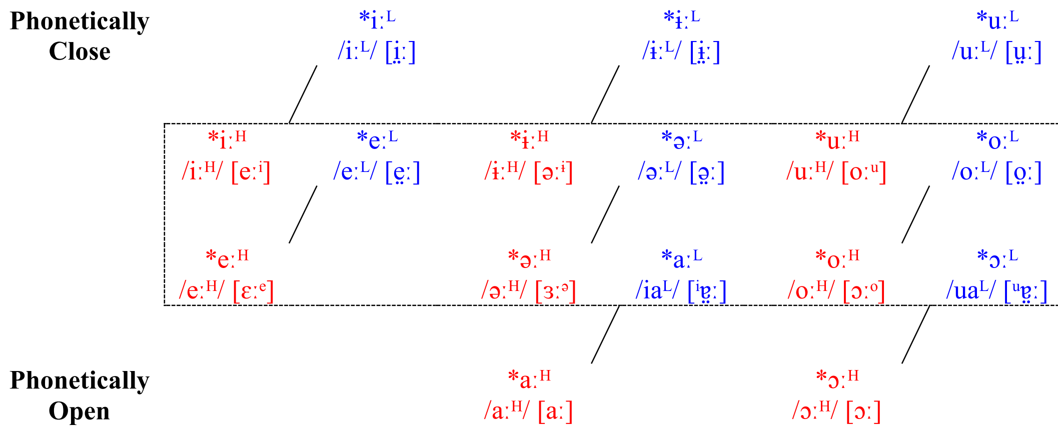
Rengao Model
(VH > Register)

<table>
<tr><td>{vl-}</td><td rowspan="2">high register</td><td rowspan="2">low register</td></tr>
<tr><td>{vd-}</td></tr>
<tr><td></td><td>{more open V}</td><td>{closer V}</td></tr>
</table>

While the Rengao Model of register formation is comparatively rare in MSEA, this pattern of development is quite plausible. In the Austroasiatic language family and beyond, vowel height and voice quality co-vary in a regular fashion. A thematic relationship between lesser vowel aperture and laxer voice quality (modal to breathy voice) on the one hand and greater vowel aperture and tenser voice quality (modal to creaky voice) on the other is well documented (Brunelle & Kirby 2016, Brunner & Żygis 2011, Esposito et al 2019, Denning 1989, Gehrmann 2015, Gregerson 1976, Huffman 1985b, Lotto et al. 1997). The natural, intrinsic co-variation of voice quality and vowel height carries with it a latent potential for phonologization and eventual phonemicization if vowels which are differentiated redundantly by vowel height and voice quality converge in terms of vowel quality while maintaining voice quality differences (cf. Section 3.2.1).

The plausibility of registrogenesis via VH is even greater when we take into account the MSEA linguistic milieu, within which North Bahnaric languages would have very likely been in contact with other register languages – perhaps ones which developed register in the more crosslinguistically common way via OP. As we have seen, in those Khmer Model register languages which employ extrinsic differences of vowel height as a cue to register, high register close vowels and low register open vowels tend to restructure. In these cases, the phonetically close vowels are consequently all in low register and the phonetically open vowels are all in high register, as the example from Bru Tri in Figure 13 demonstrates (Gehrmann 2019, 2021b). One can imagine a scenario where bilingualism between a register language such as Bru Tri and a non-registral language could potentially inspire this kind of register formation via VH. That contact with OP register languages could influence VH-conditioned registrogenesis remains a hypothesis at this point and, if it can or does play a role, is unlikely to be the only factor.

Figure 13: *Modern Bru Tri reflexes of Proto-Bru long monophthongs*



4.4.3 Early-Stage Rengao Model Registrogenesis in Sre

In surveying Austroasiatic desegmentalization, one example was found of a language in what appears to be an early stage Rengao Model register formation. Manley (1972) presents an analysis of Sre (< South Bahnaric) phonology, including a description of redundant voice quality differences being associated with different vowel height series. He describes two varieties of Sre spoken in the vicinity of Di Linh district in Lâm Đồng province, Vietnam, which he refers to as Dialect A and Dialect B.

In Dialect A, Manley describes how the phonetic realization of front vowels /iː/ and /eː/ are mostly overlapping in terms of vowel height. The close vowel /iː/ is slightly lowered to [ɪː] before obstruents but appears as [iː] elsewhere. The mid vowel /eː/ is convergent with the close vowels, being found at [ɪː]~[ẹː] before obstruents and [iː] elsewhere. As a result, the minimal pair /ntiːŋ/ 'bone' and /nteːŋ/ 'where' is indistinguishable by vowel quality alone. Manley observes that contrast is nevertheless maintained due to a difference of voice quality, the close vowel /iː/ being realized with a "deeper, breathy or 'spooky' quality" that he associates with pharyngeal cavity expansion and tongue root advancement. The mid vowel /eː/, by contrast, is characterized as having a "more tense, constricted kind of timbre" due to pharyngeal constriction and tongue root retraction. In the back vowels, /uː/ and /oː/ are not convergent in terms of vowel quality in Dialect A, but they exhibit the same pattern of differential voice quality (close vowel = breathy/lax, mid vowel = modal/tense). Dialect B shows vowel quality convergence in both the front and back vowel pairs, with voice quality differences upholding the contrast.

Manley's phonemic transcription of the Sre vowel pairs in question here employs a conservative analysis, making explicit reference to differences of vowel height which are clearly being transphonologized at this point into a difference of voice quality. Dialect A preserves more evidence for /eː/ and /oː/ as historically non-close vowels, but the vowel height difference is nearly erased in favor of a voice quality difference in Dialect B. It is clear then that the Rengao Model of registrogenesis proposed here was more or less anticipated by Manley fifty years ago. We may quote his summary of the Sre situation in full here.

> *"In a sense, the covered/non-covered*[69] *distinction might be thought of, for Sre, as a kind of "reserve" phonemic system which comes into effect (i.e. is rendered phonemic) when vowel heights converge too closely. Thus, in Dialect A, where the heights of the two high front vowels have gotten close, resulting in overlap of the allophones, the covered/uncovered distinction "comes to the rescue" to keep them distinct. Elsewhere in Dialect A, this reserve capacity is not exploited because it is not necessary. In Dialect B, however, /oː/ has risen to the point where its allophones overlap*

[69] Manley uses *covered* and *non-covered* to refer to tongue root retraction (i.e. high register) and tongue root advancement (i.e. low register), respectively. This terminology was adopted from Chomsky & Halle (1968), but never took root in the literature on MSEA phonology, as Henderson's (1952) use of the term *register* had already become conventionalized.

with those of /uː/; and here again the covered/uncovered distinction is triggered to keep them apart." (Manley 1972, 17-18)

4.5 The Hu Model (VL)

Even more uncommon than simple VH among the Austroasiatic languages is simple VL. Just one example of simple VL has been documented: the vowel length-conditioned tonogenesis already introduced above in Section 2.5.1 in the Hu language. It is therefore proposed to name this desegmentalization model the *Hu Model.*

4.5.1 The Relationship between Vowel Length and Tone

L-Thongkum et al. (2007) have demonstrated a crosslinguistically consistent difference in pitch between long and short vowels in both tonal and non-tonal MSEA languages, which rises to the level of statistical significance. At least in this region, then, short vowels are expected to be produced with higher pitch than long vowels. This represents a tonogenetic potentiality that is frequently realized in languages emplying complex desegmentalization models. We may look to the Tiddim Chin language (< Kuki-Chin < Tibeto-Burman) to take just one example. Tiddim Chin developed four tones through a combination of VL and CP, as demonstrated in Table 57 (Ostapirat 1998).

Table 66: *Desegmentalization box for Tiddim Chin (Ostapirat 1998)*

-	*2*	**{-son}**
4	*3*	**{-H}**
	1	**{-ʔ}, {-stop}**
{V̆}	**{Vː}**	

In the Tiddim Chin example, vowel length contrast was neutralized after its desegmentalization. In Central Thai (Siamese) (< Southwestern Tai < Kradai), however, the historical D tone (i.e. {-T}) is doubly split by both OP and VL, but the historical vowel length contrast persists (see Table 67).

Table 67: *Vowel length conditions tone realization in Central Thai (Siamese) {-T} "D" syllables*

{other}	*short, high*	*long, falling*	**{-T} "D"**
{vd-}	*short, low*	*long, low*	
	{V̆}	**{Vː}**	

4.5.2 Areal Influence in Hu's Uniquely Simple Vowel Length Desegmentalization

Further examples of VL in combination with other desegmentalization processes will be presented below, but, at this point, only Hu is documented as undergoing simple VL. The loss of vowel length contrast is an areal development affecting various other Palaungic languages from the Waic, Palaung, Riang and Danau languages (Diffloth 1980, 92), but it is noteworthy that only among languages of the Angkuic sub-branch do we find examples of the neutralization of pPalaungic vowel length contrast in conjunction with its desegmentalization. In the other Palaungic languages mentioned, the contrast shifted to vowel quality contrasts in some cases or was simply neutralized in others (Sidwell 2015c).

Reflecting on possible explanations for why the Hu Model of tone formation is so rare, Svantesson (1991) invokes areal pressure, noting, "Both the acquisition of tones and the loss of vowel length are ongoing processes in the area where Hu is spoken, so it is perhaps not surprising to find a language that combines both." This is true enough, but we might add to this a further, Angkuic-internal structural argument. pAngkuic, uniquely among the Palaungic languages, underwent the phonetic restructuring of its onset phonation contrasts: the Germanic Shift introduced in Section 2.5.1 (pPalaungic *D *T > pAngkuic *T *T^h). This shift precludes OP for Angkuic languages, at least in its traditional configuration, and, as we have no evidence for CP occurring in isolation, this leaves VH and VL as options for innovating desegmental phonology in Angkuic languages. As Hu and the other Angkuic languages have in common contact with Tai languages, and, as VL occurs very commonly in Tai languages, we may indeed hypothesize that it is a combination of the inapplicability of OP in Angkuic languages and bilingualism with Tai languages undergoing VL that has led to the importance of VL in Angkuic desegmentalization.[70]

4.6 The Vietnamese Model (OP + CP)

All three simple desegmentalization models have now been introduced in the preceding sections. Each of these simple desegmentalization models has a counterpart in which CP complicates the formation and/or distribution of desegmental phonemes. We begin with the combination of OP and CP, labeled the *Vietnamese Model* here. This is exactly the model described by Haudricourt and, while it is well-known, well-studied and has wide application throughout the Sinospheric Tonbund, it is, in fact, quite uncommon in Austroasiatic. Languages of the Vietic branch of Austroasiatic were already introduced in Section 2.4.1.2, including the model's namesake, Vietnamese. Vietnamese Model tonogenesis is also documented in two other Austroasiatic languages: Bolyu (< Mangic) and Li Xei (< Bahnaric). Both of these languages are introduced below.

4.6.1 Tonogenesis in Bolyu: Parallels with Vietnamese

The Mangic branch is the most recently identified branch of Austroasiatic. Mangic languages are notable for their restructured, almost entirely monosyllabic phonological word structure, for their preference for disyllabic lexical morphemes, which comprise two phonological monosyllables, and for being highly tonal languages. In historical phonological terms, Mangic is currently the least understood branch of Austroasiatic. Uncertainty remains as to whether Mangic actually does constitute one legitimate, cohesive branch or whether Mang, spoken in Vietnam and China, and the two Pakanic languages, Bugan and Bolyu (or Lai), both spoken in China, are better split into two separate primary branches of Austroasiatic. Here, we follow the default hypothesis that Mangic is one branch and will speak of it as such (Sidwell 2015a, 2021).

In an unpublished paper, Hsiu (2016) produced a preliminary reconstruction of the phonology of the most recent common ancestor of Bugan and Bolyu: Proto-Pakanic.[71] Hsiu assembled 213 cognate sets based on lexical data collected by Chinese researchers on two Bugan varieties, Bugan Manlong (Li Yunbing 2005) and Bugan Nala (Li Jinfang 2006), and one variety of Bolyu (Li Xulian 1999). Hsiu himself focuses on segmental reconstruction and left the desegmental phonology of Bugan and Bolyu largely to future research.

Hsiu's comparative database of Pakanic was taken up and expanded by Sidwell to build an unpublished comparative lexicon of the Mangic languages. Sidwell added many additional Pakanic comparanda and incorporated the Bolyu lexicon compiled by Edmondson (1995). Mang cognates were also added, drawing on and Yan & Zhou's (2012) and Nguyễn Văn Lợi et al.'s (2008) Mang lexica. The analysis below is based on my own analysis of Sidwell & Hsiu's (2021) Mangic comparative database.

The desegmentalization models employed by Bugan and Mang are not currently well understood and this is an area of active research. As for Bolyu, suggestive evidence has already been presented that it may have followed the Vietnamese Model, forming tonal contrasts from a combination of OP and CP (Benedict 1990a, Edmondson & Gregerson 1996). Even more intriguingly, the contrast between {-son} syllables and {-ʔ} syllables in pVietic appears to be cognate with tonal contrasts in Bolyu. This is a key discovery, if true, as the pattern of rime glottalization contrast in pVietic has not been shown to be cognate with any other contrast elsewhere in Austroasiatic (see Section 4.2). It would imply that either (1) pVietic and Bolyu share a common retention from pAustroasiatic rime glottalization contrast or (2) rime glottalization contrast developed as a common innovation in a common ancestor of pVietic and Bolyu. Since rime glottalization is not currently reconstructed for pAustroasiatic and since a common Vieto-Mangic branch of Austroasiatic is not currently accepted or even proposed, the cognacy of pVietic rime glottalization and Bolyu tonal contrasts would necessitate a change of analysis one way or the other.

As noted above, Sidwell & Hsiu's (2021) database includes data from two Bolyu sources (Li Xulian 1999, Edmondson 1995). Both sources record six tones for Bolyu and the correspondence between the tones is quite regular.

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[70] On Tai tonogenetic influence in northern Austroasiatic languages, cf. the parallelism between Tai Nuea tone splits conditioned by OP and simple OP in Yingla Va, as discussed in Section 4.3.4.

[71] Note that the term Proto-Pakanic has also been used in print to refer to the entire Mangic branch. The term Pakanic is based on Bugan speakers' autonym /pə^{55} ka̠n^{33}/ (Li & Luo 2015).

There is some irregularity surrounding the low tone /11/ and the mid-falling tone /31/ between the two dialects and between the mid tone /33/ and low rising tone /13/ as well. Nevertheless, based on my own analysis of the data, the two data sets are straightforwardly reconcilable into a six-tone inventory for pBolyu (presented in Table 68), based on a combination of internal and external reconstruction.

Table 68: *Reconciling intra-Bolyu tone correspondences*

pBolyu	Li Xulian (1999)	Edmondson (1995)
*11	/11/~/31/	/11/~/31/
*33	/33/~/13/	/33/~/13/
*55	/55/	/55/
*31	/31/	/31/
*53	/53/	/53/
*13	/13/	/13/

Edmondson & Gregerson (1996) compared Bolyu with Vietnamese directly and present a hypothesis of tonal cognacy between Vietnamese and Bolyu as summarized in Table 69. I have excluded their hypotheses regarding the C tones (hỏi-ngã) because they are based on very little evidence and, as they themselves admit, are speculative. We see that the Vietnamese A tones correspond to level tones /55/ and /33/ while Vietnamese B and D tones correspond to falling tones /53/ and /31/. In addition, a Bolyu rising tone /13/ is associated with Vietnamese A tones.

Table 69: *Bolyu-Vietnamese tonal correspondences (Edmondson & Gregerson 1996)*

Bolyu	Vietnamese	Historical
/55/ & /13/	*ngang*	A1 {vl-, -son}
/33/ & /13/	*huyền*	A2 {vd-, -son}
/53/	*sắc*	B1 {vl-, -ʔ}
/31/	*nặng*	B2 {vd-, -ʔ}
/53/	*sắc*	D1 {vl-, -T}
/31/	*nặng*	D2 {vd-, -T}

Building on these correspondences, I have identified additional Bolyu-Vietic cognates, this time comparing Bolyu with Ferlus's unpublished pVietic lexicon (Ferlus 2007) instead of with Vietnamese. External comparison with Vietic and internal reconstruction suggest the desegmentalization box for Bolyu in Table 70.

Table 70: *Desegmentalization box for Bolyu*[72]

{asp-}	*13*	**{-son} "A"**
{vl-}	*55*	
{vd-}	*33*	
{asp-}	*11*	**{-ʔ, -T} "B, D"**
{vl-}	*53*	
{vd-}	*31*	

The voiceless-voiced split in both the A and B/D tones proposed by Edmondson & Gregerson are corroborated in this analysis. In addition, the previously unexplained /13/ tonal correspondence of Vietic A tones are explained here as having been conditioned by historical onset aspiration, which occurred on both stops (*T^h) and sonorants (*^hN) in pre-Bolyu. An aspirated reflex of the B/D tones was also identified in the form of /11/. Thus, the

[72] {asp-} includes voiceless aspirated stops (T^h), pre-aspirated sonorants (^hN) and voiceless fricatives (h, s). This category was identified largely via internal reconstruction, as tones /11/ and /13/ occur with aspirated stops, voiceless fricatives and voiced sonorant onsets with notable frequency. The sonorants, now voiced, would appear to have been historically voiceless and pVietic cognates suggest a plausible mechanism for developing such onsets via sesquisyllable reduction in various cases (e.g. pVietic *s-laːʔ *leaf*, Bolyu /lɔ^{11}/; pVietic *c-nəm *year*, Bolyu /nam^{13}/, etc...). Onsets such as those grouped together under {asp-} here (often characterized as [+spread glottis]) frequently pattern together in terms of tone assignment in the languages of MSEA.

origins of all six pBolyu tones are accounted for here. It remains unclear how coda {-H} plays into tonal development in Bolyu at this point, as only six Bolyu-Vietic correspondences have been identified with this coda phonation type.

The Bolyu-Vietic correspondences in Table 71 support the above analysis. The correspondence of pVietic {-son} "A" rimes with the pre-Bolyu tones /13, 55, 33/ and the correspondence of pVietic {-ʔ} "B" rimes with the pre-Bolyu tones /11, 53, 31/ is 85% regular (55 out of 65 identified correspondences). This strongly supports Edmondson & Gregerson's hypothesis regarding the cognacy of pVietic rime glottalization and tonal contrasts on Bolyu and establishes that Bolyu almost certainly developed tone in the manner of the Vietnamese Model, conditioned by a combination of a three-way contrast of onset phonation ({asp-} vs. {vl-} vs. {vd-}) and a two-way contrast of coda phonation ({-son} vs. {-ʔ, -T}). The implications of this fact for pAustroasiatic rime reconstruction or for a Vieto-Mangic branch remain to be investigated (Gehrmann 2021a).

Table 71: *Examples of pVietic and pBolyu {-son} correspondence and pBolyu tone splits from OP*

pVietic			Bolyu			pBolyu		
	Ferlus (2007)		*Li Xulian (1999)*	*Edmondson (1995)*		*Tone*		*Onset Development*
A	*c-luː	*buffalo*	lai^{13}	-	*ox*	*^{13}	{asp-, -son}	*cal > sl > ʰl > l
A	*c-n-əm	*year*	nam^{13}	nəːm^{13}	*year*	*^{13}	{asp-, -son}	*can > sn > ʰn > n
A	*ɗoːj	*to feed*	t͡sʰɔ^{13}	t͡sʰɔ^{13}	*to feed*	*^{13}	{asp-, -son}	*ɗ > t͡sʰ
A	*ɗeː	*people*	t͡sʰe^{13}	t͡sʰe^{13}	*person*	*^{13}	{asp-, -son}	*ɗ > t͡sʰ
A	*ʔa-ɟaːŋ	*elephant*	sjaːŋ^{13}	-	*elephant*	*^{13}	{asp-, -son}	*ɟ > sj
A	*k-rɔːŋ	*river*	hoːŋ^{13}	huːŋ^{13}	*river*	*^{13}	{asp-, -son}	*kr > ʰr > x > h
A	*k-rəm	*to lay eggs*	tʰam^{13}	tʰəm^{13}	*egg*	*^{13}	{asp-, -son}	*tr > tx > th > tʰ [73]
A	*bɔː	*zebu, bovine*	vɔ^{33}	vɔ^{13}	*buffalo*	*^{33}	{vd-, -son}	*b > v
A	*daːŋ	*sugarcane*	teːŋ^{33}	təːŋ^{13}	*sugar*	*^{33}	{vd-, -son}	*d > t
A	*m-luː	*thigh*	-	lau^{33}	*leg, thigh*	*^{33}	{vd-, -son}	*l > l
A	*k-maː	*rain*	qɔ^{55} muɔ^{33}	-	*rain*	*^{33}	{vd-, -son}	*m > m
A	*miː	*tu|you (sing.)*	maːi^{33}	maːi^{13}	*you (pl.)*	*^{33}	{vd-, -son}	*m > m
A	*maːl	*ten*	maːn^{33}	maːn^{13}	*ten*	*^{33}	{vd-, -son}	*m > m
A	*s-maː	*flea*	mjɔ^{33}	ɲɔ^{13}	*flea*	*^{33}	{vd-, -son}	*m > m
A	*s-poː	*to dream*	paːu^{33}	paːu^{13}	*to dream*	*^{33}	{vd-, -son}	*mp > b > p [74]
A	*ɲaː	*house*	ɳ̥ɔ^{33}	ɲɔ^{33}	*house*	*^{33}	{vd-, -son}	*ɲ > ɲ
A	*rɔːŋ	*fallen tree trunk*	muɔ^{31} ɣaŋ^{33}	mɔ^{53} ɣɔːŋ^{33}	*post, pillar*	*^{33}	{vd-, -son}	*r > ɣ
A	*c-ruː	*deep*	ɣau^{33}	ɣau^{13}	*deep*	*^{33}	{vd-, -son}	*r > ɣ
A	*bɔːŋ	*crab shell*	mbuŋ^{55}	mbɔŋ^{55} ɕɔ^{53}	*skin*	*^{55}	{vl-, -son}	*ɓ > mb
A	*bɔːŋ	*spathe of bamboo*	mbɔŋ^{55}	mbɔŋ^{55}	*bamboo shoot*	*^{55}	{vl-, -son}	*ɓ > mb
A	*km-ɓoːr	*anteater*	mbaːu^{55}	-	*pangolin*	*^{55}	{vl-, -son}	*ɓ > mb
A	*saːj	*hear*	lɔ^{11} tɕaːi^{55}	lɔ^{31} tɕaːi^{55}	*ear*	*^{55}	{vl-, -son}	*c > tɕ [75]
A	*dam / tam	*right side*	kuan^{33} tɕəm^{55}	tɕəm^{55}	*right (side)*	*^{55}	{vl-, -son}	*ɗ > tɕ
A	*kɔːn	*son, daughter*	-	qɔn^{55}	*son*	*^{55}	{vl-, -son}	*k > q
A	*paː	*three*	pai^{55}	paːi^{55}	*three*	*^{55}	{vl-, -son}	*p > p
A	*taːɲ	*to weave*	taːn^{55}	-	*to weave*	*^{55}	{vl-, -son}	*t > t
A	*siː	*arm, hand*	ɣam^{33} ti^{55}	ɣəm^{13} ti^{55}	*arm*	*^{55}	{vl-, -son}	*t > t [76]

[73] (cf. pKra *ʈram 'egg' < AA)
[74] (cf. pAA *mp-)
[75] (cf. c~s variation in Vietic)
[76] (irr. *s- in Vietic)

Table 72: *Examples of pVietic and pBolyu {-ʔ} correspondence and pBolyu tone splits from OP*

	pVietic		Bolyu			pBolyu		
	Ferlus (2007)		*Li Xulian (1999)*	*Edmondson (1995)*		*Tone*		*Onset Development*
B	*jə:lʔ	*to be afraid*	ʑu^{11}	lju^{11}	*to fear*	*^{11}	{asp-, -ʔ}	*j > ʑ
B	*ja:mʔ	*to weep*	ʑa:m^{11}	-	*to weep*	*^{11}	{asp-, -ʔ}	*j > ʑ
B	*ku:mʔ	*winnow a paddy*	qham^{11}	-	*to winnow*	*^{11}	{asp-, -ʔ}	*kʰ > qʰ
B	*s-la:ʔ	*leaf*	lɔ^{11} ʔɔ^{53}	lɔ^{31} vi^{55}	*leaf*	*^{11}	{asp-, -ʔ}	*sl > ʰl
B	*s-ma:ʔ	*rice seedling*	muɔ^{11} te^{53}	mɔ^{31}	*seed*	*^{11}	{asp-, -ʔ}	*sm > ʰm
B	*s-ɲa:jʔ	*far*	ɲai^{11}	-	*far, distant*	*^{11}	{asp-, -ʔ}	*sɲ > ʰɲ
B	*k-la:ŋʔ	*kite*	muɔ^{31} lja:ŋ^{31}	mɔ^{53} lja:ŋ^{31}	*eagle, hawk*	*^{31}	{vd-, -ʔ}	*kal > l
B	* mɛ:ʔ	*mother > female*	ma^{31}	ma^{31}	*mother, female*	*^{31}	{vd-, -ʔ}	*m > m
B	*-lɛ:mʔ	*to lick*	li:m^{31}	ljim^{31}	*to lick*	*^{31}	{vd-, -ʔ}	*l > l
B	*ŋəmʔ	*to suck*	ŋam^{31}	ŋəm^{31}	*to suck*	*^{31}	{vd-, -ʔ}	*ŋ > ŋ
B	*-ci:mʔ	*bird*	san^{53}	sən^{53}	*bird*	*^{53}	{vl-, -ʔ}	*c > tɕ~ɕ~t͡s~s
B	*ci:nʔ	*ripe, cooked*	-	tɕin^{53}	*cooked, ripe*	*^{53}	{vl-, -ʔ}	*c > tɕ~ɕ~t͡s~s
B	*ʔa-cɔ:ʔ	*dog*	t͡su^{53}	t͡su^{53}	*dog*	*^{53}	{vl-, -ʔ}	*c > tɕ~ɕ~t͡s~s
B	*ci:nʔ	*nine*	ɕən^{53}	ɕən^{53}	*nine*	*^{53}	{vl-, -ʔ}	*c > tɕ~ɕ~t͡s~s
B	*ci:ʔ	*head louse*	-	ɬai^{53} mbu^{55}	*louse*	*^{53}	{vl-, -ʔ}	*Cac > ɬ
B	*kəmʔ	*to bury*	qam^{53} tham^{13}	-	*to brood, hatch*	*^{53}	{vl-, -ʔ}	*k > q
B	*t-ka:mʔ	*bran*	qa:m^{53} mbə^{53}	-	*bran*	*^{53}	{vl-, -ʔ}	*k > q
B	*ʔa-ka:ʔ	*fish*	qɔ^{53}	qɔ^{53}	*fish*	*^{53}	{vl-, -ʔ}	*k > q
B	*k-hɔ:jʔ	*smoke*	se^{53} kui^{53}	-	*smoke*	*^{53}	{vl-, -ʔ}	*kah > k
B	*k-ha:lʔ	*tiger*	kui^{53}	-	*tiger*	*^{53}	{vl-, -ʔ}	*kah > k
B	*k-ra:ʔ	*path*	muɔ^{31} kɣɔ^{53}	mɔ^{31} kɣɔ^{53}	*road*	*^{53}	{vl-, -ʔ}	*kr > kɣ
B	*po:nʔ	*four*	pu:n^{53}	pu:n^{53}	*four*	*^{53}	{vl-, -ʔ}	*p > p
B	*p-ru:ʔ	*six*	piu^{53}	pju^{53}	*six*	*^{53}	{vl-, -ʔ}	*pr > pj
B	*sa:mʔ	*eight*	sa:m^{53}	sa:m^{53}	*eight*	*^{53}	{vl-, -ʔ}	*s > s
B	*ʔa-sa:mʔ	*blood*	sa:m^{53}	sa:m^{53}	*blood*	*^{53}	{vl-, -ʔ}	*s > s
B	*s-ro:ʔ	*taro*	muɔ^{31} hu^{53}	-	*taro*	*^{53}	{vl-, -ʔ}	*sr > ʰr > x > h
B	*taŋʔ	*bitter*	tɕaŋ^{53}	tɕaŋ^{53}	*bitter*	*^{53}	{vl-, -ʔ}	*t > tɕ~t͡s
B	*tʰu:lʔ	*rotten*	t͡san^{53}	t͡sən^{53}	*stinky, smelly*	*^{53}	{vl-, -ʔ}	*t > tɕ~t͡s

Table 73: *Examples of pVietic and pBolyu {-T} correspondence and pBolyu tone splits from OP*

	pVietic		Bolyu			pBolyu		
	Ferlus (2007)		*Li Xulian (1999)*	*Edmondson (1995)*		*Tone*		*Onset Development*
D	*do:k	*poison*	-	tɔk^{31}	*poison*	*^{31}	{vd-, -T}	*d > t
D	*mo:c	*one*	mə^{33}	ma:i^{31}	*one*	*^{31}	{vd-, -T}	*m > m
D	*k-rək	*strong*	ɣək^{31}	-	*strength*	*^{31}	{vd-, -T}	*kar > r > ɣ
D	*-suk	*hair, feather*	suk^{53}	suk^{53}	*hair, feather*	*^{53}	{vl-, -T}	*s > s
D	*k-ce:t	*to die*	ɬet^{53}	ɬjit^{53}	*to die*	*^{53}	{vl-, -T}	*Cac > ɬ
D	*p-sət	*to put out (a fire)*	ɬet^{53}	-	*to extinguish*	*^{53}	{vl-, -T}	*Cas > ɬ
D	*pat	*wring*	pjit^{53}	-	*to wring*	*^{53}	{vl-, -T}	*p > p
D	*pɔ:c	*pull out*	po:k^{53}	-	*to pull up (weeds)*	*^{53}	{vl-, -T}	*p > p

Table 74: *Examples of non-correspondence between pVietic and pBolyu {-son} and {-ʔ}*

	pVietic		Bolyu			pBolyu		
	Ferlus (2007)		*Li Xulian (1999)*	*Edmondson (1995)*		*Tone*		*Onset Development*
A	*k-ɓe:	*star*	pau^{31}	qə^{31} pau^{31}	*star*	*^{31}	{vd-, -ʔ}	*b > p
A	*k-maɲ	*broken rice*	-	mən^{31}	*rice (broken)*	*^{31}	{vd-, -ʔ}	*m > m
B	*-maɲʔ	*salty*	mja:n^{13}	mja:n^{13}	*salt*	*^{13}	{asp-, -son}	*Cam > ʰm
B	*c-maɲʔ	*to hear*	-	məŋ^{33}	*to hear*	*^{33}	{vd-, -son}	*m > m
B	*buŋʔ	*stomach*	mbo:ŋ^{55}	mbu:ŋ^{55}	*liver*	*^{55}	{vl-, -son}	*ɓ > mb
B	*cɔ:jʔ	*banana*	-	tɕu:i^{55}	*banana*	*^{55}	{vl-, -son}	*c > tɕ~ɕ~t͡s~s
B	*p-səɲʔ	*snake*	ɬaŋ^{55}	ɬa:ŋ^{55}	*snake*	*^{55}	{vl-, -son}	*Cas > ɬ
B	*kɛ:ŋʔ	*wing*	qaŋ^{55}	qa:ŋ^{55}	*wing, fin*	*^{55}	{vl-, -son}	*k > q
B	*k-rə:jʔ	*thread*	ɣa:i^{55}	ɣa:i^{55}	*thread*	*^{55}	{vl-, -son}	*kar > r > ɣ
B	*kwe:ʔ	*honeybee*	kɣa:i^{55}	mɔ^{31} ka:i^{55}	*bee*	*^{55}	{vl-, -son}	*kw > kɣ~k

4.6.2 Tonogenesis in Li Xei: A Previously Undocumented Bahnaric Language

I recently had the opportunity to record a word list for Li Xei, a previously undocumented Bahnaric language spoken in Phước Sơn district, Quảng Nam province, Vietnam. The language is certainly Bahnaric, as demonstrated by the three distinctively Bahnaric lexical innovations that it exhibits (Sidwell 2015a, 183) and the forms of the numerals, which correspond to those reconstructed for pBahnaric in all cases (see Table 75).

Table 75: *Lexical evidence demonstrating that Li Xei is a Bahnaric language*

	pBahnaric	**Li Xei**	**Note**		**pBahnaric**	**Li Xei**	**Note**
one	*muəj	/muəj^{1}/		*six*	*t(n)raw	/juaw^{1}/	**nr > j*
two	*ɓaːr	/paɛ̯^{2}/	*-*ar > aɛ̯*	*seven*	*tpəh	/tpajʰ^{1}/	
three	*pɛː	/pəj^{1}/		*eight*	*t(n)haːm	/tʰam^{1}/	
four	*puən	/puat^{1}/	*-*n > t*	*nine*	*tceː$_{2}$n	/cit^{1}/	*-*n > t*
five	*pɗam	/tap^{2}/	*-*m > p*	*ten*	*ɟɨt	/mcət^{2}/	
bone	*k͡tsɨːŋ	/ksek^{1}/	*-*ŋ > k*	*fire*	*ʔuɲ	/ʔət^{1}/	*-*ɲ > t*
tongue	*lpiət	/piɛ̯ˀ^{1}/	*-*iət > iɛ̯ˀ*				

The place of Li Xei within Bahnaric is uncertain because of the paucity of data and the language's highly restructured phonology, but it does appear to share the diagnostic combination of innovations unique to North Bahnaric as suggested by Sidwell (2002a, 2009), namely, the lenition of affricate pBahnaric *t͡s and the fronting of pBahnaric *ɨː (see Table 76).

Table 76: *Phonological innovations suggesting Li Xei may best be classified as North Bahnaric*

	pBahnaric	**Li Xei**	**Note**		**pBahnaric**	**Li Xei**	**Note**
*PB *ɨː > fronted*				*PB *t͡s > lenited*			
banana	*prɨːt	/pliʔ^{1}/	*-*it > iʔ*	*to carry*	*t͡su(ː)j	/suəj^{1}/	
bone	*k͡tsɨːŋ	/ksek^{1}/	*-*ŋ > k*	*bone*	*k͡tsɨːŋ	/ksek^{1}/	*-*ŋ > k*

Whether or not Li Xei is correctly classified as North Bahnaric, the desegmental phonology of the language differs markedly from the other North Bahnaric languages to the south. I find no evidence for any register development conditioned by VH in Li Xei and the Rengao Model has played no part here. Instead, the language has developed a four-term desegmental phoneme inventory which could be classified as either a complex register contrast similar to that of Chong (see Section 4.10) or a four-tone inventory similar to that of Rục (see Section 2.4.1.2). In historical phonological terms, the language is more similar to Rục, given that both languages have followed the Vietnamese Model (OP + CP) (cf. the desegmentalization box for Li Xei in Table 77). In synchronic terms, on the other hand, one could argue that the language is more similar to Chong, as both Li Xei and Chong employ the same four voice quality distinctions among their desgmental phonemes (modal, breathy, creaky and breathy-creaky).[77]

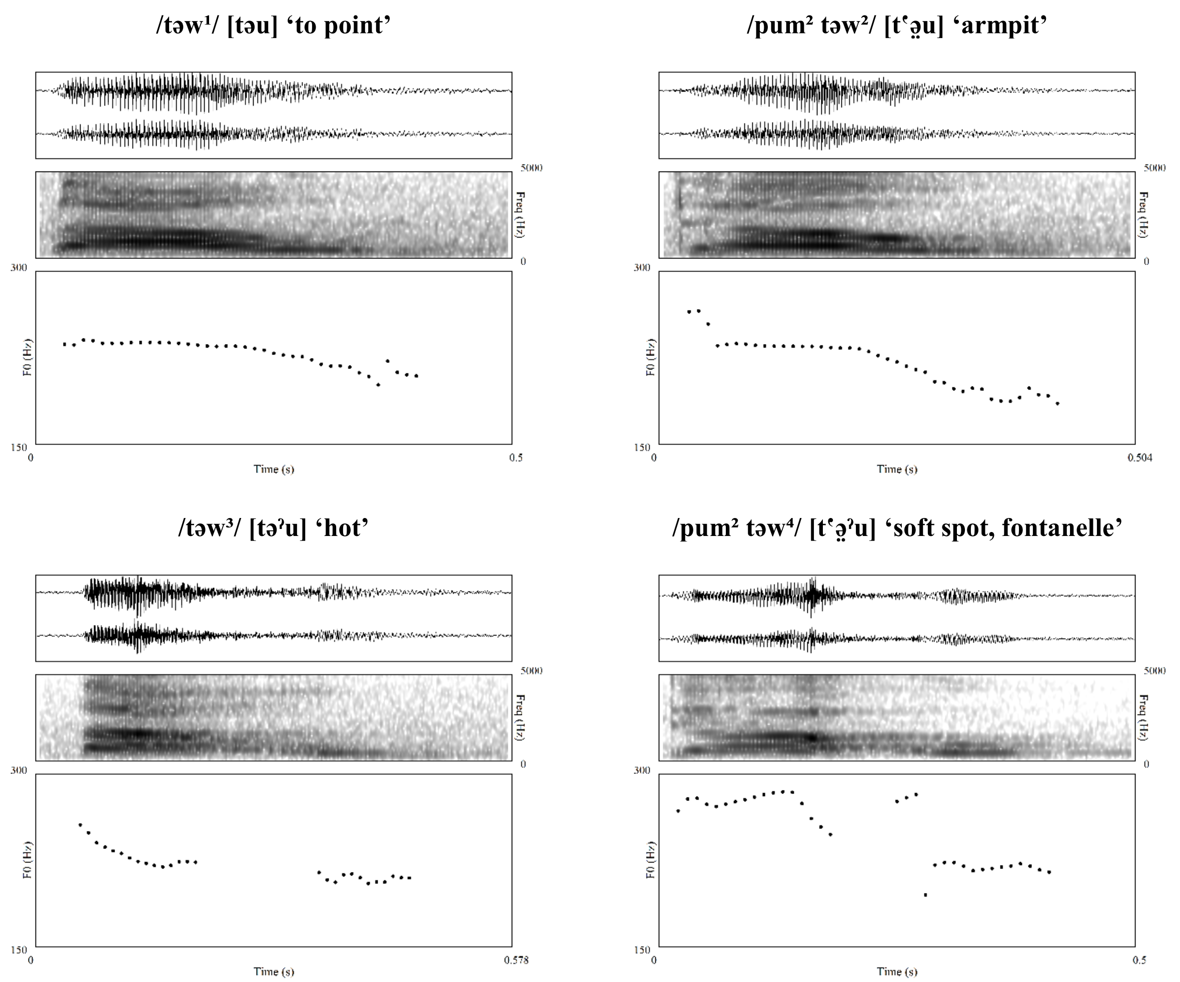
Table 77: *Desegmentalization box for Li Xei*

<table>
<tr><td>other</td><td>/^{1}/
modal</td><td rowspan="2">other</td></tr>
<tr><td>{D-}</td><td>/^{2}/
breathy</td></tr>
<tr><td>other</td><td>/^{3}/
creaky</td><td rowspan="2">{-ʔ}</td></tr>
<tr><td>{D-}</td><td>/^{4}/
breathy-creaky</td></tr>
</table>

[77] In the two breathy tones (/^{2}/ and /^{4}/), breathy voice is strongest earlier in the rime, immediately following stop release. In words with the breathy-creaky tone, the rime begins breathy and then rapidly tenses, approaching a full glottal hiatus or, in some cases, achieving it, before laxing into modal voice. This parallels the situation in Chong exactly (see Section 4.10).

The visualizations in Figure 14 exemplify the four desegmental phonemes of Li Xei in a minimal quadruplet of /təw^{1}/ ‘to point with the finger’, /pum^{2} təw^{2}/ ‘armpit’, /təw^{3}/ ‘hot’ and /pum^{2} təw^{4}/ ‘soft spot, fontanelle’.[78] No systematic acoustic investigation of this language has yet been undertaken, but my impression is that pitch is not a primary cue in Li Xei desegmental phonology. The most reliable cues appear to be difference in voice quality and, in the case of the low register tones /^{2}/ and /^{4}/, delayed stop VOT. The low register tones occur following historically voiced stops only. The two creaky tones appear only in open syllables or syllables closed by a semivowel approximant in native etyma, however, in Vietnamese loans from the *sắc-nặng* tone category (historically, {-ʔ}), we find examples of creaky tones with nasal codas (e.g. /ɲuəm^{3}/ ‘dye’ < Vietnamese <nhuộm>). We also find conservative coda fricative /-h/ in Vietnamese loans from the *hỏi-ngã* tone category (historically, {-H}) (e.g. /cuəh^{1} bɛn^{3}/ ‘to cure, heal’ < Vietnamese <chữa bệnh>). The segmental fricative coda does not appear to induce any tensing of the rime, unlike in Vietnamese and in the Jeh Model (see Section 4.7).

Figure 14: *Example wave forms, spectrograms and pitch traces for Li Xei desegmental phonemes*

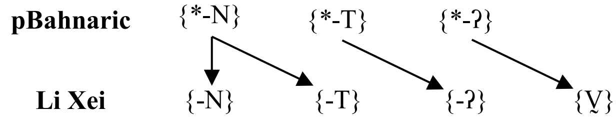


The desegmentalization of pBahnaric *ʔ codas is part of a broader chain shift affecting pBahnaric coda manner of articulation and phonation type in Li Xei. This chain shift, summarized in Table 78, involves a phase shift from rime-final glottalization {-ʔ} to rime-medial laryngealization, the debuccalization of oral stop codas {-T} to

[78] Note that there is likely a historical morphological relationship between /pum^{2} təw^{2}/ ‘armpit’ and /pum^{2} təw^{4}/ ‘fontanelle, soft spot’. The nature of this relationship is unclear, but the [təw] words behave as typical Tone 2 and Tone 4 words, respectively.

rime-final glottalization and the partial denasalization of nasal stop codas {-N} to oral stop codas. This coda denasalization is blocked in syllables with a nasal stop or glottal consonant in the onset.[79]

Table 78: *A chain shift effecting Li Xei coda phonation categories*



The examples in Table 79 demonstrate the Li Xei coda phonation chain shift. Voiceless fricative codas {-H} remain unchanged, as do open syllables. Coda liquids have been vocalized to a front, non-close semivowel approximant /-ɛ̯/ or simply deleted, depending on the preceding vowel's quality (e.g. *ʔiər 'chicken' > /ˀjiɛ̯^{1}/, *kuel 'to bark' > /koɛ̯^{1}/). Coda *-t has lenited to a glottalized version of the same approximant /ɛ̯ˀ/ or simply debuccalized to /ʔ/, again, depending on the quality of the vowel which precedes it (e.g. *mat 'eye' > /maɛ̯ˀ^{1}/, *prɨːt 'banana' > /pliʔ^{1}/). Because /ɛ̯ ɛ̯ˀ/ combine freely with most vowels, their distribution is equivalent to the other semivowel approximants /j jˀ/ and /w wˀ/. For this reason, they are interpreted as coda consonants rather than vocalic off-glides.

Table 79: *Examples of Li Xei coda manner and phonation shifts*[80]

		pBahnaric	Li Xei			pBahnaric	Li Xei
***-ʔ desegmentalized**	*hot*	*toʔ	/taw^{3}/	**Liquids vocalized or deleted**	*mortar*	*tpal	/paɛ̯^{1}/
	short	*ˀlɛʔ	/ˀlɛj^{3}/		*forget*	*wəl	/tvəɛ̯^{1}/
	shatter	*laʔ	/la^{3}/		*dig*	*ciːr	/sɛ^{1}/
	sick	*ɟiʔ	/ci^{4}/		*deer*	*ɟil	/cɛ^{2}/
	carry on back	*ɓaʔ	/pa^{4}/		*sap*	*ɟar	/caɛ̯^{2}/
	deep	*ɟruʔ	/cuəw^{4}/		*two*	*ɓaːr	/paːɛ̯^{2}/
***-T debuccalized**	*egg*	*ktap	/ktaʔ^{1}/	**Open syllables unchanged**	*eat*	*caː	/sa^{1}/
	eye	*mat	/maɛ̯ˀ^{1}/		*rat*	*knɛː	/knɛj^{1}/
	hair	*sɔk	/sɔʔ^{1}/		*hand*	*tiː	/ti^{1}/
	water	*ɗaːk	/taːʔ^{2}/		*thigh*	*bluː	/plu^{2}/
	wipe away	*ɟuːt	/cəɛ̯ˀ^{2}/		*armpit*	*dɔː	/təw^{2}/
	monkey	*ɗok	/tɔʔ^{2}/		*forest*	*briː	/pi^{2}/
***-N denasalized**	*bird*	*ceː$_{2}$m	/ksiəp^{1}/	**Nasals unchanged after *N-**	*blood*	*bhaːm	/mhaːm^{1}/
	child	*kɔːn	/kɛt^{1}/		*pimple*	*muːn	/mun^{1}/
	tail	*tiəŋ	/tɛk^{1}/		*fang*	*gniəŋ	/knɛŋ^{1}/
	long time	*ɗuːɲ	/tut^{2}/		*night*	*maŋ	/maŋ^{1}/
	full	*ɓeː$_{4}$ɲ	/pit^{2}/		crossbow	*pnaɲ	/pnɛŋ^{1}/
	seek	*daŋ	/tak^{2}/		year	*cnam	/snam^{1}/

4.7 The Jeh Model (VH + CP)

Just one example of the combination of VH and CP is found, and that is in the Jeh language, which lends its name to the *Jeh Model*. Jeh is a North Bahnaric language, and, as such, has developed a register contrast along the Rengao Model pattern (see Sections 2.5.2 and 4.4). However, unlike in the North Bahnaric languages discussed so far, voiceless fricative coda phonation {-H} (< pBahnaric *-h and *-s) has also desegmentalized in a documented variety of Jeh, introducing an innovative third register marked by vowel laryngealization. This tensing of voice quality preceding {-H} is also found in varieties of another North Bahnaric language, the Todrah language (see the Todrah Model in Section 4.12) and, of course, in Vietnamese, where {-H} produced the laryngealized *hỏi-ngã* tones (Haudricourt 1954) (see Section 2.4.1).

[79] cf. comparable final nasal fortition rules in other Bahnaric languages, including Cua/Kor (Sidwell 2010), Katua (Smith 1970), Takua (Burton 1972), Mơdra (Gregerson & Smith 1973)

[80] The pBahnaric reconstructions are Sidwell's (2011). The Li Xei transcriptions are my own.

Gradin (1966) divides the Jeh language along a north-south axis, using the modern reflexes of historical {-H} codas as a shibboleth. He reports that northern varieties of Jeh retain the segmental coda fricatives, but southern varieties have in their place a sharply rising pitch toward the end of the syllable and laryngealization midway through the syllable rime, comparable to that of the Vietnamese *ngã* tone (i.e. [V̰] or [$V^{ʔ}V$]). As a result, the historical binary register contrast of earlier Jeh, which is still retained in Northern Jeh high and low registers, is split and doubled via the desegmentalization of {-H} into four desegmental phonemes in Southern Jeh, as demonstrated in the desegmentalization boxes in Table 80. Note that superscript numbers /^{1} ^{2} ^{3} ^{4}/ are employed here to transcribe the four desegmental phonemes of Southern Jeh.

Table 80: *Desegmentalization boxes for northern and southern Jeh varieties (Gradin 1966)*

Northern Jeh		
	/^{H}/ *high register*	/^{L}/ *low register*
	{more open V}	**{closer V}**

Southern Jeh			
	/^{1}/ *modal level pitch*	/^{2}/ *breathy level pitch*	**others**
	/^{3}/ *creaky rising pitch*	/^{4}/ *breathy-creaky rising pitch*	**{-H}**
	{more open V}	**{closer V}**	

The examples comparing northern and southern Jeh varieties given in in Table 81 are provided by Gradin (1966). The transcription of the desegmental phonemes in both Northern and Southern varieties has been modified from Gradin's system to match the conventions used in Table 80.

Table 81: *Comparison of reflexes of {-H} in northern and southern Jeh*

	Northern Jeh		**Southern Jeh**		**pNorth Bahnaric**
to scythe	/teh^{H}/	[tɛh]	/te^{3}/	[tɛ^{ʔ}ɛ]	-
loud	/daj^{hH}/	[daih]	/daj^{3}/	[da^{ʔ}i]	*das 'loud'
sand	/coːj^{hH}/	[cɔːih]	/coːj^{3}/	[cɔː^{ʔ}i]	*cuas 'sand'
calf of leg	/puəj^{hH}/	[puəih]	/puəj^{3}/	[puə^{ʔ}i]	*puas 'calf of leg'
down there	/tiəh^{L}/	[ti̤əh]	/tiə^{4}/	[ti̤^{ʔ}ə]	*teːh 'there (downward)'
flexible	/puəh^{L}/	[pṳəh]	/puəh^{4}/	[pṳ^{ʔ}ə]	-

Based on Gradin's description of the phonetic correlates of Southern Jeh register and the rising tone derived from historical {-H}, we may summarize the phonetic correlates of Southern Jeh tones as presented in Table 82. Gradin described voice quality in the low register as a "deep, somewhat gruff voice quality" produced by "relaxing the faucal pillars, lowering the larynx and giving increased pressure from the diaphragm." Vowel quality in the low register is described as raised relative to the high register. The Southern Jeh four-term desegmental phoneme inventory is notably similar to that of Li Xei (Section 4.6.2 above) and that of Chong (see Section 4.10 below), though all three inventories came about by different desegmentalization models.

Table 82: *Phonetic correlates of Southern Jeh tones*

	Pitch	**Voice Quality**	**Vowel Quality**
/^{1}/	*begins mid, level*	*modal*	*more open*
/^{2}/	*begins lower, level*	*breathy*	*closer*
/^{3}/	*begins mid, rises*	*creaky*	*more open*
/^{4}/	*begins lower, rises*	*breathy-creaky*	*closer*

4.8 The Muak Sa'ak Model (VL + CP)

The Muak Sa'ak language is the only documented example of a language combining VL and CP. As a result, this desegmentalization model is labeled the *Muak Sa'ak Model*. Because the details of VL-conditioned tonogenesis in Muak Sa'ak were already presented in Chapter 2, we need not repeat them here; the reader is referred to Section

2.5.3 above. The desegmentalization box summarizing Muak Sa'ak tonogenesis in Table 83 is offered here for reference.

Table 83: *Desegmentalization box for Muak Sa'ak*

3		**{-son}**
	2	**{-ʔ}**
		{-T}
1		**{-H}**
{Vː}	**{V̆}**	

4.9 The Kriang Model (OP + VH)

Having now surveyed all simple desegmentalization models, including those which involve CP, we begin in this section to review complex desegmentalization models. By way of review, complex desegmentalization models combine two or three primary desegmentalization processes and, like simple desegmentalization models, may combine with CP as well (see discussion above in Section 3.1). The combination of all three primary desegmentalization processes was not encountered in this survey, neither with CP nor without it, but examples of each possible two-way desegmentalization process combination were forthcoming. All three such two-way combinations are attested in combination with CP (see Sections 4.10 through 4.12 below), but complex desegmentalization models without CP proved to be uncommon. Only one such combination is attested: the combination of OP + VH, which is referred to here as the Kriang Model.

We have already discussed in detail above the effect that OP can have on vowel height in the context of Khmer model registrogenesis and the register-conditioned restructuring of vowel height (see Sections 2.3.2 and 4.3). We have also seen how, in the Rengao model (see Section 4.4), the directionality of conditioning in the register-vowel height relationship may be reversed, leading to innovative register contrasts conditioned by VH. Furthermore, we have seen how this may happen even in the absence of OP, as the North Bahnaric examples in Tables 57 through 64 demonstrate. In this section, it will be shown how the complex interaction between onset phonation and vowel height may also result in register languages, in which the distribution of register has been conditioned by a combination of both OP and VH (i.e. the Kriang Model). This third way for register formation was already introduced above in Section 2.5.4, where the registrogenetic pattern of Kriang was discussed. Further examples are offered here below.

4.9.1 Minimal VH Influence (Kriang Model or Khmer Model?)

The relative influence of OP and VH in Kriang Model register languages is variable. In the simplest scenario, OP drives register formation in the expected manner and VH's only contribution is to trigger the neutralization of register contrast in certain vowel height series. In fact, we have already seen an example of this in Khmer, where in both the Standard and Northern dialects, register has conditioned vowel quality splits in nearly every Middle Khmer vowel with the exception of the diphthongs *iə *ɨə *uəː. In modern Standard Khmer, the reflexes of the diphthongs are /iə ɨə uə/ and, in Northern Khmer, they are /ɪː ɪ̈ː ʊː/ regardless of the historical phonation type of the onsets which preceded them (see Section 2.4.2.2).

Khmer is not alone in this. Another example is found in the Lavi language (< West Bahnaric < Bahnaric). The only available primary data on this innovative and, unfortunately, moribund register language comes from L-Thongkum (2001). PB *voiced stops are devoiced and transcribed as voiceless stops in the data. Based on a careful study of L-Thongkum's Lavi data in comparative Bahnaric perspective, I propose the vocalic inventory for Lavi in Table 84.[81]

[81] There are a number of differences between the phoneme inventory presented in L-Thongkum (2001) and those which actually appear in the data. The inventory I propose here only includes those which appear in the lexical data. Three additional diphthongs not listed in the inventory in Table 84 here appear in the data as well: /^{u}eː/, /^{i}ɔː/ and /^{u}a/, each of which appears one time only. I have interpreted these as transcriptional variants of /uə/, /iə/ and /uə/, respectively, based on external comparisons and taking into consideration the apparent internal structure of Lavi vocalism. There are also two rising diphthongs which occur only rarely and exclusively in open syllables: /əɨ/ and /aɨ/. These are interpreted here as vowel + coda glide sequences /əɰ/ and /aɰ/. In Lavi, PWB

Table 84: *L-Thongkum's (2001) Lavi vowel inventory*[82]

iə		ɨə		uə							
iː		ɨː		uː		i		ɨ		u	
eː	ⁱeː	əː	ⁱəː	oː	ᵘoː	e	ⁱe	ə	ⁱə	o	ᵘo
ɛː	ⁱɛː	aː	ⁱaː	ɔː	ᵘɔː	ɛ	ⁱɛ	a	ⁱa	ɔ	ᵘɔ

We see a symmetrical, 9-monophthong inventory, doubled for length contrast with a typical inventory of three mid-target diphthongs (/iə ɨə uə/). However, there are also many additional diphthongs which come in both long and short varieties. These extra diphthongs are the raised-onset, low register reflexes of historical non-close monophthongs. The long, raised-onset mid vowels /ⁱeː ⁱəː ᵘoː/ have maintained contrast with the mid-target diphthongs /iə ɨə uə/. It is unclear what phonetic difference there is between /ɨə/ and /ⁱəː/ (transcribed /ɯə/ and /ɯ̯ɤ/, respectively), but they must be distinct in some way, because /ⁱəː/ corresponds to PWB *əː after voiced stop onsets and /ɨə/ corresponds to PWB *ɨː, which has diphthongal reflexes in Lavi.[83]

Transcription issues aside, Lavi's relevance to the Kriang Model is the apparent neutralization of register contrast in the close vowels and diphthongs. This is surprising, given the robust evidence for a register contrast among the mid and open monophthong series, but Lavi is not alone in this. Close vowel register neutralization is documented in two Katuic languages. Gehrmann (2015, 2016) discusses how the Kuay Ntra variety of Kuay shows a neutralization of register contrast among the reflexes of pKuay long close vowels *iː, *ɨː and *uː, all of which are found in the low register exclusively. Neutralization of register is also common among diphthongs in various modern Bru varieties, as will be demonstrated below.

When this pattern of OP-conditioned register neutralization within a vowel height series occurs in a language, the influence of VH is minimal compared to that of OP. While this registrogenetic pattern fits the definition of Kriang Model desgmentalization, it is probably best to conceptualize it as occupying a gray space between pure Khmer Model and pure Kriang Model registrogenesis. If not, Khmer itself would not qualify as a Khmer Model register language and little classificatory insight would be gained by muddying the waters in this way. We may, therefore, consider Khmer, Lavi and Kuay Ntra to be Khmer Model register languages in which register has been neutralized in certain vowel height series, rather than Kriang Model register languages in which VH has played only a small role.

4.9.2 Well-Integrated OP + VH in Kriang and Bru

We now consider examples of true Kriang Model register formation. The complex interaction between OP and VH in Kriang has already been introduced in Section 2.5.4, so the details will not be repeated here. Instead, we will examine the emergence and evolution of register in pBru (< West Katuic < Katuic) and the modern Bru languages, which follow a somewhat different pattern, but one that is likewise sensitive to conditioning from both onset phonation and vowel height.

Register contrast across the modern Bru languages is almost entirely cognate. This suggests that register formation was already complete at the pBru stage and that registrogenesis was current during a period between pKatuic and pBru which we will refer to here as simply pre-pBru to avoid the complications of Katuic sub-classification. Register contrast was robust in pBru and each of the reconstructed pBru vowels had a pair of register-conditioned allophones. My own reconstructed vocalisms for pKatuic and pBru are presented in Table 85.

coda *l has lenited to a central glide /ɰ/. Another rising diphthong, /iɨ/ appears in three words, always between a devoiced *d onset and a /k/ coda. This is interpreted as an allophone of /ɨ/.

[82] In the source lexical data, long diphthongs are indicated using with the IPA subscript symbol for non-syllabic vowels and short are unmarked. I have re-transcribed the diphthongs to IPA standard here (e.g. *ie̯ ie* = /ⁱeː ⁱe/).

[83] Note that there are many words which should be modern Lavi /ɨə/ based on their extra-Lavi correspondences, which are nevertheless transcribed as /ɯɤ/ in this data set.

Table 85: *pKatuic and pBru vocalic inventories*

pKatuic[84]						
*	ia	ɨa	ua			
	iː	ɨː	uː	i	ɨ	u
	eː	əː	oː	-	ə	o
	ɛː	ɨɜ	uɔ	ɛ	ɨ̆ɜ	ŭɔ
		aː	ɔː		a	ɒ

pBru						
*	ia		ua			
	iə	ɨə	uə			
	iː	ɨː	uː	i	ɨ	u
	eː	əː	oː	e	ə	o
		aː	ɔː		a	ɔ

The origins of pBru register are quite complex and their description relies on a broad investigation of the correspondences between vowels and registers right across the modern Katuic languages. What is presented here, then, is necessarily an introductory overview of this issue. More detail is provided in my unpublished reconstruction of pKatuic phonology and lexicon, in which patterns of register formation in the branch are in focus. Copies are available upon request for those who want to take a closer look at the data supporting this analysis (Gehrmann 2021b).

To begin with, a desegmentalization box for pBru is presented in Table 86, which demonstrates that the reconstructed pKatuic vowel phonemes may be divided into two sets based on the patterns of register assignment evident in their pBru reflexes. In Set 1, which includes non-close monophthongs and the open-target diphthongs *ia and *ua, the unmarked pattern of register assignment pertains, with all voiceless onsets conditioning high register and all voiced onsets conditioning low register. A different pattern is evident among reflexes of the pKatuic close monophthongs and mid-target diphthongs. In this second vowel set, low register is unexpectedly found following voiceless stop onsets (*p *t *c *k), but otherwise, register is conditioned by onset voicing as expected.[85] The open-target diphthong *ɨa does not pattern with the other open target diphthongs and is included under Vowel Set 2. At this time, it is unclear why *ɨa behaves differently.

Table 86: *Desegmentalization box for registrogenesis in pre-pBru*

<table>
<tr><td>{other vl-}</td><td rowspan="2">*H</td><td>*H</td></tr>
<tr><td>{T-}</td><td rowspan="2">*L</td></tr>
<tr><td>{vd-}</td><td>*L</td></tr>
<tr><td></td><td>Vowel Set 1
Non-Close Vowel Pattern

<u>Non-Close Monophthongs</u>
{ eː ə(ː) o(ː) ɛ(ː) a(ː) ɒ(ː) }

<u>Open-Target Diphthongs</u>
{ ia ua }</td><td>Vowel Set 2
Close Vowel Pattern

<u>Close Monophthongs</u>
{ i(ː) ɨ(ː) u(ː) }

<u>Mid-Target Diphthongs</u>
{ ɨə uɔ ɨ̆ɜ ŭɔ }

<u>and</u>
{ ɨa }</td></tr>
</table>

There is a logic behind the sub-classification of the pKatuic vowels into two sets here, which involves vowel height. Obviously, the split in the monophthongs has to do with vowel height as the close vowels are in Set 2 and the non-close vowels are in Set 1. We have seen this division before in Kriang and this is why pBru register falls under the Kriang Model. Register assignment among the diphthongs is also explicable with respect to vowel height. It is usually the case among those modern Katuic languages with two diphthong series that one series begins with a steady state close vowel and then glides down to a mid-vowel target (e.g. /iə/ [iːᵊ]) and the other series glides from a near-

[84] If we compare this pKatuic vowel inventory to that reconstructed for pAustroasiatic (see Table 52), the primary difference is the innovation of the open-mid glided vowels *ɨɜ *uɔ *ɨ̆ɜ and *ŭɔ and the central vowels *ɨː and *ɨa. Note that Sidwell & Rau (2015) tentatively reconstruct pAustroasiatic *ie and *uo based on pKatuic *ɨɜ and *uɔ, which were already identified as pKatuic diphthongs in Sidwell's (2005) pKatuic reconstruction, though spelled differently.

[85] It should be noted that the pKatuic glottalized/implosive stops (*ɓ *ɗ *ʄ) and glottal consonants (*h *ʔ) behave as voiceless consonants for the purposes of pBru register assignment.

close or close mid vowel down to a steady state open mid vowel (e.g. /ia/ [ˈɐː]). This was almost certainly the case in pKatuic as well and it is, therefore, quite natural to find that the steady state close vowels present at vowel onset for pKatuic mid-target diphthongs has resulted in these diphthongs patterning with close vowels for the purposes of register assignment. Setting *ɨa aside, it is likewise natural to find the open-target diphthongs patterning with non-close vowels. It should also be noted that pBru exhibits a split in the reflexes of pKatuic *ia and *ua, such that the majority of their modern reflexes are in fact non-close monophthongs in Bru languages today.

A result of the bifurcation of the pKatuic vowel phonemes into two categories for the purposes of register assignment in pre-pBru is a differential skewing in the ratio of high to low register incidence in the reflexes of the various pKatuic vowels. The non-close vowel pattern (Set 1) results in a skewing towards high register and the close vowel pattern (Set 2) results in a skewing towards low register in pBru vowel phonemes. This skewing in register proportion persists in most cases in modern Bru languages, which has allowed for the observation and documentation of this phenomenon (Gehrmann 2015, 2016, 2019). However, there are pBru vowel phonemes in which this register skewing has been rebalanced via partial mergers of pKatuic vowel phonemes with different register skewing (i.e. one vowel from Set 1 and one vowel from Set 2). A difference in the proportion of high and low register among phonetically similar vowels presents an inviting opportunity for vowel quality merger with minimal loss of contrast. The historical phonemic contrast, formerly upheld by vowel quality, would be mostly maintained in this scenario, provided the difference of register distribution endures. There is clear evidence that kind of partial merger is the origin of a number of pBru phonemes, including pBru *iː and *uː. Figure 16 demonstrates how reflexes of pKatuic *iː and *uː, being mostly in low register, and reflexes of pKatuic *eː and *oː, being mostly in high register, merged to pBru *iː and *uː in terms of their vowel qualities, while retaining their differential register categories.

Figure 15: *Complementary imbalance of register distribution and merger in pre-pBru close long vowels*

pKatuic *iː	>	(iː^{H})	iː^{L}			pKatuic *uː	>	(uː^{H})	uː^{L}		
		↓	↑	>	**pBru *iː$^{H/L}$**			↓	↑	>	**pBru *uː$^{H/L}$**
pKatuic *eː	>	eː^{H}	(eː^{L})			pKatuic *oː	>	oː^{H}	(oː^{L})		

In fact, there is evidence for six such mergers with retention of historical register category in pBru *iː, *uː, *ə, *o, *ia and *ua. All other pBru vowel phonemes were either skewed towards high register if they were descended from non-close, Set 1 pKatuic vowels or towards low register if they were descended from close, Set 2 pKatuic vowels. Table 87 summarizes the development of register in the pre-pBru period and the status of register skewing among the resulting pBru vowel phonemes. This demonstrates clearly how both onset voicing and vowel height influenced the development of register in pBru and its distribution in modern Bru languages.

Table 87: *Register formation in pre-pBru and register skew among pBru vowels*[86]

	pKatuic		pre-pBru				pBru	Register Skew
Diphthongs	***ɨɜ [ɨːᵌ]**	>	*ɨɜ$^{(H)/L}$	>	*ɨə$^{(H)/L}$	>	*ɨə$^{(H)/L}$	*Low*
				>	*iə$^{(H)/L}$	>	*iə$^{(H)/L}$	*Low*
	***ɨa [ᵊɐː]**	>	*ɨa$^{(H)/L}$	>	*ia$^{(H)/L}$	>	***ia$^{H/L}$**	***Balanced***
	***ia [ᴵɐː]**	>	*ia$^{H/(L)}$	>	*ia$^{H/(L)}$			
				>	*eː$^{H/(L)}$	>	*eː$^{H/(L)}$	*High*
	***uɔ [uːᵓ]**	>	*uɔ$^{(H)/L}$	>	*uə$^{(H)/L}$	>	*uə$^{(H)/L}$	*Low*
				>	*ua$^{(H)/L}$	>	***ua$^{H/L}$**	***Balanced***
	***ua [ᵘɐː]**	>	*ua$^{H/(L)}$	>	*ua$^{H/(L)}$			
				>	*oː$^{H/(L)}$	>	*oː$^{H/(L)}$	*High*
Long Monophthongs	***iː [iː]**	>	*iː$^{(H)/L}$			>	***iː$^{H/L}$**	***Balanced***
	***eː [eː]**	>	*eː$^{H/(L)}$					
	***ɛː [ɛː]**	>	*ɛː$^{H/(L)}$			>	*ɛː$^{H/(L)}$	*High*
	***uː [uː]**	>	*uː$^{(H)/L}$			>	***uː$^{H/L}$**	***Balanced***
	***oː [oː]**	>	*oː$^{H/(L)}$					
	***ɒː [ɒː]**	>	*ɒː$^{H/(L)}$			>	*ɔː$^{H/(L)}$	*High*
	***ɨː [ɨː]**	>	*ɨː$^{(H)/L}$			>	*ɨː$^{(H)/L}$	*Low*
	***əː [əː]**	>	*əː$^{H/(L)}$			>	*əː$^{H/(L)}$	*High*
	***aː [aː]**	>	*aː$^{H/(L)}$			>	*aː$^{H/(L)}$	*High*
Short Monophthongs	***i [i]**	>	*i$^{(H)/L}$			>	*i$^{(H)/L}$	*Low*
	***ɛ [ɛ]**	>	*ɛ$^{H/(L)}$			>	*ɛ$^{H/(L)}$	*High*
	***u [u]**	>	*u$^{(H)/L}$			>	*u$^{(H)/L}$	*Low*
	***o [o]**	>	*o$^{H/(L)}$			>	***o$^{H/L}$**	***Balanced***
	***ŭɔ [uᵓ]**	>	*ŭɔ$^{(H)/L}$					
	***ɒ [ɒ]**	>	*ɒ$^{H/(L)}$			>	*ɔ$^{H/(L)}$	*High*
	***ɨ [ɨ]**	>	*ɨ$^{(H)/L}$			>	*ɨ$^{(H)/L}$	*Low*
	***ə [ə]**	>	*ə$^{H/(L)}$			>	***ə$^{H/L}$**	***Balanced***
	***ɨ̆ɜ [ɨᵌ]**	>	*ɨ̆ɜ$^{(H)/L}$					
	***a [a]**	>	*a$^{H/(L)}$			>	*a$^{H/(L)}$	*High*

It is noteworthy that Bru registrogenesis presents a rare amalgam of Khmer Model and Rengao Model registrogenesis. In the Khmer Model, register contrast forms via onset phonation-conditioned splits in historical vowel phonemes and, in the Rengao Model, register contrast forms via vowel height-conditioned mergers between historical vowel phonemes. Bru is the only language I am aware of with a simple, binary register contrast that arose via both Khmer Model and Rengao Model register formation strategies at the same time. This is an interesting potentiality of the Kriang Model, one which is not realized in Kriang itself, but must be understood to accurately model the development of Bru register and will perhaps prove necessary in explaining the emergence of register in other Kriang Model register languages that have not yet been documented.

[86] Note the phonemic splits in this table involving pKatuic *ia, *ua, *ɨɜ and *uɔ.

4.9.3 VH and Consonants: Semivowel Glides and Palatal Consonant Transitions

In the discussion on Kriang registrogenesis in Section 2.5.4, it was mentioned without further comment that two of the pKatuic's palatal consonants, /j/ and /ɟ/, pattern with the historically voiced stops forming a "low series" of consonants for the purposes of Kriang register formation. This low series conditions low register irrespective of the vowel height of a following vowel. The palatal glide /j/ (< pKatuic *j) is articulated as expected ([j]) and the palatal stop /ɟ/ (< pKatuic *ʄ) is produced as a pre-stopped glide [^{ɟ}j] today (Gehrmann 2017). Note that the reflexes of the other pKatuic glottalized/implosive stops, *ɓ and *ɗ (> Kriang /b/ and /d/), do not pattern with the pKatuic voiced stops in the Kriang low series (see Table 37). This is a peculiarity of the palatal glottal/implosive.

In the Lawa language (< Waic < Palaungic), we find a separate, similar phenomenon where four palatal onsets from pWaic (*j, *^{h}j, *ɲ, *^{h}ɲ) pattern with the pWaic voiced stops to condition low register, even though other pWaic voiced sonorant onsets do not condition low register and despite the fact that two of those palatal consonants are voiceless. In addition, two back sonorants from pWaic (*w and *^{h}w) also join in this category of consonants that condition low register (Diffloth 1980, 56).

This apparent irregularity in Kriang and Lawa, when viewed in light of the broader desegmentalization paradigm, may be taken as evidence that, in certain cases, vowel height desegmentalization can be conditioned by consonants as well as vowels. Diffloth, searching for a common property shared between devoicing stops and fricativizing sonorants proposes the term "buzziness", invoking both the "noisy" release into breathy phonation accompanying devoicing stops and the "noisy" frication that is inherent in the modern realization of pWaic semivowels and the palatal nasal.[87] However, if we take into account the parallelism between Lawa and Kriang and incorporate what we have learned in the intervening decades about the role that vowel height can play in register assignment, a better-supported hypothesis may be offered.

All of the sonorants listed as being associated with low register in Kriang and Lawa are produced with significantly raised tongue positions in places of articulation that overlap with those of close vowels. As the connection between close vowels and low register is uncontroversial, a more straightforward explanation is that the close vowels inherent in the semivowels themselves or the close vowel articulations introduced by the raised vocalic transition from a palatal consonant to a following vowel are being desegmentalized in these languages and affecting the distribution of register. As a result, close vocalic transitions from onset consonants can and should be modeled as VH effects when they play a role in tone or register formation; they should not be misconstrued as onset phonation desegmentalization, even though they originate in segmental onsets. The desegmentalization boxes for Kriang and Lawa in Table 88 demonstrate how this may be accomplished by using {C^{i}-} to indicate onset consonants with inherent close vowel transitions. This {C^{i}-} should be placed below the box along with any other VH conditioning environments.

Table 88: *Desegmentalization boxes for Lawa and Kriang*

Lawa	**other**	H	L
	{D-}	L	
		other	**{C^{i}-}**

Kriang	**{T-, *s-}**	H		
	other			
	{D-}		L	
		{open V}	**{non-open V}**	**{C^{i}-}**

[87] Diffloth states that the semivowel glides *j *^{h}j *w and *^{h}w are now produced with "a great deal of friction" in Lawa, approaching [z], [s], [v] and [f], respectively. He further notes that "the release of ɲ- is also very fricative" (Diffloth 1980, 50).

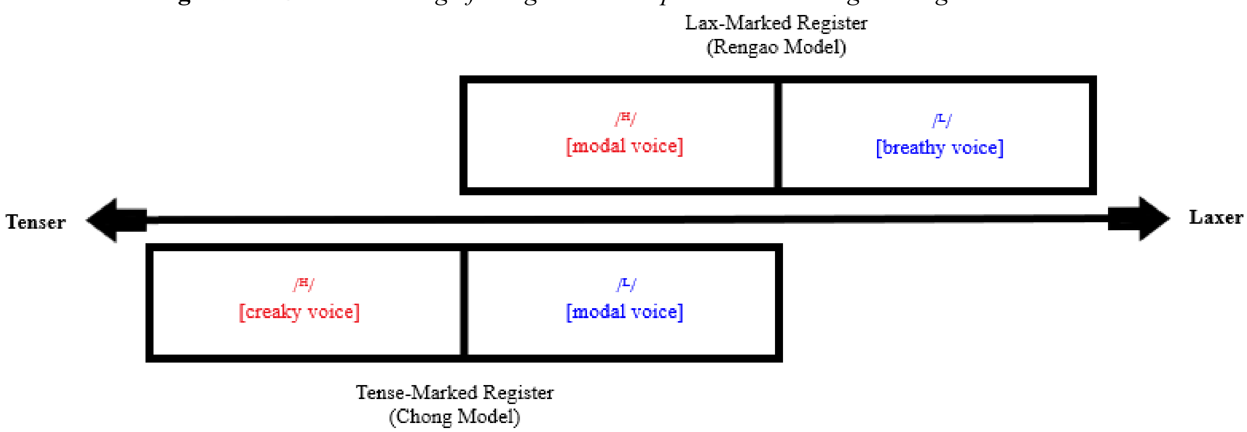
4.10 The Chong Model (OP + VH + CP)

4.10.1 OP and the General Tensing of Rengao Model Register Contrast

At this point, we will begin to investigate the most complex desegmentalization models found in this survey of Austroasiatic desegmentalization. We have no examples of a desegmentalization model which combines all three primary desegmentalization processes and CP, but every possible combination of two primary desegmentalization processes plus CP are attested. We start by introducing the Chong Model, which is in essence an extension of the Rengao Model (i.e. VH only), complicated by the addition of OP and CP. In this section, four languages that have been affected by a combination of OP, VH and CP (Chong, Sedang, Ta'oiq and Stieng) are discussed. The combination of these desegmentalization processes creates a four-term desegmental phoneme inventory as in Chong and Stieng, which may subsequently simplify into a two-term inventory as in Sedang and Ta'oiq.

The Chong model is named for the Chong language (< Chongic < Pearic). Chong and its close relatives under the Chongic sub-branch of Pearic is one of three examples of a register contrast which has undergone *general tensing*, by which the voice quality correlates of the historical high and low registers have shifted from modal and breathy to creaky and modal, respectively (see Figure 16). The other examples are found in Sedang (< Bahnaric) and Ta'oiq (< Katuic). We are fortunate to have three apparently discrete examples from three separate branches of Austroasiatic to compare, because each one offers complementary evidence for a shared model of how the general tensing of a register contrast may come about. Although the modern register contrasts in these three languages differ somewhat, it is quite clear that they share an evolutionary trajectory and that each language's development can be understood in light of the other two.

Figure 16: *General tensing of a register developed via vowel height desegmentalization*



We begin with Sedang, which offers us direct evidence for the general tensing of a register contrast. Sedang's closest relatives in the North Bahnaric sub-branch of Bahnaric (Rengao, Hre, Halang, Jeh, etc…) have register contrasts which are *lax-marked*, which is to say that the low register, the register which is comparatively lax in laryngeal terms, is the more phonetically marked of the two registers. The low register is characterized by non-modal voice quality: breathy voice. Sedang, on the other hand, is a *tense-marked* register language, as its high register is the one with non-modal phonation: creaky voice. Despite the phonetic differences between Sedang's register contrasts and that of its siblings, their register contrasts are nevertheless histroically cognate (Smith 1972), having evolved via the reanalysis of Proto-Bahnaric vowel height contrasts (Sidwell 2015b).

So we see that Sedang is innovative compared to the other North Bahnaric languages with respect to the phonetic correlates of its two registers. This raises the question of why or, perhaps more to the point, how? If we search for an explanation within Sedang itself, there is one striking difference between Sedang and the other North Bahnaric register languages that recommends itself as a possible explanation; Sedang alone among the North Bahnaric languages has devoiced the pNorth Bahnaric voiced stops.[88] Is there perhaps a case to be made that vowel height-conditioned register contrasts may be disrupted by OP and the registrogenetic process that this entails? It is a promising hypothesis, but modern Sedang has no desegmental phonemes which are cognate with pNorth Bahnaric onset voicing contrasts. Consequently, there is no direct evidence that conventional, onset phonation-conditioned registrogenesis has confounded the phonetics of its earlier, vowel height-conditioned register contrast.

This brings us to Ta'oiq, which offers confirmation that the register pattern of Sedang is not unique. Ta'oiq is not a North Bahnaric language; it is a Katuic language that is spoken over 200 kilometers away from Sedang, as the crow flies, over high mountains, deep jungles and a national border. Nevertheless, in much the same way as Sedang, Ta'oiq developed a register contrast which is cognate with vowel quality contrasts in related languages (Gehrmann 2015, 2019, 2021b). Furthermore, that register contrast is tense-marked today and pKatuic voiced stop onsets are devoiced without any remaining registral reflex of the old onset voicing contrast (Ferlus 1974a, Diffloth 1989). Again, onset devoicing appears to be implicated in the general tensing of a register contrast, but we lack direct evidence.[89]

This is where the Chongic languages dovetail with Sedang and Ta'oiq to provide the "missing link". Very little remains of the Pearic branch of Austroasiatic. All of the Pearic languages are endangered and those languages which remain and/or have been documented are quite uniform in phonological terms (Ferlus 1979, 2011; Headley 1985a, Sidwell 2019). Unlike for Sedang and Ta'oiq, we have no evidence for a more conservative Pearic language with vowel height contrasts that are cognate with register contrasts in Chongic languages. Nevertheless, internal reconstruction clearly indicates that close vowels were associated with a historically lax register (Sidwell 2019), and this is exactly the same pattern found in North Bahnaric (including Sedang) and Ta'oiq. Crucially, Chongic languages retain direct evidence that this older, vowel height-conditioned register contrast was interrupted and changed with the advent of a newer register contrast that developed via OP, because both contrasts still exist today. Chongic languages exhibit a unique *double register* contrast, which integrates the older vowel height-conditioned pattern and the newer onset phonation-conditioned pattern into a unitary register complex that opposes four registers rather than two. The older register contrasts underwent general tensing, such that older low register became associated with modal voice and the older high register with creaky voice. This freed up the marked phonetic cue of [breathy voice] to become associated with the new low register, cognate with historical onset voicing, and introduced the marked phonetic cue of [creaky voice] to become associated with the older high register, cognate with historically non-close vowel qualities. The result is the desegmental phoneme inventory presented in the desegmentalization box in Table 93.[90]

Table 89: *Desegmentalization box for Chongic languages*

{vl-}	/^{1}/ modal	/^{3}/ creaky
{vd-}	/^{2}/ breathy	/^{4}/ breathy-creaky
	{close V}	**other**

Taken together, Sedang, Ta'oiq and Chongic demonstrate the pathway by which the general tensing of a vowel height-conditioned register contrast may be triggered by conventional registrogenesis from onset voicing. Only Chongic retains a double register contrast, while in Sedang and Ta'oiq, onset phonation-conditioned registrogenesis did not result in the phonemicization of extra registers. Sedang and Ta'oiq did begin down that road - the tensing of

[88] Note that pBahnaric *implosives and *voiced stops were merged to pNorth Bahnaric *voiced stops (Smith 1972, Sidwell 2011)

[89] Pacoh, another language of the Katuic branch, also has a register contrast that developed out of historical vowel quality differences (Diffloth 1982b, Gehrmann 2015) and also has undergone pKatuic stop devoicing without developing cognate register contrasts. Furthermore, there is some evidence that the high register involves tenser-than-modal phonation, but vowel quality remains by far the most reliable acoustic correlate to Pacoh register contrast (Gehrmann 2022). Pacoh does appear to have developed along the Chong Model, which was referred to as *pseudoregister formation* in Gehrmann (2022) – a term which is new deprecated in favor of the desegmentalization terminology proposed here in this thesis. Pacoh differs in eschewing or abandoning marked differences in voice quality between the two registers, leading to what appears to be the gradual loss of register in this language.

[90] Various phonetic studies are available on the Chongic double register phenomenon (e.g. L-Thongkum 1991, Edmondson 1996, DiCanio 2009).

older vowel height-conditioned registers and the devoicing of *voiced stops testify to this - but it is unclear why OP failed to crosscut and split the older, VH-conditioned register in Sedang and Ta'oiq while it succeeded in doing so in Chongic.

The progression in Figure 17 summarizes the series of developments proposed for the Chong Model. Note that the point at which any of these developments becomes phonemic will depend on other factors in the language. For this reason, Stages 1 and 2 in Figure 17 represent sub-phonemic developments in the distribution of voice quality and Stages 1a, 2a and 2b represent examples of how the phonologized voice quality features may become phonemic.

Figure 17: *The progression of Chong Model registrogenesis and general tensing*

Stage 1: Early Rengao Model
(e.g. Sre)

[breathy]	[modal]
{close}	**other**

Stage 1a: Rengao Model
(e.g. Rengao, General North Bahnaric)

$/^{L}/$ [breathy]	$/^{H}/$ [modal]
{close}	**other**

Stage 2: Early Chong Model
(Unattested)

{vl-}	[modal]	[creaky]
{vd-}	[breathy]	[breathy-creaky]
	{close}	**other**

Stage 2a: Chong Model Type 1 - Double Register
(e.g. Chongic Languages)

{vl-}	$/^{1}/$ [modal]	$/^{3}/$ [creaky]
{vd-}	$/^{2}/$ [breathy]	$/^{4}/$ [breathy-creaky]
	{close}	**other**

Stage 2b: Chong Model Type 2 - Single, Tensed Register
(e.g. Sedang, Ta'oiq)

{vl-} **{vd-}**	$/^{L}/$ [modal]	$/^{H}/$ [creaky]
	{close}	**other**

The resulting desegmental contrast is sufficiently different between Chong on the one hand and Sedang / Ta'oiq on the other that we are justified in naming the latter a *Sedang Variant* of the Chong Model.

4.10.2 Coda Deletions and Coda Mutations in Tense-Marked Register Languages

Up to this point, we have focused only on the repercussions of OP and VH on Chong Model register languages, but in all three of the languages reviewed above, CP applies as well. In Sedang, register contrast was neutralized to the low register before {-H}, {-ʔ} and {-T} in conjunction with various coda consonant deletions in the high register (Smith 1968, 1972, 1973). These developments are summarized in the more detailed desegmentalization box for Sedang in Table 90, which shows the development of both register and coda consonants. Recall that Sedang is a tense-marked register language, and so $/^{H}/$ is marked by creak and $/^{L}/$ by modal voice. The column headers $*^{H}$ and $*^{L}$ refer to the earlier, Rengao Model register contrast in Sedang before general tensing occurred. The creaky voiced high register conditioned the deletion of coda oral stops and coda fricatives with an accompanying shift to low register. Because coda glottal stops from pBahnaric {-ʔ} have been deleted in both registers with a parallel shift to low register for historical *-Vʔ^H rimes, it is likely that high register words with {-T, -H} finals shifted to glottalized rimes first before a general deletion of rime glottalization occurred.[91]

Table 90: *Register development and final consonant deletions in Sedang*

<table>
<tr><th>*H</th><th>*L</th><th></th></tr>
<tr><td>V(N)^H</td><td>V(N)^L</td><td>{-son}</td></tr>
<tr><td rowspan="3">V^L</td><td></td><td>{-ʔ}</td></tr>
<tr><td>VH^L</td><td>{-H}</td></tr>
<tr><td>VT^L</td><td>{-T}</td></tr>
</table>

In Ta'oiq, we find coda consonant mutations rather than deletions under the creaky high register (Ferlus 1974a, Diffloth 1989, Gehrmann 2019). pKatuic coda oral stops lenite to glottalized sonorants or a simple glottal stop segment in the case of coda *-k with accompanying shift to low register. Laryngealization shifts to post-glottalization for coda nasals in the high register, but only for short vowels. Vowel length contrast is neutralized before the fricatives *-s and *-h and the rhotic trill *-r. Table 91 summarizes the effects of high register on coda consonants and vowel length in modern Ta'oiq and demonstrates how the distribution of high register in modern Ta'oiq has been affected by CP (see gray-shaded cells).

Table 91: *Modern Ta'oiq reflexes of pKatuic rimes*

<table>
<tr><th></th><th>*-ø</th><th>*-ʔ</th><th>*-p</th><th>*-t</th><th>*-c</th><th>*-k</th><th>*-m</th><th>*-n</th><th>*-ɲ</th><th>*-ŋ</th><th>*-l</th><th>*-r</th><th>*-j</th><th>*-w</th><th>*-s</th><th>*-h</th></tr>
<tr><td>*V:^L</td><td>V:</td><td>V:ʔ</td><td>V:p</td><td>V:t</td><td>V:c</td><td>V:k</td><td>V:m</td><td>V:n</td><td>V:ɲ</td><td>V:ŋ</td><td>V:l</td><td>V:r</td><td>V:j</td><td>V:w</td><td>V:s</td><td>V:h</td></tr>
<tr><td>*V^L</td><td></td><td>Vʔ</td><td>Vp</td><td>Vt</td><td>Vc</td><td>Vk</td><td>Vm</td><td>Vn</td><td>Vɲ</td><td>Vŋ</td><td>Vl</td><td>Vr</td><td>Vj</td><td>Vw</td><td>Vs</td><td>Vh</td></tr>
<tr><td>*V:^H</td><td>V̰:</td><td>V:ʔ</td><td>V:mˀ</td><td>V:nˀ</td><td>V:jˀ</td><td>V:ʔ</td><td>V̰:m</td><td>V̰:n</td><td>V̰:ɲ</td><td>V̰:ŋ</td><td>V̰:l</td><td rowspan="2">V̰:r</td><td>V̰:j</td><td>V̰:w</td><td rowspan="2">V̰:s</td><td rowspan="2">V̰:h</td></tr>
<tr><td>*V^H</td><td></td><td>Vʔ</td><td>Vmˀ</td><td>Vnˀ</td><td>Vjˀ</td><td>Vʔ</td><td>Vmˀ</td><td>Vnˀ</td><td>Vɲˀ</td><td>Vŋˀ</td><td>V̰l</td><td>V̰j</td><td>V̰w</td></tr>
</table>

Chong has experienced neither coda deletions nor mutations and retains the pPearic coda consonants intact. Nevertheless, CP has had an effect on register distribution, as words with glottal fricative codas {-H} are found to be in non-creaky registers only. This indicates that general tensing was blocked in this environment. General tensing was also blocked in words beginning with a glottal consonant in Chong. The desegmentalization box in Table 92 gives a more detailed summary of register development in Chong.[92]

Table 92: *Desegmentalization box for Chong*

<table>
<tr><td rowspan="2">{vl-}</td><td colspan="2" rowspan="3">/¹/ [modal]
/³/ [creaky]</td><td>{-H}</td></tr>
<tr><td>other</td></tr>
<tr><td>{glot-}</td><td></td></tr>
<tr><td rowspan="2">{vd-}</td><td colspan="2" rowspan="2">/²/ [breathy]
/⁴/ [breathy-creaky]</td><td>{-H}</td></tr>
<tr><td>other</td></tr>
<tr><td></td><td>{close}</td><td>other</td><td></td></tr>
</table>

4.10.3 Stieng and the Possibility of F0-Prominent Output for the Chong Model

Finally, there is another language, Stieng (< South Bahnaric < Bahnaric) which has developed a four-term desegmental phoneme contrast under essentially identical conditioning to the Chong Model presented above. Bon

[91] Further coda consonant mutations under the high register are documented in certain Sedang dialects, as discussed in Smith (1968, 1973), but the main dialect that was targeted in Smith's extensive work on Sedang is described here.

[92] Analysis of Chong registrogenesis is currently ongoing. Sidwell (2019) presented initial findings and the summary presented here is a synthesis of his report and my own subsequent analysis of the comparative lexical database of Pearic, which he has kindly made available.

(2014) compares the phonologies of two varieties of Cambodian Stieng: one from Bok Snual village (BS) and one from Têêh Dôm village (TD). Bon describes the emergence of two desegmental phonemes in Stieng TD, which she characterizes as tones. A rising tone has developed in etyma with pBahnaric final fricatives *-h and *-s, which have subsequently disappeared leading to merger with open rimes /-ø/ and rimes in final /-j/ respectively. The same rising tone contour is found in words descended from pSouth Bahnaric *close vowels, whether they remain phonetically close vowels in modern Stieng TD or have undergone vowel quality changes. In all other environments, a falling tone is found in native South Bahnaric etyma. The examples in Table 93 are extracted from Bon (2014) to illustrate these developments. pSouth Bahnaric reconstructions are from Sidwell (2000).

Table 93: *Examples of vowel height and coda phonation desegmentalization in Stieng TD*

	PSB		**Stieng TD**		**PSB**		**Stieng TD**
Non-Fricative	*pa:j	*flesh*	/pâ:j/	**Non-Close V**	*kət	*tie up*	/kə̂t/
Fricative	*pa:s	*cotton*	/pǎ:j/	**Close V**	*kit	*frog*	/kə̌t/
Non-Close V	*siar	*pipe*	/cʰî:r/	**Non-Close V**	*do:k	*monkey*	/dôk/
Close V	*si:r	*dig*	/cʰǐ:r/	**Close V**	*du:k	*boat*	/dǒk/

Bon also notes that Stieng TD is undergoing OP among reflexes of voiceless and voiced stops, though she does not go into detail and leaves this as a topic for future investigation. Assuming that a register contrast is now splitting the rising and falling tones, the desegmentalization box in Table 94 summarizes Stieng TD tonogenesis. If we compare this to Table 92, we see that the Stieng TD's four tones are distributionally equivalent to Chong's four registers. Falling tone contour is equivalent to creak in the Chong context and rising contour to the absence of creak. All of this is highly suggestive that Stieng TD is another example of a double register language in which the older, VH-conditioned register contrast has shifted from being cued by the presence or absence of laryngealization to being cued by differential pitch patterns. Further phonetic investigation of Stieng TD and other Stieng dialects is called for.

Table 94: *Desegmentalization box for Stieng Têêh Dôm*

<table>
<tr><td rowspan="2">{other-}</td><td colspan="2">/^{1}/ [modal, rising]</td><td>{-H}</td></tr>
<tr><td></td><td>/^{3}/ [modal, falling]</td><td>other</td></tr>
<tr><td rowspan="2">{D-}</td><td colspan="2">/^{2}/ [breathy, rising]</td><td>{-H}</td></tr>
<tr><td></td><td>/^{4}/ [breathy, falling]</td><td>other</td></tr>
<tr><td></td><td>{close}</td><td>other</td><td></td></tr>
</table>

4.11 The U Model (OP + VL + CP)

Only one language, U, is documented as having combined OP, VL and CP. U is the third Angkuic language that we have looked at in this thesis, the other two being Hu (see Sections 2.5.1 and 4.5) and Muak Sa'ak (see Sections 2.5.3 and 4.8). Svantesson (1988) presents a toneme inventory of four tones for U: high, low, falling and rising. At first glance, U appears to be the most complex example of desegmentalization documented. As Svantesson (1988, 86) himself states:

> *"U acquired tones in a complicated way. The process will be described here although it is not fully understood in all details. At least four different factors are involved:*
> a) *Vowel length*
> b) *Vowel quality*
> c) *Final consonant type*
> d) *Initial consonant type"*

Though Svantesson asserts that all four desegmentalization processes are involved in U tone formation, it seems that, in fact, what appears to be VH reflects a historical neutralization of vowel length that took place in the close vowels only (a development shared with Hu, see Section 2.5.1). As such, it was not the vowel quality of the close vowels that affected the distribution of tone in U, it was merely the absence of vowel length contrast in this vowel height series that had an impact.

As in Hu, pPalaungic vowel length contrast has desegmentalized as tone in U, but tonal distribution is affected by additional complications. To begin with, pPalaungic short vowels, which are reflected as high tone in Hu, have two tonal reflexes in U, depending on the coda phonation type; words with pPalaungic {-son} coda phonation developed low tone and words with pPalaungic {-T} or coda *-s developed high tone. This would have begun as sub-phonemic, predictable difference of pitch before different coda types, but the pitch difference was phonemicized in conjunction with the denasalization of nasal codas following short vowels in U and their merger with homorganic oral stops (e.g. *aT *aN > *áT *àN > /áT/ /àT/). Examples illustrating these developments drawn from Svantesson (1988) are provided in Table 95. High tone and low tone are transcribed using acute and grave accents, respectively, in U and Hu. Note that there are a few examples of mismatch between Lamet vowel length and Angkuic tone in these examples (the Lamet etyma are in parentheses in these cases), but Hu and U are in agreement.

Table 95: *U tonal reflexes for historically short vowels before {-son} and {-T/s}*[93]

{V̆ -son}				{V̆ -T/s}/			
	U	**Hu**	**Lamet**		**U**	**Hu**	**Lamet**
to die	/jàp/	/jám/	/jàm^{L}/	*cold*	/kʰát/	/kʰát/	/kat^{H}/
to wash	/sùp/	/θúm/	(/hú:m^{H}/)	*to bite*	/káʕ/	/kák/	/kak^{L}/
claw	/ncʰìp/	/nθím/	(/lmhí:m^{H}/)	*rice*	/sáʕ/	/θák/	-
five	/sàt/	/paθán/	/pʰán^{H}/	*to break*	/pʰɨ́ʕ/	-	/pɨk^{H}/
heavy	/kèt/	/ncɛ́n/	/kcɛ̀n^{L}/	*to boil*	/ʔalɨ́ʕ/	-	/rlɨk^{L}/
to shoot	/pʰèt/	/pʰɨ́ɲ/	/pɨ́ɲ^{H}/	*hair*	/súʕ/	/θúk/	/kʰuk^{H}/
termite	/ŋqʰùt/	/maʁúɲ/	(/prù:ɲ^{L}/)	*to swell*	/ʔáʕ/	/pʰaʔát/	/ʔɛs^{H}/
horse	/ŋqʰàʕ/	/maʁáŋ/	/mràŋ^{L}/	*charcoal*	/sé/	/kʰasét/	/krsas^{H}/
fire	/ŋàw/	/ŋál/	/ŋàl^{L}/	*to count*	/kí/	-	/krɨs^{L}/
silver	/mùn/	/mm̥úl/	(/kmù:l^{L}/)				
to fly	/mpʰə̀/	/pʰɨ́ʁ/	/mpɨ́r^{H}/				

The situation among historically long vowels before {-son} or {-T/s} coda types is yet more complicated, we find three separate tones in these environments in U, all of which correspond to Hu low tone (< {V:}). In words with long vowels before {-T/s}, U has developed a rising tone, as demonstrated in the examples in Table 96.

93 Velar stop codas have debuccalized in U to back vocalic offglides, resulting in a shift from *-k to a creaky and/or pharyngealized [ɑ̰ˤ]. Svantesson interprets the reflex of coda *k as a segmental voiced pharyngeal fricative /ʕ/. This happened subsequent to the historical hardening of final nasals, as evidenced by the fact that reflexes *-ŋ also becomes /ʕ/ when they follow historically short vowels (i.e. *ak *aŋ > *ák *àŋ > *ák *àk > /áʕ/ /àʕ/).

Table 96: *U tonal reflexes for historically long vowels before {-T/s}*

{V: -T/s}			
	U	**Hu**	**Lamet**
to fear	/lăt/	-	/la:t^{H}/
to stay	/ʔŏt/	/ʔòt/	-
sand	/nt͡sʰăt/	/nθàc/	/ma:c^{H}/
buffalo	/qʰăʕ/	/tʰʁàk/	/tra:k^{H}/
sambar deer	/jăʕ/	-	/kja:k^{L}/
chest	/qʰĭʕ/	/pʰʁèk/	/pre:k^{H}/
ear	/sŭʕ/	/nasòk/	/jo:k^{H}/
to laugh	/ɲăʕ/	/nɲàt/	/kɲa:s^{L}/
lightning	/ʔaqʰăʕ/	-	/krsa:s^{H}/

In words with historically long vowel and {-son}, both a falling tone and a high tone are found in U. The falling tone corresponds to voiced onsets and the high tone corresponds to voiceless onsets. Examples are provided in Table 97. Lamet preserves evidence for pPalaungic onset voicing in its register contrast. Both Hu and Lamet preserve evidence of pPalaungic vowel length in their tone and vowel length correspondences, respectively. As a reminder, U and the other Angkuic languages did not have a voicing contrast among stop onsets due to their shared Germanic Shift (see Section 2.5.1).

Table 97: *U tonal reflexes of long vowels before {-son}*[94]

{vl- V: -son}			
	U	**Hu**	**Lamet**
crab	/tʰám/	-	/kta:m^{H}/
four	/pʰón/	/ʔapʰòn/	/po:n^{H}/
white	/pán/	/pàɲ/	(/pa:ɲ^{L}/)
thorn	/χáɑ̃/	-	/ra:ŋ^{H}/
foot	/kíɑ̃/	/cèŋ/	(/ce:ŋ^{L}/)
high	/líɑ̃/	/lèŋ/	/le:ŋ^{H}/
sour	/saʔá/	/θaʔàw/	/sʔa:r^{H}/
two	/ʔá/	/kaʔà/	/ˀla:r^{H}/
fowl	/jɛ́/	/ʔìʁ/	/ʔɛ:r^{H}/
to climb	/sáw/	-	/ha:w^{H}/
three	/wáj/	/kaʔɔ̀j/	/ˀlɔ:j^{H}/
to have	/kʰój/	/kʰòj/	/ko:j^{H}/

{vd- V: -son}				
	U	**Hu**[95]	**Lamet**	
field	/mâ/	/mà/	/ma:r^{L}/	
grandmother	/ɲâ/	-	/ja:^{L}/	
to itch	/ŋâ/	/ŋáʔ/	/ŋa:ʔ^{L}/	
Va	/vâ/	-	-	*cf. pWaic *(r-)waʔ*
door	/ʔavâ/	-	-	*cf. pWaic *r-waʔ*
sugar	/mê/	-	-	*cf. pWaic *rm-meʔ*
you	/mî/	/méʔ/	/mi:ʔ^{L}/	
flower	/χâɑ̃/	/ʁàŋ/	-	*cf. Khmu /ra:ŋ^{L}/*
beautiful	/jɔ̂ɑ̃/	/jɔ̀ŋ/	-	
to cry	/jâm/	/jàm/	/ja:m^{L}/	
tiger	/ʔavâj/	-	/rwa:j^{L}/	

pPalaungic had many words with glottalized coda phonation {-ʔ}, as the pAA prohibition on open syllables was preserved in this branch (see Section 4.2). The pPalaungic glottal stops are now deleted in modern U, but words which had them previously appear in low tone unless the vowel was historically close. The examples in Table 98 demonstrate how U developed low tone in {-ʔ} words for non-close vowels and high tone in {-ʔ} words, irrespective of pPalaungic vowel length contrast (as reflected in the Lamet etyma) in both cases.

[94] Velar nasal codas have debuccalized in U to back vocalic offglides, resulting in a shift from *-ŋ to a nasalized [ɑ̃]. This happened subsequent to the historical hardening of final nasals, as evidenced by the fact that /ɑ̃/ is found only after historically long vowels.

[95] Hu /ŋáʔ/ and /méʔ/ are in high tone because long vowels before glottal stops became short in Hu before the advent of VL (i.e. *V:ʔ V̆ʔ > V̆ʔ).

Table 98: *U tonal reflexes of close and non-close vowels before {-ʔ}*

{non-close -ʔ}				{close -ʔ}				
	U	Hu	Lamet		U	Hu	Lamet	
fish	/kʰà/	-	/kaːʔ^{H}/	*people*	/ʔí/	/ʔí/	/ʔiːʔ^{H}/	
leaf	/là/	/láʔ/	/laːʔ^{H}/	*to do*	/cí/	-	-	*cf. pWaic *g-/jiʔ*
to steal	/ŋqʰà/	/maʁáʔ/	/ntraːʔ^{L}/	*louse*	/ncʰí/	/nsíʔ/	/siʔ^{H}/	
wind	/samà/	/θamáʔ/	/ˀmaːʔ^{H}/	*pine tree*	/kí/	-	-	*cf. pWaic *ŋgiʔ*
tail	/satʰà/	/θatʰáʔ/	/ntaʔ^{H}/	*nature*	/qí/	/pʁíʔ/	/priːʔ^{L}/	
rain	/salè/	/saléʔ/	/slɛːʔ^{L}/	*spirit*	/qí/	/kʁíʔ/	-	
meat	/nè/	/nŋéʔ/	-	*rope*	/sí/	/pasíʔ/	/plsiʔ^{H}/	
earth	/tʰè/	/katʰéʔ/	/ktaʔ^{H}/	*arm*	/tʰí/	/tʰíʔ/	/tiːʔ^{H}/	
louse	/mlì/	-	/mplɛʔ^{L}/	*skin*	/ŋkú/	-	/ŋkuːʔ^{L}/	
tree	/sì/	/θéʔ/	/kʰeːʔ^{H}/	*breast*	/pú/	-	/mpuːʔ^{L}/	
nose	/tì/	/katə́ʔ/	-	*salt*	/qú/	/palúʔ/	/pluːʔ^{L}/	
I	/ʔò/	/ʔɔ́ʔ/	/ʔɔːʔ^{H}/	*sick*	/sú/	-	/suʔ^{H}/	
dog	/sò/	/sɔ́ʔ/	/sɔʔ^{H}/	*hole*	/ntʰú/	-	/ntuʔ^{H}/	
stone	/samò/	/samóʔ/	-	*vegetable*	/tʰú/	-	/tuːʔ^{H}/	
yesterday	/kʰù/	/sŋkʰóʔ/	-					
rice grain	/ŋkʰù/	/ŋkʰóʔ/	-					

As mentioned above, this seemingly vowel height-conditioned tone split in words with {-ʔ} is explicable in light of the neutralization of vowel duration to short in *close vowels. We can imagine the pPalaungic duration contrast before {-ʔ}, which is preserved in Lamet, was neutralized to long at a stage that we may call pre-U-1 (see Table 99). After that, at a Pre-U-2 stage, vowel duration contrast was neutralized to short among close vowels and this would have caused the shortening of close vowels before *ʔ as well. Finally, short close vowels before glottal stop (iʔ) would have developed into the same tone category as short close vowels before oral stops (iT), both developing high tone.

Table 99: *Developments in {-ʔ} and {-T} tones with respect to vowel height and length in U*

<table>
<tr><th colspan="2">pPalaungic</th><th colspan="2">pre-U-1</th><th colspan="2">pre-U-2</th><th colspan="2">U</th></tr>
<tr><td>*aːʔ</td><td>*iːʔ</td><td rowspan="2">*aːʔ</td><td rowspan="2">*iːʔ</td><td rowspan="2">*aːʔ</td><td rowspan="2">*iʔ</td><td rowspan="2">à</td><td rowspan="2">í</td></tr>
<tr><td>*aʔ</td><td>*iʔ</td></tr>
<tr><td>*aːT</td><td>*iːT</td><td>*aːT</td><td>*iːT</td><td>*aːT</td><td rowspan="2">*iT</td><td>ǎT</td><td rowspan="2">íT</td></tr>
<tr><td>*aT</td><td>*iT</td><td>*aT</td><td>*iT</td><td>*aT</td><td>áT</td></tr>
</table>

With this explanation for the split in the {-ʔ} tone, we can eliminate one of the four desegmental processes Svantesson posited for U tonogenesis, namely, vowel height. Difference of vowel height did not directly split the {-ʔ} tone; rather, it was the general shortening of close vowels and the new length distinction that it brought about in glottalized rimes that conditioned the split in {-ʔ}.

We may now present a desegmentalization box for U (see Table 100), which graphically represents the unique combination of VL, OP and CP that has occurred in this language. Note that Svantesson presents only five examples of words which likely had {-H} coda phonation in pre-U and is unable to draw any conclusions about the development of tone in words with *-h codas. We must leave that issue to future research.

Table 100: *Desegmentalization box for U*

{vl-}	L	F	**{-son}**
{vd-}		H	
	H	L	**{-ʔ}**
		R	**{-T}**
	{V̆}	**{Vː}**	

4.12 The Todrah Model (VH + VL + CP)

The combination of VL, VH and CP is uniquely documented in the Todrah language. Gregerson & Smith (1973) discuss the development of register in Didrá and Modra, two varieties of a broader language community that they refer to as *Todrah*, spoken in Kontum province, Vietnam. As North Bahnaric languages, Didrá and Modra developed register via VH as expected (cf. the Rengao Model in Section 4.4), but subsequent desegmentalization of vowel length and coda phonation has altered the distribution of register in these languages. In terms of CP, Didrá and Modra developed in a manner similar to Jeh, undergoing the tensing of register before {-H} (cf. the Jeh Model in Section 4.7). However, unlike in Jeh, only the historical high register underwent tensing before {-H} in Didrá and Modra. Where this has occurred, the coda fricative has been deleted and the rime is described as being laryngealized. As a result, a third desegmental phoneme has been introduced in open syllables, and we will transcribe the desegmental phonemes of Didrá and Modra using three tone numbers. As in the proposed transcription for Southern Jeh above, historical *^{H} becomes /^{1}/ (still cued by modal voice quality), historical *^{L} becomes /^{2}/ (still marked by breathy voice quality) and the new, laryngealized desegmental phoneme is transcribed as /^{3}/. In this case, however, no breathy-creaky desegmental phoneme has arisen (cf. Southern Jeh /^{4}/), because low register words ending in {-H} did not develop laryngealization in Didrá and Modra. These rimes did experience tensing, however, moving from low register to high register and, thereby, filling in the space vacated by *-VH^{H}. This is another example of non-transphonologizational desegmentalization, as the conditioning segmental environment ({-H}) is not lost, even as the distribution of suprasegmental phonemes changes (see Section 3.2.2). Lexical examples are provided in Table 101. Note that pNorth Bahnaric *-s lenites to /j^{h}/ and patterns with *-h in these languages.

Table 101: *Register tensing in {-H} words in Didrá and Modra*

pNorth Bahnaric		**Rengao**	**Didrá**	**Modra**
*pah	*split, cleave*	pah^{H}	paː^{3}	paː^{3}
*blah	*fight*	blah^{H}	təblaː^{3}	təblaː^{3}
*bɔh	*salt*	boh^{H}	bɔː^{3}	bɔː^{3}
*ʔɔh	*younger sibling* [96]	ʔoh^{H}	ʔɔː^{3}	ʔɔː^{3}
*tʔnɛh	*earth/dirt*	təˀnih^{H}	tanɛː^{3}	ˀnɛː^{3}
*mɛh	*that, there*	meh^{H}	mɛː^{3}	mɛː^{3}
*riah	*root*	rih^{H}	rɛː^{3}	reː^{3}
*puas	*calf of leg*	puːs^{H}	puːj^{3}	puːj^{3}
*ruas	*elephant*	ruːs^{H}	ruːj^{3}	ruːj^{3}
*bəs	*snake*	bas^{L}	bɛh^{1}	baj^{h1}
*ksəs	*shoulder*	kət͡sas^{L}	kasɛh^{1}	kat͡saj^{h1}
*ɟoːh	*wet*	həɟoh^{L}	həɟoh^{1}	kəcoh^{1}
*ʔih	*you (sg.)*	ʔih^{L}	ʔɛh^{1}	ʔɛh^{1}
*tpəs	*seven*	təpas^{L}	təpɛj^{h1}	təpɛj^{h1}
*ruh	*wash clothes*	ruh^{L}	rɔh^{1}	roh^{1}
*truh	*arrive*	truh^{L}	trɔh^{1}	troh^{1}
*muh	*nose*	muh^{L}	moh^{1}	moh^{1}

96 The meaning has shifted from 'younger sibling' to 'younger sibling-in-law' in Rengao

In words with {-T} coda phonation, the high register has conditioned the debuccalization of oral stop codas to /ʔ/. This is likely the result of the tensing of high register before {-T}, as this kind of coda stop lenition is associated with laryngealization/creak in other register languages (e.g. Ta'oiq and Sedang – see Section 3.6.1), but these words carry the /^{1}/ tone/register in modern Didrá and Modra. Examples of {-T} debuccalization in the high register are presented in Table 102.

Table 102: *High register coda stop debuccalization in Didrá and Modra*

pNorth Bahnaric		Rengao	Didrá	Modra
*dɔk	*monkey*	dok^{H}	dɔːʔ^{1}	dɔːʔ^{1}
*daːk	*water*	daːk^{H}	deaʔ^{1}	daːʔ^{1}
*haːk	*vomit*	haːk^{H}	hiaʔ^{1}	haːʔ^{1}
*klɔk	*navel*	klok^{H}	klɔʔ^{1}	klɔːʔ^{1}
*ŋɔk	*mountain*	ŋok^{H}	ŋɔʔ^{1}	ŋɔːʔ^{1}
*cok	*punch*	coːk^{H}	-	cɔːʔ^{1}
*[ ]mɔːk	*bark of tree*	^{h}moːk^{H}	kamuːʔ^{1}	-
*tbɔːk	*white*	təboːk^{H}	dəboʔ^{1}	-
*ktap	*egg*	kətap^{H}	sətaːʔ^{1}	-
*mat	*eye*	mat^{H}	maʔ^{1}	maːʔ^{1}
*tʔŋiat	*cold, malaria*	təŋet^{H}	təŋɛʔ^{1}	təŋɛʔ^{1}
*puat	*half, cut in half*	pot^{H}	poːʔ^{1}	pɔːʔ^{1}
*hlat	*die*	^{h}lat^{H}	^{h}laʔ^{1}	^{h}laʔ^{1}
*ʔɲat	*grass*	ɲat^{H}	ɲaːʔ^{1}	-

Historically low register words with {-T} coda phonation are sensitive to VL. Short vowels before {-T} have tensed to modal voice (/^{1}/). Examples comparing low register tensing to /^{1}/ [modal] in {V̆ -T} rimes and conservative /^{2}/ [breathy] in {V̆ -N} rimes are presented in Table 103. Low register words with long vowels before {-T} do not tense to /^{1}/ [modal] as their short counterparts do. They remain conservative /^{2}/ [breathy].

Table 103: *Low register tensing before {-T} for short vowels in Didrá and Modra*

pNorth Bahnaric		Rengao	Didrá	Modra
*sək	*hair*	ʦak^{L}	sak^{1}	sak^{1}
*kət	*tie up*	kat^{L}	kat^{1}	kat^{1}
*ɟət	*ten*	ɟat^{L}	ɟət^{1}	ɟat^{1}
*kɟip	*centipede* [97]	kəɟip^{L}	gaɟɛp^{1}	kacɛp^{1}
*bit	*to stab*	bit^{L}	-	bɛt^{1}
*juk	*cloud*	juk^{L}	jok^{1}	jok^{1}
*mut	*enter*	mut^{L}	mɔt^{1}	mɔt^{1}
*drut	*push*	drut^{L}	ɟrɔːt^{1}	ɟrot^{1}
*ɟip	*sew*	-	ɟɛp^{1}	ɟɛp^{1}
*krəŋ	*knee*	kraŋ^{L}	krak^{2}	kraŋ^{2}
*təŋ	*hear*	taŋ^{L}	tak^{2}	taːŋ^{2}
*biŋ	*full (container)*	biŋ^{L}	bik^{2}	beŋ^{2}
*kən	*large, tall*	kan^{L}	kət^{2}	kən^{2}
*hen	*many*	-	hit^{2}	hin^{2}
*goŋ	*forest land*	guŋ^{L}	-	goŋ^{2}
-	*mouth*	kuŋ^{L}	kuk^{2}	kuŋ^{2}

A final CP process affects Modra only. In Modra, register contrast was neutralized to low before {-ʔ} codas and modern reflexes are in /^{2}/ [breathy], the regular reflex of low register in Modra (see examples in Table 104). The coda /ʔ/ was also deleted. It is unclear what precipitated this general rime deglottalization in Modra, but it is likely part of a push chain event related to the shift from *VT^{H} > /Vʔ^{1}/ described above. This resulted in a large number of

[97] The meaning has shifted from 'centipede' to 'scorpion' in Didrá and Modra

new words with glottalized rimes, and this may have encouraged deglottalization of the historical *Vʔ rimes. That being said, the laxing of *Vʔ^{H} to breathy /V^{2}/ is unmotivated and no explanation can be proposed here.

Table 104: *Desegmentalization of {-ʔ} to /^{2}/ [breathy voiced] in Modra*

pNorth Bahnaric		Rengao	Didrá	Modra
*kraʔ	*old*	kraʔ^{H}	kraːʔ^{1}	kraː^{2}
*waʔ	*want*	waʔ^{H}	waːʔ^{1}	waː^{2}
*ɟɔʔ	*correct*	ɟoʔ^{H}	ɟɔːʔ^{1}	ɟɔː^{2}
*kaʔ	*chew, eat*	kaʔ^{H}	kaːʔ^{1}	kaː^{2}
*diʔ	*finished, all (gone)*	diʔ^{L}	diːʔ^{2} dəŋ^{2}	diː^{2} dok^{2}
*ʔmeːʔ	*bad* [98]	^{ʔ}meʔ^{L}	^{ʔ}meːʔ^{2}	^{ʔ}mɛː^{2}
*ɟiʔ	*sick*	ɟiʔ^{L}	ɟiːʔ^{2}	ɟiː^{2}
*ʔjoʔ	*fear*	juʔ^{L}	juːʔ^{2}	juː^{2}
*ʔuʔ	*suckle, nurse* [99]	ʔuʔ^{L}	ʔuːʔ^{2}	puː^{2} ʔuː^{2}

The desegmentalization boxes for Didrá and Modra in Table 105 summarize the Todrah Model and its combination of VH, VL and CP.

Table 105: *Desegmentalization boxes for Didrá & Modra*

Didrá

<table>
<tr><td rowspan="2">/^{1}/</td><td rowspan="2" colspan="2">/^{2}/</td><td>{-son}</td></tr>
<tr><td>{-ʔ}</td></tr>
<tr><td>/^{3}/
*-H > ø</td><td colspan="2">/^{1}/</td><td>{-H}</td></tr>
<tr><td>/^{1}/
*-T > /-ʔ/</td><td>/^{2}/</td><td>/^{1}/</td><td>{-T}</td></tr>
<tr><td>any</td><td>{Vː}</td><td>{V̌}</td><td></td></tr>
<tr><td>{more open V}</td><td colspan="2">{closer V}</td><td></td></tr>
</table>

Modra

<table>
<tr><td>/^{1}/</td><td colspan="2">/^{2}/</td><td>{-son}</td></tr>
<tr><td colspan="3">/^{2}/
*-ʔ > ø</td><td>{-ʔ}</td></tr>
<tr><td>/^{3}/
*-H > ø</td><td colspan="2">/^{1}/</td><td>{-H}</td></tr>
<tr><td>/^{1}/
*-T > /-ʔ/</td><td>/^{2}/</td><td>/^{1}/</td><td>{-T}</td></tr>
<tr><td>any</td><td>{Vː}</td><td>{V̌}</td><td></td></tr>
<tr><td>{more open V}</td><td colspan="2">{closer V}</td><td></td></tr>
</table>

4.13 Summary

This chapter has presented a framework for identifying and classifying desegmentalization models. Each model may be defined as a unique combination of desegmentalization processes. Out of fourteen hypothetically possible combinations of the three primary desegmentalization processes (OP, VH, VL) and the secondary desegmentalization process (CP), ten were encountered in this survey of Austroasiatic desegmental phonology. Further discussion on the findings of this survey is found in Section 5.1.

In order to provide a concise summary of desegmentalization in Austroasiatic, Table 106 presents all of the Austroasiatic languages surveyed that employ desegmental phonology, arranged according to their relevant desegmentalization models. The languages are arranged by branch and relevant literature is referenced. Note that for a small number of additional Austroasiatic languages with suprasegmental contrasts, the origin of these contrasts is not yet understood. These are introduced in Section 5.2 as proposed avenues for further research.

[98] The meaning has shifted from 'bad' to 'dirty' in Didrá and Modra
[99] The meaning has broadened from 'suckle, nurse' to 'suck' in Didrá and Modra

Table 106: *Summary of Desegmentalization Models in Austroasiatic Languages*

OP	VH	VL	CP	Model	Branch	Language & References
+	-	-	-	**Khmer Model Proper**	**Khmeric**	*Khmer (Ferlus 1992a)*
					Monic	*Mon (Diffloth 1984)*
						Nyah Kur (Diffloth 1984)
					Bahnaric	*Chrau (Tạ et al. 2019)*
						Mnong/Bunong (Phillips 1973, Butler 2010, 2015)
						Ramam/Lamam (Ferlus 1972)
						Juk (L-Thongkum 2001)
						Alak (Huffman 1971)
						Lavi (L-Thongkum 2001, Section 3.9.1)
					Katuic	*Kuay (Ferlus 1971a, 1979; Diffloth 1982b; Gehrmann 2016)*
						Chatong (L-Thongkum 2001)
					Vietic	*Kri (Enfield & Diffloth 2009)*
				Khmu Variant	**Khmuic**	*Northern/Western Khmu (Premsrirat 2001, 2004)*
					Palaungic	*Wa (Diffloth 1980, Watkins 2002, Sidwell 2015c)*
						Riang (Sidwell 2015c)
						Lamet (Ferlus 1979, Sidwell 2015c)
				Va Variant	**Palaungic**	*Yingla Va (Sun 2018)*
-	+	-	-	**Rengao Model**	**Bahnaric**	*Rengao (Smith 1972; Sidwell 2002b, 2015b)*
						Hre (Smith 1972; Sidwell 2002b, 2015b)
						Jeh (Smith 1972; Sidwell 2002b, 2015b)
						Halang (Smith 1972; Sidwell 2002b, 2015b)
						Sre/Koho (Manley 1972)
-	-	+	-	**Hu Model**	**Palaungic**	*Hu (Svantesson 1989, 1991; Sidwell 2015b)*
+	-	-	+	**Vietnamese Model**	**Vietic**	*General Vietic (Haudricourt 1954; Ferlus 1998b)*
					Mangic	*Bolyu (Benedict 1990a, Edmondson & Gregerson 1996)*
					Bahnaric	*Li Xei (Section 4.6.2)*
-	+	-	+	**Jeh Model**	**Bahnaric**	*Jeh (Gradin 1966)*
-	-	+	+	**Muak Sa'ak Model**	**Palaungic**	*Muak Sa'ak (Hall 2010, Sidwell 2015b)*
+	+	-	-	**Kriang Model**	**Katuic**	*Kriang (Gehrmann 2017)*
						Bru (Gehrmann 2016, 2019)
					Palaungic	*Lawa (Diffloth 1980)*
+	-	+	-	*Unattested*		
-	+	+	-	*Unattested*		
+	+	-	+	**Chong Model Proper**	**Pearic**	*Chong (Sidwell 2019)*
					Bahnaric	*Stieng (Bon 2014)*
				Sedang Variant	**Bahnaric**	*Sedang (Smith 1968, 1972, 1973; Sidwell 2002b, 2015b)*
					Katuic	*Ta'oiq (Gehrmann 2015, 2019)*
+	-	+	+	**U Model**	**Palaungic**	*U (Svantesson 1988, 1989; Sidwell 2015b)*
-	+	+	+	**Todrah Model**	**Bahnaric**	*Todrah (Gregerson & Smith 1973)*
+	+	+	-	*Unattested*		
+	+	+	+	*Unattested*		

5 Conclusions and Outlook

5.1 Addressing the Research Questions

We return here to the research questions proposed in Section 1.2. Each question will be addressed in turn, summarizing the findings of this thesis and drawing conclusions where appropriate based on those summaries.

5.1.1 Desegmentalization (Research Question 1)

Research Question 1:
Given that (1) suprasegmental contrasts developed in the vast majority of Mainland Southeast Asian languages under conditioning from historically segmental contrasts and (2) the received models of tonogenesis and registrogenesis for the region are insufficient to capture the diversity of environments in which segmental > suprasegmental sound change may take place, can a broader framework (i.e. desegmentalization*) be designed, which incorporates both the traditional models and the purportedly "unorthodox" models?*

In Chapter 3, the concept of *desegmentalization* was proposed as a unitary framework for tonogenesis and registrogenesis in MSEA languages. The definition of desegmentalization is sufficiently broad so as to incorporate any kind of segmental > suprasegmental sound change, in which the conditioning environment is present on the segmental tier, and the consequence is an alteration in the distribution of suprasegmental contrasts. Furthermore, desegmentalization has not been constrained to transphonologizational sound change only, but to any kind of phonemicization or neutralization of contrast in a language's suprasegmental phonology. It has been stressed that desegmentalization is not a replacement for the concepts of tonogenesis and registrogenesis, but rather a term meant to incorporate both under a superordinate framework which facilitates crosslinguistic comparison of these kinds of sound change.

5.1.2 Desegmentalization Processes (Research Question 2)

Research Question 2:
What kinds of segmental contrast are documented as undergoing segmental > suprasegmental sound change in MSEA (i.e. desegmentalization processes)*?*

Just four desegmentalization processes were found in the Austroasiatic desegmentalization survey:

OP: *onset phonation desegmentalization*
VH: *vowel height desegmentalization*
VL: *vowel length desegmentalization*
CP: *coda phonation desegmentalization*

Three of these, OP, CP and VL, are well known to affect the distribution of tone in languages of the Sinospheric Tonbund (see Section 2.4.1) but VH is an outlier. VH's inclusion here is due to its propensity to condition innovative register contrasts, a development documented in only a few Austroasiatic languages at this point. This humble inventory of four desegmentalization processes is well supported, both among the Austroasiatic languages and, more widely, among the Sinospheric Tonbund languages.

Still, one wonders, "why this particular set of processes?" That differential consonant phonation should interact with suprasegmental phonology based, at least in part, on differences of pitch and voice quality is to be expected, given their shared grounding in laryngeal gestures. Vowel length's and vowel height's interaction with tone and register are more indirect, but hypotheses to explain these connections have been introduced above based on a natural tendency for pitch to lower over time across words and utterances in the former case and, in the latter case, based on strategies related to supralaryngeal cavity expansion.

It remains to be seen whether any further segmental conditioning environments affecting tone / register formation and distribution will need to be added, as additional examples of languages with desegmental phonology are documented and analyzed. If any new desegmentalization processes are forthcoming, the desegmentalization paradigm is ready and able to incorporate them.

5.1.3 Formal Desegmentalization Models (Research Question 3)

Research Question 3:
In what combinations do these desegmentalization processes occur (i.e. desegmentalization models*) and which of them occur more frequently (i.e. in a greater number of discrete cases) than others?*

Ten formal combinations of desegmentalization processes were encountered in the Austroasiatic desegmentalization survey. Consequently, ten desegmentalization models have been identified and labeled as follows:

The Khmer Model:	*OP alone*
The Rengao Model:	*VH alone*
The Hu Model:	*VL alone*
The Vietnamese Model:	*OP + CP*
The Jeh Model:	*VH + CP*
The Muak Sa'ak Model:	*VL + CP*
The Kriang Model:	*OP + VH*
The Chong Model:	*OP + VH + CP*
The U Model:	*OP + VL + CP*
The Todrah Model:	*VH + VL + CP*

Of these, the model that occurs most often within Austroasiatic is by far the Khmer Model. We see this in Table 106 above, where seventeen separate Khmer Model desegmentalization events are listed. This tabulation of examples was created ad hoc, of course, and issues surrounding what should constitute a discrete desegmentalization event or a discrete language are too problematic to engage with here. Nevertheless, the fact that this desegmentalization model occurs in eight separate branches of Austroasiatic shows quite clearly that the Khmer Model is considerably more common and widespread than the other models.

Another notable trend is the diversity of desegmentalization models found within one sub-branch, the Angkuic sub-branch of Palaungic. Three out of the ten proposed models (the Hu, Muak Sa'ak and U Models) are all contained in this one small linguistic grouping. All of these models have in common VL, which is otherwise found only in the Todrah language and its eponymous desegmentalization model. While VL is commonly found to split coda {-T} syllables in Sinospheric Tonbund languages (e.g. Tai, Yue Chinese), VL has proved to be an uncommon desegmentalization process in Austroasiatic.

The Rengao Model and its slightly more complex iteration, the Jeh Model, appear in many examples, but all of these are within the Bahnaric language family and it is unclear at this time how many of these represent one shared, historical development and how many represent separate, individual innovations within a language. This question will be difficult to answer without much closer analysis of the distribution of register within each language and across Bahnaric cognates. That being said, the VH that underlies Rengao Model registrogenesis has also occurred in Katuic and Pearic languages, so there is no reason to assume that the intra-Bahnaric Rengao Model register contrasts are historically cognate and not the product of separate, analogous developments.

Finally, the Vietnamese, Chong and Kriang Models, while not occurring particularly commonly, are all fairly well-spread, being found in two or more separate branches of Austroasiatic.

5.1.4 Desegmentalization Models and their Output Typologies (Research Question 4)

Research Question 4:
What are the characteristics of the tone / register contrasts that emerge out of each desegmentalization model and, for those models which combine more than one desegmentalization process, is there any evidence to indicate that the order in which the constituent processes have obtained (i.e. relative chronology) affects the output typology?

5.1.4.1 Characteristics of Each Desegmental Model's Output Typology

A brief description of the output typologies of each of the desegmentalization models identified in this thesis is presented below, focusing on (1) the size of the desegmental phoneme inventory produced, (2) the phonetic cues which uphold the contrast and (3) a summary of the segmental conditioning environments in the examples discussed above.

Khmer Model: A binary, lax-marked register contrast has emerged in the majority of documented cases of Khmer Model desegmentalization. However, pitch-primary outcomes which are described as simple, binary tone contrasts have also been the result (The Khmu Variant). In one case only, a trinary, pitch-primary contrast has resulted from the Khmer Model (The Va Variant).

	OP
Suay:	({T-} – {D-})
Khmer:	({vl-} – {vd-})
Yingla Va:	({asp-} – {vl-} – {vd-})

Rengao Model: A binary, lax-marked register contrast has emerged in all documented cases of Rengao Model desegmentalization.

	VH
Sre:	({other} – {i, u})
North Bahnaric:	({more open V} – {closer V})

Hu Model: A binary, pitch-primary contrast described as tone with extrinsic differences of vowel length retained as cues to the desegmental contrast is described for the one documented case of Hu Model desegmentalization (Hu).

	VL
Hu:	({V̆} – {V:})

Vietnamese Model: We find tonal outcomes combining pitch and voice quality cues in cases of Vietnamese Model desegmentalization documented within Vietic and Mangic. In these languages, four to six tones emerge depending on the number of onset phonation categories and coda phonation categories that have desegmentalized. The resulting contrast in Li Xei appears not to be pitch-primary, but rather resembles the the double register phenomenon in Chong in phonetic terms.

	OP	CP
Vietnamese:	({vl-} – {vd-})	({-son} – {-ʔ} – {-H})
Rục:	({vl-} – {vd-})	({-son} – {-ʔ})
Bolyu:	({asp-} – {vl-} – {vd-})	({-son} – {-ʔ})
Li Xei:	({others-} – {D-})	({-son} – {-ʔ})

Jeh Model: A trinary register contrast combining extrinsic pitch and voice quality cues is described for the one documented case of Jeh Model desegmentalization (Southern Jeh).

	VH	CP
Southern Jeh:	({more open V} – {closer V})	({-other} – {-H})

Muak Sa'ak Model: A trinary, pitch-primary tone contrast has emerged in the one documented case of Muak Sa'ak Model desegmentalization (Muak Sa'ak).

	VL	CP
Muak Sa'ak:	({V̆} – {Vː})	({-son} – {-ʔ} – {-H} – {-T})

Kriang Model: A binary, lax-marked register contrast has emerged in all documented cases of Kriang Model desegmentalization.

	OP	VH
Kriang:	({T-, *s-} – {others-} – {D-, *j- *ʄ-})	({open V} – {non-open V} – {Cⁱ-})
Bru:	({other vl-} – {T-} – {vd-})	({more open V} – {closer V})
Lawa:	({others-} – {D-})	({other} – {Cⁱ})

Chong Model: A four-term, double register contrast has emerged in Chong and, seemingly, in Stieng, marked by voice quality contrasts primarily in the former case and by a combination of pitch and voice quality in the latter case. Alternatively, a two-term, tense-marked register contrast may result, which continues the reflexes of the VH register. This happens if the OP register fails to phonemicize or is neutralized (the Sedang Variant).

	OP	VH	CP
Chong:	({vl-} – {glot-} – {vd-})	({close V} – {other})	({-other} – {-H})
Stieng:	({other-} – {vd-})	({close V} – {other})	({-other} – {-H})
Sedang:	*now neutralized*	({more open V} – {closer V})	({-son} – {-ʔ} – {-H, -T})
Ta'oiq:	*now neutralized*	({more open V} – {closer V})	({-other son} – {-ʔ} – {-T, -N})

U Model: A four-term tonal contrast has emerged in the one example of U Model desegmentalization (U).

	OP	VL	CP
U:	({vl-} – {vd-})	({V̆} – {Vː})	({-son} – {-ʔ} – {-T})

Todrah Model: A trinary register contrast described in terms of differential voice quality is described for the one documented case of Todrah Model desegmentalization (Todrah: Didrá and Modra varieties, only).

	VH	VL	CP
Didrá & Modra:	({more open V} – {closer V})	({V̆} – {Vː})	({-son} – {-ʔ} – {-H} – {-T})

5.1.4.2 Relative Chronology of Desegmentalization Processes

It must be admitted that the sub-classification of desegmentalization models along purely formal lines with respect to desegmentalization processes obscures some important connections between the models. For example, the combination of OP and VH is found in both the Kriang Model and the Chong Model. A different classification scheme would bring out this connection over the presence or absence of CP, which is the difference between the Kriang and Chong Models as they are defined here. And indeed, the difference between the Kriang and Chong Models likely has more to do with the relative ordering, or at least relative impact, of OP and VH than it does with the presence or absence of CP.

Let us consider two hypothetical languages: one in which OP is first or prominent and one in which VH is. In the OP-first case, something resembling Khmer Model registrogenesis would occur and the distribution of register, determined primarily by historical onset voicing, would then be affected differentially by the interaction between different phonetic vowel height series and the two registers. On the other hand, in the VH-first case, something resembling Rengao Model registrogenesis would occur and the distribution of register, determined primarily by historical vowel height, would then be affected differentially by the interaction between different onset phonation categories and the two registers. The core "problem" that each of these scenarios needs to address is different because the phonetic nature of the two interactions is different.

In the OP-first case, the {closer V} environment, which carries a crosslinguistically well-supported preference for lax voice quality and low register (see Sections 2.3.1 and 4.4), puts pressure on the /high register/ to mutate in some way, so as to come into compliance with the preferred alignment of vowel height and register. This drives the lowering of close vowels in high register which is seen commonly in Khmer Model register languages (see Section 2.4.2.2) and also, in other cases, the neutralization of register to low in close vowels (see Section 4.9.1) (Gehrmann 2015, 2019). A parallel, opposite effect is found in the {open V} vowels, which prefer tenser voice quality and high register. Eventually, register languages succumb to these pressures one way or another, either through vowel height restructuring (e.g. Khmer) or through the re-organization of register assignment to more natural alignments of vowel height and register (e.g. Bru) or through the de-emphasis of voice quality as an extrinsic register cue, thereby avoiding the entire issue (e.g. pitch-primary register in the Khmu Variant of the Khmer Model).

The problem is framed differently in the VH-first case. In this scenario, the {D-} environment (or, by extension, the entire {vd-} environment, depending on the language), which, like the {closer V} environment, carries the latent potential to desegmentalize towards laxer voice quality and low register, applies pressure to the register contrast as a whole. If a language is already registral due to VH, but its voiced onsets begin to devoice and impart low register features in the prototypical, Khmer Model manner, this poses a problem for the maintenance of VH register contrast. The VH-conditioned /low register/ cannot become more breathy and so, if the VH-conditioned /high register/ moves towards low register because of OP, a neutralization of the whole VH-conditioned register contrast could occur in the new, OP-conditioned low register (e.g. *TV^L [TV̤] *DV^L [DV̤] > /TV^L/ [TV̤] /TV^L [TV̤]). As discussed above, general tensing of the entire VH-conditioned register contrast is one documented solution to this problem (e.g. *TV^L [TV̤] *DV^L [DV̤] > *TV^L [TV] *DV^L [DV̤~TV̤] > /TV^1/ [TV] /TV^2/ [TV̤]) (see Section 4.10.1 for details on general tensing).

And so, because the problem of contrast maintenance introduced by each of these two scenarios, OP-first vs. VH-first, is different, the manner in which the problem may be resolved is also different, leading to phonological developments which are different in kind. When VH occurs subsequent to OP (or along with it, playing a secondary role, if we do not wish to insist on a strict chronological ordering), the result is skewing in the assignment of register within different vowel height strata. This is exactly what has been described for the Kriang Model in Section 4.9. In the VH-first scenario, however, the interaction between onset voicing and the VH-conditioned register contrast tends to induce general tensing of the entire VH-conditioned register contrast in order to free up the [breathy] cue as an extrinsic cue to the nascent OP-conditioned register contrast. The Chong Model has been described in exactly these terms in Section 4.10.

In summary, the difference between the Kriang Model and Chong Model appears to have less to do with the influence of CP than it has to do with the relative chronology of OP and VH. That CP comes into play in the Chong Model is, in all probability, a secondary effect of either (1) the general tensing inherent in the Chong Model register languages, because laryngealization frequently triggers coda consonant interactions and/or mutations, or (2) the growing reliance on pitch cues, in Stieng's case, which, likewise, interact with coda phonation in ways that can lead to phonological change. By contrast, the Kriang Model languages remain lax-marked register languages with a foundationally OP-conditioned register contrast. No precedent for this kind of register contrast interacting with coda phonation was found in the Austroasiatic desegmentalization survey.

It seems, then, that relative chronology of OP and VH is the actual fundamental difference between the Kriang and Chong Models as illustrated in Figure 18. That this crucial fact is obscured by the way the desegmentalization models have been classified in this thesis highlights the fact that the schema proposed here is not the definitive word on this issue, but rather only a step along the way in investigating the interrelations that exist between desegmentalization processes and the kinds of desegmental phoneme inventories they may produce.

Figure 18: *Relative chronology of OP and VH in the Kriang and Chong Models*

	Primary Desegmentalization Process		Secondary Desegmentalization Process		Tertiary Desegmentalization Process
Kriang Model	OP	>	VH	>	-
Chong Model	VH	>	OP	>	CP

Because we have found no evidence that CP may occur on its own in a language in isolation from one of the primary desegmentalization processes, the issue of relative chronology between CP and the primary processes in the Vietnamese, Jeh and Muak Sa'ak Models is irrelevant. It is taken for granted based on the data available that CP occurred secondarily to OP, VH and VL, respectively, in these models (cf. discussion in Section 5.2.3). In the remaining U and Todrah Models, however, we should interrogate whether the ordering of desegmentalization processes has played a role.

In the U Model, there is every reason to believe that VL preceded OP in the development of its modern desegmental phonology. The default hypothesis, in light of the desegmentalization patterns documented in Hu's sister Angkuic languages, Hu and Muak Sa'ak, is that VL came first (as in Hu – VL only), followed perhaps by CP (as in Muak Sa'ak – VL + CP) and that the tone split conditioned by OP came last, as this is a unique development in U. This is not necessarily the true story, of course, but it makes sense both in the context of Angkuic desegmentalization and in terms of the actual structure of the U desegmental phoneme inventory (see Table 100). Furthermore, assuming that CP cannot have come first, it is very unlikely that OP would have emerged before VL in this language, since pAngkuic was without *voiced stops due to the Germanic Shift in its stop onsets. The weight of the evidence points to the relative ordering of desegmentalization in U as demonstrated in Figure 19.

While OP almost certainly did not precede VL in the U language, there are many languages outside of Austroasiatic which show the U Model combination of desegmentalization processes and certainly did develop in that order. We have already seen one example above in the form of Cantonese tonogenesis (see Table 6). In Yue Chinese dialects and many Tai languages, the D {-T} tone is split by VL. While VL is fundamental to the development of U tone, it represents only a smaller, secondary conditioned split in Yue and Tai. Figure 19 demonstrates the different ordering of OP relative to VL in U on the one hand and Yue and Tai on the other.

Figure 19: *Relative chronology of OP and VL in the U Model and Tai / Yue languages*[100]

	Primary Desegmentalization Process		Secondary Desegmentalization Process		Tertiary Desegmentalization Process
U Model	VL	>	CP	>	OP
Tai / Yue Model	OP	>	CP	>	VL[101]

[100] The relative ordering OP and CP within this Yue / Tai Model and more broadly within the Sinospheric Tonbund is discussed below in Section 5.2.3.

[101] D tone category only

Finally, in the Todrah Model, we can similarly draw on related languages to infer, if not conclusively confirm, a relative ordering of VH, CP and VL. Todrah's close relatives among the North Bahnaric languages all share the fundamental VH-conditioned register development, which occurs on its own in the Rengao Model languages. In the one example of the Jeh Model, CP complicates register in a manner quite similar to the pattern evident in Todrah. Finally, the contribution of VL in Todrah is only minor, representing a probably late split in the {closer V -T} environment. We may hypothesize the relative chronology of Todrah Model desegmentalization processes, then, as demonstrated in Figure 20. The Todrah Model combination of desegmentalization processes is unique as far as I am aware, and so we have no other languages within Austroasiatic or without, against which to compare Todrah Model desegmentalization. Other orderings of the desegmentalization events remain hypothetically possible, but unattested.

Figure 20: *Relative chronology Todrah Model desegmentalization*

	Primary Desegmentalization Process		Secondary Desegmentalization Process		Tertiary Desegmentalization Process
Todrah Model	VH	>	CP	>	VL

5.2 Outlook & Suggestions for Future Research

5.2.1 Desegmentalization and Resegmentalization

This thesis has concerned itself with segmental > suprasegmental sound change almost exclusively. The other side of this coin, a change of state from suprasegmental contrast to segmental contrast or *resegmentalization*, also merits some attention here. When it comes to tone, this is a topic that is little discussed in MSEA, and it is unclear if such a development is even documented. In Ratliff's (2015) discussion on *tonoexodus*, she raises as examples a Min Chinese variety which has reportedly restructured tonal contrast into one of accent (Shih 1985), a Mandarin variety which has simply neutralized tonal contrast in a high contact situation with an atonal language (Janhunen et al. 2008) and a Central Vietnamese variety with phonetic and phonological reduction in its tone inventory compared to the standard Northern and Southern Vietnamese tone inventories (Pham 2005). None of these examples involve resegmentalization of a tone contrast.

As far as register is concerned, resegmentalization is quite well-documented. We have discussed at length the resegmentalization of Khmer Model register as vowel quality contrast above (e.g. *taː *daː > *taː^{H} *taː^{L} > /taː/ /tɨa/) (see Sections 2.4.2 and 3.2.1). Another topic, which was only briefly touched on above, is the resegmentalization of tense-marked register contrast as coda manner or phonation contrasts. As an example, we see this clearly in the coda consonant mutations conditioned by the high, creaky register in Ta'oiq (see Table 91). To briefly summarize, pKatuic coda oral stops *p *t *c *k are lenited to /mˀ nˀ jˀ ʔ/, respectively, in the high register but remain /p t c k/ in the low register. Along with the lenitions, we also find a shift from high to low register or, in phonetic terms, from creaky voice to modal voice. In a sense, the laryngeal tension inherent in the historical high register has undergone a phase shift to the right in this environment, becoming reinterpreted as coda consonant glottalization. This is a historical change, not a synchronic one, as discussed in Gehrmann (2019).

We interpret this as resegmentalization of the Ta'oiq register contrast; the erstwhile register contrast marked by rime-medial laryngealization has neutralized before oral stops in concert with splits in the reflexes of those oral stops, which carry on the former register contrast. However, by the definition proposed above, this development also qualifies as desegmentalization. To review the definition:

> **Desegmentalization***: a change in the distribution of a language's suprasegmental phonemes, conditioned by a contrastive property in its segmental phonology*

The fact of the register neutralization before {-T} in Ta'oiq clearly represents a change in the distribution of the language's suprasegmental phonemes and the fact that the environment in which this happens may be defined in terms of a contrastive property in the language's segmental phonology (i.e. before oral stop codas) fits the definition of desegmentalization precisely. This brings us back to the issue of transphonologization in desegmentalization, discussed at length in Section 3.2. The fact that register-conditioned coda lenition in Ta'oiq is an example of both resegmentalization and desegmentalization at the same time is due to the fact that this lenition is transphonologizational. Transphonologization occurs because the desegmental contrast shifts out of the suprasegmental phonology and into the segmental phonology.

We may contrast this with non-transphonologizational resegmentalization, such as that described for Kuy in Section 3.2.2. In this example, we saw how low register, which had developed through Khmer Model registrogenesis, conditioned a VOT lengthening in the devoiced reflexes of pKatuic *voiced stops (e.g. *ba > *pa^{L} > /p^{h}a^{L}/). Voiceless stops in high register words, by contrast, did not become aspirated (e.g. *pa > *pa^{H} > /pa^{H}/). So we see that in the same segmental environment, syllables with a voiceless stop onset, the register contrast resegmentalized as difference in onset aspiration, but the register contrast itself remained in place in Kuy. In the Ta'oiq example, on the other hand, the register contrast resegmentalized as difference in coda manner / phonation and the register contrast subsequently disappeared. The implication is that transphonologizational resegmentalization implies desegmentalization, but non-transphonologizational resegmentalization does not. This explains how a sound change can represent both resegmentalization and desegmentalization at the same time.

Further research on resegmentalization in MSEA is recommended. It is hoped that future work on this topic will shed light on whether the definition proposed here for desegmentalization should be adjusted in some way, so as to preclude transphonologizational resegmentalization. For now, this particular type of sound change will be defined as both desegmentalization and resegmentalization.

5.2.2 Registrogenesis Revisited

The systematic review of desegmentalization processes carried out in this thesis and the careful analysis of the desegmentalization models that lead to registral outcomes constitute a significant advancement in the study of register formation. It is now possible to present a more or less unified model of registrogenesis for MSEA languages. Much has already been said on this topic above, but it is worthwhile to lay out the paradigm succinctly here, in order to review what has been learned and to set the agenda for further research into the matter.

We have shown above that register development relies primarily on two desegmentalization processes: OP and VH. Except for in a minority of cases, OP on its own results in a lax-marked register contrast (i.e. the Khmer Model Proper or conventional registrogenesis as proposed by Huffman (1976) - Section 4.3) and, when VH occurs on its own, it is documented as producing lax-marked register contrasts exclusively (see the Rengao Model or Sidwell's (2002, 2015b) proposal for the origin of North Bahnaric register contrasts - Section 4.4). When OP and VH both occur, the typology of the resulting desegmental contrast depends primarily on the relative ordering of the two desegmentalization processes (see Section 5.1.4.2). If OP is first or primary, the result is a lax-marked register contrast with aberrations in the expected distribution of register that are conditioned by vowel height differences (see the Kriang Model – Section 4.9). If VH is first or primary, on the other hand, the result is either a double-register contrast where the older VH-conditioned register contrast undergoes general tensing to a tense-marked contrast and the newer OP-conditioned register contrast splits the older contrast into four (see the Chong Model Proper – Section 4.10) or the older VH-conditioned register contrast undergoes general tensing but the newer OP-conditioned register contrast fails to phonemicize (or phonemicizes and is subsequently neutralized) (see the Sedang Variant of the Chong Model – Section 4.10).

It is proposed here that there are just three basic models of registrogenesis, as presented together in Table 107 using desegmentalization boxes: the Khmer Model Proper, the Rengao Model and the Chong Model Proper. All of the remaining models which produce register contrasts (the Kriang, Jeh and Todrah Models and the Sedang Variant of the Chong Model) represent innovations on one of the three prototypical models of registrogenesis. We may conceptualize the Kriang Model developments as a special case of Khmer Model registrogenesis, where VH confuses the distribution of a register contrast that is otherwise fundamentally rooted in OP. Similarly, the Jeh and Todrah

Models may be cast as sub-types of the Rengao Model, where CP related to the desegmentalization of {-H} introduces open syllable laryngealization into a register contrast that is otherwise fundamentally rooted in VH. In the Todrah Model case, an additional, VL-conditioned split obtains as well. Finally, the Sedang Variant of the Chong Model is just the Chong Model without phonemic reflexes of historical onset voicing.

Table 107: *Three basic models of registrogenesis*

Khmer Model (OP > Register)

	{closer V}	{more open V}
{vl-}	*high register*	
{vd-}	*low register*	

Rengao Model (VH > Register)

	{closer V}	{more open V}
{vl-}	*low register*	*high register*
{vd-}		

Chong Model (OP & VH > Double Register)

	{closer V}	{more open V}
{vl-}	*modal register*	*creaky register*
{vd-}	*breathy register*	*breathy-creaky register*

This expanded framework for registrogenesis, rooted in concepts from desegmentalization, helps us to appreciate the various factors potentially at play in registrogenesis. The Austroasiatic desegmentalization survey has clearly demonstrated the role that vowel height can play in desegmentalization – especially in registrogenesis – and it is fair to say that, of the four desegmentalization processes, the influence of vowel height has been comparatively underappreciated. It is possible, or perhaps even likely, that vowel height has played a larger role in conditioning the distribution of desegmental phonemes in MSEA than we collectively realize. Some of the outstanding mysteries of tone and register distribution in the region may well be resolved by a closer investigation into the correspondence between historical vowel height differences and modern desegmental phonemes. Particularly within Austroasiatic, this seems an especially promising avenue of investigation.

5.2.3 Coda Phonation Desegmentalization as a Secondary Desegmentalization Process

A conventional hypothesis, or perhaps an assumption, of Vietnamese Model tonogenesis in the Sinospheric Tonbund is that CP came first and the tones that resulted from CP were subsequently split by OP. This idea goes all the way back to Haudricourt's (1954) seminal paper, in which he specifically projects Vietnamese CP back to the sixth century CE and suggests that the register split (i.e. secondary OP) took hold thereafter in the twelfth century. Ferlus (1998b, 2004), in his work on broader Vietic tonogenesis, adopts the same relative chronology. He hypothesizes that Vietnamese developed a six-tone inventory when OP crosscut three pre-existing tones from CP, while languages like Rục developed a four-tone inventory when OP crosscut two tones (see discussion on Vietic tonogenesis in Section 2.4.1.2).

This CP-first hypothesis is well supported. If we look at OP-conditioned tone splits and mergers across Sinitic, Kra-Dai and Hmong-Mien languages, they are self-evidently non-cognate across each family. It is universally recognized that these splits were not a feature of their respective proto-languages, or even necessarily of higher order proto-branch level languages within these families. The three-way, CP-conditioned contrast in open syllables (< {-son} vs. {-ʔ} vs. {-H}), by contrast, is stable and cognate within the families, lending credence to the idea that CP is older. Further support is found in the historical record in the form of the Classical Chinese rhyming dictionaries and older orthographies, which appear to present the reflexes of CP as suprasegmental features, or at least have been interpreted that way.

There is one significant problem with this CP-first hypothesis, however. While CP occurs with great frequency among MSEA languages, there is no unambiguous example that I can point to where it has occurred in isolation, unaccompanied by some other desegmentalization process.[102] The results of the Austroasiatic

[102] One possible exception is a West Hmongic variety spoken in Fuyuan County, Guizhou Province, China called simply *Fuyuan* by Wang & Mao (1995). This language is described as having four tones, each of which corresponds to one of the four CP categories of the Sinospheric Tonbund (i.e. A B C D), and no splits conditioned by OP (Wang 1994, Wang & Mao 1995, Ratliff 2010). However, one cannot yet rule out the possibility that OP did, in fact, precede CP in Fuyuan. It is quite possible that OP began and encouraged CP, but the phonemic desegmentalization of OP was never fully realized as tonal reflexes of OP failed to become

desegmentalization survey in this thesis turned up no such example and this should give us pause, especially when we consider how frequently OP occurs on its own (i.e. the Khmer Model). This raises the possibility that there is a flaw in the received periodization of Haudricourtian tonogenesis and suggests that an alternative, OP-first model for the Sinospheric Tonbund languages should be given careful consideration.

While a careful consideration of this topic is outside the scope of this project, I will offer a few thoughts. Firstly, the non-cognacy of the tone splits previously mentioned must be reconciled with an OP-first model. I propose that the sound change progression assumed by the Haudricourtian tonogenetic model fails to appreciate that the OP process is or, at least, may be long-lasting and dynamic. A language may enter the transitional, register phase of OP (see Section 3.2.1), and simply remain a register language. There is no indication that this is an unstable stage. Furthermore, overt differences in the voicing / phonation of onsets may continue as extrinsic cues to the register contrast. In the case of early Tai orthography, for example, the fact that glyphs which represent Indic voiced stops were chosen for reflexes of pTai *voiced stops does not necessarily mean that those stops were literally, phonetically pre-voiced at the time of their adoption and that OP had not yet occurred. We can imagine a scenario for pTai where OP had already taken hold, but extrinsic differences in the phonation types associated with reflexes of *voiced and *voiceless stops continued, even as CP progressed. This is, of course, speculation, but the idea merits further investigation.

Another issue is the fact that Sinospheric Tonbund tone languages almost never show vowel quality alterations conditioned by OP, just pitch/voice quality changes. If OP came first and, say, Proto-Tai was actually a register language, would we not expect to find some evidence of register-conditioned vocalic restructuring (i.e. resegmentalization)? This is, after all, by far the more common typology of OP-only, Khmer Model register languages (see the Khmer Model Proper – Section 4.3.2). However, we should not forget the more northern Khmer Model languages which demonstrate the Khmu Variant (see Section 4.3.3). These languages have F0-prominent register contrasts, often with extrinsic voice quality cues as well and with little to no vocalic restructuring. If Proto-Tai was a register language, it would have been one of the Khmu Variant type.[103]

This ties in to a separate question which has not been addressed up until now: why does the Khmu Variant occur less frequently than the Khmer Model Proper and in a more geographically constrained distribution? My own hypothesis is that Khmu Variant languages are less common because the Khmu Variant encourages CP, while the Khmer Model Proper does not. Interactions between register and coda phonation are much less likely to occur in F1-prominent register languages, because vowel quality does not naturally interact with differential coda phonation the way pitch and voice quality do. In other words, the reason why the majority of register languages are F1-prominent and follow the Khmer Model Proper trajectory is that F0-prominent register languages of the Khmu Variant type tend to become tone languages, whereas the former do not.[104]

Finally, an OP-first hypothesis helps to explain another difficult, perennial problem in MSEA historical tonology. It is difficult if not impossible to predict what effect coda phonation will have on pitch. Discussing the interactions between consonants and pitch, Michaud & Sands (2020, 9) suggest, "Examination of tonogenetic data from African languages confirms that the tonogenetic potential of certain consonants is mediated by the state of the phonological system as a whole (as well as by patterns of language contact)." And elsewhere, speaking more specifically about coda phonation, they write, "The tonogenetic effects of final glottalization depends on the overall state of the linguistic system: thus, in Vietnamese and Chinese (§2.2), evolution of final glottalization towards a rising tone (category B) was very probably influenced by the presence of a falling/breathy tone (category C, from an earlier

established and merger between the reflexes of pHmong-Mien voiced and voiceless stops was never accomplished. Modern reflexes of the *voiceless stops remain unchanged in Fuyuan, but reflexes of the *voiced stops have become voiced fricatives (*b > /v/, *d > /ð/, etc…). The lenition of the *voiced stops may be ultimately responsible for interrupting and precluding the expected merger. The special case of Fuyuan tonogenesis warrants a closer investigation, which is regrettably beyond the scope of this project.

103 Or perhaps the Va Variant (see Section 4.3.4).

104 Matisoff (1973, 86), looking at the same issue from a slightly different angle, put it another way when he wrote, "Perhaps we could say that the Mon-Khmer languages escaped the fate of becoming tone languages by the expedient of multiplying their vocalic nuclei." While this is certainly an inappropriate generalization on the face of it, if we switch "Mon-Khmer languages" for "Khmer Model Proper register languages" here, and if we accept that OP was in all likelihood the initial jumping off point for tonogenesis for the vast majority of MSEA tone languages, then the statement actually summarizes the state of things quite well.

final –h)…" (Michaud & Sands 2020, 9). Setting aside the specific point made about differential pitch effects of {-ʔ} and {-H}, which is an assertion grounded in the CP-first hypothesis, the general point is well taken and applicable for the OP-first hypothesis as well. If CP is necessarily a second-order desegmentalization and encouraged by earlier OP, then coda phonation types may interact with the higher vs. lower pitch patterns from the register contrast in a number of different ways. The ultimate effect on pitch, then, is subject to a greater number of variables from the input typology or the "overall state of the linguistic system". This may be a partial explanation for the variability of pitch height and contour outcomes from CP.

In summary, the findings of this thesis do not support the received CP-first periodization for conventional tonogenesis in the Sinospheric Tonbund. I propose that an OP-first model, which, in truth, has never been given serious consideration, should be further investigated in light of these findings. The relative chronology for desegmentalization processes in conventional Haudricourtian tonogenesis (i.e. the Vietnamese Model) and for the Haudricourtian model with VL in the D tone ({-T}) (i.e. the Yue/Tai Model introduced above in Section 5.1.4.2) presented in Figure 21 is hypothesized.

Figure 21: *An OP-first hypothesis for the relative chronology inherent in Sinospheric Tonbund tonogenesis*

	Primary Desegmentalization Process		Secondary Desegmentalization Process		Tertiary Desegmentalization Process
Vietnamese Model	OP	>	CP	>	-
Tai / Yue Model	OP	>	CP	>	VL

5.2.4 Outstanding Issues in Austroasiatic Desegmentalization

A number of Austroasiatic languages that were researched as part of the Austroasiatic desegmentalization survey were not included in the discussion above. The reasons for their exclusion fall into three broad categories, including:

1. The origins of the suprasegmental contrast are not segmental
2. The origins of the suprasegmental contrast are unexplained
3. The origins of the suprasegmental contrast are explained and desegmental but an outlier in the paradigm

In this section, we will discuss the languages which fall under these categories and point out avenues for further research where needed.

5.2.4.1 Non-Desegmental: Tone in Mal

Mal is a Khmuic language spoken in Nan Province, Thailand. It may be considered a dialect of the T'in or Lua' language, along with its sister language, Prai. Mal is the only Austroasiatic language of which I am aware that has become tonal without any direct involvement from desegmentalization. Filbeck (1972, 1978) was the first to describe the innovation of a rising tone in Mal and to suggest that is was innovated through contact with the local variety of Northern Thai. L-Thongkum & Intajamornrak (2008) later confirmed this analysis in historical phonological and phonetic terms. The rising tone is, in essence, a loan tone which is present on most of the Northern Thai loan words in the language. The other tone, which L-Thongkum & Intajamornrak describe as falling, is present on most of the native Mal words. They further hypothesize that the reason the Mal loan tone has a rising pitch contour is that the majority of tones in the local variety of Northern Thai, including all A category ({-son}) and DS category ({V̌ -T}) tones, have a phonetically rising contour. In the minds of the speakers, as the hypothesis goes, the prototypical

Northern Thai word has a rising pitch contour and that is why this particular pitch contour became conventionalized as a marker for Northern Thai loans.

Mal has developed a tonal contrast via a particular process of loan-tone integration – a development which has been documented elsewhere as well (cf. Mandarin influence on Southern Qiang (Evans 2001)). This tonogenetic pathway does not involve desegmentalization directly, but because Northern Thai has developed tone in the typical manner via desegmentalization, it is safe to say that Mal tonogenesis is ultimately derived from and dependent on desegmentalization as well, if only secondarily.

5.2.4.2 Unexplained: Tonal Contrasts in Three Palaungic Languages (Danau, Khang & Samtao)

There are three documented Palaungic languages with tonal contrats of unexplained origin. The first, Danau, is a small and underresearched language of Myanmar. Available data and analysis on Danau includes Luce's unpublished work and a grammar sketch (Aung Si 2015). Sidwell (2015c) has reviewed Luce's work on the language and, while he does not offer an explanation for the provenance of the four tones proposed by Luce, he does describe their pitch contours and asymmetrical distribution as presented in Table 108. Further documentation and scrutiny of the language's historical tonology is needed.

Table 108: *Danau tone inventory, pitch patterns and notes on distribution*

/^{1}/ high, level *(mostly open syllables)*	/^{3}/ level, falling *(mostly oral stop codas)*
/^{2}/ high, falling *(mostly approximant codas)*	/^{4}/ low, falling *(mostly nasal stop codas)*

Another tonal Palaungic language with unexplained tonogenesis is the Khang language, spoken far to the east of Danau in Vietnam. A recent paper by Tạ Quang Tùng (2021) briefly describes the language's phonology, including its six contrastive tones in sonorant-final syllables and two contrastive tones in stop-final syllables. While no explanation is given for the origin of these tones in native etyma, a sizable set of examples showing the tonal patterns present in Tai loan words into Khang is presented. Tạ proposes a regular correspondence of modern Khang tones with the historical tone categories of Tai, as summarized in the tone box in Table 109. This is highly suggestive that Khang is a Vietnamese Model tone language, but further investigation into Khang tone in Khmuic perspective is needed to confirm this.

Table 109: *Danau tone inventory, pitch patterns and notes on distribution*

	A	**B**	**C**	**D**
1	/^{1}/ [44] *modal*	/^{2}/ [212] *creaky*	/^{5}/ [323] *modal*	/^{8}/ [12] *modal*
2	/^{3}/ [35^ʔ] *glottalized*	/^{4}/ [31^ʔ] *glottalized*	/^{2}/ [11^ʔ] *glottalized*	/^{7}/ [43] *modal*

A third language, Samtao or Blang/Bulang, spoken in Myanmar and China. There are conflicting reports as to whether this is a Khmu Variant register language with optional breathy voice quality in the low tone (Diffloth 1980, Sidwell 2015c) or whether there are actually four desegmental phonemes, with high pitch and low pitch being crosscut by an orthogonal voice quality contrast (modal vs. breathy) (Paulsen 1992, Harper 2009). Further acoustic phonetic and historical phonological study is needed to untangle this issue.

5.2.4.3 Unexplained: Coda Glottalization in pVietic

In Section 4.2, the pattern of rime glottalization across the Austroasiatic branches was described. An outlier in this regard is pVietic, which had a thoroughgoing contrast of {-son} vs. {-ʔ} contrast present in open syllables and syllables closed by a sonorant coda consonant (see Table 53). The origins of this rime glottalization contrast are currently undemonstrated, though two hypotheses have been put forward.

Diffloth (1989) argued that it may reflect a voice quality contrast between modal voice and creaky voice that was present in pAustroasiatic phonology. This hypothesis was based largely on the fact, unexplained at that time, that modal vs. creaky register contrasts with optional restructuring into rime glottalization appeared in Bahnaric, Katuic and Pearic languages. Diffloth himself admits, however, that the distribution of these modal-creaky contrasts is not cognate across the branches and subsequent work has demonstrated that those modal-creaky contrasts are the result of the general tensing of VH-conditioned register contrasts, as has been summarized above.

A much different hypothesis regarding the origin of pVietic rime glottalization contrast comes from Ferlus (1998a, 2009), who argues for an explanation rooted in contact between pVietic and Old Chinese. In order to discuss Ferlus's proposal, we must first introduce some key concepts in the reconstruction of Old Chinese phonology.

5.2.4.3.1 Old Chinese as a Register Language?

Our knowledge of Old Chinese phonology is thanks in large part to the early witness of the 切韻 (Qièyùn)[105] and the 韻鏡 (Yùnjìng), two medieval "dictionaries" detailing the literary standard pronunciation used in the recitation of classical Chinese texts. The Qièyùn deconstructs monosyllabic words into four constituent properties: *onset*, *rime*, *tone* and *grade*.[106] Of these four, the *grade* property has proven the more challenging to reconstruct. There has been much debate over the phonetic and phonological reality of the four grades in Old Chinese and Middle Chinese, but we will focus here on the fundamental distinction between Grade-III on the one hand and Grades-I, II and IV on the other.

Comparative evidence from the modern Sinitic languages demonstrates clearly that Old Chinese vowels developed differently in Grade-III words than in the other grades. Building on much previous work, Pulleyblank (1984, 1994) proposed the term Type-B to refer to the Grade-III words and Type-A to refer to the other grades. This provides a convenient shorthand for making reference to the two different patterns of Old Chinese vowel development. Put succinctly, if an Old Chinese vowel occurred in a Type-A word according to the Qièyùn, its modern reflexes indicate a lowering in vowel height relative to the same Old Chinese vowel in a Type-B word. Karlgren's (1957) foundational reconstruction of Old Chinese phonology interpreted Type-B syllables as having a medial *-j- sound, but, while this *medial yod* has served as a transcriptional shorthand for indicating Grade-III words ever since, the relative frequency of *yodicized* vocabulary (slightly greater than 50%) and the lack of any evidence of medial palatals in Sinitic loan words into other languages argues against a medial *-j- having been the actual phonetic expression of Type-B syllables.

It is now widely accepted that Type-A and Type-B words were marked by a general *tenseness* and *laxness* in their articulation, respectively. Baxter and Sagart (2014), following Norman (1994), have interpreted this tension differential in terms of a contrast of secondary pharyngealization in Old Chinese onsets. Under this model, onset pharyngealization would have conditioned vowel lowering in Type-A syllables. Furthermore, Sagart & Baxter (2016) propose a possible origin for Old Chinese onset pharyngealization in the transphonologization of hypothesized Proto-Sino-Tibetan "plain consonants followed by geminate vowels separated by a pharyngeal fricative" as pharyngealized consonants.

Ferlus (1998a, 2009), on the other hand, drew inspiration from the MSEA register phenomenon to propose that Type-B syllables were produced with breathy voice, lower pitch and vowel raising (i.e. *low register)*, while Type-A syllables were characterized by modal voice, higher pitch and vowel lowering (i.e. *high register*). Under Ferlus's model, sesquisyllabic words would have collapsed to monosyllables with tense, geminated onsets which eventually produced the Type-A high register while monosyllabic words would have had relatively lax, non-geminate onsets, which led to the Type-B low register. J. Smith (2018) offers support for this syllable shape-conditioned model in the so-called *mixed-onset phonetic series* of Middle Chinese, in which Old Chinese syllable Type and syllable shape (sesqui- vs. monosyllable) appear to be mutually covarying properties.

[105] In fact, only the preface survives from the original Qièyùn, but its contents are preserved in the later 廣韻 (Guǎngyùn)
[106] The four grades are also sometimes referred to as the four divisions.

A summary of the various labels and interpretations related to the Old Chinese types is provided in Table 110 for reference. This is very much an area of ongoing research and the diversity of proposed interpretations is due to the fact that, as Baxter & Sagart (2014, 69-70) note, "The evidence for a distinction between Type-A and Type-B syllables is overwhelming, but the evidence for any particular phonetic interpretation of that distinction is much more elusive."

Table 110: Old Chinese *Type A and Type B syllables summarized*

Grades *(Qièyùn)*	**Type** *(Pulleyblank)*	**Relative Tenseness**	**Vowel Quality**	**Yodicized** *(Karlgren)*	**Pharyngealized** *(Norman, B&S)*	**Register** *(Ferlus)*	**OC Shape** *(Ferlus)*
I, II, IV	A	Tense	Lowered	No	Yes	High	Sesquisyllabic
III	B	Lax	Raised	Yes	No	Low	Monosyllabic

Both Baxter & Sagart's onset pharyngealization hypothesis and Ferlus's syllable shape hypothesis present plausible explanations for the Type A/B contrast of Old Chinese, but neither is without issue. The pharyngealization hypothesis has a typology problem. Firstly, in the grand scheme of language typology, no language is known to have a perfect bifurcation of all consonantal onsets into a pharyngealized series and a non-pharyngealized series (Ferlus 2012, Pain 2020).[107] Secondly, zooming in on East and Southeast Asia, no language here has ever been shown to employ contrastive onset pharyngealization which conditions systematic vowel lowering. By contrast, vowel lowering due to a register contrast is a familiar and frequently recurring development. Even so, when we speak of Old Chinese phonology, which stretches back to the mid-2nd millennium BCE, we are very likely stepping back into a time before which arguments from the expected phonological typology of East and Southeast Asian languages carry any real weight.

Ferlus's hypothesis, which amounts to registrogenesis by monosyllabicization, has its own drawbacks. While sesquisyllable collapse can indeed lead to a contrast of onset gemination, as Ferlus's (1971b) own work on Nyaheun (< Bahnaric) demonstrates, it is entirely unprecedented for such a gemination contrast to develop into a register contrast. While one could imagine a phonetically plausible sequence of sound changes by which such a thing could happen, it is difficult to propose that it did happen in the absence of evidence from precedent to support the claim.

5.2.4.3.2 Proto-Vietic as a Register Language?

Having introduced the Old Chinese Type A/B syllables, we can now review Ferlus's hypothesis regarding the origin of pVietic rime glottalization. Whether pVietic rime glottalization contrast was a conservative hold-over from pAustroasiatic that died out in other branches, or whether it was an innovation in pVietic, it is almost certain that this issue has something to do with pVietic's long history of close contact with Old Chinese. Simply put, Old Chinese was highly influential in pVietic, and Old Chinese was a language with contrastive rime glottalization in sonorant-final codas (Baxter & Sagart 2014, 194-197).[108] To be clear, Old Chinese rime glottalization was not conditioned by the Old Chinese types; these are separate issues.

Ferlus (1998a, 2004) accepts the hypothesis that pAustroasiatic was without open syllables (see Section 4.2) and proposes that pVietic deglottalized pAustroasiatic *Vʔ rimes under certain conditions. His solution relates rime deglottalization to the gradual monosyllabicization of northern varieties of pVietic. The hypothesis is that northern, urban varieties of pVietic, under heavy Old Chinese influence, developed a register contrast in conjunction with sesquisyllable collapse along the Old Chinese model described above. Sesquisyllables produced geminated onset consonants which went on to condition a relatively tense, high register in opposition to the relatively lax, low register that developed in etymological monosyllables. Unlike in his Old Chinese syllabicity-to-register hypothesis, however, Ferlus suggests that the registers which developed in pVietic had no ramifications for vowel quality, only for coda phonation. The desegmentalization box for pVietic in Table 111 summarizes Ferlus's (2004) interpretation of pVietic syllabicity-conditioned register and coda mutations. We see that the high register conditioned the innovation of rime

[107] Baxter & Sagart (2014, 73-74) do acknowledge this and discuss possible explanations.

[108] Baxter & Sagart (2014, 195-196) characterize rime glottalization as the presence of a segmental, post-coda glottal stop *-ʔ at the Old Chinese stage.

glottalization contrast in {-son} coda words as it was resegmentalized into coda glottalization. Rime glottalization contrast was also introduced in open syllables under conditioning from the high register, which, in this case, conditioned the deglottalization of the pAustroasiatic-inherited {-ʔ} coda in a pattern reminiscent of Sedang (see Table 90).

Table 111: *Late pVietic rime glottalization distribution in relation to syllabicity-conditioned register*

*H (< *C.C)	*L (< *C)		
-Nˀ	*-N*	**{-son}**	*-m *-n *-ɲ *-ŋ *-l *-r *-j *-w*
-V	*-Vˀ*	**{-ʔ}**	*-ʔ*
-H		**{-H}**	*-h *-s*
-T		**{-T}**	*-p *-t *-c *-k*

To summarize the above, Ferlus proposes that both Old Chinese and pVietic developed a register contrast conditioned by differences in syllable shape (Ferlus 1998a, 2009; J. Smith 2018; Pain 2020); early Old Chinese and early pVietic sesquisyllables would have collapsed into geminate-onset monosyllables and the tension inherent in the geminate onset would then have been transposed to the rime in the form of a suprasegmental tense, high register. The absence of tension in the non-geminate onsets of historical monosyllables, by contrast, would have been reflected in a suprasegmental lax, low register. In Old Chinese, the register contrast would have gone on to behave in a manner described for the Khmer Model in this thesis, conditioning vowel quality splits in the conventional manner. In pVietic, the register contrast would have behaved in a manner more reminiscent of the Chong Model, with a tense-marked register contrast that interacts with coda phonation triggering coda consonant mutations or deletions (see Section 4.10.2).

Whatever the merits of this syllabicity desegmentalization hypothesis in Old Chinese, and I am in no position to evaluate its appropriateness in that context, the hypothesis is far from confirmed when it comes to pVietic. It is a neat explanation, and the proposal that an early pVietic register contrast is responsible for the confusion of the pAustroasiatic rime glottalization pattern in late pVietic is in all likelihood correct; but, the evidence to suggest that differences of syllable shape conditioned the emergence of that early pVietic register contrast is quite limited. Ferlus (2004) himself presents two small sets of cognate comparing Vietnamese and Khmu as evidence for the deglottalization of rimes in sesquisyllables and their retention in monosyllables. These are reproduced in Table 112, where the sắc (accute accent) and nặng (subscript dot) tones reflect late pVietic {-ʔ} and the ngang (unmarked) and huyền (grave accent) tones reflect late pVietic {-son}. As far as I am aware, this is the only evidence that has been put forward to this point in support of the syllabicity register hypothesis.

Table 112: *Ferlus's (2004) examples of syllabicity > (de)glottalization in pVietic*

Monosyllables > ᴸ > Conservative			**Disyllables > ᴴ > Deglottalization**		
Khmu	**Vietnamese**		**Khmu**	**Vietnamese**	
/sɔʔ/	<chó>	*dog*	/kmaʔ/	<mưa>	*rain*
/kaʔ/	<cá>	*fish*	/mpoʔ/	<(chiêm) bao>	*to dream*
/taʔ/	<đứa>	*individual*	/tmpaʔ/	<(con) ba ba>	*tortoise*
/ʰlaʔ/	<lá>	*leaf*	/lmboʔ/	<bò>	*zebu*
/seʔ/	<chấy>	*headlouse*	/sŋiʔ/	<ngày>	*day*
/buʔ/	<vú/bú>	*breast / to suckle*	/cndreʔ/	<chày>	*pestle*
/pleʔ/	<trái>	*fruit*	/ɟruʔ/	<sâu>	*deep*
/bɔʔ/	<bó>	*tie in a bundle*	/ɟriʔ/	<si>	*banian*
/sroʔ/	<(khoai) sọ>	*taro*	/meʔ/	<mày/mi>	*thou/you*
/rŋkoʔ/	<gạo>	*husked rice*	/pdoʔ/	Arem: /dɔ/	*yeast / alcohol*
/klɲaʔ/ (< *kə̆l ɲaʔ)	<nhựa>	*resin*			
/klmeʔ/ (< *kə̆l meʔ)	<mía>	*sugarcane*			

Assuming that there really was an early pVietic register contrast that affected rime glottalization, the findings of this thesis offer an alternative hypothesis to explain its emergence. There is clear precedent among Chong Model register languages for a VH-conditioned register contrast undergoing general tensing and subsequently affecting the distribution of coda phonation types (see Section 4.10). If we posit that the early pVietic register contrast was in fact conditioned by VH rather than by sesquisyllable collapse, the following sequence of events may be hypothesized:

(1) VH occurs conditioning register (high vs. low) (cf. Rengao Model)
(2) OP begins, triggering general tensing of the register contrast and splitting it (*low > modal /^{1}/, breathy /^{2}/; *high > creaky /^{3}/, breathy-creaky /^{4}/) (cf. Chong Model Proper)
(3) The two creaky registers (/^{3}/ and /^{4}/) interact with natural classes of codas in different ways
    - {-H} and {-T}: neutralization of creak, shift to /^{1}/ and /^{2}/, respectively
    - {-ʔ}: deglottalization and shift to /^{1}/ and /^{2}/, respectively
    - {-son} codas: glottalization of coda and shift to /^{1}/ and /^{2}/, respectively
(4) Now, in late pVietic, we have a formerly Chong Model, double register language which has restructured its creaky registers, /^{3}/ and /^{4}/. The old VH-conditioned register is thereby neutralized. The newer, OP-conditioned register is maintained. Vietnamese Model tonogenesis then begins in different Vietic varieties over time.

These developments are illustrated using desegmentalization boxes in Figure 22.

Figure 22: *A Chong Model-based hypothesis to explain pVietic rime glottalization patterns*

Stage 1: Early pVietic
VH only

[breathy]	[modal]
{closer V}	**{more open V}**

Stage 2: Early pVietic 2
OP crosscuts register and triggers general tensing

{vl-}	/^{1}/ [modal]	/^{3}/ [creaky]
{vd-}	/^{2}/ [breathy]	/^{4}/ [breathy-creaky]
	{close}	**other**

Stage 3: Late pVietic
Coda mutations and register shifts in creaky registers /^{3}/ and /^{4}/

{vl-}	/VN^1/	/VN^{ʔ1}/	**{-son} coda**
	/Vʔ^1/	/V^1/	**{-ʔ}**
	/VH^1/	/VH^1/	**{-H}**
	/VT^1/	/VT^1/	**{-T}**
{vd-}	/VN^2/	/VN^{ʔ2}/	**{-son} coda**
	/Vʔ^2/	/V^2/	**{-ʔ}**
	/VH^2/	/VH^2/	**{-H}**
	/VT^2/	/VT^2/	**{-T}**
	{close}	**other**	

For now, this hypothesis relating the peculiar distribution of pVietic rime glottalization to VH-conditioned registrogenesis in the manner of the Chong Model is not supported by evidence; it is only supported by precedent. A closer examination of the pVietic reconstruction is called for in order to test the merits of this hypothesis.

5.2.4.4 Unexplained: Tonogenesis in Mang and Bugan

Moving from Vietic to Mangic, it was demonstrated above that the rime glottalization pattern of pVietic is cognate with tonal contrasts in the Mangic language Bolyu (see Section 4.6.1). This is an exciting area for continuing research with implications regarding the historical relationship between the Vietic branch and the proposed Mangic branch. The two other documented Mangic languages, Bugan and Mang, are also tone languages. The next step in investigating the origins of Mangic tone is to investigate whether tonal correspondences can be demonstrated between all four of these languages (Mang, Bugan, Bolyu and pVietic). I am currently working on this problem and preliminary results suggest that Mang, Bugan and Bolyu tones all do have regular correspondences with each other and with laryngeal contrasts on the pVieitc rime that are unique within AA, supporting the idea of a Vieto-Mangic branch (Gehrmann 2021a).

5.2.4.5 Outlier: High Register Laryngealization in Mon Rao of Ka Mar Wet

No examples were found in this survey of an OP-conditioned, Khmer Model register language undergoing the kind of general tensing that is documented occurring in VH-conditioned, Rengao Model register languages. The reason for this, as postulated in this thesis, is that general tensing is catalyzed by OP, when it occurs in a language that is already registral, having undergone vowel height-conditioned registrogenesis. Consequently, a language which has already developed register via OP is unlikely to undergo OP again, shifting the register contrast innovated in the first wave of OP to the tenser. While this is hypothetically possible if, for example, a new series of voiced stops were innovated after the devoicing of the original voiced stop series, this chain of events is, for now, unattested.

There is one OP-conditioned register language which has undergone a partial tensing (not a general tensing) of its high register in certain environments. Diffloth (1982a) discusses the development of register in a variety of Mon spoken in Myanmar's Mon State which he calls Mon Rao. Two dialects of Mon Rao are discussed: (1) Mon Rao as spoken in the vicinity of Mudon and (2) Mon Rao as spoken around Ka Mar Wet. Both of these Mon Rao dialects are notable for a particular pattern of diphthongization present in it high register vowels, which Diffloth describes as *distortion*. The Mudon dialect shows only diphthongization as a consequence of distortion, but the distorted vowels are doubly marked by diphthongization and pharyngealization, as Diffloth characterizes it, in the Ka Mar Wet dialect. Crucially, this vowel pharyngealization is not found in *all* high register words in Ka Mar Wet Mon Rao, but rather only in those high register words containing vowels which participate in the distortion phenomenon.

The distortion effect occurs in a limited environment. It may only appear with certain vowel qualities, onset phonation types and coda places of articulation. Diffloth discusses the origins of distortion in only three vowels (*ə, *i and *u) which he reconstructs for a stage intermediate between pMonic and pMon called Pre-Mon. pMonic vowel length contrast was already neutralized at this point (see Diffloth (1984) for details of Monic historical phonology). We are left to wonder whether distortion is found in the reflexes of the other Pre-Mon vowels, including open vowels *a *ɔ, mid vowels *e *o and the one Pre-Mon diphthong *iə; Diffloth does not discuss these. For the Pre-Mon open vowels *a and *ɔ, at least, we would not expect them to take part in high register diphthongization as they are unable to lower their onsets.

The environments in which Pre-Mon high register underwent distortion, according to Diffloth (1982a), are presented in Table 113 and lexical examples may be found in Table 114.

Table 113: *Environments with high register "distortion" in Mon Rao (Ka Mar Wet)*

Pre-Mon Vowel	Pre-Mon Onset	Pre-Mon Coda
*ə	*p *t *c *k *s *ɓ *ɗ *ʔ *h	velar
*i *u	*p *t *c *k *s	non-velar

Table 114: *The distortion of Pre-Mon *ə, *i and *u*

Gloss	Pre-Mon	Mon Rao (Mudon)	Mon Rao (Ka Mar Wet)
sambar deer	*ɓəŋ	ɓaəŋ	ɓɒˤəŋ
completed	*ɗək	ɗaək	ɗɒˤək
hornet	*həŋ	haəŋ	hɒˤəŋ
to pluck	*pək	paək	pɒˤək
sand	*bəti	hətɔɛ	hətɒˤi
to know	*tim	taɛm	tɒˤəɲ
stairs	*kənin	kənɛn	ʔənɒˤən
earth	*tiʔ	tɔɛʔ	tɒˤic
macaque	*khnuj	nɔɛ	nɒˤuj
be burning	*tu	tao	tɒˤu
to spout	*klut	klɒt	klɒˤut
moon	*gətuʔ	hətauʔ	hətɒˤuʔ
five	*pəsun	pəsɒn	ʔəsɒˤun

High register reflexes of Pre-Mon *ə only distort when they precede a velar coda consonant. Elsewhere, Diffloth contends that previously distorted vowels have re-monophthongized to /ɒ/ and thereby avoided pharyngealization, as the examples in Table 115 demonstrate.

Table 115: *Lowered, non-distorted reflexes of Pre-Mon *ə before non-velar codas*

Gloss	Pre-Mon	Mon Rao (Mudon)	Mon Rao (Ka Mar Wet)
to get up	*tə	tɒ	tɒ
pus	*pətəh	pətɒh	pətɒh
thick	*təm	tɒm	tɒm
to climb	*tən	tɒn	tɒn

In reflexes of Pre-Mon *i and *u, we find that distortion of high register vowels is blocked both by velar codas and by glottal(ized) onsets *ɓ *ɗ *ʔ *h. The situation before velar codas is easily explained as *i and *u seem to have merely shifted to another vowel quality in the environment preceding velars before the distortion occurred. The lack of distortion following glottal(ized) onsets is more difficult to explain, especially given the fact that high register reflexes of *ə do indeed distort following such onset consonants (e.g. *sambar deer, completed*, and *hornet* in Table 114). It is a particularity of the close vowels that the interaction of glottal(ized) onsets and close vowel quality blocks distortion. Examples of undistorted high register reflexes of *i and *u following glottal(ized) onsets are found in Table 116.[109]

Table 116: *Non-distorted reflexes of Pre-Mon *i and *u following glottal/implosive onsets*

Gloss	Pre-Mon	Mon Rao (Mudon)	Mon Rao (Ka Mar Wet)
sea	*ɓi	ɓɨi	ɓəi
mortar	*gəʔi	həʔɨi	həʔəi
to drift	*hi	hɨi	həi
blood	*chim	chim	chɨim
intoxicated	*bəɓu	həɓu	həɓu
medicine	*gəʔuj	həʔəuj	həʔəuj
to bathe	*hum	hum	hum
knife	*ɓun	ɓun	ɓun

[109] Note that the transcription of Mon Rao data in Diffloth (1982a) appears to be less than phonemic with some extraneous phonetic detail in the vowels. The slight centralization or lowering of the vowels in Table 116 are apparently not sufficient to constitute distortion, in Diffloth's estimation.

Diffloth puts forward a hypothesis that glottal and implosive onsets may have conditioned a third register in Mon Rao. All things being equal, we expect that glottal(ized) onsets will follow the voiceless stop onsets in conditioning the high register series when onset voicing is desegmentalized. This is not always the case, however. There are numerous cases of glottal(ized) consonants series conditioning tone splits or mergers, as is well described in Tai (Gedney 1972). In a registral context, we find that in Western Cham, the quality of vowels following *implosive onsets follows the high register pattern but, unexpectedly, the pitch pattern associated with syllables with an *implosive in the onset do not match the relatively high vocal pitch associated with high register in this language. Rather, these onsets are associated with F0 values which are, on average, even lower than those in the language's low register (Edmondson & Gregerson 1993). In both of these cases, the glottalized/implosive onsets have indeed created a middle register of sorts, which conditions register distribution differently than the prototypical *high/*voiceless and *low/*voiced series. A further example of a middle register effect is found in Kriang, as described above in Section 2.5.4.

To summarize, then, there are three Pre-Mon vowels which experience significant diphthongization in the high register: the close vowels *i and *u (except before velars) and the mid vowel *ə (only before velars). In the Ka Mar Wet dialect, they have all diphthongized and developed pharyngealization becoming /ɒˤi/, /ɒˤu/ and /ɒˤə/, respectively. In one environment, namely, following glottal and implosive onsets, close vowels *i and *u failed to diphthongize and become pharyngealized in this dialect. Instead, they remained as more conservative close vowels, either at a stable vowel height level ([i u]) or slightly onglided ([ɨi əu]).

This is potentially a case of vowel height desegmentalization, but it is unclear at this time what the phonemic status of pharyngealization is. Diffloth's analysis makes it seem that pharyngealization is a predictable concomitant feature of highly diphthongal, historically high register mid and close vowels. If, however, this pharyngealization is no longer predictable, then there has been a split in the high register of the Ka Mar Wet variety of Mon Rao conditioned by vowel height. Furthermore, one wonders what the phonetic correlates of the "pharyngealized" diphthongs might be and what phonetic explanation there might be for explaining the emergence of this unique articulation of high register. The Mon Rao variety of Ka Mar Wet should be considered a priority for further documentation, so that we might gain a better understanding of the phonetics and phonology of its "distorted" high register vowels.

5.2.4.6 Outlier: "Register" Conditioned by Coda Nasalization in Mah Meri

While it is common for nasal codas to affect the distribution of desegmental phonemes, they do so almost exclusively as a subset of the natural class of sonorant codas {-son}. However, there is one remarkable case in the Aslian branch, where the historical contrast of nasality between oral stop codas {-T} and nasal stop codas {-N} appears to have been desegmentalized. Desegmental phonology is otherwise absent in the Aslian branch,[110] but in the Mah Meri language, {-T} and {-N} codas have conditioned what is described as a high register and low register, respectively, with the subsequent loss of nasality contrast in the codas and merger to oral stops. Phillips (2012) provides the examples presented in Table 117.

Table 117: *Examples of coda nasality desegmentalization in Mah Meri (Phillips 2012)*

pAslian	Mah Meri		pAslian	Mah Meri	
*ʔəntap	tɛp^{H}	*testicle*	*tam	təp^{L}	*to plant*
*mat	mɛt^{H}	*eye*	*cɛːn	cit^{L}	*cooked*
*kaːc	koc^{H}	*to dig*	*koːɲ	kuc^{L}	*father*
*bək	bək^{H}	*to tie*	*ʔəntaŋ	tək^{L}	*ear*

The Mah Meri register contrast is phonetically quite subtle, reportedly, and was missed entirely in earlier work on the language. More recently, Stevens et al. (2006) and Kruspe & Hajek (2009) have identified and investigated the phenomenon. The high register is characterized as having relatively tense voice quality, relatively lower pitch and relatively short duration. The low register is described as relatively lax in voice quality, tending towards breathy voice,

[110] Bishop (1996) does note a small number of tonal contrasts in the Kensiw language, however, which are reportedly recent innovations, encouraged by heavy contact with Southern Thai.

relatively higher pitch and relatively longer duration. Register minimal pairs are readily identifiable (e.g. /luwat^{H}/ 'mangrove worm' vs. /luwat^{L}/ 'front'), but none of the proposed register cues were found to be consistent, reliable indicators to the register contrast in a production study (Stevens et al. 2006). Furthermore, the association of lower pitch with high register and higher pitch with low register is the opposite of the expected relationship, hinting at the possibility that we are not dealing with a prototypical register contrast here.

To put this atypical register formation process in context, Mah Meri is a Southern Aslian language and pAslian coda nasals are typically realized as phonetically pre-stopped in this sub-branch (i.e. *VN > [V^{T}N]). This helps to bridge the gap between pAslian coda nasals and their denasalized modern reflexes in Mah Meri and, perhaps, offers us a clue as well as to how Mah Meri register developed. Kruspe & Hajek (2009) describe coda oral stops in low register words (i.e. denasalized stops) have as having a "…muted articulation, and although it may exhibit simultaneous glottalization or checking like plosives following Register 1 vowels…it may also appear unchecked." This descriptions indicates that the predictable, co-articulatory glottalization and lack of release associated with oral stop codas in most Austroasiatic languages is not necessarily present in the Mah Meri denasalized stop codas. This suggests a historical difference in laryngeal tension between the /T/ <*T [ˀT] codas and the /T/ < *N [^{T}N] codas. It is most likely this laryngeal tension differential which has been desegmentalized as a kind of register in Mah Meri or, perhaps more accurately, is in the process of being desegmentalized, given the paradigmatic (if optional) difference in coda /T/ glottalization between reflexes of *T and *N that Krupse & Hajek point out.[111]

In summary, Mah Meri is a language in transition from a coda stop nasality contrast (*T vs. *N) to something else. Currently, the former nasality contrast is being upheld by a combination of the register bundle of features (minus vowel height differences and with an inverted pitch-register association) and a difference of coda oral stop tension. It is unclear at this point whether any of these register cues or the coda tension differential (glottalized vs. plain) will phonemicize to perpetuate the pAslian coda nasality contrast. If none of these cues become phonemicized, we may expect that Mah Meri will experience a general merger of *T and *N codas to /T/, as is documented in other Austroasiatic languages of the Bahnaric branch, including Li Xei (see Section 4.6.2), Cua/Kor (Sidwell 2010), Katua (Smith 1970), Takua (Burton 1972), Mơdra (Gregerson & Smith 1973).

The phonetic cues currently associated with Mah Meri coda stop nasality or register are summarized in Table 118.

Table 118: *Summary of cues associated with pAslian coda stop nasality contrast in modern Mah Meri*

	-T	***-N***
Coda Glottalization	*yes*	*optional*
Vocalic Voice Quality	*tenser*	*laxer*
Vocalic Pitch	*lower*	*higher*
Vowel Duration	*shorter*	*longer*

If this is, indeed, a desegmentalization pathway, it is a unique one. If we were to characterize the Mah Meri development as the desegmentalization of coda nasality contrast, this would engender an increase in the inventory of documented desegmentalization processes to five. On the other hand, if we were to characterize this as an example of coda phonation desegmentalization among oral stops (i.e. {-ˀT} vs. {-T}), then this would be a unique example of a language undergoing CP in the absence of any of the three proposed primary desegmentalization process, calling into question CP's classification as a secondary desegmentalization process. Further investigation into coda denasalization in Southern Aslian is called for in order to investigate this issue further.

5.2.5 Expanding the Scope of Desegmentalization

In conclusion, the scope of desegmentalization has been purposefully kept circumscribed within MSEA and, more specifically, within Austroasiatic for this thesis. This was done for practical reasons, given the constraints on the size of a PhD project. For this first step in the investigation, an unapologetically bottom-up approach was taken and the model for phonological change that was developed is rooted more in the work of previous generations of historical

[111] Note that Phillips (2012, 53) proposes a similar explanation for the emergence of Mah Meri register

phonologists focused on the languages of MSEA in particular than in broader theoretical work on sound change in general. Discovering whether the insights gained in this thesis will be applicable and/or helpful in work on other MSEA language families, first of all, and then in other languages outside of MSEA constitutes the next step in this line of inquiry.

The most obvious next frontier in work on desegmentalization will be to survey another large language family of MSEA with an ancient lineage and many diverse examples of desegmental innovation: the Tibeto-Burman language family. Tonogenesis has already been extensively investigated in certain Tibeto-Burman branches, such as Lolo-Burmese and Karenic, but there is much complexity within the family that must be surveyed and synthesized in order to hone and, potentially, expand the desegmentalization paradigm. This will be no simple task, however, given that reconstructing the segmental origins of tones is more difficult for the typologically diverse Tibeto-Burman languages than it is for the comparatively homogeneous Austroasiatic languages.

Beyond Austroasiatic, Tibeto-Burman and the other language famlies of MSEA, it is uncertain whether desegmentalization as a concept will be of use. Nevertheless, it is very much hoped that scholars concerned with the origins of tone and other types of suprasegmental contrasts will find something useful in what has been presented here, or, at least, something to spark further conceptual insights toward our collective goal: coming to a better understanding of suprasegmental contrast and its origins.

6 References

Abramson, A. S., Mark K. Tiede & Theraphan Luangthonkum. 2015. Voice register in Mon: Acoustics and electroglottography. *Phonetica* 72. 237-256.

Abramson, A. S., Patrick W. Nye & Theraphan Luangthonkum. 2007. Voice register in Khmu': Experiments in production and perception. *Phonetica* 64. 80-104.

Alves, Mark. 2021. Linguistic influence of Chinese in Southeast Asia. In In Paul Sidwell & Mathias Jenny (eds.), *The Languages and Linguistics of Mainland Southeast Asia,* 649-672. (World of Linguistics 8). Berlin/Boston: de Gruyter Mouton.

Archangeli, Diana & Douglas Pulleyblank. 1994. *Grounded Phonology.* (Current Studies in Linguistics 25). Cambridge, MA: MIT Press.

Aung Si. 2015. Danau. In Mathias Jenny & Paul Sidwell (eds.), *The Handbook of Austroasiatic Languages*, 1104-1143. Leiden: Brill.

Barnes, Jonathan. 2006. *Strength and Weakness at the Interface: Positional Neutralization in Phonetics and Phonology.* Berlin, New York: Mouton de Gruyter.

Baxter, William & Laurent Sagart. 2014. *Old Chinese: A New Reconstruction*. New York: Oxford University Press.

Baxter, William. 1992. *A Handbook of Old Chinese Phonology*. Berlin: Mouton de Gruyter.

Becker, Michael & Peter Jurgec. 2017. Interactions of tone and ATR in Slovenian. In Wolfgang Kehrein, Björn Köhnlein, Paul Boersma & Marc van Oostendorp. (eds.), *Segmental Structure and Tone*, 11-26. Berlin: de Gruyter.

Benedict, Paul. 1942. Thai, Kadai and Indonesian: A new alignment in South-Eastern Asia. *American Anthropologist* 44: 576-601.

Benedict, Paul. 1990a. How to tell Lai: An exercise in classification. *Linguistics of the Tibeto-Burman Area* 13.2. 1–26.

Benedict, Paul. 1990b. *Japanese/Austro-Tai*. Ann Arbor: Karoma.

Bermúdez-Otero, Ricardo. 2015. Amphichronic explanation and the life cycle of phonological processes. In Patrick Honeybone & Joseph Salmons (eds.), *Handbook of Historical Phonology*, 374-399. Oxford: Oxford University Press.

Bisang, Walter. 2015. Modern Khmer. In Mathias Jenny & Paul Sidwell (eds.), *The Handbook of Austroasiatic Languages*, 677-716. Leiden: Brill.

Bishop, Nancy. 1996. A preliminary description of Kensiw (Maniq) phonology. *Mon-Khmer Studies* 25. 227-253.

Bon, Noëllie. 2014. *Une Grammaire de la Langue Stieng: Langue en Danger du Cambodge et du Vietnam*. [A Grammar of the Stieng Language: An Endangered Language of Cambodia and Vietnam]. Lyon: Université Lumière Lyon 2 PhD thesis.

Bradley, David. 1982. Register in Burmese. In David Bradley (ed.), *Papers in South-East Asian Linguistics, No. 8: Tonation*, 117-131. (Pacific Linguistics Series A – No. 62). Canberra: Australian National University.

Brunelle, Marc & James Kirby. 2015. Re-assessing tonal diversity and geographical convergence in Mainland Southeast Asia. In Bernard Comrie & Enfield, Nick (eds.), *Languages of Mainland Southeast Asia: The State of the Art*, 82–110. Berlin: Mouton de Gruyter.

Brunelle, Marc & James Kirby. 2016. Tone and phonation in Southeast Asian languages. *Language & Linguistics Compass* 10:4. 157-207.

Brunelle, Marc, James Kirby, Alexis Michaud & Justin Watkins. 2020. Prosodic systems: Mainland Southeast Asia. In Carlos Gussenhoven & Aoju Chen (eds.), *The Oxford Handbook of Language Prosody*. Oxford: Oxford University Press.

Brunelle, Marc, Thành Tấn Tạ, James Kirby & Đinh Lư Giang. 2019. Obstruent devoicing and registrogenesis in Chru. In Sasha Calhoun, Paola Escudero, Marija Tabain & Paul Warren (eds.), *Proceedings of the 19th International Congress of Phonetic Sciences*, 517–521. Melbourne: Australasian Speech Science and Technology Association Inc.

Brunelle, Marc, Thành Tấn Tạ, James Kirby & Đinh Lư Giang. 2020. Transphonologization of voicing in Chru: Studies in production and perception. *Laboratory Phonology: Journal of the Association for Laboratory Phonology*, 11(1), 15.

Brunelle, Marc. 2004. Monosyllabicization in Eastern Cham. In Wilaiwan Khanittanan & Paul Sidwell (eds.), *SEALSXIV: Papers from the 14th Meeting of the Southeast Asian Linguistics Society, Volume 1*, 43-58. Canberra: Pacific Linguistics.

Brunelle, Marc. 2005a. Register and tone in Eastern Cham: Evidence from a word game. *Mon-Khmer Studies* 35. 121–132.

Brunelle, Marc. 2005b. *Register in Eastern Cham: Phonological, Phonetic and Sociolinguistic Approaches*. Cornell University PhD dissertation.

Brunelle, Marc. 2009a. Contact-induced change? Register in three Cham dialects. *Journal of Southeast Asian Linguistics* 2. 1–22.

Brunelle, Marc. 2009b. Tone perception in Northern and Southern Vietnamese. *Journal of Phonetics* 37. 79–96.

Brunelle, Marc. 2010. The role of larynx height in the Javanese tense ~ lax stop contrast. In Rafael Mercado, Eric Potsdam & Lisa Travis (eds.), *Austronesian Contributions to Linguistic Theory: Selected Proceedings of AFLA*, 7–24. Amsterdam & Philadelphia: John Benjamins.

Brunelle, Marc. 2012. Dialect experience and perceptual integrality in phonological registers: Fundamental frequency, voice quality and the first formant in Cham. *Journal of the Acoustical Society of America* 131.4. 3088–3102.

Brunner, Jana & Marzena Żygis. 2011. Why do glottal stops and low vowels like each other? *Proceedings of the 17th International Congress of Phonetic Sciences* (ICPhS XVII), Hong Kong, 376–379.

Burton, Eva. 1972. *Takua Cognates to Proto-North Bahnaric*. Unpublished.

Butler, Becky. 2010. Registrogenesis in Bunong: The interaction of phonetics and phonology. Poster presented at the *International Workshop on Sound Change,* Universitat Autònoma de Barcelona and Institut d'Estudis Catalans, Barcelona, Spain, Oct. 2010.

Butler, Becky. 2015. Approaching a phonological understanding of the sesquisyllable with phonetic evidence from Khmer and Bunong. In N.J. Enfield and Bernard Comrie (eds.), *The Languages of Mainland Southeast Asia: The State of the Art*, 443-499. Berlin: De Gruyter Mouton.

Campbell, Eric W. 2021. Why is tone change still poorly understood, and how might documentation of less-studied tone languages help? In Patience Epps, Danny Law & Na'ama Pat-El (eds.), *Historical Linguistics and Endangered Languages: Exploring Diversity in Language Change*. New York & London: Routledge.

Caplow, Nancy Jill. 2009. *The Role of Stress in Tibetan Tonogenesis: A Study in Historical Comparative Acoustics*. Santa Barbara, CA: University of California, Santa Barbara PhD dissertation.

Casali, Roderic F. ATR harmony in African languages. 2008. *Language and Linguistics Compass* 2/3. 496-549.

Chamberlain, James R. 1972. Tone borrowing in five northeastern dialects. In Jimmy G. Harris and Richard B. Noss (eds.), *Tai Phonetics and Phonology*, 43–46. Bangkok: Central Institute of English Language, Mahidol University.

Chantrupanth, Dhanan and Chartchai Phromjakgarin. 1978. *Khmer (Surin)-Thai-English Dictionary*. Bangkok: Chulalongkorn University Language Institute, Indigenous Languages of Thailand Research Project.

Charoenma, Narumol. 1982. The phonologies of Lampang Lamet and Wiang Papao Lua. *Mon-Khmer Studies* XI. 35-45.

Chen, Matthew Y. 1970. Vowel length variation as a function of the voicing of the consonant environment. *Phonetica* 22. 129-59.

Chen, Matthew Y. 1987. The syntax of Xiamen Tone Sandhi. *Phonology Yearbook*, 4. 109-149.

Chen, Matthew Y. 2000. *Tone Sandhi: Patterns Across Chinese Dialects.* Cambridge: Cambridge University Press.

Chen, Wei-Rong, D.H. Whalen & Mark K. Tiede. 2021. A dual mechanism for intrinsic f0. *Journal of Phonetics* 87.

Chomsky, Noam and Morris Halle. 1968. *The Sound Pattern of English*. New York: Harper and Row.

Coetzee, Andries W., Patrice Speeter Beddor, Kerby Shedden, Will Styler & Daan Wissing. 2018. Plosive voicing in Afrikaans: Differential cue weighting and tonogenesis. *Journal of Phonetics* 66. 185-216.

Comrie, Bernard. 2007. Areal typology of Mainalnd Southeast Asia: What we learn from the WALS maps. *Manusya* 13. 18-47.
Conver, Lynn. 1999. A sketch of the phonology of a Lamet dialect. *Mon-Khmer Studies* 29. 35-56.
Cooper, James & Nancy Cooper. 1964. *Halang Dictionary*. Unpublished manuscript.
Cooper, James & Nancy Cooper. 1976. *Halang Vocabulary: Halăng – Vietnamese – English Thesaurus*. Huntington Beach, California: Summer Institute of Linguistics.
Denning, Keith. 1989. *The diachronic development of phonological voice quality, with special reference to Dinka and the other Nilotic languages*. PhD dissertation, Stanford University.
DeLancey, Scott. 2013. The origins of Sinitic. In Zhuo Jing-Schmidt (ed.), *Increased Empiricism: Recent Advances in Chinese Linguistics*, 73–100. Amsterdam & Philadelphia: John Benjamins.
DiCanio, Christian T. 2009. The phonetics of register in Takhian Thong Chong. *Journal of the International Phonetic Association* 39/2, 162-188.
Diffloth, Gérard. 1980. The Wa languages. *Linguistics of the Tibeto-Burman Area* 5.2. 1-182.
Diffloth, Gérard. 1982a. Proto-Mon registers: Two, Three, Four…? *Proceedings of the Eighth Annual Meeting of the Berkeley Linguistics Society*. 148-157.
Diffloth, Gérard. 1982b. Registres, dévoisement, timbres vocaliques: leur histoire en Katouique. [Registers, devoicing and voice quality: their history in Katuic]. *Mon-Khmer Studies* 11. 47-82.
Diffloth, Gérard. 1984. *The Dvaravati-Old Mon language and Nyah Kur* (Monic Language Studies 1). Bangkok: Chulalongkorn University Printing House.
Diffloth, Gérard. 1989. Proto-Austroasiatic creaky voice. *Mon-Khmer Studies* 15. 139-154.
Diffloth, Gérard. 2001. Les expressifs du Surin, et où cela conduit. *Bulletin de l'Ecole française d'Extrême-Orient* 88. 261-269.
Dockum, Rikker. 2019. *The Tonal Comparative Method: Tai Tone in Diachronic Perspective*. New Haven, CT: PhD dissertation. Yale University dissertation.
Edmondson, Jerold & Kenneth Gregerson. 1993. Western Cham as a register language. In Jerold Edmondson & Kenneth Gregerson (eds.), *Tonality in Austronesian Languages*, 61–74. Honolulu: University of Hawaii Press.
Edmondson, Jerold & Kenneth Gregerson. 1996. Bolyu tone in Vietic perspective. *Mon-Khmer Studies* 26. 117-133.
Edmondson, Jerold A & David B. Solnit. 1997. Comparative Shan. In Jerold A. Edmonson & David B. Solnit (eds.), *Comparative Kadai: The Tai Branch*, 337-360. The Summer Institute of Linguistics & The University of Texas at Arlington.
Edmondson, Jerold A. & John H. Esling. 2006. The valves of the throat and their functioning in tone, vocal register and stress: Laryngoscopic case studies. *Phonology* 23. 157-191.
Edmondson, Jerold A. 1995. English-Bolyu glossary. *Mon-Khmer Studies* 24. 133-159.
Edmondson, Jerold A. 1996. Voice qualities and inverse filtering in Chong. *Mon-Khmer Studies* 26. 107-116.
Edmondson, Jerold A. 1996. Voice qualities and inverse filtering in Chong. *Mon-Khmer Studies* 26. 107–116.
Ehrman, Madeleine. 1972. *Contemporary Cambodian: Grammatical Sketch*. Washington D.C.: Foreign Service Institute.
Enfield, N. J. & Gérard Diffloth. 2009. Phonology and sketch grammar of Kri, a Vietic language of Laos. *Cashiers de Linguistique Asie Orientale* 38(1). 3-69.
Enfield, N. J. 2005. Areal linguistics and Mainland Southeast Asial. *Annual Review of Anthropology* 34: 181–206.
Enfield, Nicholas. 2019. *Mainland Southeast Asian Languages: A Concise Typological Introduction*. Cambridge: Cambridge University Press.
Esposito, Christina M., Morgan Sleeper & Kevin Schäfer. 2019. Examining the relationship between vowel quality and voice quality. *Journal of the International Phonetic Association* 1-32. https://doi.org/10.1017/S0025100319000094
Esposito, Christina. 2012. An acoustic and electroglottographic study of White Hmong tone and phonation. *Journal of Phonetics* 40. 466-476.
Evans, Jonathan. 2001. Contact-induced tonogenesis in Southern Qiang. *Language and Linguistics* 2(2). 63-110.

Evans, Jonathan. 2009. Is there a Himalayan tone typology? In Yasuhiko Nagano (ed.), *Issues in Tibeto-Burman Historical Linguistics*, 199-221. (Senri Ethnological Studies 75). Osaka: National Museum of Ethnology.

Fagan, Joel. 1988. Javanese intervocalic stop phonemes. *Studies in Austronesian Linguistics* 76. 173–202.

Ferlus, Michel. 1971a. La langue Souei: Mutations consonantiques et bipartition du système vocalique. [The Souei language: Consonant mutations and the splitting of its vowel system]. *Bulletin de la Société de Linguistique de Paris* 66. 379-88.

Ferlus, Michel. 1971b. Simplification des groupes consonantiques dans deux dialectes austroasiens du sud-Laos. *Bulletin de la Societé de Linguistique de Paris* 66. 389-403.

Ferlus, Michel. 1972. Notes sur les dialectes Austroasiens du sud Laos. [Notes on the Austroasiatic varieties of southern Laos]. *Asie du Sud-Est et Monde Insulindien* 3(2). 35-49.

Ferlus, Michel. 1974a. La langue Ong, mutations consonantiques et transphonologisations. [The Ong language, consonant mutations and trasphonologizations]. *Asie du Sud-Est et Monde Insulindien* 5.113-21.

Ferlus, Michel. 1974b. *Lexique Souei-Français*. [Souei-French Lexicon]. *Asie du Sud-Est et Monde Insulindien* 5. 141-59.

Ferlus, Michel. 1975. Vietnamien et Proto-Viet-Mương. *Asie du Sud-Est et Monde Insulindien* 6.4. 21–56.

Ferlus, Michel. 1979. Formation des registres et mutations consonantiques dans les langues Mon-Khmer. [The formation of registers and consonant mutations in the Mon-Khmer languages]. *Mon-Khmer Studies* 8. 1-76.

Ferlus, Michel. 1982. Spirantisation des obstruantes médiales et formation du systèm consonantique du vietnamien. *Cahiers de Linguistique, Asie Orientale* 11.1. 83–106.

Ferlus, Michel. 1991. Vocalisme du Proto-Viet-Muong. Paper presented at The 24th ICS-TL&L. Chiang Mai University, Oct. 10–11, 1991.

Ferlus, Michel. 1992a. Essai de phonétique historique du khmer (du milieu du premier millénaire de notre ère à l'époque actuelle). [Essay on the phonological history of Khmer (from the middle of the first millennium AD to the present day)]. *Mon-Khmer Studies* 21. 57-89.

Ferlus, Michel. 1992b. Histoire abregée de l'évoltion des consonnes initials du vietnamien. *Mon-Khmer Studies* 20: 111–127.

Ferlus, Michel. 1992c. Sur l'origine géographique des langues Viet-Muong. *Mon-Khmer Studies* 18–19: 52–59.

Ferlus, Michel. 1996. Langues et peuples viet-muong. *Mon-Khmer Studies* 26. 7–28.

Ferlus, Michel. 1997. Problèmes de la formation du systèm vocalique du vietnamien. *Cahiers de Linguistique, Asie Orientale* 26.1. 37–51.

Ferlus, Michel. 1998a. Du chinois archaïque au chinois ancien: Monosyllabisation et formation des syllabes tendu/lâche (Nouvelle théorie sur la phonétique historique du chinois). [From Old Chinese to Middle Chinese: Monosyllabicization and the formation of tense/lax syllables (A new theory on the phonetic history of Chinese)]. Paper presented at *The 31st International Conference on Sino-Tibetan Languages and Linguistics*, University of Lund, Sweden, Oct. 1998.

Ferlus, Michel. 1998b. Les systèmes de tons dans les langues Viet-Mương. *Diachronica* 15.1: 1–27.

Ferlus, Michel. 2004. The Origin of Tones in Viet-Muong. In Somsonge Burusphat (ed.), *Papers from the Eleventh Annual Meeting of the Southeast Asian Linguistics Society*, 297-313. Tempe, Arizona: Arizona State University, Program for Southeast Asian Studies.

Ferlus, Michel. 2005. Proto-Viet-Muong (Proto-Vietic). Unpublished manuscript. Online: https://halshs.archives-ouvertes.fr/halshs-02490370/document (Accessed Sept 1, 2021).

Ferlus, Michel. 2007. *Lexique de Racines Proto Viet-Muong*. Unpublished manuscript. Online: http://sealang.net/monkhmer/database/ (Accessed Sept 1, 2021).

Ferlus, Michel. 2009. What were the four divisions of Middle Chinese? *Diachronica* 26.2. 184-213.

Ferlus, Michel. 2011. Toward Proto-Pearic: Problems and historical implications. In Sophana Srichampa & Paul Sidwell (eds.), *Austroasiatic Studies: Papers from ICAAL4*: *Mon-Khmer Studies Journal Special Issue No. 2*. Dallas: SIL International; Canberra: Pacific Linguistics; Salaya: Mahidol University.

Ferlus, Michel. 2012. Remarques sur la 'pharyngalisation' en chinois archaïque (Old Chinese) dans le système de Baxter-Sagart. Presented at the *Vingt-Cinquièmes Journées de Linguistique de l'Asie Orientale, CRLAO (EHESS – CNRS)*, Paris, June 28-29, 2012.

Filbeck, David. 1972. Tone in a dialect of T'in. *Anthropological Linguistics* 14(4). 111-117.

Filbeck, David. 1978. *T'in: A Historical Study*. Canberra: Department of Linguistics, Research School of Pacific Studies, the Australian National University.

Friberg, Timothy & Kvoeu Hor. 1977. Register in Western Cham phonology. In David Thomas, Ernest Lee & Nguyen Dang Liem (eds.), Papers in Southeast Asian Linguistics No. 4: Chamic Studies. (Pacific Linguistics Series A – No. 48). Canberra: Pacific Linguistics.

Gage, William. 1985. Glottal stops and Vietnamese tonogenesis. In V. Z. Acson & R. L. Leed (eds.), *For Gordon F. Fairbanks*. (Oceanic Linguistics Special Publication No. 20). Honolulu: University of Hawaii Press.

Gandour, Jackson T., Eva Gårding & Kristina Lindell. 1978. Tones in Northern Kammu: A perceptual investigation. *Acta Orientalia* 39. 181-189.

Gedney, William. 1972. A checklist for determining tones in Tai dialects. In M. Estellie Smith (ed.), *Studies in Linguistics in Honor of George L. Trager*. The Hague: Mouton.

Gehrmann, Ryan & James Kirby. 2019. The register phenomenon across Kuay dialects: Analysis of the Huffman Katuic audio archives. Paper presented at the *29th Meeting of the Southeast Asian Linguistics Society*, Tokyo University of Foreign Studies, Tokyo, Japan, May 27-29, 2019.

Gehrmann, Ryan. 2015. Vowel height and register assignment in Katuic. *Journal of the Southeast Asian Linguistic Society* 8. 56-70.

Gehrmann, Ryan. 2016. *The West Katuic Languages: Comparative Phonology and Diagnostic Tools*. Chiang Mai: Payap University MA thesis.

Gehrmann, Ryan. 2017. The historical phonology of Kriang, a Katuic language. *Journal of the Southeast Asian Linguistics Society* 10.1: 114-139.

Gehrmann, Ryan. 2019. On the origin of rime laryngealization in Ta'oiq: a case study in the phonatory restructuring of vowel quality contrasts. Paper presented at the *8th International Conference on Austroasiatic Linguistics*, Chiang Mai University, Chiang Mai, Thailand, Aug. 29-31, 2019.

Gehrmann, Ryan. 2021a. Evidence for the common origins of rime glottalization in Northeastern Austroasiatic (Vietic, Bolyu, Bugan & Mang). Paper presented at *The 9th International Conference on Austroasiatic Linguistics (ICAAL 9)*, Centre for Languages and Literature, Lund University, Sweden, Nov. 18-19, 2021.

Gehrmann, Ryan. 2021b. *Proto-Katuic*. Unpublished manuscript.

Gehrmann, Ryan. 2022. Pseudoregister in Pacoh: Preliminary acoustic analysis and implications for a general model of pseudoregister formation in Austroasiatic. In *Proceedings of the 30th Annual Meeting of the Southeast Asian Linguistics Society (SEALS XXX).* To appear.

Goldsmith, John. 1976. *Autosegmental Phonology*. Cambridge, MA: Massachusetts Institute of Technology PhD dissertation.

Goldsmith, John. 1990. *Autosegmental and Metrical Phonology*. Basil Blackwell.

Gordon, Matthew & Peter Ladefoged. 2001. Phonation types: A cross-linguistic overview. *Journal of Phonetics* 29.4. 383-406.

Gradin, Dwight. 1966. Consonantal tone in Jeh phonemics. *Mon-Khmer Studies* 2. 41-53

Gregerson, Kenneth & Kenneth Smith. 1973. The development of Tơdrah register. *Mon-Khmer Studies* 4: 143-184.

Gregerson, Kenneth, and Marilyn Gregerson. 1977. N*gữ Vựng Rơngao*. [Rengao vocabulary]. Manila, Philippines: SIL.

Gregerson, Kenneth. 1976. Tongue-root and register in Mon-Khmer. In Philip N. Jenner, Laurence C. Thompson & Stanley Starosta (eds.) *Austroasiatic Studies* (Oceanic Linguistics Special Publication No. 13). Honolulu: University of Hawai'i Press.

Gregerson, Kenneth. 1984. Pharynx symbolism and Rengao phonology. *Lingua* 62. 209-238.

Gruber, James. 2011. *An Articulatory, Acoustic, and Auditory Study of Burmese Tone*. Georgetown University PhD dissertation.

Guion, Susan G., Mark W. Post & Doris L. Payne. 2004. Phonetic correlates of tongue root vowel contrasts in Maa. *Journal of Phonetics* 32. 517-542.

Hagège, Claude & André Haudricourt. 1978. La Phonologie Panchronique. [Panchronic Phonology]. Paris: Presses Universitaires de France.

Haiman, John. 2011. *Cambodian Khmer*. Amsterdam and Philadelphia: John Benjamins.

Hall, Elizabeth. 2010. *A Phonology of Muak Sa-aak*. Chiang Mai: Payap University MA thesis.

Harper, Jerod Alan. 2009. *Phonological Descriptions of Plang Spoken in Man Noi, La Gang, and Bang Deng Villages (in China)*. Chiang Mai: Payap University MA thesis.

Haudricourt, André-Georges. 1954. De l'origine des tons en Viêtnamien. [On the origin of tones in Vietnamese]. *Journal Asiatique* 242. 69-82.

Haudricourt, André-Georges. 1961. Bipartition et tripartition des systèmes de tons dans quelques langues d'Extrême-Orient. [Two-way and three-way splitting of tonal systems in some Far Eastern languages]. *Bulletin de la Société de Linguistique de Paris* 56(1). 163–180.

Haudricourt, André-Georges. 1965. Les mutations consonantiques des occlusives initiales en môn-khmer. [Consonant mutations in Mon-Khmer initial stops]. *Bulletin de la Société de Linguistique de Paris* 60.1. 160–172.

Hayward, Katrina, D. Grafield-Davies, B. J. Howard, J. Latif & Ray Allen. 1994. *Javanese Stop Consonants: The Role of the Vocal Folds*. London: School of Oriental and African Studies.

Headley, Robert. 1985. Proto-Pearic and the classification of Pearic. In Suriya Ratanakul, David D. Thomas & Suwilai Premsrirat (eds.), *Southeast Asian Linguistic Studies Presented to André-G Haudricourt*, 428-478. Bangkok: Mahidol University.

Henderson, Eugénie. 1952. The main features of Cambodia pronunciation. *Bulletin of the School of Oriental and African Studies* 14.1. 149-174.

Henderson, Eugénie. 1965. The topography of certain phonetic and morphological characteristics of South East Asian languages. *Lingua* 15. 400-434.

Henderson, Eugénie. 1967. Grammar and tone in South-east Asian languages. *Wissenschaftliche Zeitschrift der Karl-Marx-Universität-Leipzig* 16. 171–78.

Hoemeke, K. A., & Diehl, R. L. 1994. Perception of vowel height: The role of F_1—F_0 distance. *Journal of the Acoustical Society of America* 96(2, Pt 1). 661–674.

Hombert, Jean-Marie, Ohala, John J and Ewan, William G. 1979. Phonetic explanations for the development of tones. *Language* 55. 37–58.

Hombert, Jean-Marie. 1977. Development of tones from vowel height. *Journal of Phonetics* 5, 9-16.

Honda, K. & O. Fujimura. 1991. Intrinsic vowel F0 and phrase-final F0 lowering: phonological vs. biological explanations. In Gauffin, J. & B. Hammarberg (eds.), *Vocal Fold Physiology: Acoustic, Perceptual, and Physiological Aspects of Voice Mechanisms*, 149–157. San Diego, CA: Singular Publishing Group.

Howe, Penelope Jane. 2017. Tonogenesis in Central Dialects of Malagasy: Acoustic and Perceptual Evidence with Implications for Synchronic Mechanisms of Sound Change. Houston: Rice University PhD thesis.

Hsiu, Andrew. 2016. *A Preliminary Reconstruction of Proto-Pakanic*. Unpublished.

Huffman, Franklin. 1967. *An Outline of Cambodian Grammar*. Ithaca: Cornell University. PhD dissertation.

Huffman, Franklin. 1971. *Analysis of Souei and Alak*. In Paul Sidwell (ed.), *Huffman Papers*. Online: www.sealang.net/archives/huffman (Accessed 16 October, 2017).

Huffman, Franklin. 1972. The boundary between the monosyllable and the disyllable in Cambodian. *Lingua* 29. 54-66.

Huffman, Franklin. 1976. The register problem in fifteen Mon-Khmer languages. In Philip N. Jenner, Laurence C. Thompson & Stanley Starosta (eds.), *Austroasiatic Studies*, 575-590. Honolulu: The University Press of Hawaii.

Huffman, Franklin. 1985a. The phonology of Chong. In Suriya Ratanakul, David Thomas & Suwilai Premsrirat (eds.), *Southeast Asian Linguistics Studies Presented to Andre G. Haudricourt*, 355-388. Thailand: Mahidol University.

Huffman, Franklin. 1985b. Vowel permutations in Austroasiatic languages. In Graham Thurgood, James A. Matisoff and David Bradley (eds.), *Linguistics of the Sino-Tibetan Area: The State of the Art. Papers Presented to Paul K. Benedict for his 71st Birthday*, 141-45. Canberra: Department of Linguistics, Research School of Pacific Studies, Australian National University.

Hyman, Larry M. 2001. Tone systems. In Martin Haspelmath et al. (eds.), *Language Typology and Language Universals: An International Handbook, Vol. 2*, 1367-1380. Berlin & New York: Walter de Gruyter.

Hyman, Larry M. 2006. Word-prosodic typology. *Phonology* 23. 225-257.

Hyman, Larry M. 2011. Tone: Is it different? In John A. Goldsmith, Jason Riggle & Alan C. L. Yu (eds.), *The Handbook of Phonological Theory, 2nd Edition*, 50–80. (Blackwell Volumes in Linguistics, Vol. 75). Hoboken, NJ: John Wiley and Sons.

Hyman, Larry. 1976. Phonologization. In A. Juilland (ed.), *Linguistic Studies Presented to Joseph H. Greenberg*, 407-418. Saratoga, California: Anna Libri.

Hyman, Larry. 2013. Englarging the scope of phonologization. In Alan C. Yu (ed.), *Origins of Sound Change: Approaches to Phonologization*, 3-28. Oxford: Oxford University Press.

Hyslop, Gwendolyn. 2009. Kurtöp tone: A tonogenetic case study. *Lingua* 119. 827–845.

Jacob, Judith M. 1968. *Introduction to Cambodian*. London: Oxford University Press.

Janhunen, Juha, Marja Peltomaa, Erika Sandman, and Xiawu Dongzhou. 2008. *Wutun*. Munich: Lincom.

Jenny, Mathias & Paul Sidwell. 2015. *The Handbook of Austroasiatic Languages.* Leiden: Brill.

Kang, Yoonjung. 2014. Voice onset time merger and development of tonal contrast in Seoul Korean stops: A corpus study. *Journal of Phonetics* 45. 76-90.

Karlgren, Bernhard. 1957. *Grammata Serica Recensa*. Stockholm: Museum of Far Eastern Antiquities.

Keyser, Samuel Jay & Kenneth Noble Stevens. 2006. Enhancement and overlap in the speech chain. *Language* 82.1. 33-63.

Kingston, John, Neil A. Macmillan, Laura Walsh Dickey, Rachel Thorburn & Christine Bartels. 1997. Integrality in the perception of tongue root position and voice quality in vowels. *Journal of the Acoustical Society of America* 101.3. 1696-1709.

Kiparsky, Paul. 2015. Phonologization. In Patrick Honebyone & Joseph Salmons (eds.), *Handbook of Historical Phonology*, 563-582. Oxford: Oxford University Press.

Kirby, James. 2021. Acoustic properties of voiceless and preglottalized continuants in Khmu. Paper presented at the *30th Meeing of the Southeast Asian Linguistics Society (SEALS XXX)*, Online. https://sites.google.com/site/sealsjournal/seals-and-jseals-history/seals-online-2021/seals-2021-program (Accessed Sept. 1, 2021)

Kruspe, Nicole & John Hajek. 2009. Mah Meri. Sounds of the World. *Journal of the International Phonetic Association,* 39.

Kuang, Jianjing. 2013. The tonal space of contrastive five level tones. *Phonetica* 70. 1–23.

Kulikov, Vladimir. 2010. Voicing and vowel raising in Sundanese. In *Proceedings of the 17th Annual Meeting of the Austronesian Formal Linguistics Association*. Stony Brook, NY, 2010.

Ladefoged, Peter. 1964. *A Phonetic Study of West African Languages*. (West African Language Monographs 1). Cambridge: Cambridge University Press.

Lee, Gina. 1993. *Comparative, Diachronic and Experimental Perspectives on the Interaction between Tone and the Vowel in Standard Cantonese*. Columbus: Ohio State University PhD dissertation.

Li Jinfang & Luo Yongxian. 2015. Bugan. In Mathias Jenny & Paul Sidwell (eds), *The Handbook of Austroasiatic Languages*. Leiden: Brill.

Li Jinfang. 2006. 西南地区濒危语言调查研究. *Xī nán dì qū bīn wēi yǔ yán diào chá yán jiū*. [Studies on Endangered Languages in Southwest China]. Beijing: Minzu University.

Li Xulian. 1999. 俫语研究. *Lái yǔ yán jiū*. [A Study of the Lai Language]. Beijing: 中央民族大学出版社 [Minzu University Press].

Li Yunbing. 2005. 布赓语研究. *Bù gēng yǔ yán jiū*. [A study of the Bugan Language]. Beijing: 民族出版社 [Ethnic Publishing House].

Li, Daoyong, Nie Xizhen & Qiu Efeng. 1986. 布朗语简志. *Bùlǎng yǔ jiǎn zhì*. [A Sketch of the Bulang Language Beijing: 民族出版社 [Nationalities Publishing House].

Liao Hanbo. 2016. Tonal Development of Tai Languages. Chiang Mai: Payap University MA thesis.

Lindell, Kristina, Jan-Olaf Svantesson & Damrong Tayanin. 1978. Two dialects of the Romeet (Lamet) language. *Cahiers de Linguistique, Asie Oriental* 4. 5-22.

Lotto, A.J., L.L. Holt & K.R. Kluender. 1997. Effect of voice quality on perceived height of English vowels. *Phonetica* 54, 76-93.

L-Thongkum, Theraphan & Chommanad Intajamornrak. 2008. Tonal evolution induced by language contact: A case study of the T'in (Lua') language of Nan province, northern Thailand. *Mon-Khmer Studies* 38. 57-68.

L-Thongkum, Theraphan, Phanintra Teeranon & Chommanad Intajamornrak. 2007. The interaction between vowel length and pitch in Southeast Asian (SEA) Languages: Implication for tonogenesis. In S. Burusphat & J. E. Harris (eds.), *Studies in Tai and Southeast Asian Linguistics*, 241-262. Bangkok: Ekphinthai, Ltd

L-Thongkum, Theraphan. 1991. An instrumental study of Chong registers. In Jeremy Davidson (ed.), *Essays in Mon-Khmer Linguistics in Honour of H. L. Shorto*, 141–160. London: School of Oriental and African Studies.

L-Thongkum, Theraphan. 1997. Implications of the retention of proto-voiced plosives and fricatives in the Dai Tho language of Yunnan province for a theory of tonal development and Tai language classification. In Jerold A. Edmondson and David B. Solnit (eds.), *Comparative Kadai: The Tai Branch*, 191-219. Dallas: SIL.

L-Thongkum, Theraphan. 1997. Tone change and language contact: a case study of Mien-Yao and Thai. In Arthur S. Abramson (ed.), *Southeast Asian Linguistic Studies in Honour of Vichin Panupong*, 153–160. Bangkok: Chulalongkorn University Press.

L-Thongkum, Theraphan. 2001. ภาษาของนานาชนเผ่าในแขวงเซกองลาวใต้. *Phasǎ khǒng nana chon phàw nai khwěng se kong lao tâi*. [Languages of the tribes in Xekong province southern Laos]. Bangkok: The Thailand Research Fund.

Maddieson, Ian. 1997. Phonetic universals. In W. Hardcastle & J. Laver (eds), *The Handbook of Phonetic Sciences*, 619-639. Oxford: Blackwell Publishers.

Manley, Timothy M. 1972. *Outline of Sre Structure*. Honolulu: University of Hawai'i Press.

Maran, L.R. 1973. On becoming a tone language: A Tibeto-Burman model of tonogenesis. In L.M. Hyman (ed.), *Consonant Types and Tone*, 98–114. (Southern California Occasional Papers in Linguistics Vol. 1). Los Angeles: University of Southern California.

Maspero, Henri. 1911. Contribution à l'étude du système phonétique des langues thai. [A contribution to the study of the phonetic system of Thai languages]. *Bulletin de l'École Française d'Extrême-Orient* 11. 153–169.

Maspero, Henri. 1912. Étude sur la phonétique historique de la langue annamite: les initiales. [A study on the historical phonetics of the Annamese language: initials]. *Bulletin de l'École Française d'Extrême-Orient* 12. 1–126.

Matisoff, James. 1973. Tonogenesis in Southeast Asia. In L.M. Hyman (ed.), *Consonant Types and Tone*, 71-96. (Southern California Occasional Papers in Linguistics 1). Los Angeles: University of Southern California.

Matisoff, James. 1990. On megalocomparison. *Language* 66:1. 106-120.

Matisoff, James. 1991. Areal and universal dimensions of grammatization in Lahu. In Elizabeth [Closs] Traugott & Bernd Heine (eds.), *Approaches to grammaticalization, Volume 2: Focus on Types of Grammatical Markers*, 383-453. Amsterdam: John Benjamins.

Matisoff, James. 2000. Tibeto-Burman tonology in an areal context. In *The Fifth International Symposium on Languages and Linguistics, Hochiminh City*, 85-151. Ho Chi Minh City: University of Social Sciences and Humanities, Vietnam National University.

Matisoff, James. 2001. Genetic versus contact relationship: Prosodic diffusibility in South-East Asian languages. In Alexandra Y. Aikhenval & R.M.W. Dixon (eds.), *Areal Diffusion and Genetic Inheritance: Problems in Comparative Linguistics*, 291–327. Oxford: Oxford University Press.

Mazaudon, Martine & Alexis Michaud. 2008. Tonal contrasts and initial consonants: A case study of Tamang, a 'missing link' in tonogenesis. *Phonetica* 65. 231-256.

Mazaudon, Martine. 1977. Tibeto-Burman tonogenetics. *Linguistics of the Tibeto-Burman Area* 3.2. 1–123.

Mazaudon, Martine. 2005. On tone in Tamang and neighbouring languages: Synchrony and diachrony. In Shigeki Kaji (ed.), *Proceedings of the Symposium on Cross-Linguistic Studies of Tonal Phenomena. Historical Development, Tone-Syntax Interface and Descriptive Studies*, 79-96. Tokyo: Research Institute for Languages and Cultures of Asia and Africa (ILCAA), Tokyo University of Foreign Studies.

Mazaudon, Martine. 2012. Paths to tone in the Tamang branch of Tibeto-Burman (Nepal). In G. de Vogelaer & G. Setler (eds.), *The Dialect Laboratory: Dialects as a Testing Ground for Theories of Language Change*, 139-177. Amsterdam/Philadelphia: John Benjamins.

Michaud, Alexis & Bonny Sands. 2020. Tonogenesis. In Mark Aronoff (ed.), *Oxford Research Encyclopedia of Linguistics*. Oxford: Oxford University Press.

Michaud, Alexis. 2012. Monosyllabicization: Patterns of evolution in Asian languages. In Thomas Stolz, Nicole Nau & Cornelia Stroh (eds.), *Monosyllables: From Phonology to Typology*, 115–130. Berlin: De Gruyter Mouton.

Misnadin & James Kirby. 2020. Acoustic correlates of plosive voicing in Madurese. *Journal of the Acoustical Society of America* 147.4. 2779-2790.

Misnadin. 2016. *The Phonetics and Phonology of the Three-Way Laryngeal Contrast in Madurese*. Edinburgh: University of Edinburgh PhD thesis.

Mitani, Yasuyuki. 1965. A descriptive and comparative study of the Khamet phonology. *South East Asian Studies* 3.3. 22-51.

Morén, Bruce & Elizabeth Zsiga. 2006. The lexical and post-lexical phonology of Thai tones. *Natural Language & Linguistic Theory* 24.1. 113-178.

Nguyễn Văn Lợi, Nguyễn Hữu Hoành, Tạ Văn Thông. 2008. *Tiếng Mảng*. [The Mang Language]. Hanoi: Nhà xuất bản khoa học xã hội [Social Science Publishing House].

Nguyễn Văn Lợi. 1993. *Tiếng Rục*. [The Rục language]. NXB Khoa học Xã hội [Social Sciences Publishing House].

Norman, Jerry. 1994. Pharyngealization in Early Chinese. *Journal of the American Oriental Society* 114. 397-405.

Ohala, John. 1973 *Explanations for the intrinsic pitch of vowels*. Unpublished manuscript.

Ohala, John. 1983. The origin of sound patterns in vocal tract constraints. In MacNeilage, P.F. (ed.), *The Production of Speech*. New York: Springer-Verlag, 189-216.

Ohala, John. 2011. Accommodation to the aerodynamic voicing constraint and its phonological relevance. In Wai-Sum Lee & Eric Zee (eds.), *Proceedings of the 17th International Conference of Phonetic Sciences, Hong Kong, 17-21 August 2011*. Hong Kong: City University of Hong Kong.

Ostapirat, Weera. 1998. Tiddim Chin tones in historical perspective. *Linguistics of the Tibeto-Burman Area* 21(1). 235-248.

Ostapirat, Weera. 2005. Kra-Dai and Austronesian: Notes on phonological correspondences and vocabulary distribution. In Lauren Sagart, Roger Blench & Alicia Sanchez-Mazas (eds.), *The Peopling of East Asia: Putting Together Archaeology, Linguistics and Genetics*, 107-131. London: Routledge Curzon.

Pain, Frederic. 2020. *Giao Chỉ (Jiāozhǐ 交趾) as a Diffusion Center of Chinese Diachronic Changes: Syllabic Weight Contrast and Phonologisation of its Phonetic Correlates*. Online: https://halshs.archives-ouvertes.fr/halshs-02956831. (Accessed Oct. 24, 2021).

Paulsen, Debbie. 1992. A phonological reconstruction of Proto-Plang. *Mon-Khmer Studies* 18-19. 160-222.

Peiros, Ilia J. 2004. Генетическая классификация аустроазиатских языков. *Geneticheskaja Klassifikatsija Aystroaziatskix Jazykov*. [The Genetic Classification of the Austroasiatic Languages]. Moscow: Российский государственный гуманитарный университет [Russian State University for the Humanities] PhD dissertation.

Perwitasari, Arum, Marian Klamer, Jurriaan Witteman & Niels O. Schiller. 2017. Quality of Javanese and Sundanese vowels. *Journal of the Southeast Asian Linguistics Society* 10.2. 1-9.

Pham, Andrea. 2005. Vietnamese tonal system in Nghi Loc dialect: a preliminary report. *Toronto Working Papers in Linguistics* 24, 183-201.

Phillips, Richard, Hôi-Thánh & Tin-Lành. 1961. *Glossary of the Hrê Language of the Minh-Long District, Guang Ngai Province, Vietnam: Hrê-Vietnamese-English*. Dallas: Summer Institute of Linguistics.

Phillips, Richard. 1973. Mnong vowel variation with initial stops. *Mon-Khmer Studies* IV. 119-127.

Phillips, Timothy Carl. 2012. *Proto-Aslian: Towards an Understanding of its Historical Linguistic Systems, Principles and Processes*. Bangi: Institute Alam Dan Tamadun Melayu, Universiti Kebangsaan Malysia PhD thesis.

Pike, Kenneth L. 1967. Tongue-root position in practical phonetics. *Phonetica* 17.129–40.

Pinnow, Heinz-Jürgen. 1963. The position of the Munda languages within the Austroasiatic language family. In Harry L. Shorto (ed.), *Linguistic comparison in Southeast Asia and the Pacific*, 140–152. London: SOAS.

Pittayaporn, Pittayawat & James Kirby. 2016. Laryngeal contrasts in the Tai dialect of Cao Bằng. *Journal of the International Phonetic Association* 47.1. 65–85.

Pittayaporn, Pittayawat. 2009. *The Phonology of Proto-Tai*. Ithaca: Cornell University PhD dissertation.

Pittayaporn, Pittayawat. 2015. Typologizing sesquisyllabicity. In N.J. Enfield and Bernard Comrie (eds.), *The Languages of Mainland Southeast Asia: The State of the Art.* Berlin/Boston: Walter de Gruyter Inc.

Post, Mark W. 2011. Prosody and typological drift in Austroasiatic and Tibeto-Burman: Against "Sinosphere" and "Indosphere". In Sophana Srichampa, Paul Sidwell and Kenneth Gregerson (eds.), *Austroasiatic Studies: Papers from ICAAL4*, 198-221. (Mon-Khmer Studies Journal Special Issue No. 3). Dallas, SIL International; Salaya, Mahidol University; Canberra, Pacific Linguistics.

Premsrirat, Suwilai. 1999. Phonological variation and change in the Khmu dialects of northern Thailand. *Mon-Khmer Studies* 29. 57-69.

Premsrirat, Suwilai. 2001. Tonogenesis in Khmu dialects of Southeast Asia. *Mon-Khmer Studies* 31. 47-56.

Premsrirat, Suwilai. 2004. Register complex and tonogenesis in Khmu dialects. *Mon-Khmer Studies* 34. 1-17.

Pulleyblank, E. G. 1978. The Nature of the Middle Chinese Tones and their Development to Early Mandarin. *Journal of Chinese Linguistics* 6. 173-203.

Pulleyblank, Edwin G. 1962. The consonantal system of Old Chinese. Asia Major 9. 58–144, 206–265.

Pulleyblank, Edwin G. 1977-78. The final consonants of Old Chinese. *Monumenta Serica* 33.180–206.

Pulleyblank, Edwin G. 1984. *Middle Chinese: A Study in Historical Phonology*. Vancouver: University of British Columbia Press.

Pulleyblank, Edwin G. 1994. The Old Chinese origin of type A and B syllables. *Journal of Chinese Linguistics* 22(1). 73-100.

Purnell, Thomas, Joseph Salmons, Dilara Tepeli & Jennifer Mercer. 2005. Structure, heterogeneity and change in laryngeal phonetics. *Journal of English Linguistics* 33. 307-338.

Ratliff, Martha. 1992. *Meaningful Tone: A Study of Tonal Morphology in Compounds, Form Classes, and Expressive Phrases in White Hmong*. DeKalb: Northern Illinois University Press.

Ratliff, Martha. 2002. Timing tonogenesis: Evidence from borrowing. In Patrick Chew (ed.), *Proceedings of the Twenty-Eighth Annual Meeting of the Berkeley Linguistics Society: Special Session on Tibeto-Burman and Southeast Asian Linguistics*, 29-41. Berkeley: Center for South and Southeast Asian Studies.

Ratliff, Martha. 2010. *Hmong-Mien Language History*. Canberra, Australia: Pacific Linguistics.

Ratliff, Martha. 2015. Tonoexodus, tonogenesis and tone change. In Patrick Honeybone & Joseph Salmons (eds.), *Handbook of Historical Phonology*, 245-261. Oxford: Oxford University Press.

Remijsen, Bert, Otto G. Ayoker & Timothy Mills. 2011. *Shilluk*. *Journal of the International Phonetic Association* 41. 131–145.

Sagart, Laurent, & William H. Baxter. 2016. A hypothesis on the origin of Old Chinese Pharyngealization. *Bulletin of Chinese Linguistics* 9. 179-189.

Shih, Chi-lin. 1985. From tonal to accentual: Fuzhou tone sandhi revisited. In *Proceedings of the Eleventh Annual Meeting of the Berkeley Linguistics Society*, 316-326. Berkley, CA: Berkley Linguistics Society.

Shorto, Harry L. 1962. *A Dictionary of Modern Spoken Mon*. London: Oxford University Press.

Shorto, Harry. 2006. *A Mon-Khmer Comparative Dictionary*. Canberra: Pacific Linguistics.

Sidwell, Paul & Andrew Hsiu. 2021. *Mangic Comparative Lexicon*. Unpublished.

Sidwell, Paul & Felix Rau. 2015. Austroasiatic comparative-historical reconstruction. In Mathias Jenny & Paul Sidwell (eds.), *The Handbook of Austroasiatic Languages*, 221-363. Leiden: Brill.

Sidwell, Paul. 2000. *Proto South Bahnaric: A Reconstruction of a Mon-Khmer Language of Indo-China*. Canberra: Pacific Linguistics.

Sidwell, Paul. 2002a. Genetic classification of Bahnaric languages: A comprehensive review. *Mon-Khmer Studies* 32. 1-24.

Sidwell, Paul. 2002b. *Proto-North Bahnaric: A Reconstruction of Phonology and Lexicon.* Unpublished manuscript.

Sidwell, Paul. 2005. *The Katuic Languages: Classification, Reconstruction and Comparative Lexicon*. Munich: Lincom Europa.

Sidwell, Paul. 2009. *Classifying the Austroasiatic languages: History and state of the art*. Munich: Lincom Europa.

Sidwell, Paul. 2010. Cua (Kor) historical phonology and classification. *Mon-Khmer Studies* 39: 105-122.

Sidwell, Paul. 2011. *Proto-Bahnaric*. Unpublished manuscript. Online: http://sealang.net/monkhmer/database/

Sidwell, Paul. 2015a. Austroasiatic classification. In Mathias Jenny & Paul Sidwell (eds.), *The Handbook of Austroasiatic Languages*, 144-220. Leiden: Brill.

Sidwell, Paul. 2015b. Local drift and areal convergence in the restructuring of Mainland Southeast Asian languages. In N. J. Enfield and Bernard Comrie (eds.), *The Languages of Mainland Southeast Asia: The State of the Art*, 51-81. Berlin: De Gruyter Mouton.

Sidwell, Paul. 2015c. *The Palaungic Languages: Classification, Reconstruction and Comparative Lexicon*. Munich: Lincom Europa.

Sidwell, Paul. 2018. Proto-Nicobarese phonology. In Ring, Hiram & Felix Rau (eds.), *Papers from the 7th International Conference on Austroasiatic Linguistics* (Journal of the Southeast Asian Linguistics Society Special Publication No. 3), 132-156. Honolulu: University of Hawai'i Press.

Sidwell, Paul. 2019. Proto-Pearic and the role of vowel height in register formation. Paper presented at the *8th International Conference on Austroasiatic Linguistics*, Chiang Mai University, Chiang Mai, Thailand, Aug. 29-31, 2019.

Sidwell, Paul. 2021. Classification of MSEA Austroasiatic languages. In Paul Sidwell & Mathias Jenny (eds.), *The Languages and Linguistics of Mainland Southeast Asia*, 179-206. (World of Linguistics 8). Berlin/Boston: de Gruyter Mouton.

Smalley, William. 1976. The problem of consonants and tone: Hmong (Meo, Miao). In W. Smalley (ed.), *Phonemes and Orthography: Languages Planning in Ten Minority Languages in Thailand*. [Pacific Linguistics Series C No. 43]. Canberra: Australian National University.

Smith, Jonathan. 2018. A/B Type segregation in mixed-onset phonetic series is the key to early Chinese onset complexity. *Cashiers de Linguistique Asie Orientale* 47. 165-197.

Smith, Kenneth & Paul Sidwell. 2015. Sedang. In Mathias Jenny & Paul Sidwell (eds.), *The Handbook of Austroasiatic Languages*, 789-836. Leiden: Brill.

Smith, Kenneth. 1968. Laryngealization and delaryngealization in Sedang phonemics. *Linguistics* 38, 52-69.
Smith, Kenneth. 1968. Laryngealization and delaryngealization in Sedang phonemics. *Linguistics* 38, 52-69.
Smith, Kenneth. 1970. *Kơtua Word List*. Unpublished.

Smith, Kenneth. 1972. *A Phonological Reconstruction of Proto-North-Bahnaric*. (Language Data: Asian-Pacific Series, No. 2). Santa Ana, California: Summer Institute of Linguistics.

Smith, Kenneth. 1973. Denasolaryngealization in Sedang folk linguistics. *Mon-Khmer Studies* 4, 53-62.

Smith, Kenneth. 1975. *Phonology and Syntax of Sedang*. Philadelphia: University of Pennsylvania PhD dissertation.

Srivises, Prasert. 1978. *Kui (Suai) – Thai – English Dictionary*. Jerry W. Gainey & Theraphan L. Thongkum (eds.). Bangkok: Indigenous Languages of Thailand Research Project, Chulalongkorn University Language Institute.

Stevens, Mary, Nicole Kruspe & John Hajek. 2006. Register in Mah Meri: A preliminary phonetic analysis. In Rüdiger Hoffman & Hansjörg Mixdorff (eds.), *Proceedings of the 3rd International Speech Prosody Conference, Dreseden.*

Sun, Jackson T.-S. 2018. New contributions to Waic phonological studies: Va. Online: https://www.academia.edu/35782066/New_contributions_to_Waic_phonological_studies_Va (Accessed Sept. 1, 2021).

Svantesson, Jan-Olof & David House. 2006. Tone production, tone perception and Kammu tonogenesis. *Phonology* 23. 309-333

Svantesson, Jan-Olof. 1983. *Kammu phonology and morphology*. Lund: Gleerup.

Svantesson, Jan-Olof. 1988. U. *Linguistics of the Tibeto-Burman Area* 11.1. 64-133.

Svantesson, Jan-Olof. 1989. Tonogenetic mechanisms in northern Mon-Khmer. *Phonetica* 46. 60-79.

Svantesson, Jan-Olof. 1991. Hu - a language with unorthodox tonogenesis. In J.H.C.S. Davidson (ed.), *Austroasiatic Languages: Essays in Honour of H. L. Shorto*, 67-80. London: School of Oriental and African Studies, University of London.

Tạ Quang Tùng. 2021. A phonology and lexicon of Khang in Vietnam. *Journal of the Southeast Asian Linguistics Society* 14(2). I-xxix.

Tạ Thành Tấn, Marc Brunelle & Trần Quý Nguyễn. 2019. Chrau register and the transphonologization of voicing. In Sasha Calhoun, Paola Escudero, Marija Tabain & Paul Warren (eds.), *Proceedings of the 19th International Congress of Phonetic Sciences*, 2094–2098. Melbourne: Australasian Speech Science and Technology Association Inc.

Tạ Thành Tấn. 2020. The tone system of Rục: A link between tonogenesis and registrogenesis in Vietic languages. Online: https://youtu.be/1BkBkumZ8OY (Accessed Sept. 1, 2021).

Tạ Thành Tấn. 2021. The role of pitch in registrogenesis and tonogenesis of Vietic languages: New evidence from Rục and Arem. Paper presented at the *30th Meeing of the Southeast Asian Linguistics Society (SEALS XXX)*, Online. https://sites.google.com/site/sealsjournal/seals-and-jseals-history/seals-online-2021/seals-2021-program (Accessed Sept. 1, 2021)

Thomas, David. 1992. On sesquisyllabic structure. *Mon-Khmer Studies* 21. 206-210.

Thông & Dwight Gradin. 1979. *Chù Chih Dŏ Tơtayh Jeh*. [Jeh Vocabulary]. Huntington Beach, California: Summer Institute of Linguistics.

Thurgood, Ela. 2004. Phonation types in Javanese. *Oceanic Linguistics* 43. 277–295.

Thurgood, Graham & Fengxiang "Frank" Li. 2007. From Malayic to Sinitic: The restructuring of Tsat under intense contact. In Ratree Wayland, John Hartmann & Paul Sidwell (eds.), *SEALSXII: Papers from the 12th Meeting of the Southeast Asian Linguistics Society, 2002*, 129-136. Canberra: Pacific Linguistics.

Thurgood, Graham. 1996. Language contact and the directionality of internal drift: The development of tones and registers in Chamic. *Language* 72:1. 1-31.

Thurgood, Graham. 1997. Restructured register in Haroi: Reconstructing its historical origins. In Arthur Abramson (ed.), *Southeast Asian Linguistic Studies in Honour of Vichin Panupong*, 283-295. Bangkok: Chulalongkorn Press.

Thurgood, Graham. 1999. *From ancient Cham to modern dialects: Two thousand years of language contact and change*. (Oceanic Linguistics Special Publications, No. 28). Honolulu: University of Hawai'i Press.

Thurgood, Graham. 2002. Vietnamese and tonogenesis: Revising the model and the analysis. *Diachronica* 19.2. 333-363.

Thurgood, Graham. 2003. Hrê contact and the origins of the Haroi restructured register system: A case of shared sound changes. In Karen Adams (ed.), *Papers from the Seventh Annual Meeting of the Southeast Asian Linguistics Society*, 199-207. Tempe: Arizona State University, Program for Southeast Asian Studies.

Thurgood, Graham. 2007. Tonogenesis revisted: Revising the model and the analysis. In Jimmy G. Harris, Somsonge Burusphat & James E. Harris (eds.), *Studies in Tai and Southeast Asian Linguistics*. 263-291. Bangkok: Ek Phim Thai Co.

Thurgood, Graham. 2021. The influence of contact between Austroasiatic and Austronesian. In Paul Sidwell & Mathias Jenny (eds.), *The Languages and Linguistics of Mainland Southeast Asia: A Comprehensive Guide,* 649-672. (World of Linguistics 8). Berlin/Boston: de Gruyter Mouton.

Wang, Fushi and Zongwu Mao. 1995. 苗瑶语古音构拟. *Miáoyáoyǔ Gǔyīn Gòunǐ*. [Reconstruction of the sound system of Proto-Miao-Yao]. Beijing: 中国社会科学出版社 [China Social Sciences Press].

Wang, Fushi. 1994. 苗语古音构拟. *Miáoyǔ Gǔyīn Gòunǐ*. [Reconstruction of the sound system of proto-Miao]. Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.

Watkins, Justin. 2001. Burmese. *Journal of the International Phonetic Association* 31. 291–95.

Watkins, Justin. 2002. *The Phonetics of Wa: Experimental Phonetics, Phonology, Orthography and Sociolinguistics.* Canberra: Pacific Linguistics.

Watson, Richard, Saundra Watson & Cubuat Canxóiq. 2013. *Pacoh-Vietnamese-English Dictionary*. SIL International. Online: http://pacoh.webonary.org/ (Accessed 16 July., 2021)

Wayland, Ratree & Allard Jongman. 2002. Registrogenesis in Khmer: A phonetic account. *Mon-Khmer Studies* 32. 101-115.

Wayland, Ratree. 1997. *Acoustic and Perceptual Investigation of Breathy and Clear Phonation in Chanthaburi Khmer: Implications for the History of Khmer Phonology*. Ithaca: Cornell University PhD dissertation.

Whalen, D. H. & Andrea G. Levitt. The universality of intrinsic F0 of vowels. *Journal of Phonetics* 23. 349-366.

Yan Qixiang & Zhou Zhizhi. 2012. 中国孟高棉语族语言与南亚语系. *Zhōngguó mèng gāo mián yǔzú yǔyán yǔ nán yǎ yǔxì*. [Mon-Khmer Languages of China and the Austroasiatic Family]. Beijing: Social Sciences Academy Press.

Yang, Cathryn and Yi Xu. 2019. Cross-linguistic trends in tone change: A review of tone change studies in East and Southeast Asia. *Diachronica* 36. 417-459.

Ying, Lin. 1972. Chinese loanwords in Miao. In Herbert C. Purnell Jr. (ed.), *Miao and Yao Linguistic Studies: Selected Articles in Chinese*, 55–81. (Linguistics Series 5, Data Paper 88). Ithaca: Southeast Asia Program, Department of Asian Studies, Cornell University.

Yip, Moira. 2002. *Tone*. Cambridge: Cambridge University Press.

Zhou Zhizhi & Yan Qixiang. 1984. 佤语简志. *Wǎ yǔ jiǎn zhì*. [A Bried History of the Wa Language]. Beijing: 民族出版社 [Nationalities Publishing House].