Vietnamese and tonogenesis: revising the model and the analysis[1]

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Our most widely-used model of tonogenesis is Haudricourt's 1954 classic analysis of Vietnamese tonogenesis. This paper examines Vietnamese, the dominant model of tonogenesis, and argues that the Haudricourt analysis should be updated, replacing its segmentally-driven model by a laryngeally-based model, incorporating the effects of voice quality distinctions.

This proposed model provides phonetically-plausible paths of change, not just for Vietnamese, but also for the widely-attested correlations between initial voicing and pitch height and between voice quality and vowel quality. At the same time, these same laryngeal considerations provide a phonetic motivation for the preference for the development of breathy voice from voiced stop onsets over sonorants and fricatives. Of equal importance, the model appears to provide significant insights into tonogenesis in Southeast Asia, East Asia, South Asia, Africa, Europe, and the Americas, that is, the applicability model is not restricted to any particular geographical area.

1.0 Updating Haudricourt's model of tonogenesis

André-Georges Haudricourt's 1954 paper on Vietnamese tonogenesis has become the classic account of the mechanisms of the origins of tone. In Haudricourt's model the consonants play a central and direct role in pitch assignment: initial consonants determine pitch height and final consonants determine pitch contours.[2] In addition to suggesting a source for pitch assignment, the Haudricourt model includes the loss of a voicing distinction (cf. also Hombert, Ohala, and Ewan 1979). Haudricourt's 1954 account of tonogenesis has become extremely influential.

This consonant-based account of tonogenesis is widespread in the literature. It did not start with Haudricourt. Maspero, as early as 1912, had noted that Vietnamese tones correlated with the voicing of initial obstruents, and still earlier Edkins (1853:6-54, esp. 47) and Steinthal 1854 (Edmondson 1999:381-413, p. 400) had made similar observations for Chinese, although not as clearly. More recent authors have focused even more strongly on the correlation with initials. Hombert (1978:78), for instance, writes that the best documented path for the development of contrastive tones on vowels is the loss of the voicing distinctions in prevocalic obstruents. He notes that relatively high pitch develops after voiceless initials and relatively low pitch after voiced ones. He adds that these patterns are attested in Chinese, in various Tibeto-Burman languages (Karen, Gurung, and so on), Austronesian (Phan Rang Cham), Tai-Kadai languages (Thai, Lao, and so on), Hmong-Mien, Mon-Khmer (Vietnamese), and Khoisan. To these, countless other languages could be added: with respect to West African tone systems, for instance, Hyman (1978:265-266) notes that "A tone can undergo modification if it is adjacent to or occurs on a segment of a given type. The effect of consonant types on tone has been studied by a number of scholars, who generally agree that voiceless consonants exert a pitch-raising effect on the following tone, while voiced consonants (especially breathy and obstruent) exert a pitch-lowering effect." Hyman's observation that voiced obstruents and breathy-voiced stops are particularly prone to pitch-lowering foreshadows much of the discussion to follow.

There is some irony in the fact that the Haudricourt's account of Vietnamese is now the most prevalent model of tonogenesis, since specialists within Mon-Khmer have long since modified the original Haudricourt account. They have come to realize that the Vietnamese developments are adequately explained only if the laryngeal effects of voice quality distinctions are recognized as central.

This paper updates Haudricourt's analysis of Vietnamese and then extends it by showing how our growing understanding of the data has forced Haudricourt's essentially consonant-based account to evolve into an account in which the laryngeal gestures associated with voice qualities are the primary mechanism for the pitch assignment. These modifications in the history of Vietnamese need to be accompanied by parallel adjustments in our general model of tonogenesis in which it is the laryngeal gestures accompanying voice quality distinctions, not the consonants, that play the central role. These changes result in a much more viable general model of tone development while, at the same time, accounting for a number of otherwise odd typological and distributional characteristics of existing tone systems.

In Haudricourt's account of Vietnamese (see Figure 1), the tones developed directly out of earlier classes of finals and initials. In the first stage, distinctions among the post-vocalic finals led to the emergence of three pitch contours: level, rising, and falling. Syllables ending in vowels or proto-voiced sonorants developed level pitch, syllables ending in proto-stops (including glottal stops) developed rising pitch, and syllables ending in proto-voiceless fricatives developed falling pitch. Note that there were no voiced non-sonorant final stops in the proto-language.

Finals:	open finals, nasal finals [level]	stopped finals; final glottal stop [rising]	voiceless fricatives [falling]
Initials: proto-voiceless [high pitch]	*pa > pa "ngang"	*pak > pắk "sắc"	*pas > pả "hỏi"

Initials: proto- voiced [low pitch]	*ba > pà "huyền"	*bak > pạk "nặng"	*bas > pã "ngã"

Figure 1: Vietnamese tonogenesis

Haudricourt 1954; Matisoff 1973:74-75; Diffloth 1989:146. Note that the diacritics accompanying the syllable "pa" indicate the Vietnamese tones; the names in the quotation marks are the native Vietnamese names for the tones. The hỏi and ngã tones have fused in Saigon Vietnamese but are still kept distinct in Hanoi.

In a subsequent stage, each of the three categories generated by the finals is further split by the voicing contrast in the initials: Forms with proto-voiceless initials developed higher pitch and forms with earlier voiced initials developed lower pitch.

However, although Haudricourt's analysis accounts for much of the data, specialists in Mon-Khmer have been aware for some time that it does not account for all of it. In the Haudricourt account, forms in the *ngang* and *huyền* tones should derive from open syllables or from syllables with final proto-voiced sonorants. But, as Gage (1985) noted, a significant number of such forms actually end in final glottal stops elsewhere in Mon-Khmer (MK); Haudricourt's model suggests that such forms should be in the *sắc* or *nặng* tone category. Similarly, according to the model, forms in the *sắc* or *nặng* tones should derive from syllables with final proto-stops. But, as Gage again noted, many of the forms with *sắc* or *nặng* tones are found in Chong, a Pearic language, with the expected glottalization but with an unexpected final continuant, not the expected stop final (see Figure 1). Gage (1985), thus, makes it clear that Haudricourt's consonantal finals alone are insufficient to account for either the *ngang-huyền* category or for the *sắc-nặng* category.

Diffloth (1982, 1989, 1990) reconstructed an earlier distinction between clear and creaky (tense) voice that accounted for most of the discrepancies that Gage and others had noted. In Diffloth's analysis (see Figure 2), the ngang and huyền items reflect an earlier clear voice, while the sắc and nặng items reflect an earlier creaky voice. The evidence for this distinction is widespread and ancient, reconstructing at least to the stage of proto-Vietic, the subgroup that includes Vietnamese. The significance of Diffloth's reanalysis is that it recognizes that it is the voice quality distinctions, not the final consonantal distinctions, that are behind the division in Vietnamese into the *ngang-huyền* and *sắc-nặng* categories. Thus, the *sắc-nặng* items are the result either of inherited creakiness or they derive from the final stops. The proto-clear voice quality correlates with the *ngang-huyền* category. And, of course, the voicelessness of the voiceless final fricatives accounts for the *hỏi-ngã* category.

Finals:	proto-voiced sonorants; open syllables	proto-voiced sonorants; open syllables	stopped finals	voiceless fricatives
Register:	proto-clear	proto-creaky	(?) (> creaky)	(?)
Initials: proto-voiceless	pa "ngang"	pá "sắc"	pắk "sắc"	pả "hỏi"

Initials: proto-voiced	pà "huyền"	pạ "nặng"	pạk "nặng"	pã "ngã"

Figure 2: Vietnamese tonogenesis (Diffloth 1989:148)

In short, the three-way tonal split Haudricourt attributed to three classes of finals has been reanalyzed as due to three types of laryngeal configuration: the sonorant finals led to the *ngang* and *huyền* tone classes, the voiceless finals led to the *hỏi* and *ngã* tone classes, and the creaky voice and final stops resulted in the *sắc-nặng* tone classes. The original final stops found in the *sắc* and *nặng* tone classes are still found as final stops in modern Vietnamese. Later in this paper, it will be argued that these stop finals are accompanied by simultaneous glottal closure and that it was actually this glottal closure that caused these forms to merge with the creaky-voiced forms and produce the *sắc-nặng* category.

Finals:	proto-voiced sonorants; open syllables	proto-voiced sonorants; open syllables	stopped finals	non-stopped voiceless finals
Register:	proto-clear	proto-creaky	(?) (> creaky)	(?)

Initials: proto-voiceless (clear)	pa "ngang" (clear)	pá "sắc"	pắk "sắc"	pả "hỏi"
Initials: proto-voiced > breathy	pà "huyền" (breathy)	pạ "nặng"	pạk "nặng"	pã "ngã"

Figure 3: Vietnamese tones and voice quality distinctions

The role of Haudricourt's initials is also susceptible to reanalysis. In the Haudricourt model, the pitch height distinctions were attributed directly to the distinction between the proto-voiceless and the proto-voiced initials. However, this paper will argue that the role of initials in tonogenesis is not a direct one but instead has typically been mediated through a voice quality stage. For Vietnamese, there is strong evidence that it was the distinction between clear and breathy voice that split each of the three earlier categories into a high-pitched and a low-pitched variant (Figure 3).

The evidence for these voice quality distinctions is fairly straightforward. Ratliff (1997) pointed out that the work of Vũ Thê Thạch (1992) presents evidence of a two-way voice quality distinction, in which the three tones correlated with prevocalic proto-voiceless stops (*ngang*, *sắc*, and *hỏi*) are in opposition to the three tones correlated with proto-voiced initials (*huyền*, *nặng*, and *ngã*).

Tone of root:		Tone of bound morpheme :	Bound morpheme (example):
ngang, sắc, or hỏi	>	ngang	-ang ‘very’
huyền, nặng, or ngã	>	huyền	
ngang, sắc, or hỏi	>	sắc	-âp ‘perfect and pleasant’
huyền, nặng, or ngã	>	nặng	
ngang, sắc, or hỏi	>	hỏi	-e ‘very (with positive quality)’
huyền, nặng, or ngã	>	ngã	

Table 1: Voice quality harmony in Vietnamese reduplicatives (Vũ 1992)

Vũ Thê Thạch (1992) describes what he terms ‘tone harmony’ patterns found in some 4000 Vietnamese lexical items in which the tones of the bound morphemes harmonize with the tones of the roots. As Vũ notes (see Table 1), the harmony patterns depend upon the division of Vietnamese tones into two groups: the *ngang-sắc-hỏi* group, that is, the forms correlated with proto-voiceless initials and the *huyền-nặng-ngã* group, that is, the forms correlated with the proto-voiced initials. Each of the bound morphemes has two tonally-distinct variants, one from the *ngang-sắc-hỏi* group and a corresponding variant from the *huyền-nặng-ngã* group. If the root morpheme is from the *huyền-nặng-ngã* group, so is the bound morpheme; if the root is from the *huyền-nặng-ngã* group, again so is the bound morpheme. For example, the suffix -ang ‘very’ is in the *sắc* tone when the root is in the *ngang*, *sắc*, or *hỏi* tone; however, it is in the *nặng* tone when the root is in the *huyền*, *nặng*, or *ngã* tone. Parallel alternations also occur with other bound morphemes.

Vũ describes these alternations as tone harmony, which they are in the modern language. However, diachronically these alternations only make sense if they developed as the reflexes of an earlier system involving, not the pitch of the root spreading to the bound morpheme, but rather its voice quality spreading. Thus, these alternations are evidence that an earlier voice quality distinction developed after the initials in Vietnamese. In 1965, Thompson (1984-5 [1965]:40-41) described the phonetics of the paired *ngang* and *huyền* tones: in his description, the original phonetics of these earlier voice quality distinctions was still retained: the higher-pitched *ngang* tone is still accompanied by clear voice, while the lower-pitched *huyền* tone is accompanied by breathiness.[3] It is reasonable to assume that the remaining pairs of tones were also split in the same way: breathy voice developed after the proto-voiced initials, producing a lower pitch on those forms and putting them into contrast with the forms after proto-voiceless initials.

Thus, the Vietnamese model of tonogenesis has become one in which the pitch characteristics found in the tones are derived directly from the phonetics of the voice quality distinctions, and only indirectly from earlier distinctions in the consonants.

2.0 Toward a laryngeal account

Specialists in phonetics have their own reservations about the Haudricourt's consonant-based model and have particular trouble providing a phonetic account of how consonants directly assign pitch to neighboring vowels.[4] Gandour and Maddieson (1976), Riordan (1980), and others have established that neither the magnitude nor the timing of larynx height adjustments correlates well with the effect of consonants on pitch. Hombert and Ladefoged (1977) and others have established that the degree of voicing of a voiced obstruent does not correlate well with the degree of pitch lowering. And, more generally, Hombert, Ohala, and Ewan (1979) note that there is no model that accounts for how the laryngeal movements associated with consonant production become pitch distinctions on the vowels.[5]

The issue of contention is the precise role of consonants in pitch assignment. The answer lies in the fact that it is the various consonant classes, not the individual consonants, that correlate with pitch assignment. This correlation suggests the relationship: it is distinctive laryngeal gestures associated with the particular classes of consonants that is the crucial factor in pitch assignment. Except in the case of postvocalic consonants, the role is an indirect one. For instance, voiced obstruent onsets may result in breathy voice, with the resultant lower pitch being a phonetic product of the laryngeal gesture that caused the breathiness produced, a co-occurring relatively lower pitch that breathiness typically still has synchronically in many systems. Note that it is the laryngeal gestures associated with the production of the voice quality that affect the pitch of the vowel.

Thus, this laryngeal model of tonogenesis suggests that it is voice quality distinctions that have produced the pitch perturbations. Early, Egerod (1971) wrote about the correlation between phonation types and tones, recognizing that tone splitting often correlated with phonation types rather than with tones per se. More recently scholars such as Thongkum (1990:13) have argued for the primacy of phonation types in tonogenesis, stating, "…lexically contrastive pitches have developed primarily from voice register [voice quality] governing the whole syllable."[6] In this analysis, the role of consonants is secondary rather than primary: in tonogenesis, typically different consonant types first lead to register distinctions and it was the phonation or voice quality[7] component of the register distinctions that carried the pitch distinctions.

This view of tonogenesis (and, for that matter, typically the earlier stages of registrogenesis) is one that should not come as a surprise to phoneticians: in this model the mechanism for tonogenesis (and, for that matter, registrogenesis) is the phonetics of laryngeal gestures and configurations. The major mechanism for pitch production is laryngeal gestures, in particular two gestures: one, the downward movement associated with the maintenance of voicing in obstruents (by expanding the supraglottal cavity) and, two, the tilting of the thyroid cartilage in relation to the cricoid cartilage below it. Since it is the latter movement which most strongly affects the tension of the vocal cords, the muscle responsible for it (the cricothyroid muscle) is generally assumed to be the main pitch controller. Returning to the main focus: the laryngeal mechanisms used to produce voice quality distinctions also produce pitch distinctions. In some cases these pitch distinctions were phonemicized and tones were born.

2.1 Laryngeals (< final consonants)

If the literature on tonogenesis is read carefully, it becomes clear that it is the laryngeal activity connected with the final consonants, not the final consonants themselves, that led to the eventual development of tones. It has long been recognized that only an extremely limited set of postvocalic consonants contribute directly to pitch generation, specifically the postvocalic consonants that involve a distinctive laryngeal adjustment—glottal stops and -h.

The Vietnamese data might at first appear to be an exception to this generalization. The final stops in Vietnamese, apparently without a distinctive laryngeal adjustment, have developed distinctive tones. The exception is only apparent, however. The Vietnamese final stops co-occur with glottal closure and it is this glottal closure that is central to tonogenesis.

It is not uncommon in Southeast Asia for final stops to be accompanied by glottal closure, with this indicated by their rather conspicuously unreleased, unexploded character. It is also evident that such glottal closure may result in tonogenesis. For instance, Michailovsky (1975:214) shows that for Khaling, at least on the verb roots, the two-way tone system is "correlated with the finals and derived from them." He then suggests that "since final stops per se have not been observed to have a phonetic pitch-raising effect" the motivation for the Khaling tones might be found in the simultaneous glottal closure that accompanies final stops in closely-related Hayu and in many of the Kiranti languages. Diehl (1992b:6, cited in Wannemacher (1998:28) states this explicitly; “anyone who has done much language study in East and Southeast Asia knows that a syllable-final stop is often an abandoned companion to a former (co-articulated) oral stop.” Michailovsky suggests that the earlier existence in Khaling of this simultaneous glottal closure is a likely source of the Khaling tones, drawing a parallel in passing with Haudricourt's analysis of the tonogenetic effect of final stops in Vietnamese! Ebert (forthcoming) notes the existence of glottalized final stops in various Kiranti languages; Wannemacher (1998) notes their existence in Zaiwa specifically, and in Tibeto-Burman in particular. Similarly, Denning (1989:61, footnote 37) also suggests that rising contours may also come from conditioning by a glottally-constricted final consonant.

There are two potential effects that final laryngeal features can have on pitch: lower it or raise it. Further, in contrast to the laryngeal states of prevocalic consonants, which produce a voice quality (with its accompanying pitch) that is usually (always?) distributed over the whole syllable, the pitch lowering or raising effect may be restricted to the end of the syllable, thus resulting in a falling or rising contour.

Certain laryngeal consonants have been noted in the literature as having specific effects on pitch. The early literature, for example, Matisoff (1973:76) and Ohala (1973:3), included speculation that final glottal stop would be exclusively associated with pitch raising and final -h with pitch lowering, a generalization that cannot be maintained, at least not without an enriched typology of final laryngeals. The pitch raising effect of final glottal stop is widely attested; however, there are also cases of a pitch lowering effect. As Mazaudon (1977:65-66) suggests, this apparent discrepancy strikes is reconcilable if the abrupt, complete glottal closure accompanying a final glottal stop is distinguished from the less complete, less abrupt glottal stricture found, for example, in Burmese ‘creaky’ tone. This incomplete constriction, which results in a tense voice (sometimes termed creakiness), is usually but not always diachronically derived from a final glottal stop and resembles what is often termed vocal fry. Again, as Mazaudon (1977:66) observes, the more abrupt, more complete glottal stop leads to pitch raising, while the more imperfect, less abrupt variant leads to often-sharp pitch lowering accompanied by tenseness. Of course, the phonetics of final laryngeals are far richer than the simplistic two-way distinction suggested here---but this much of distinction has already been established in the literature.

Note that such mechanisms do not, of course, account for all instances of creakiness, nor are they intended to. It is relatively clear that when pitch dips low enough creakiness often follows, for example, the third tone of Mandarin often has a creaky component apparently only conditioned by the lowness of the dip in pitch.

The reflexes of final -h show a parallel dichotomy. In two well-documented cases, final -h leads to a high rather than a low reflex. As Ohala himself points out (1973:11), in Punjabi high tones, not low tones, appear on vowels which were followed by -h or by breathy-voiced stops in Middle Indo-Aryan (Arun 1961; Gill and Gleason 1969, 1972). Similarly, final -h in the Chamic languages has led to a high tone reflex in Tsat (Thurgood 1996). However, in Vietnamese the final *-s > *-h has apparently led to a low tone, as did the other voiceless final sonorants. And, elsewhere what appears to be final -h has also lowered tone. My suspicion is that once final -h [nonbreathy] and -ɦ [breathy] are systematically distinguished (and some misanalyses are culled out), there will be far less variability in the effect of these finals on pitch.

The contribution of the final consonants to pitch modification is clearly laryngeally based. Only those postvocalic consonants whose articulation involves some sort of distinctive laryngeal gesture contribute directly to the pitch pattern, specifically, an abrupt glottal stop [-ʔ abrupt] and nonbreathy -h [nonbreathy] relate to the raising of pitch or to a high pitch and a creaky glottal stop [-ʔ creaky] and a breathy final -h [-ɦ breathy] relate to lowering of pitch or a low pitch.

2.2 The prevocalic consonants

Prevocalic consonants induce voice quality distinctions on the following vowel, which often lead to the development of voice quality distinctions, of which three are of particular relevance to tonogenesis. In Southeast Asian languages,[8] as Thongkum (1988:321) has noted, although more exist, only three basic voice qualities seem to play a major role in tonogenesis:[9] breathy, clear (or normal or modal), and tense voice. Breathiness, produced with abducted arytenoid cartilages, typically but certainly not always is accompanied by a lowering of the larynx that correlates with the lowering of pitch; tenseness (or creakiness), produced with adducted arytenoid cartilages, typically but certainly not always is accompanied by a raising of the larynx (Abramson, personal communication) that, when it occurs, correlates with the raising of pitch; and, a clear voice neither raises nor lowers the larynx significantly; thus, it does not alter pitch.[10]

It is important to note there are certainly other determinants of pitch production: Abramson (personal communication) mentions the research of Löfqvist, Baer, McGarr, and Story 1989, which has indicated that varying degrees of contraction of the cricothyroid muscle of the larynx help with the maintenance or suppression of voicing; in this research it is argued that using greater contraction to suppress voicing, combined with aerodynamic consequences upon opening the glottis, causes higher vibration rates. Thus, it is certainly not just raising and lowering of the larynx that produces pitch distinctions; however, when the mechanism is laryngeal movement, the gesture often leaves an identifiable signature behind in the form of a distinctive voice quality.

Note that, since it is typically the vowel as a whole that carries the voice quality distinction with its distinctive pitch height, the pitch height is a characteristic of the whole vowel, not just its onset. This is significant: voiced and voiceless initials also induce pitch perturbations on following vowels, but unlike the laryngeal gestures associated with the more marked voice quality distinctions such as breathiness and creakiness, experimental research suggests that the perturbations induced by initial consonants only affect the onset of a vowel. This experimental finding presents at least two problems if one attempts to derive tones directly from initials: first, how and why does the pitch height get distributed evenly over the whole vowel, and, second, why don't at least some initials result in contour tones, as might be expected given that prevocalic consonants only seem to affect vowel onsets.

The three laryngeal configurations accompanying the three voice qualities are sufficient to provide the pitch distinctions which frequently co-occur with voice quality distinctions, not just in Southeast Asia, but throughout the world. Breathiness tends to co-occur with the lowering of pitch, tenseness with the raising of pitch, and clear voice without significant modification of pitch. Of course it is also possible to produce breathy voice with a high or mid pitch, but breathy voice typically occurs with low pitch; it is also possible to produce tense voice with a low pitch, but it typically occurs with high pitch.

Also note that it is neither necessary nor even typical for a given language to have all three voice quality distinctions. Just having either breathy or tense voice is enough to provide an opposition to clear voice and is, in fact, the more typical situation. If, for example, a language has both breathy and clear voice and the breathy voice quality is accompanied by low pitch, the contrasting clear voice counterpart is automatically relatively high. Naturally, once the system has been brought into existence the likelihood of perceptually induced restructuring exists, maximizing the perceptual salience of the pitch differences. Thus, after their creation, many modern systems have restructured in various ways. Nonetheless, the phonetic mechanisms outlined here are more than sufficient for developing the basic two-way pitch height distinction that still characterizes many modern systems.[11]

It is the primarily, although not exclusively, the initial consonants that produce the voice quality distinctions responsible for pitch height distinctions and it is primarily laryngeal consonants in postvocalic position that produce the voice quality distinctions responsible for contours.

3.0 Phonetic evidence for a laryngeal model

A variety of other types of evidence argue that tones have evolved out of the laryngeal gestures associated with earlier voice quality distinctions. First, the laryngeal model accounts rather nicely for the phonetic nature of many tone systems. Second, it provides a plausible source for many otherwise inexplicable pitch distinctions. Third, the model explains why vowel quality differences appear, not just widely in register complexes, but also quite frequently in tone systems. Fourth, it explains much of what would otherwise be inexplicable about certain cases of 'tone' spreading. Fifth, it accounts for part of the asymmetrical behavior between voiced obstruents and voiced sonorants in tonogenesis: Although voiced obstruents and sonorants usually pattern together, when they pattern differently, the lower tone usually occurs after voiced obstruents, not after voiced sonorants. Finally, the most obvious piece of evidence is the phonetics of known historical cases in which tone systems have come from earlier register systems.

3.1 The phonetic nature of tone systems

The realization that earlier voice quality differences underlie many tone systems explains why the clusters of phonetic features that make up the typical tone system are so similar to the clusters that constitute the typical register complexes. Over thirty years ago, Eugénie Henderson (1967:171) wrote with reference to Southeast Asian tone systems:

> It is important to recognize that pitch is frequently only one of the phonetic components of 'tone' as a phonological category. A phonological tone is in our area very frequently a complex of other features besides pitch—such as intensity, duration, voice quality, final glottal constriction and so on.

What makes Henderson's characterization of Southeast Asian tone systems interesting is that the phonetic components in these complexes are the same as those found in register complexes. In fact, the difference between a tone system and a register complex seems to lie more in what seems to constitute the organizing principle in each system than in the list of features *per se.* In a tone system, the speakers have come to treat the pitch characteristics as salient; in a register system, it is the voice quality differences.

Such configurations are not, of course, limited to Southeast Asia, but are found in tone systems throughout the world, making the standard definition of tone as the lexical phonemicization of pitch distinctions is at best a misleading simplification, at worst a serious impediment to understanding. Even a cursory examination of tone systems in the Americas, in Africa, and even in Europe makes it clear that most, if not all, tone systems contain similar clusters of features.

Notice that the listing of the phonetic characteristics of a register system in Figure 4 contains the same range of phonetic features as does Henderson's characterization of the typical Southeast Asian tone system (Figure 4 is a modified composite of Henderson (1952, 1977), Matisoff (1973:76), Edmondson and Gregerson (1993:61-63), and Bradley 1982).

	Tense Register	Unmarked	Breathy Register
original initials:	proto-voiceless		proto-voiced

voice quality:	tense (creaky)	modal (clear)	breathy
vowel quality:	lower (open);		higher (closed);
	more fronted vowels;		more backed vowels;
	tendency to		tendency to
	diphthongization;		to centralization;
	often shorter		often longer
pitch distinctions:	higher pitch;		lower pitch;
	associated with -ʔ		association with -h
state of larynx:	larynx tense and/or		larynx lax and/or
	raised (= reduced		lowered (= increased
	supraglottal cavity)		supraglottal cavity)

Figure 4: The three most common register complexes

Of course, the most frequent register is the unmarked modal or clear voice. Although there certainly are systems in which all three registers or even four registers occur, the contrast in a typical register system is between the unmarked modal voice and one of the two marked registers described in Figure 4. In the two marked register complexes certain sets of features typically cooccur: In the tense register complex the vowels have a tense, laryngealized, or creaky voice quality, are more open (lower), have a higher pitch, and a tendency toward vowel fronting and diphthongization. In the breathy register complex the vowels have a breathy voice quality, are more closed (higher) vowels, have a lower pitch, and a tendency toward vowel backing. The tense-voiced vowels are historically correlated with final glottal stops or, less frequently, with voiceless onsets; the breathy voiced vowels correlate voiced obstruent onsets and often affiliated with final -h. Not too surprisingly, when the tense-voiced vowels are shorter, the tenseness is often derived historically from a final glottal stop. The final feature (modified from Matisoff (1973:76)) is the state of the larynx; with tense voice the larynx is often raised, thereby reducing the supraglottal cavity, while with breathy voice the larynx is often lowered, thereby increasing the supraglottal cavity.

Register complexes are also referred to by a variety of names, but these terms must often be used with some caution as they are often used, not with cross-linguistic comparison in mind, but instead simply to describe a two-way register contrast in a specific language. Maddieson and Ladefoged (1985), for instance, discuss problems with regard to the cross-linguistic variability in the use of the terms tense and lax. At times, tense and lax are used to describe a relative contrast in tenseness rather than the presence of specific voice qualities. For example, if a language has a distinctive breathy register complex contrasting with clear voice, the breathy complex will be labeled lax and the contrasting clear register will be labeled tense. However, if a language has a distinctive tense register complex contrasting with clear voice, the tense register will be labeled tense with the contrasting clear voice being labeled lax. However, for cross-linguistic comparisons it is crucial to know if, for example, the term tense refers to a creaky voice quality or to a clear voice quality that happens to be in opposition to a breathy voice quality. Similar indeterminacies exist with the terms First Register versus Second Register, which are associated with tense and breathy voice, respectively.

If we compare this characterization of register complexes with Henderson's earlier characterization of Southeast Asian tones, we discover that tones, like register complexes, frequently consist of a cluster of features including pitch, voicing, duration, voice quality, and final glottal constriction. In short, the comparison of tonal systems with register systems shows the two systems have striking typological similarities. The realization that tone systems often evolve out of voice quality distinctions provides an explanation for the widespread presence of voice quality distinctions in tone systems. Note that for a register complex to evolve into a tonal system, it is only necessary for the pitch component to become more salient than the voice quality component.

3.2 A plausible source for pitch height distinctions

Part of the argument in this paper rests on the assumption that, even though pitch is probably not an invariable feature of voice quality distinctions and thus of register systems, it is at least a widely present feature. When Gregerson (1976:54) states that, for Mon-Khmer languages, “pitch is never a major feature”, this claim seems to say little more than voice quality features are more important than pitch features in a register system, something that is almost definitional.[12] However, when he further notes that pitch is more often absent than present in descriptions of register languages, it seems that the comment is more about the descriptions in question than about the widespread presence of pitch in register languages. Insofar as Gregerson is claiming pitch differences are absent in the majority of register languages, this does not appear to be true. For the languages of Southeast Asia, Thongkum (1988:328) directly challenges Gregerson's claim; she states that, in her opinion, “pitch differences are always present in register languages. Unfortunately, it has always been ignored or unheard by Mon-Khmer specialists.” Certainly, the presence of pitch distinctions correlated with voice quality distinctions is widely attested in Southeast Asia (see various examples in this paper). In most cases the evidence is impressionistic; in others it is instrumental, for example, Lee (1985) provides instrumental evidence for such pitch distinctions in Mon, a Mon-Khmer language. More often than not the data has been recorded by a field linguist. Huffman (1976) records some 15 Mon-Khmer dialects; in comparing these, he contrasts the first register with the second register, noting that when phonetic features are manifested, high pitch and tense vowels occur with the first register while low pitch and breathy register occur with the second. Denning (1989) surveys the world’s voice quality systems, using a sample that includes languages of Asia, North Africa, West Africa, and North and Central America. He too divides voice quality systems into contrasting sets, one relatively lax, with significant spectral tilt (an indication of breathiness), relatively low larynx, and lower pitch, the other relatively tense, with slight spectral tilt, relatively high larynx, and higher pitch (1989:60).

In short, it is clear that voice quality distinctions are widely accompanied by pitch distinctions. More specifically, breathy voice is associated with lower pitch and the lowering of the larynx, while tense voice is associated with higher pitch and the raising of the larynx. And, as Laver (1980:27-31) notes, lower pitch correlates with the lowering of the larynx, while higher pitch correlates with the raising of the larynx.[13]

3.3 An acoustic explanation for vowel quality differences

The literature documents two correlations between voice quality and vowel quality, one universally attested and the other more marginally attested. The most accurate statement of these correlations is found in Bradley (1982:120), who describes the vowels deriving from the older voiced and, as is obvious from the modern phonetics, breathy-voiced register as "higher" and "more fronted", while describing the vowels deriving from the older creaky-voiced register as "lower" and "more backed". The correlation between voice quality and vowel height, that is, F1 is widely attested and uncontroversial: countless scholars have observed that breathy-voiced vowels tend to be relatively higher (e.g., /i/ versus /I/), while tense-voiced vowels tend to be relatively lower (Henderson (1952, 1977), Huffman (1976), Denning (1989), Hombert (1978), Bradley (1982) and so on). The correlation of tenseness (laryngealization) with lower vowels is seen in Mpi, a language in the Lolo-Burmese branch of Tibeto-Burman; Denning (1989:29-33) examined the two-way phonation contrast between modal and tense voice in Mpi and noted that Mpi the tense-voiced vowels showed lowered vowels, that is, the tense-voiced vowels had a higher F1.

The second correlation, between voice quality and vowel fronting, that is F2, is neither as often observed, nor as clearly designated: in Bradley's terms (1982:120), breathy-voiced vowels tend to be more backed, while tense-voiced vowels tend to front. Henderson (1952, 1977:259) describes what seems to be the same correlation but in different terms; the breathy-voiced vowels have a "tendency to diphthongize", while the tense-voiced vowels have a "tendency to centralize".

Similar tendencies observed by other authors (e.g. Huffman 1976) tend to parallel either Bradley's or Henderson's characterization.

Although the literature does contain examples in which these correlations do not hold, such cases are marked as atypical, not only by their rarity, but also by the fact that such putative exceptions are invariably restricted to a small subset of the language's vowels. More important in terms of this paper is the fact that such vowel quality differences are also present, although not as widely attested, in tone systems. For instance, the correlation of breathiness with higher vowels is seen in Hani, a language in the Lolo-Burmese branch of Tibeto-Burman. Maddieson and Ladefoged (1985:67-70) established instrumentally that their Hani breathy vowels … are higher, that is, the breathy-voiced vowels have a lower F1.

A large part of the explanation for these correlations is found in the distinct laryngeal gestures typically associated with the production of breathy versus tense voice. The vowel chart[14] in Figure 5 is added for ease of exposition; those with expertise in acoustic phonetics will not need it but those without the acoustic facts at their fingertips will find it useful. As Figure 5 makes clear, vowel height differences correlate with F1. Thus, when the larynx is lowered under breathy voice, the vocal tract is lengthened; the lengthened vocal tract lengthens the wave lengths of the sounds and generally lowers the formants. Thus, all other things being equal, with the lowering of the larynx under breathy voice the F1 would be lower, making the vowels higher (Figure 5). Conversely, when the larynx is raised under tense voice, the vocal tract is shortened; the shortened vocal tract shortens the wave lengths of the sounds and generally raises the formants. Consequently, with the raising of the larynx under tense voice the F1 would be higher with the vowels lower.[15]

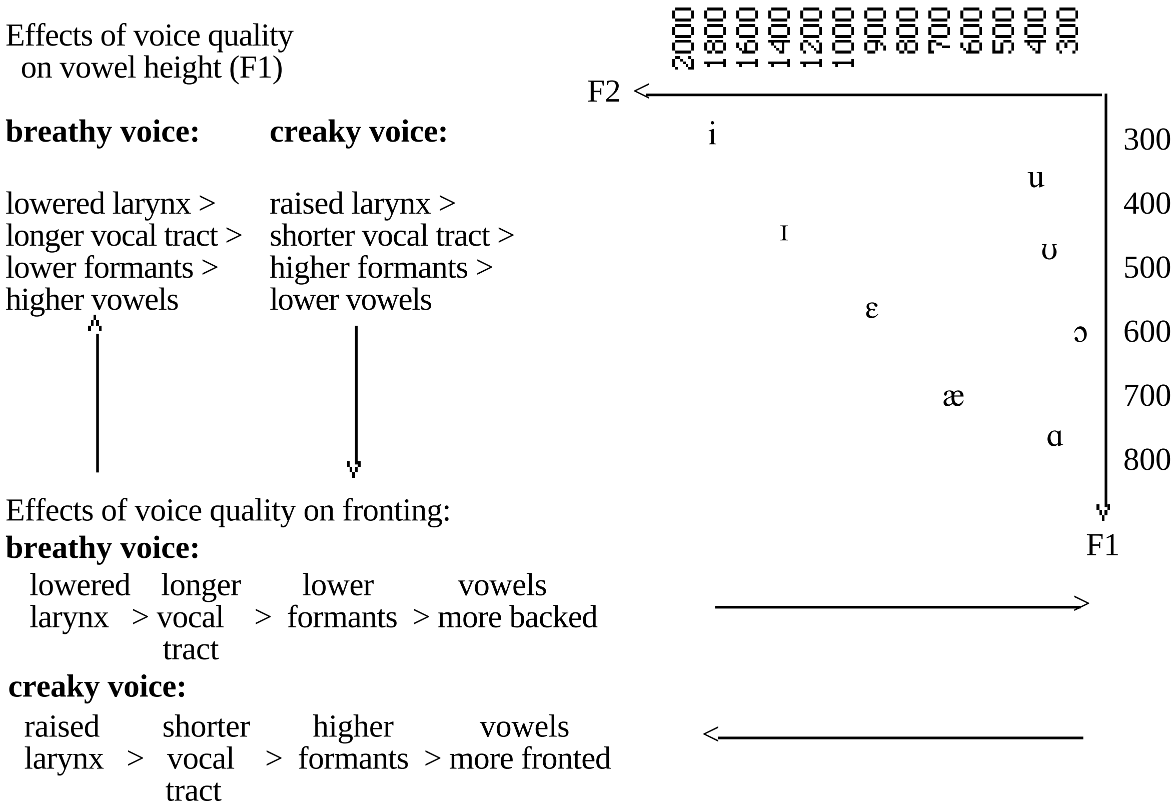

Figure 5: The effects of voice quality on vowel height and fronting

Exactly the same gestures also affect the fronting the vowels, except that it is the effect on the F2, not on F1, that determines vowel fronting: the larynx is lowered in producing breathy voice, the vocal tract is lengthened, the lengthened vocal tract lengthens the wave lengths, lowering the formants. As Figure 5 makes clear, vowels with a lower F2 are more backed. Conversely, the raising of the larynx in producing tense voice, the consequent shortening of the vocal tract, and the resulting shortened wave lengths, produce higher formants. As Figure 5 shows, vowels with a higher F2 are more fronted.

Insofar as the correlation is between voice quality and what Bradley (1982) describes for Burmese as fronting, this model accounts for it. However, the connection between this model and what Henderson (1977 and elsewhere) and others have labeled as diphthongization (with tenseness) and centralization (with breathiness) is more problematic. Under the influence of voice quality differences it is the front vowels that move most noticeably, and insofar as it is primarily the movement of the front vowels, the model provides at least a partial account of the patterns: the front vowels move toward the front under tenseness and toward the back under breathiness. However, if the back vowels are described as centralizing, their movement should be toward the front, not toward the back. The instrumental data found in Bradley ed. (1982) is consistent with his terms fronting and backing and will be used here. Cf. also Thurgood (2000) for the effects of voice quality on vowel quality.

Adapting Bradley's description and terminology only solves part of the problem. That is, we can in part account for the observation that in register and tone languages, breathy vowels have a tendency toward backing. And, we have an explanation of why tense-voiced vowels tend to front. However, it is not clear, at least to me, why these tense-voiced vowels have a widely attested tendency, not just toward fronting, but also towards diphthongization (Henderson 1952, and so on; Huffman 1976). The answer may lie in the relative tenseness of tense-voice and the relative laxness of breathiness but this problem will be left for another time.

In summary, there is a widely-noted causal relationship between the direction of laryngeal gestures involved in the production of specific voice qualities and vowel height and fronting. As a result, because tone systems have frequently evolved out of the phonetics of voice quality distinctions, specific tones are sometimes associated with specific vowel quality features.

3.4 An account of certain cases of 'tone' spreading

In certain cases of so-called tone spreading, it is a voice quality, not a pitch characteristic, which has spread. One example is the Vietnamese voice quality harmony in Vietnamese reduplicatives, which Vũ (1992) described as tone harmony, discussed earlier. Such cases are not uncommon. Particularly clear examples are found in Phan Rang Cham and Tsat, two Chamic languages of Vietnam (Thurgood 1996, 1999). Their spreading patterns provide strong evidence that it was the voice quality distinctions, not the voicing of the initials, that determined the modern tones. In both languages only voiced stops induce breathiness on the following vowel, but if the presyllable begins with a voiced stop and the main syllable begins with a voiced sonorant, the main syllable develops the tone expected for forms with voiced initial stops. This spreading makes sense if a voice quality spread from the presyllable to the main syllable, with the tones developing only later.

Particularly striking are the Tsat changes which involve breathiness spreading through main-syllable-initial voiceless stops.

Malay	PC	Chru	N. Roglai	Tsat	
dĕpa	*dəpa	təpa	tupa	pa^{11}	‘armspan’
---	*batɛ̆y	pətəi	pitəi	u^{11} tai^{11}	‘banana’
bĕsi	*bəsɛ̆y	pəsəi	pisəi	sai^{11}	‘iron’
buta	*buta	---	---	ta^{11}	‘blind’
---	*batɔ	pətɔ	pato	to^{11}	‘teach’
batu	*batɔ̆w	pətəu	patəu	tau^{11}	‘stone’
batuk	*batuk	pətuʔ	pituʔ	$tuʔ^{42}$	‘cough’
dikit	*dikit	təki:ʔ	tiki:ʔ	$kiʔ^{42}$	‘few; little’

Table 2: Spreading through Tsat voiceless stops.

In the examples of Table 2, it is the voiced stop of the presyllable, not the voiceless stop of the main syllable, that correlates with the Tsat 11 low-level and the 42 falling tone. Thus, in these examples, in which the Proto-Chamic presyllable begins with a voiced stop and the main syllable begins with a voiceless stop, it is obviously the breathiness, not voicing, that has spread from the presyllable to the main syllable.

The fact that at a later historical stage voice quality spreading looks like tone spreading follows naturally if tones have evolved out of the earlier phonetics of voice quality distinctions. The parallels between voice quality spreading and tone spreading are quite striking: As with ‘tone’ spreading, the tendency is for voice quality to spread from left to right, although prefixes sometimes pick up their voice quality from a following root. As with ‘tone’ spreading, voice quality spreading is subject to boundary phenomena, that is, the domain for spreading is a word or a phrase; however, in voice quality systems boundaries do little more than impose a limit on spreading, while in tone systems boundary phenomena sometimes interact with pitch and induce changes.

Finally, as with ‘tone’ spreading, certain consonants are more compatible with voice quality spreading, while other consonants tend to block it. Thus, there is a hierarchy for voice quality spreading, with breathy voice spreading most readily through sonorants, less readily through /s/, /h/, and, intriguingly, /ʔ/, and least readily through voiceless stops. In a similar way, tense voice spreads readily through sonorants but far less readily through voiced obstruents. Strikingly parallel patterns have also been reported, not for voice quality spreading, but for tone spreading in African tone languages. Thus, for West African languages, Hyman and Schuh (1974:108) report that the spreading of low tone can be blocked by voiceless consonants, while the spreading of high tone can be blocked by voiced consonants, typically voiced obstruents. For instance, in Ikalanga (Hyman and Mathangwane 1998:204), there is a set of what Bantuists call “depressor consonants”. The typical effect of these consonants is either to lower a high tone or to stop the spread of a high tone. It is not all the voiced consonants but rather specifically the voiced obstruents that constitute the depressor consonants, just the class of consonants most closely associated with breathy voice.[16]

Thus, where tones have evolved out of voice quality differences, certain tone spreading patterns are the historical residue of an earlier pretonal stage that involved voice quality, not tonal, spreading.

3.5 Voiced stops versus voiced sonorants

Sometimes voiced stops and sonorants pattern similarly in tonogenesis, but with some frequency there is an asymmetry in their behavior. Writing about West Africa, Hyman (1978:266) notes that among the voiced consonants, it is particularly the voiced obstruents and breathy voiced stops that tend to lower pitch. When the obstruents and sonorants pattern differently, the lower tone usually occurs after voiced stops, but not after voiced sonorants. This is certainly true for Southeast Asia (cf. Phan Rang Cham and for Tsat of Southeast Asia (Thurgood, 1996)). The converse, if indeed it exists, is far, far rarer. Other related asymmetries also exist: It is frequently only the voiced stops, not the voiced sonorants or voiced fricatives, that develop breathy voice.

These asymmetries are related to the fact that voiced stops are marked. Typologically, while all systems have voiceless stops, many do not have the voiced stops. Historically, it is not at all uncommon historically for voiced stops to simply lose their voicing. There seems to be a common phonetic basis for these asymmetries and for the fact that the most common voice quality found in register systems is the development of breathy voice from a series of voiced stops.

It is relatively well-known that it is the airflow across the vocal folds that causes voicing, the Bernoulli effect, but as various scholars have pointed out the airflow only exists when there is a sufficient difference in pressure between the thoracic cavity and the supraglottal cavity. If there is an insufficient pressure differential between the thoracic cavity and the supraglottal cavity, voicing will cease. As Westbury (1983) pointed out, in the production of voiced stops the maintenance of a sufficient transglottal pressure differential is a problem. The very closure that makes a stop a stop cuts off airflow and causes the pressure in the supraglottal cavity to increase rapidly, which, in turn, stops the airflow and leads to the cessation of voicing. Note that this problem is at its greatest with stops; fricatives and nasals both involve the continual venting of air, and thus have a far less damping effect on the maintenance of voicing. On the basis of estimates of the volume of the supraglottal cavity, the rate and volume of airflow, and knowledge of the length of voicing during the production of voiced stops, Westbury (1983) argued that the supraglottal cavity does not have a sufficient volume to maintain voicing for as long as it actually occurs in natural speech. Thus, speakers must be making some additional adjustments in order to maintain voicing.

The general conclusion of Westbury (1983:1332) was that during the production of voiced stops there was an overall increase in the volume of the supraglottal cavity, while in some voiceless stops there was a decrease in volume, but with the voiceless stops the change was of far smaller magnitude. Much more specifically, Westbury found that in his one subject two basic factors played a role in increasing the surpraglottal volume and thus in maintaining voicing, with larynx movement playing a major role and tongue root movement playing a more minor one. Summarizing his more detailed account, it is important to note that Westbury (1983:1327) found that the larynx tended to be lower during voiced than voiceless stops. The findings for larynx movement, rather than larynx position, are mixed at other syllable positions, but utterance-initial /b,d,g/ all show "the larynx moved steadily downward during the closures". This movement, characteristic of utterance-initial voiced stops, is the same gesture characteristic of breathy-voiced stops; in fact, the change from voiced stops to breathy-voiced stops would only require that this downward gesture be augmented so as to produce a higher transglottal pressure drop, thereby raising the leakage airflow through the laxer glottal closure and thus causing breathiness at the consonant-vowel transition.

This mechanism for the phonetic transition from voiced stops to breathy-voiced stops to breathy-voiced vowels receives further support from the phonetics of the change. Typically, it is in the oldest historical layer that fully voiced stops are found, but the ultimate outcome of the string of changes is a layer characterized by voiceless aspirated stops followed by breathy-voiced vowels. Not only is the voicing completely lost from the former voiced stop but there is a trace left behind from the slight increase in the volume of air allowed to escape from the subglottal cavity---the aspiration of the aspirated voiceless stop now constituting the onset of breathiness. Note that the claim is not that there was a jump directly from lax phonation to voiceless aspiration on the preceding stop; the initial stage was probably a voiced stop followed by a voiced breathy release.

These phonetic findings also provide an explanation for what is otherwise a distributional anomaly: the fact that former voiced stops often have lower tones than voiced sonorants. This asymmetry follows from the fact that voiced stops are more likely than voiced sonorants to develop breathy voice and it is the breathiness, not the voicing, that has produced the lower pitch.

3.6 The phonetics of other historical parallels

The typological and the phonetic evidence is supplemented by historical examples. For example, if we return to the phonetics of Vietnamese tones just examined, it is clear that the six modern tones are still complexes of various features, not just pitch (Thompson 1984-1985:16): among the forms without final stops the low-pitched huyền tone, described as "often accompanied by breathy voice quality", is in contrast with the mid or high-mid pitched ngang tone, while among the forms with final stops, the low-dropping-pitched nặng tone which "ends in [a] stop or is cut off abruptly by [a] glottal stop" is in contrast with the high-rising-pitched sắc tone. That is, the Vietnamese "tone" system still contains a variety of voice quality oppositions, some of which have contributed to the modern pitch patterns of Vietnamese.

Burmese offers a clear example of a tone system whose phonetics suggests an earlier origin as a register system. Maddieson (1984:10) writes, "Traditionally, Burmese has been regarded as having four "tones" but the differences between them include vowel length and other properties of the syllables besides the pitch level and contour (cf. Javkin and Maddieson 1983)."

	tone 1 'level'	tone 2 'heavy'	tone 3 'creaky'	tone 4
voice quality	clear	breathy	creaky	clear
vowel length	average	long	short	extra-short
pitch	low onset, rises at end	high onset, falling contour	high onset, falling contour	high, abrupt, short
diachronic correlates	proto-voiceless initials	proto-voiced initials	*s- prefix before proto-voiced initials	final stops > final glottal stop

Figure 6: The phonetic properties of the Burmese tone system

The tones themselves differ not just in pitch, but also in vowel length (Haas, p.c.) and, in part, in voice quality types, although the voice quality distinctions are at times not particularly salient. Were the Burmese voice quality differences to be more salient than the pitch differences, Burmese would have a register system. In short, the Burmese tonal system looks to be strikingly similar to a register system (cf. Bradley 1982).[17]

Another historical parallel, much simpler than the Vietnamese case, is found in Khmu, described by Suwilai (2001). The initial stage is an original voice distinction, the second stage is a derived voice quality difference, and the final stage is a binary tone contrast.

4.0 Conclusions

First, the paper replaces the older, segmentally-based account of Vietnamese tonogenesis with an updated, laryngeally-based account. Then, on the basis of data from a widely distributed selection of the world's languages, the paper replaces a consonantally-based account of tonogenesis with a laryngeally-based one. It is argued that distinctive laryngeal gestures are the primary mechanism of tonogenesis and that in most, if not all cases, these gestures have developed in the context of voice quality distinctions. Such a laryngeally-based model helps provide phonetically plausible explanation for the widely-attested correlation of pitch height and initial voicing and for correlations between voice quality and vowel quality.

In the course of providing a laryngeally-based account, the paper also correlates data already existing in the literature, suggesting a reason why final glottal stop and final -h sometimes raise pitch and sometimes lower pitch. Further, these same laryngeal considerations provide a phonetic explanation for the preference for developing breathy voice from voiced stop onsets rather than sonorants or fricatives. In addition, the mechanisms in the laryngeal account such a mechanism that may account for the vowel raising and, to a lesser extent, fronting effect of breathy voice quality and the vowel lowering and, to a lesser extent, backing effect of tense vowel quality attested in the literature. Such a model also accounts for various cases of tone spreading, which turn out to be the residue of earlier voice quality spreading patterns. The model provides phonetic and acoustic explanations for tonogenesis, while being equally applicable to tonogenesis in Southeast Asia, East Asia, South Asia, Africa, Europe, and the Americas.

Finally, several caveats are in order. The phonetic account of the effects of laryngeals is still too simplistic. Ladefoged's (1971) lists some seven linguistically-significant status of the glottis, some manifested with attested differences in degree and quality. And, other articulators besides the glottis may contribute to voice quality. For instance, Edmondson, Esling, Li, Harris, and Lama (2000), in their laryngoscopic examination of tense voice in the Bai language of Yunnan Province, argues that contributions are made not just by the true vocal folds adducting but also in part by movement of the ventricular (false) vocal folds and by sphinctering of the aryepiglottic folds, causing bulging upward into the pharynx.

Second, this account has focused on what Eug nie Henderson termed tonogenesis from scratch, i.e., the development of tones in a formerly non-tonal languages. Alone these mechanisms are not enough to fully account for the tonal distributions in many modern tone systems. A full understanding of modern distributions would require a better understanding than I have of the vast, quite complex, and often sophisticated literature on tone systems; this literature makes it clear that modern redistributions involve, in addition to what has been discussed here, the effects of layers of splits, mergers, spreading, and contact. That is, a full understand requires not only an understanding of the origins, but also of the subsequent history of the systems.

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Notes

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I shall be astonished if all my errors should prove minor and grateful to readers for their corrections.

[2]As a Neo-Praguian, Haudricourt himself would undoubtedly have been not as rigidly segmental in his own conceptualizations of the developments than many of his followers have been.

[3] It is necessary to note that, despite the fact that the *huyền* tone appears to have once been breathy voiced, it is not at all clear to what degree it still is. For example, an experimental study of six native speakers by Nguyen and Edmondson found that some speakers today (1997) have only clear voice others have slight laxness, but none had true breathiness. Nguyen and Edmondson describe the voice quality difference as in terms of the glottis in the *huyền* tone appearing to be laxer in vocal fold tension than in production of the *nang* tone, as their glottograms suggest.

[4]Maddieson (1984) provides a succinct survey of the problems faced by consonant-based accounts.

[5] It needs to be pointed out that not all of the characteristics of modern systems can be explained in terms of laryngeal height alone. Instead, other factors must also play a role

[6]For Thongkum, the only place in which the voicing of consonants plays a direct role is in tone splitting, that is, in the adding of tone distinctions in already tonal systems. I suspect that in many if

not all of these cases the splits may come, not directly from the consonants, but may instead be mediated through voice quality distinctions.

[7]Denning (1989) is an excellent work focusing on the diachronic development of voice quality distinctions and including references to such systems in many parts of the world.

[8]My own admittedly cursory survey of languages in other areas (cf. Denning 1989; Gregerson 1976, and so on) seems to suggest a similar situation pertains elsewhere. This is not, however, to say that there are not significant phonetic differences in the various manifestations, but only to note that there is a basically breathy voice quality, a basically constricted voice quality, and, of course, a modal voice quality.

[9]Ladefoged (1971) has argued that there are seven linguistically-significant states of the glottis. However, of these, only three play any central role in Southeast Asian registrogenesis and, should it occur, subsequently in tonogenesis.

[10]Although this is a simplified picture of an enormously complicated literature, it does nonetheless represent the general patterns.

[11]I see no evidence whatsoever that tonogenesis, as opposed to tone splitting, ever initially involves more than a two-way opposition. Not only are there no apparent diachronic instances of a three-way system evolving but the prevalence of two-way pitch height distinctions both in register and tone languages also suggests an initial two-way split. In those cases of Southeast Asian tone systems with more than two levels of pitch height we usually, but not always, can account for the additional pitch height distinctions in terms of subsequently tone splitting.

[12]It is crucial to realize that for languages which contain both voice quality and pitch features, the question of whether the major feature is voice quality or pitch cannot be determined solely by the linguist's ear or even by instrumental studies, but instead must be determined by perceptual experiments designed to determine what the speakers of the language use as their so-called primary cues. Even here, however, there is likely to be a surprising (to some disturbing) variability.

[13] The correlation of breathiness with higher, rather than lower, vowels is seen in Hani, a language in the Lolo-Burmese branch of Tibeto-Burman; Maddieson and Ladefoged (1985:67-70) established

instrumentally that their Hani breathy vowels not only have lower pitch but also are higher, that is, the breathy-voiced vowels have a lower F1.

[14]Neither the precise positions of the vowels on the chart, nor the particular set of vowels chosen for exposition is of any particular significance. That is, it does not represent a particular language, nor necessarily a typical register system.

[15]I wish to thank Peter Ladefoged in particular for discussing this with me, but also Arthur Abramson for his help. I also want to thank Theraphan Thongkum, who also alludes to these correlations in one of her many outstanding papers on register systems, on tonogenesis, and on their interaction.

[16]The reverse correlations are seen with the “uplifter consonants”. As Hyman and Mathangwane (1998:227) note, the uplifter consonants, e.g. voiceless obstruents and implosives, block low tone spreading and raise pitch. However, it is not obvious that these are historically associated with a distinctive voice quality. It is more likely that the high tone is a default class, consisting of just those items not in the phonetically more marked low tone class.

[17] It is hard not to note the pitches of tone 1 and 2 end up other than what might be expected from the original state of the initial consonants.

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[1] [1]I have to acknowledge that in some very real sense this paper has been a group project with its merits often the results of the contributions of others. In particular, I wish to thank Peter Ladefoged, Arthur Abramson, Theraphan Thongkum, Gérard Diffloth, Marc Hideo Miyake, George Grace, Ricky Jacobs, Christopher Court, Gregg Lee, and Blaine Erickson. Theraphan Thongkum supplied me with a number of valuable papers and pointed me to others. The works of Theraphan Thongkum, Keith Denning, Eugénie Henderson, Kenneth Gregerson, Ian Maddieson, Jean-Pierre Hombert, John Ohala, and James Matisoff—even where I have disagreed with them in one way or another, have been the foundations for this study. Last, but not least, I wish to thank Martha Ratliff, Jerry Edmondson, and Jørgen Rischel for reading an earlier version, for catching some egregious errors, and, in some cases, for offering paraphrases that significantly improved the readability.

I shall be astonished if all my errors should prove minor and grateful to readers for their corrections.

[2]As a Neo-Praguian, Haudricourt himself would undoubtedly have been not as rigidly segmental in his own conceptualizations of the developments than many of his followers have been.

[3] It is necessary to note that, despite the fact that the *huyền* tone appears to have once been breathy voiced, it is not at all clear to what degree it still is. For example, an experimental study of six native speakers by Nguyen and Edmondson found that some speakers today (1997) have only clear voice others have slight laxness, but none had true breathiness. Nguyen and Edmondson describe the voice quality difference as in terms of the glottis in the *huyền* tone appearing to be laxer in vocal fold tension than in production of the *nang* tone, as their glottograms suggest.

[4]Maddieson (1984) provides a succinct survey of the problems faced by consonant-based accounts.

[5] It needs to be pointed out that not all of the characteristics of modern systems can be explained in terms of laryngeal height alone. Instead, other factors must also play a role

[6]For Thongkum, the only place in which the voicing of consonants plays a direct role is in tone splitting, that is, in the adding of tone distinctions in already tonal systems. I suspect that in many if not all of these cases the splits may come, not directly from the consonants, but may instead be mediated through voice quality distinctions.

[7]Denning (1989) is an excellent work focusing on the diachronic development of voice quality distinctions and including references to such systems in many parts of the world.

[8]My own admittedly cursory survey of languages in other areas (cf. Denning 1989; Gregerson 1976, and so on) seems to suggest a similar situation pertains elsewhere. This is not, however, to say that there are not significant phonetic differences in the various manifestations, but only to note that there is a basically breathy voice quality, a basically constricted voice quality, and, of course, a modal voice quality.

[9]Ladefoged (1971) has argued that there are seven linguistically-significant states of the glottis. However, of these, only three play any central role in Southeast Asian registrogenesis and, should it occur, subsequently in tonogenesis.
[10]Although this is a simplified picture of an enormously complicated literature, it does nonetheless represent the general patterns.
[11]I see no evidence whatsoever that tonogenesis, as opposed to tone splitting, ever initially involves more than a two-way opposition. Not only are there no apparent diachronic instances of a three-way system evolving but the prevalence of two-way pitch height distinctions both in register and tone languages also suggests an initial two-way split. In those cases of Southeast Asian tone systems with more than two levels of pitch height we usually, but not always, can account for the additional pitch height distinctions in terms of subsequently tone splitting.
[12]It is crucial to realize that for languages which contain both voice quality and pitch features, the question of whether the major feature is voice quality or pitch cannot be determined solely by the linguist's ear or even by instrumental studies, but instead must be determined by perceptual experiments designed to determine what the speakers of the language use as their so-called primary cues. Even here, however, there is likely to be a surprising (to some disturbing) variability.
[13] The correlation of breathiness with higher, rather than lower, vowels is seen in Hani, a language in the Lolo-Burmese branch of Tibeto-Burman; Maddieson and Ladefoged (1985:67-70) established instrumentally that their Hani breathy vowels not only have lower pitch but also are higher, that is, the breathy-voiced vowels have a lower F1.

[14]Neither the precise positions of the vowels on the chart, nor the particular set of vowels chosen for exposition is of any particular significance. That is, it does not represent a particular language, nor necessarily a typical register system.
[15]I wish to thank Peter Ladefoged in particular for discussing this with me, but also Arthur Abramson for his help. I also want to thank Theraphan Thongkum also alludes to these correlations in one of her many outstanding papers on register systems, on tonogenesis, and on their interaction.
[16]The reverse correlations are seen with the "uplifter consonants". As Hyman and Mathangwane (1998:227) note, the uplifter consonants, e.g. voiceless obstruents and implosives, block low tone spreading and raise pitch. However, it is not obvious that these are historically associated with a distinctive voice quality. It is more likely that the high tone is a default class, consisting of just those items not in the phonetically more marked low tone class.
[17] It is hard not to note the pitches of tone 1 and 2 end up other than what might be expected from the original state of the initial consonants.