

Voice quality differences and the origin of diphthongs

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Introduction. The literature documents a widely-noted correlation between three clusters of features widely-distributed in Southeast Asian languages: a so-called tense register (associated with several distinct voice quality or phonation types (specifically, with creaky, tense, and sometimes harsh voice)), a modal register, which is unmarked, and a breathy-voiced register (associated with breathy voice). See Figure 1 for the three bundles of co-occurring features.

Figure 1: The three most common register complexes

	Tense Register	Unmarked	Breathy Register
original initials:	proto-voiceless (esp. obstruents) >	voiced/voiceless	proto-voiced (esp. obstruents) >
voice quality:	creaky, tense, or harsh	modal (clear)	breathy
vowel quality:	lower (open); more fronted vowels		higher (closed); more backed vowels
diphthongization:	tendency to offglides		tendency to to onglides (centralization)
length:	often shorter		often longer
pitch distinctions:	higher pitch; associated with -ʔ and/or laryngeal tension		lower pitch; association with -h and/or laryngeal laxness
state of larynx:	larynx tense and/or raised (= reduced supraglottal cavity)		larynx lax and/or lowered (= increased supraglottal cavity)

Figure 1 is a modified and selectively-chosen composite of Henderson (1952, 1977), Matisoff (1973:76), Edmondson and Gregerson (1993:61-63), and Bradley 1982). Notice also that the listing in Figure 1 contains the same phonetic features Henderson uses to characterize a typical Southeast Asian tone system.¹

¹ I have to acknowledge that the merits of this work own much to the contributions of Peter Ladefoged, Jerry Edmondson, John Ohala, Ian Maddieson, Theraphan Thongkum, Gérard

It is important to note that the first diachronic stage is the development of a marked register. There are several potential origins for this voice quality difference. For example, the voiced obstruent series might develop into a breathy-voiced series, the proto-voiceless obstruent series might develop into a so-called tense-voiced series (less likely), or, alternately, the existence of final glottal stops might lead to a tense-voiced series. It is these resultant voice qualities that are associated with the remaining clusters of features. Further note that it is only necessary for one marked voice quality to emerge; once one has made its appearance, the system now has a marked voice quality distinction.

Of the remaining features, it is the vowel quality distinctions found in two particular manifestations, that are of special interest here. The most obvious manifestation is the widely-noted correlation of tense (or, creaky, or harsh) voice quality with both lowered and fronted vowels and the correlation of breathy voice quality with raised and backed vowels. The other manifestation, not as widely noted, is between the so-called tense register and diphthongs (offglides), on the one hand, and between the so-called breathy register and centralization (onglides), on the other. It will be argued in this paper that, in large part, the correlation between voice quality and diphthongization patterns is simply another manifestation of the tendency of tense vowels to lower and front and of breathy vowels to raise and back.

Vowel quality and voice quality correlations. The correlations between voice quality and vowel quality are widely noted. In Burmese, it is evident from Thein Tun's (1982:94) acoustic study that developed from the historical breathy-voiced register (Bradley 1982) tend to be "higher" and "more backed", while the vowels associated historically with the creaky-voiced register tend to be "lower" and "more fronted". Countless others have observed that breathy-voiced vowels tend to be higher, while tense-voiced vowels tend to be lower Henderson (1952, 1977), Huffman (1976), Denning (1989), Hombert (1978), Bradley (1982) and so on. The observation that tenseness (laryngealization, harsh or creaky voice, that is, any voice quality with heightened tenseness) correlates with lower vowels is widely reported: Mpi (Denning 1989:29-33), Hani (Maddieson and Ladefoged 1985:67-70), Western Cham (Edmondson and Gregerson 1993), various

Diffloth, Marc Hideo Miyake, George Grace, William Gage, David Solnit, Justin Watkins, Martha Ratliff and Blaine Erickson. The works of Theraphan Thongkum, Jerry Edmondson, Keith Denning, Eugénie Henderson, Kenneth Gregerson, Ian Maddieson, Jean-Pierre Hombert, John Ohala, and James Matisoff have been the foundations for this study.

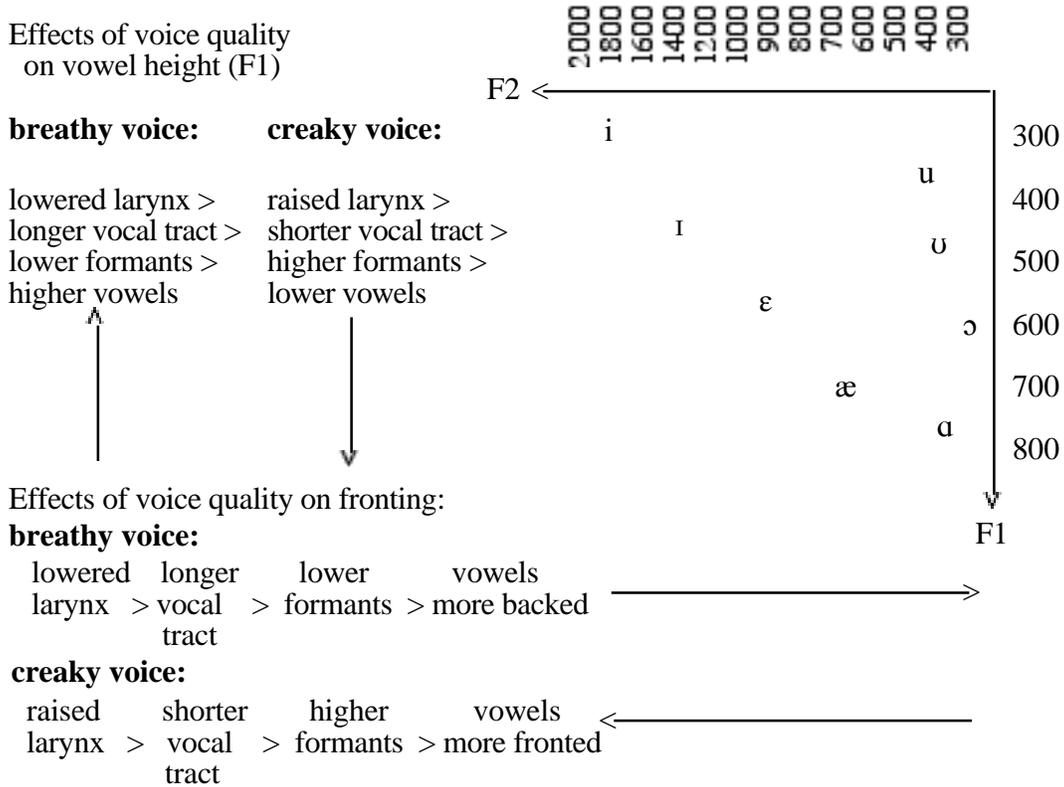
Aside perhaps from my attempt to treat the articulatory and acoustics behind development of certain diphthongs, this paper makes no claims to originality. Thus, it was written to pull certain things together that are found in various places in the literature.

I should be astonished if all my errors are minor and grateful for correction from readers.

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languages of the world (Denning 1989).

Figure 2: The correlation of voice quality with vowel height and fronting



In some cases, the correlation between voice quality and vowel quality is really a correlation between voice quality and vocal tract length. That is, breathiness frequently correlates with a lowering of the larynx and tenseness with raising. Thus, when the larynx is lowered, 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, under the lowering of the larynx associated with breathy voice the F1 would be lower, making the vowels higher. Conversely, when the larynx is raised in association with tense voice (or, creaky, or harsh 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 the F1 is be higher, making the vowels lower. With the fronting and backing of vowels parallel correlations are found, but here it is the effect on F2 that is being tracked: the larynx is lowered in association with breathy voice, the vocal tract is lengthened, the lengthened vocal

tract lengthens the wave lengths, lowering the formants. Conversely, the raising of the larynx in association with the production of tense voice with the consequent shortening of the vocal tract, results in shortened wave lengths, and produces higher formants. Thus, vowels with a lower F2 are more backed; those with a higher F2 are more fronted. These correlations are presented graphically in Figure 2.²

Correlations with diphthongization patterns. Various scholars including Henderson (1977) have noted correlations of voice quality with diphthongization patterns, particularly the tendency of the tense register to correlate with offglides but the breathy register to correlate with onglides (centralization). In a similar vein and most likely referring to the same languages, Huffman (1985:144) also observed that correlations between voice quality and vowel quality hold for the onsets of long vowels in the registers of various Mon-Khmer languages: tenseness produces lowered onsets in high and mid vowels, while laxness produces raised onsets in low and mid vowels; hence, diphthongization in both cases.

Figure 3. Diachronic paths leading to register systems (Huffman).

	Proto- language	Conservative	Transitional	Register	Restructured	(Tonal)
2 nd	*/gaa/	/gaa/	/k'aa/	/kàa/	/kia/	(/kàa/)
1 st	*/kaa/	/kaa/	/kaa/	/kaa/	/kaa/	(/káa/)

Before discussing the diphthongization patterns, however, Huffman (1985:141) briefly sketches the diachronic paths that have led to the development of register (and tonal) distinctions in a number of Mon-Khmer languages (The tonal developments will be ignored here). Reading Figure 3 from left to right, it

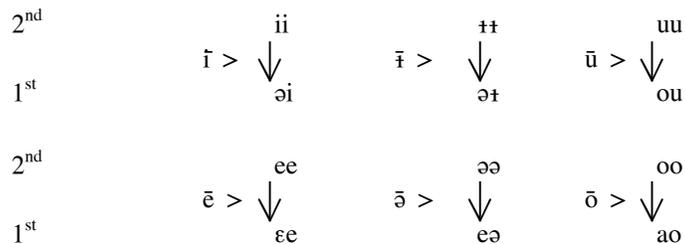
² This figure developed out of a conversation in the summer of 1997, in which I asked Peter Ladefoged how breathy voice could end up producing higher vowels. Subsequently, I primarily listened as Peter Ladefoged explained to me how a lower larynx led to a longer vocal tract, how a longer vocal tract led to lower F1 formants, and how lower F1 led to higher vowels. As noted elsewhere in the paper variants of this observation are found various places in the literature. Had I thought at the time to ask how breathy voice could also end up producing backer vowels, doubtless that would have been made clear to me then, too, but it wasn't until a month or so later that I became aware of the vowel backing effect of breathy voice. However, the extension of the notion to F2 was obvious enough even for me to grasp; doubtless it too is in the literature and I will be happy to cite it if someone would be kind enough to point it out to me. For instance, I suspect that it is somewhere in Silverman (1997) but thus far I have not found it; it is implicit in it, if not explicit.

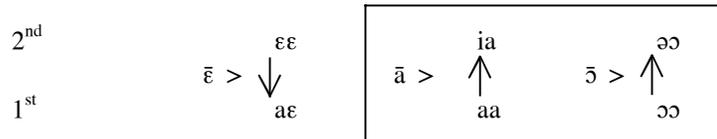
begins with the proto-language, with a contrast between voiceless initials (ultimately to be associated with the so-called first register) and voiced initials (ultimately to be associated, in languages with such distinctions, with the so-called second register, often a breathy register). This initials contrast is still maintained unaltered in Huffman's conservative dialects. The next stage is Huffman's transitional dialects, in which the voiced stops have developed into breathy-voiced stops, typically becoming voiceless aspirated stops with the breathiness, of course, manifested on the vowel. The next stage is Huffman's register stage, in which the system has essentially into two phonetically-distinct sets of vowels, one in the breathy register and one in the contrasting register (however, it is not unknown for one or more vowels not to participate in this split). If the vowel distinctions remain but the voice quality differences that originally conditioned them disappear, we have Huffman's restructured register. Of course, this is not just idealized but there are also other paths to the development of register systems.

The development of onglides. One of the vocalic developments pictured in Huffman's schematic (Figure 3) shows the development of an onglide: the change of the earlier, long, breathy-voiced /âa/ of /kâa/ into the ongliding /ia/ of /kia/. This development, this paper argues, is due to the influence of breathiness on the first mora of the vowel; the F1 has been raised, lowering the vowel and producing the ongliding /i/. Quite similarly in Haroi, a Chamic language of Vietnam, long /aa/ has developed into /ia/ under the influence of earlier breathiness induced by what were historically voiced stop onsets. Not coincidentally it is apparently only long vowels that seem to develop onglides and offglides.

The development of offglides. Huffman (1985:142) also provides a chart illustrating the development of offglides as well as several offglides in various Khmer dialects (Figure 4). The figure deals the effects of voice quality on vowels under the influence of what Huffman reconstructs as a the breathy-voiced second-register in contrast with a tense-voiced first register.

Figure 4. The development of diphthongs in Khmer dialects (Huffman).





Several patterns in Figure 4 merit comment. First, the vowels themselves were originally long (as, in a sense, are the resultant diphthongs). Second, as Huffman notes, the onsets of the high vowels lower under first register, but not under breathy register. Impressionistically, the ‘failure’ of the high vowels to raise under breathy register is not particularly surprising; where would they go? However, it would be interesting to examine them instrumentally. Although not found in this data set, in a similar way, impressionistically the long vowels are not further lowered under the tense register. Third, the onsets of the two back low vowels are raised under the influence of breathy voice.

Toward a ‘real’ explanation. Some parts of the explanation seem clear; other parts remain to be clarified. It is certainly clear that the origin of these diphthongs involves (1) long vowels in which the first and second mora have distinct voice qualities and (2) these vowel quality differences correlate in a straightforward way with the diphthongization patterns. Long vowels in which the first and second mora have distinct voice qualities are not particularly uncommon in Southeast Asia (and elsewhere). In fact, there is convincing instrumental documentation: in Bai, a Sino-Tibetan language of China, there are long vowels that have harsh-modal sequences and breathy-tense sequences (Edmondson et al. ms.); in Chong, there is a register in which vowels have a clear-creaky sequence and another in which vowels have a breathy-creaky voice (Thongkum 1988, 1990, 1991, cited in Silverman 1991:62); and there are a number of others that are documented); and, a number of others could easily be cited. It is equally clear that the diphthongization patterns correlate with the voice quality differences.

However, despite my focus on vocal tract length as an explanation of the correlations between voice quality and vowel quality, it is unlikely that vocal tract length explains all of the correlations in the literature between vowel quality and voice quality. Certainly the literature suggests a correlation between voice and vowel quality with larynx height (Lindblom and Sundberg 1971, Jakobson 1980, Silverman 1997, to cite three) and it does seem that at least some of the changes in vowel height and frontness are due to changes in the size of the vocal tract. Further, although I have not yet found explicit references, observations about parallel correlations between voice quality differences and relative vowel frontness must also be in the literature. In any case, the question of whether such correlations exist does not seem to be a major issue of contention.

However, in some cases larynx height may not be the causative variable.

Indeed, in some cases it looks as if the larynx movement is secondary. Jakobson (1980:185-186), for instance, notes that pharyngeal constriction results in the raising of the larynx, while suggesting the possibility that the pharyngealization itself was the causative factor in the accompanying vowel raising, with the raising of the larynx being secondary. Certainly, this is the position taken by Gregerson (1976). Thus, while we have found a correlation, the intriguing question of precise causation still eludes us.

Nonetheless, whatever the precise diachronic mechanisms were, it is clear that the diphthongization patterns discussed above originated in the phonetics of bimoraic vowels in which the individual moras differed in their voice quality — the breathy voice generally producing raised onsets and the creaky producing lowered onsets (and codas).

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