# High vowel fricativization and chain shift

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## 1 Introduction*

Chain shifts are a thoroughly studied phenomenon by which intra-categorical changes occur in several categories in tandem, such that one adjustment appears to drive another. I argue for expanding the typology of chain shifts to include chain shifts that involve the raising of non-high vowels in tandem with the fricativization of high vowels. I refer to the latter sound change here as *high vowel fricativization* (HVF), an unusual but sporadically attested change in which a reconstructible rounded or unrounded front vowel becomes a voiced strident coronal fricative (e.g. [i y] → [z̩ z̩ʷ]), or a back rounded vowel becomes a voiced labiodental fricative (e.g. [u] → [v̩]). HVF is due, in some better-studied cases, to allophonic coarticulation of high vowels with immediately preceding consonantal fricatives (e.g. [si] → [sz̩]). However, still other cases of HVF appear to involve the movement of an entire high vowel category to production as a voiced fricative, even in the absence of a potential conditioning environment (e.g. [Øi] → [Øz̩]).

It is the latter set of vowel fricativizations that interest us here. I posit that HVF is, in these cases, involved as one intra-categorical change in a chain shift of one or more vocalic phonemes: in other words, that it takes part in a raising chain shift (i.e. $e \rightarrow i \rightarrow z$). To bolster this argument, I examine the attestation of the fricativized vowels in question and reconstruct their associated raising chains in a small but genetically diverse set of languages. I argue from the attested changes that an explanation for HVF lies in the aerodynamics of speech: high vowels, particularly peripheral high vowels, tend to be realized with some turbulent airflow given their narrow aperture, which provides the "seed" for the eventual phonologization of fricative noise as

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a high vowel category's primary characteristic. To clarify the mechanics of this phonologization, I provide an account of HVF in which an exemplar-based account of phonological categories and cue structure produces the desired effects, with the model accounting for certain crucial observations while raising questions for further research into intra-categorical changes of this sort.

With HVF on firm footing in several cases, I take an opportunity to use this new formulation in order to shed light on the phonological history of an understudied linguistic area, the Grassfields of northwestern Cameroon. In a detailed case study that includes several phonological reconstructions of shallow time-depth for relevant subgroups, I argue that HVF has occurred as part of a raising chain shift that has spread via language contact among several unrelated linguistic groupings; this allows for some clarification of the unusually complex phonological history of the high vowels in the Bantoid subgroup of the Niger-Congo languages. Supporting evidence is drawn from subgroup reconstruction, geographical distribution, and known sociohistorical tendencies of the area; the information collected and organized for this case study provides a valuable additional example of HVF via chain shift.

## 1.1 Fricativized vowels

A brief discussion of the acoustics and articulation of fricativized vowels, which occur at two places of articulation, is provided here to familiarize the reader with this uncommon segment type. The first and most common subset of these sounds, the so-called "apical" vowels, are articulated coronally. They can broadly be characterized in articulation as having simultaneous tongue tip and tongue body constriction, have been a subject of concerted study for many years, and have been acknowledged as a distinct and unusual class of phonetic segment for some time (Gjerdman, 1916; Karlgren, 1926). The second broad type of fricativized vowel, somewhat less common than the coronal type, is produced with labiodental constriction. The labiodental fricativized vowels have not been the subject of concerted study in the same way as the coronal type but are commonly mentioned in discussions of syllabic consonants (Bell, 1978).

Fricativized vowels are in some ways quantifiably indeterminate between high vowels and voiced fricatives, having acoustic and articulatory characteristics of both. Acoustically, they generally resemble syllabic voiced fricatives, but with a more clearly audible formant structure resembling that of "high vowels rather than a schwa-like quality often associated with syllabic fricatives" (Connell, 2007, 15). This formant structure is not of a peripheral (very front or back) high vowel, however, and is more frequently reflective of a centralized quality approaching [ɨ] (Connell, 2007; Cheung, 2004; Engstrand et al., 2000). For coronal fricative vowels, F1 is typically higher than might be expected and F2 lower than might be expected given the vowel's frontness and height (Engstrand et al., 2000; Feng, 2007).[1] Despite the presence of fricative noise at or above F3 or

[1] See Feng (2007) for details. She proposes that this is, in large part, directly due to the tongue tip-raising gesture at the

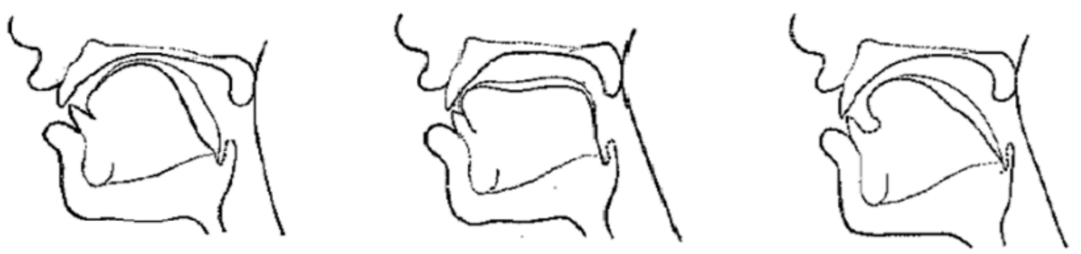

Figure 1: Traces of midsagittal X-ray images showing articulatory configurations for (left–right): [i], [z̩], and [ʐ̩] in Standard Mandarin. Figures originally from Zhou & Wu (1963), as presented in Lee-Kim (to appear, 4).

F4, F3 is also salient enough to be useful in cuing distinctions between different types of coronal fricativized vowels, as in Standard Mandarin's contrast between apico-alveolar [z̩] and retroflex [ʐ̩] (Cheung, 2004, 26).

The frication associated with fricativized vowels is invariably strident (Connell, 2007; Faytak, 2013), with the directing of a jet of air at an *obstacle*—in this case the alveolar ridge or lower teeth. This articulatory maneuver is responsible for the creation of the *obstacle noise source* characteristic of strident fricatives (Shadle, 1990), an articulatorily defined class that appears to include the fricativized vowels. In the case of the coronal fricativized vowels, as seen in Figure 1, the simultaneous activation of the tongue tip and tongue body that generates this frication creates a complex articulatory plan quite different from that of a plain high vowel (Stone & Lundberg, 1996). There is significant variation from language to language in the specific quality and intensity of the frication (cf. Lee-Kim (to appear)), but this is generally not included in existing discussions of the acoustics of fricativized vowels; it is typically somewhat less intense than one would encounter in an analogous voiced fricative. Timing of this frication also varies somewhat, as indicated in Figure 2: in most cases, strident frication lasts over nearly the whole duration of the vowel. If the frication does not extend over the entire vowel, a brief central vowel "offglide" can be heard following the fricated portion.

There is still considerable debate on the phonological status of fricativized vowels, especially given their complex motor plans and unusual acoustics. Much of the debate , and in particular what broad class of segment they are best analyzed as. Among those with a stake in fricativized vowels' phonological representation, researchers have given numerous affiliations to the segments: as syllabic fricatives (Bell, 1978; Dell, 1994; Yu, 1999), approximants (Lee-Kim, to appear; Duanmu, 2000), or even zero syllable nuclei "filled" by spread of frication from initial affricates and fricatives (Li, 1966; Pulleyblank, 1984). Phonological alternations or

front of the oral cavity (576). It is unclear how these general findings for coronal fricative vowels apply to the labiodental type, given that the tongue tip is presumably not involved.

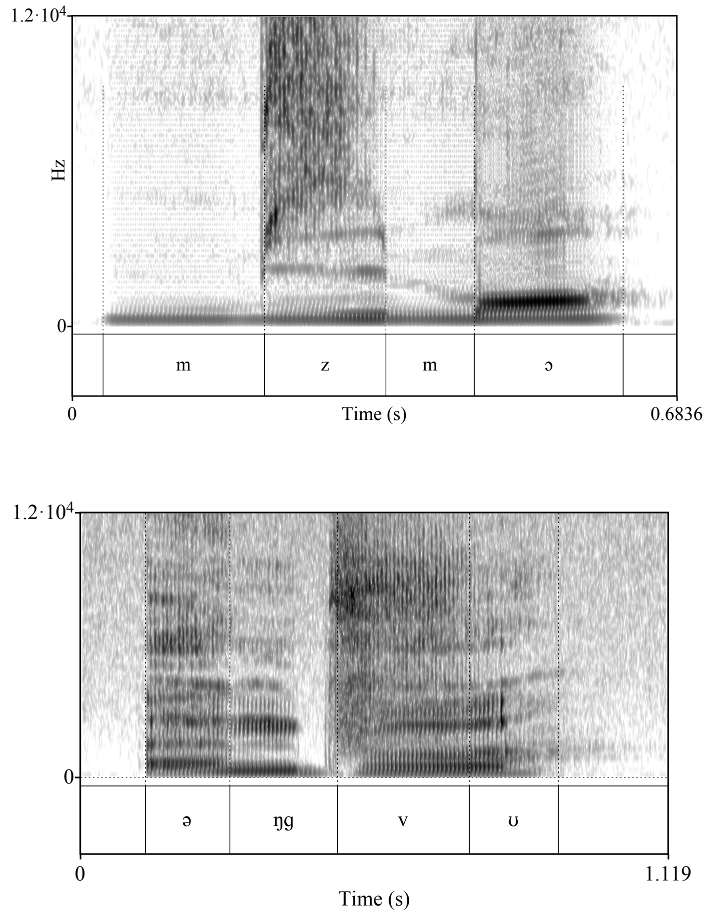


Figure 2: Top: a token of the Wanghao Wu Chinese word [mz̩̄mɔ́] 'eyebrow', with frication (visible especially in the upper half of the spectrogram) realized across the entire fricativized vowel. Bottom: a token of the Kom word [ə̀ŋgv͡ə̰̀] 'chicken', with a central vowel "offglide" (given as rounded [ʊ] here) after frication tapers off. Spectrograms produced from audio collected by the author.

behavior also prove to be enigmatic: in spite of their obstruency and in numerous languages, fricative vowels are licensed as syllabic nuclei more readily than certain non-obstruent segment classes such as laterals, rhotics, or nasals (Faytak, in press). Crucially, it can be seen that in many cases fricativized vowels are either allophones of high vowels or correspond transparently with them in closely related languages without fricativized vowels (discussed further in Section 3.1). In much of the rest of this paper, I explore the changes that take place to produce fricativized vowels in order to better understand this historical connection.

## 1.2 Chain shifts

Chain shifts the world over have been thoroughly catalogued, particularly those involving movements of multiple vowel categories in tandem around the vowel space (Labov, 1994). Below, I provide a brief overview of models of vocalic chain shifting, with an aim to expand our focus to include chain shifts adding or removing vocoid features (nasality, rhoticity, etc.).

### 1.2.1 Shifting around the vowel space and beyond

The focus in this paper is the type of vocalic chain shift that introduces extra dimensions along which contrastiveness may play out. This is in contrast to the strictly vocalic chain shifts that dominate discussions of chain shift, namely those chain shifts that result in formant values of vowels. F1 and F2 values form a two-dimensional plane, an articulatorily bounded portion of which is typically taken to constitue the "vowel space." Typically, this is construed as the portion of the acoustic F1-F2 plane that can be produced by a human vocal tract while maintaining other canonically vowel-like settings—voicing, laminal airflow, and the resulting largely periodic acoustic output (Pike, 1971; Catford, 1977), and the resulting articulatory and acoustic spaces are taken to be populated with vowel categories. Many chain shifts result in the movement of a category off of this F1-F2 plane through the phonologization of another dimension of contrast (Figure 3); the dimensions of this sort discussed in Labov (1994) are primarily internal dynamicity (diphthongization, or the addition of a time dimension) and rhoticity, but may also include nasalization or laryngealization (289–91) and, I will argue, the presence of fricative noise. These extra dimensions are not typically conceived of as planes that intersect with the F1-F2 plane, but rather as parallel "subsystems" consisting of parallel planes (Labov, 1994, 271-272,286). As such, membership in subsystems tends to be valued discretely rather than continuously—a given vowel would not be described as (say) 52% diphthongized, or perhaps "half diphthongized," but would be taken as participating entirely in either a monophthongal or diphthongal vowel subsystem.

My primary descriptive and theoretical focus in this paper is the *fricativizing chain shift*: a high vowel, pressured by encroaching lower vowel categories, becomes increasingly peripheral (high, tense) and supralaryngeally constricted until the resulting turbulent airflow is phonologized as strident frication at a labiodental or coronal place of articulation. This has the effect of creating a "fricative" vowel subsystem consisting of fricativized vowels (Figure 4), and could be described as a raising chain shift. This sound change presents a prominent addition to the well-worn paths of chain shift attested in numerous languages (Labov et al., 1972; Labov, 1994). While it is acknowledged (especially in Labov (1994)) that chain shifts often result in interchange between vowel subsystems within a language, there is, to my knowledge, no discussion of high vowels populating a novel subsystem of fricativized vowels. It is also noteworthy that this change is regular in its actuation and outputs but still fairly rare: far more commonly in raising chain shifts, the highest vowel in the chain simply moves into a diphthongal subsystem or centralizes (Figure 5). The latter two types of displacement are, in fact, so commonly attested in chain shifting that they are titled in Labov (1994)—as

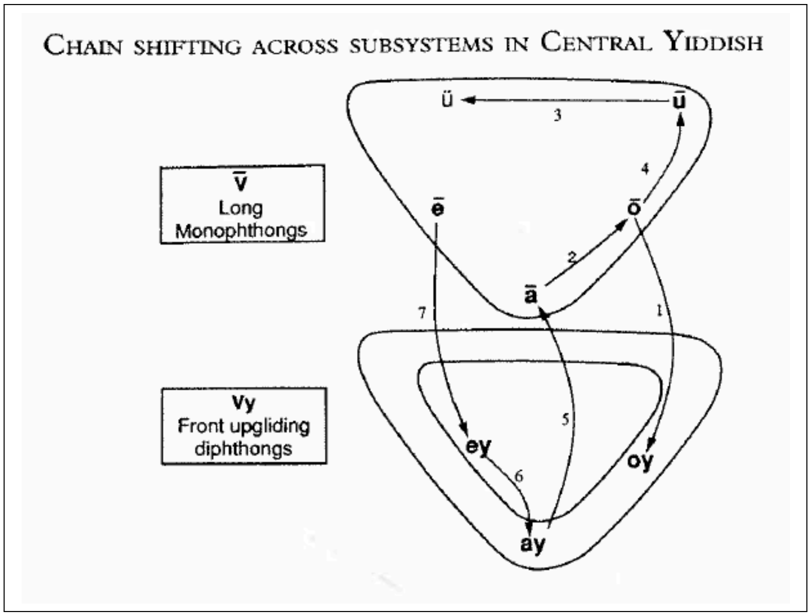


Figure 3: Chain shifting between monophthongal and diphthongal subsystems in Central Yiddish; note that subsystems are represented as bounded portions of two F1-F2 planes that do not intersect. Minimally adapted from figure in Labov (1994), p. 286.

Pattern 1 and Pattern 3, respectively.

#### 1.2.2 Push *vs.* pull chains and fricativization

Before proceeding, I must digress to note that HVF as an output of chain raising resembles a "push" of high vowel categories away from densely populated parts of the vowel space (and, in fact, out of the vowel space entirely). As such, it is tempting to view the model of HVF from chain shifts advanced here as a novel example of push chain shift, the existence of which is frequently called into question. I remain agnostic on whether HVF chain shifts are push or pull, but will point out that regardless, the model discussed here provides a *possible* and testable source of true push chains.

Since Martinet (1952) first made the distinction, the existence of push chains, or more generally adjustment of a category away from another encroaching category, has been called into question. A number of researchers have argued (and continue to argue into the present day) that category *encroachment* is not attested as a driver of chain shifts such that one category repels another (King, 1969; Samuels, 2006); an additional stipulation of this is that encroachment *does* exist as a mechanism that produces category merger and nothing else. Further arguments against push chains have been levied based on the seemingly teleological notion of "avoidance" of category merger under encroachment (King, 1969).

How one defines encroachment is central to the debate over push chains, and to some extent the modeling of HVF: if one understands encroachment as a gradient and continuous process (as when categories are

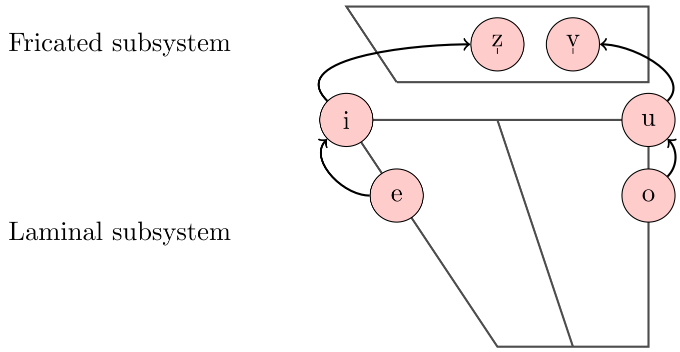


Figure 4: A pair of minimal spirantizing chain shifts: non-high categories raise (lower F1) in tandem with the fricativization of the highest vowels.

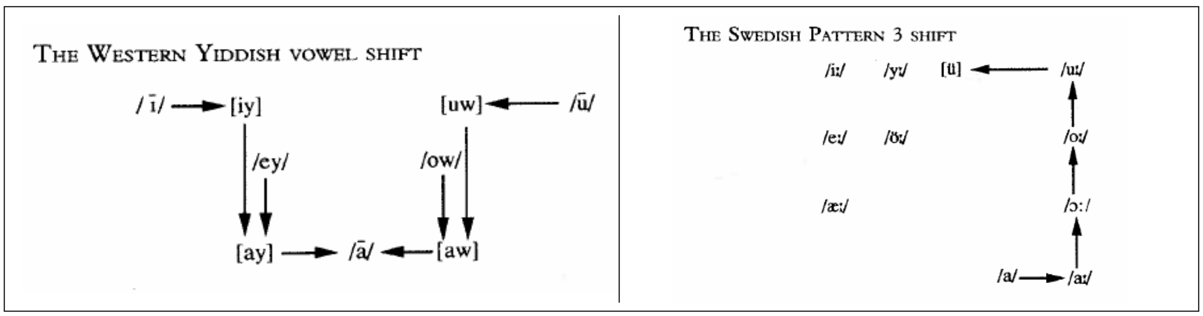


Figure 5: Two cases of a high vowel (/u/, /uw/, etc) displaced in a chain shift. Left: diphthongization (Pattern 1); Right: centralization (Pattern 3). Figures from Labov (1994), pp. 125 and 131.

exemplar-based), rather than as an instantaneous and discrete one (as when categories are feature-based), then encroachment becomes a ubiquitous and unavoidable factor in categorizing continua such as vowel spaces. In later sections, I will model HVF assuming a more rigorous definition for encroachment that is defined in terms of the reliability of cues, which draws heavily from research into phonological categories as exemplar clouds with Gaussian (normal) distributions (Ettlinger, 2007; Kirby, 2011). Although I remain agnostic on the exact motivation for HVF-related chain shifts for lack of sufficiently detailed chronological data to *demonstrate*, rather than theorize, that push chains have actually occurred, I find reason to model a hypothetical account of push chains: it seems unlikely that a speaker with an exemplar-based vowel category would spontaneously abandon the highly audible cues associated with the vowel's exemplars in favor of other incidental and variably present characteristics of high vowels such as turbulent noise.

## 1.3 Overview of sections

The structure of the remainder of this paper is as follows. I have alluded to the limited typological scope of most surveys of chain shifts. In Section 2 I undertake a survey of reconstructible high vowel fricativization and demonstrate the chain shifts that accompany it. The material in this section comprises existing descriptions of a genetically diverse set of languages with clear and unambiguous relatives on which shallow historical reconstruction can be performed or has been done, with the relevant chain shifting reconstructed or highlighted. These include two distantly related groups of Sinitic languages, Swedish, and several distantly related Tibeto-Burman languages. Section §2.3 of this paper is given over to a separate reconstruction of an additional case with much less accessible comparative material: the Grassfields Bantu languages of Cameroon, which frequently exhibit fricativized high vowels as part of their vowel systems. Although several subgroups of the family not immediately related to one another are involved, it is shown that HVF is a recent innovation that has spread in a wave-like fashion to a number of languages in a particular geographic area in the northern Grassfields.

In Section 3, I explore phonetic motivations for the regularity (and rarity) of high vowel fricativization. In particular, I explore *wall noise sources*, from turbulent airflow through a narrow aperture, (Shadle, 1990) as a phonetic seed regularly leading to phonologized frication in high vowels. The phonologization of this fricative noise is further explored in Section 3.2, where I argue that a push chain is the likely driver of high vowel fricativization: while fricative noise is robustly associated with high vowels, it only becomes an important characteristic of these categories if canonically vowel-like parameters such as F1 are not useful as cues to the category. A model of the sound change in which fricative noise is probabilistically enhanced in response to reduced usefulness of F1 is explored.

Finally, in section 3, I discuss the various complications and implications of a model of HVF. On the one hand, the unusual nature of HVF-related chain shifts potentially offers insight for chain shifts in general, as has been alluded to in the immediately preceding section. However, I also address the question of what leads a group of languages to undergo HVF rather than a more typical type of chain shifting—both attested as an apparent result of similar typological factors like a crowded high vowel space. Investigations into HVF also shed new light on phonological reconstruction of Niger-Congo, the broader language family that Grassfields Bantu belongs to. A model for chain-shift-associated HVF carries implications for a long-running problem of reconstruction within the Bantuist literature, namely the phonetic characteristics and even the phonological specification of the *first-degree vowels* that can be reconstructed to a proposed ancestor language to most subgroups discussed here, Proto-Southern Bantoid (Watters & Leroy, 1989).

## 2 Proposed examples of the sound change

In this section, I begin by providing a canonical example of high vowel fricativization from a pretheoretical perspective. More importantly, I propose several real examples of HVF obtained from examining the literature. Not all attested cases of fricativized vowels have enough evidence to be described as part of a chain shift: Swedish's fricativized vowels are fairly well-known, but the historical and comparative data available is puzzling and inconclusive in a number of ways. There are several further cases where a language group may have sufficient evidence for HVF in the literature, but the data is disorganized; but at the least this includes the Na languages of inland southwestern China (Chris Donlay, p.c.) and possibly two separate language groups in New Guinea, Dani (Bromley, 1981) and the West Lakes Plains languages (Clouse & Clouse, 1993). I am unable to discuss these here but leave open the possibility of further research in these areas.

HVF has been schematized as in Figure 4, with a high vowel developing frication (most often strident, but occasionally not) at an analogous consonantal place of articulation. The data in this section repeatedly also show relatively high mid vowels raising to a higher position in conjunction with HFV. The chronology of these two intracategorical shifts is not fixed, with examples to be illustrated tending to have unclear ordering or ordering that varies across a dialect continuum.

## 2.1 Wu Chinese

The Wu dialects of Chinese are a large dialect continuum spoken around the Yangtze River delta in coastal eastern China, an area encompassing most of Zhejiang Province, the Shanghai Special Administrative Area, and portions of neighboring Jiangsu and Anhui provinces (Qian, 1992). Speakers of all Wu dialects are estimated to number about 77 million (Lewis et al., 2009). There is long-standing consensus that Wu is a proper genetic subunit of the Chinese languages, particularly when considering the dialects in the center of the Wu geographical area (Ballard, 1969; Baron, 1983). However, long-standing contact with the Mandarin dialect group to the north often results in varieties with characteristics of both the Wu and Mandarin dialect areas, to the point where the boundary between the two is often disputed (Simmons, 1999).

The Wu dialects present a number of examples of chain shift, many of which have broad consequences for the phonological organization and phonotactics of these languages. Baron (1983) comprehensively describes a number of back raising chain shifts that generally involve fronting or diphthongization of high back *u at one end of the chain and monophthongization of *au at the other end. In a less-studied case,[2] raising chain shifts operate in the front of the vowel space in conjunction with monophthongization of non-monophthongs and reduction of nasal codas to vowel nasalization, such that a CV syllable template tends to emerge. In particular, the Taihu sub-branch of Wu tends to have monophthongs, often denasalized, as reflexes of Proto-Wu (PWu) diphthongal rhymes with nasal codas. These changes, I will put forward, form part of a fricativizing chain shift that ends in complete fricativization of reconstructible *i and *y for a number of languages in the area. The rearrangements involved in this chain shift are summarized in Figure 6.

[2]The particular chain shift discussed here may in fact completely lack analysis in English-language materials on the topic, and is only briefly alluded to in piecemeal fashion in Chinese-language writings.

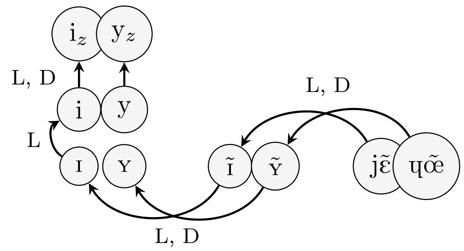


Figure 6: Various parts of the chain shift discussed above; languages undergoing a particular step are identified by initial.

| PWu | | Danyang | Liyang | Taiping | Shanghai |
|---|---|---|---|---|---|
| ***pjen III** | To Change | pɪ$^{324}$ | pi$^{412}$ | piẽ$^{35}$ | pi$^{334}$ |
| ***pi III** | To Close | pi$_z^{324}$ | pi$_z^{412}$ | pi$^{35}$ | pi$^{334}$ |
| ***p'jen III** | Slice | p$^h$ɪ$^{324}$ | p$^h$i$^{412}$ | p$^h$iẽ$^{324}$ | p$^h$i$^{334}$ |
| ***p'i III** | Flatulence | p$^h$i$_z^{324}$ | p$^h$i$_z^{412}$ | p$^h$i$^{324}$ | p$^h$i$^{334}$ |
| ***ɦjen I** | Salt | ɦɪ$^{213}$ | i$^{323}$ | ɦiẽ$^{312}$ | ɦi$^{113}$ |
| ***ɦi I** | To Shift | ɦi$_z^{213}$ | i$_z^{323}$ | ɦi$^{312}$ | ɦi$^{113}$ |
| ***kɥʌn I** | To Donate | tɕʏ$^{22}$ | tɕyʊ$^{445}$ | tɕyœ̃$^{523}$ | tɕyø$^{52}$ ∼ tɕy$^{52}$ |
| ***ky I** | Residence | tɕyz$^{22}$ | tɕyz$^{445}$ | tɕy$^{523}$ | tɕy$^{52}$ |
| ***ʔɥɤn II** | Far | ʏ$^{44}$ | ʔʏʊ$^{445}$ | ɦyœ̃$^{22}$ | ɦyø$^{113}$ ∼ ɦy$^{113}$ |
| ***ʔy II** | Rain | y$_z^{44}$ | ʔy$_z^{445}$ | ɦy$^{22}$ | ɦy$^{113}$ |

Figure 7: Comparative Wu, focusing on the simplified nasal rhymes at issue. Proto-Wu from Ballard (1969), other Wu from Qian (1992). Roman numerals indicate tone classes, and raised apostrophes indicate aspiration. Reconstructions for 'flatulence' and 'salt' are extrapolated from regular correspondences between Qian and Ballard's data.

My account for this sound change draws primarily on data from Danyang and Liyang Wu, two dialects spoken in the northern part of the Taihu Wu-speaking area that are not spoken in geographically contiguous areas but are clearly closely related. A number of lexemes are provided in Figure 7 that show the general pattern that Li et al. (1995) comments upon explicitly: rounded and unrounded front diphthongal mid rhymes (which Ballard (1969) reconstructs as *-ɥɤn and *-jen, respectively) are reflected in a number of innovative daughter languages as high or nearly high oral monophthongs. The resulting rhymes are today typically transcribed as denasalized [i] and [y], although one dialect, Wanghao, appears to exhibit sporadic nasalization of a monophthongal /i/, e.g. [i] ∼ [ĩ].[3]

At the same time, high front monophthongal rhymes that Ballard reconstructs as *y and *i develop into rhymes given by Qian (1992) as /i$_z$/ and /y$_z$/, both "accompanied by a [z] sound" (12). The precise identity of /i$_z$/ and /y$_z$/ may be subject to some debate, but I find compelling evidence for identifying them with fricativized high vowels of the sort described above. First, numerous descriptions of similarly spirantized vowels exist for closely related languages, for instance Zhenhai and Shanghai Wu (Zhu, 2006). Secondly, and a good deal more concretely, I have had the opportunity to elicit lexical forms from a speaker of a

[3]Observations on Nantong are from my own collected data.

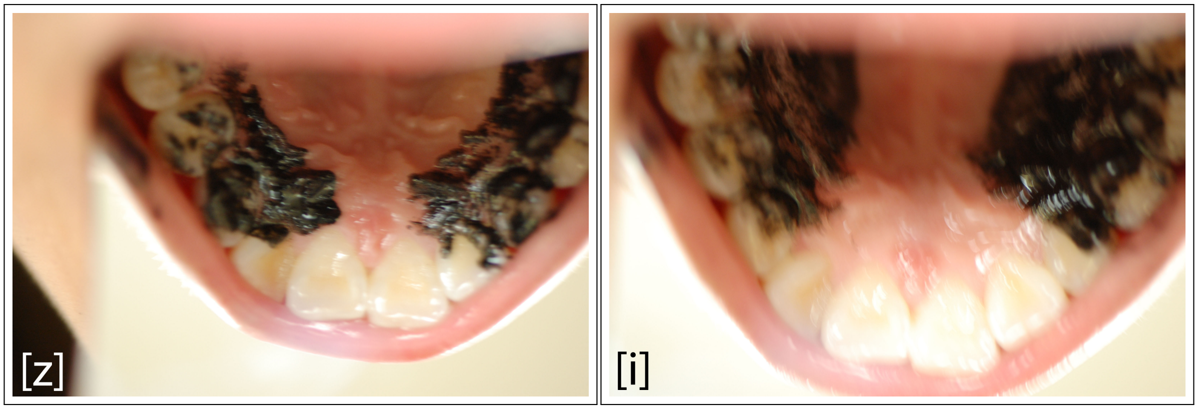


Figure 8: Palatograms of the fricativized and non-fricativized front (high) vowels in Nantong. Left: fricativized [z̩] as elicited in [pz̩] 'competition, race'. Right: slightly nasalized [ĩ] as elicited in [pĩ] 'change'. Images from own data collection.

Wu dialect (Nantong) from the same dialect area as Danyang and Liyang; without much of a question, the relevant lexemes are produced with strident frication as predicted. A palatogram from the unrounded vowel is contrasted with a palatogram of a high front vowel /i/ in Figure (8).

Unlike the back vowel shifts inventoried in Baron (1983), where there is some evidence that *u moved first, initiating a pull chain,[4] these are of unclear chronology, and there is some difficulty in dating the loss of vowel nasalization in nasalized rhymes. A Wu dialect's propensity towards fricativization of some of its rhymes is not randomly determined, and HVF overwhelmingly appears in the appropriate lexemes when the language in question has monophthongized and raised its *-ɥɤn and *-jen rhymes. This seems to suggest an ordering whereby the raising of some rhymes is a necessary precondition for the fricativization of other rhymes, and this in turn suggests an order whereby the former must precede the latter.

On the other hand, the propensity of a Wu dialect towards HVF does *not* appear to depend on its *denasalization* of the relevant rhymes, suggesting that change in these rhymes may have proceeded more or less independently of vowel fricativization. In the Nantong and Jintan varieties, the relevant rhymes are always raised, but not consistently denasalized. The rhymes in question are produced variably as [i] ∼ [ĩ] and [y] ∼ [ỹ] in Nantong, and Qian (1992) gives the Jintan equivalents as [ĩ] and [yʊ̃]. In the case of Nantong we might speculate that nasalization is no longer a major cue to these categories but still participates at some reduced level, although it is not clear how this extends to Jintan. Examination of the comparative data in Qian (1992) shows that there are no Wu dialects listed that fricativize *y and *i but *do not* raise their *-ɥɤn and *-jen rhymes. While the chain shift in question may prove to have other systemic motivations that are not obvious here, it appears clear, at least, that vowel fricativization and rhyme monophthongization are often connected in a way that may suggest the account proposed in Section 3.2.

[4]In many cases, a canonical Pattern III type (Labov, 1994).

## 2.2 Northwestern Mandarin Chinese

The Mandarin dialects of Chinese are spoken by some 847 million speakers (Lewis et al., 2009) throughout China and numerous other countries. One must distinguish between the Mandarin dialects as a whole, Standard Mandarin, and Beijing Mandarin: the generic label "Mandarin" refers to the dialect continuum spoken across most of China from its original northeastern area to Gansu province in the northwest and Sichuan and Yunnan provinces in the southwest. Standard Mandarin is a particular, if widely spoken, variety that is promulgated as the standard by the People's Republic of China, which is largely based on Beijing Mandarin, the particular dialect spoken around that city.

One set of fricativized vowels is shared by all Mandarin (and Wu) dialects: high front vowels have historically assimilated to a preceding strident initial consonant, which may be reflected as a fricative or an affricate. Standard Mandarin presents a neat example of the results of this change, whereby /i/ is in complementary distribution with a set of spirantized, voiced fricative segments that match alveolar and retroflex onsets for place of articulation (Duanmu, 2000).[5] While this vowel fricativization is clearly demarcated in its operation by segmental context, the examples discussed so far are "context-free" changes involving the fricativization of an entire high vowel category regardless of segmental context. Occasionally, raising chain shifts in northwestern dialects of Mandarin cause mergers with the non-spirantized allomorph, e.g. /i/, which frequently results in the spirantized variant gaining phonemic status due to the generation of new contrasts in the environments that formerly predictably conditioned vowel spirantization.

Northwestern dialects of Mandarin have fricativized vowels that largely appear to be generated as allophones in the same way Standard Mandarin's fricativized vowels, but close examination shows that an additional chain shift has generated fricativized vowels in other contexts. This combination of fricativization sources can be seen in (Zhang & Zhu, 1987), where a combination of syntagmatic (from neighboring consonants) and paradigmatic (from other vowels) pressures appear to act on the reconstructible set of front high vowels and diphthongs. As can be seen based on phonological correspondences with Standard Mandarin (Figure 9), Xining Mandarin exhibits a few minor innovations that Mandarin does not in terms of fricativization, namely the affrication of some initials preceding /i/ (Fig. 9b) and the spirantization of the high front rounded vowel /y/ when preceded by fricative or affricate initials (Fig. 9e). The right portion of Figure 9 displays these assimilations as arrows pointing to the right and left, with occur in the contexts of particular consonants

Lexemes (13f–13j) are illustrative of the major difference between Xining and Standard Mandarin: arguably, the falling diphthong *ie monophthongizes and raises, taking part in a chain shift *ie → *i → z̩.

[5]A large number of other examples of this sort can be found in Dell (1994).

| | PMnd | | Xining | Standard |
|---|---|---|---|---|
| a. | ***tsi** | Purple | tsz$^{53}$ | tsz$^{213}$ |
| b. | ***ti** | Low | tsz$^{53}$ | ti$^{55}$ |
| c. | ***tʂi** | To Know | tʂʐ̩$^{44}$ | tʂʐ̩$^{55}$ |
| d. | ***tɕi** | To Remember | tɕʑ$^{213}$ | tɕi$^{51}$ |
| e. | ***tɕʰy** | To Go | tɕʰʑʷ$^{213}$ | tɕʰy$^{51}$ |
| f. | ***pi** | Pen | pʑ$^{44}$ | pi$^{55}$ |
| g. | ***i** | Clothing | ʑ$^{44}$ | i$^{55}$ |
| h. | ***tɕie** | To Cut | **tɕʰi$^{44}$** | tɕʰiɛ$^{51}$ |
| i. | ***tie** | To Stick | **tʰi$^{44}$** | tʰiɛ$^{55}$ |
| j. | ***ie** | Night | **i$^{24}$** | iɛ$^{51}$ |

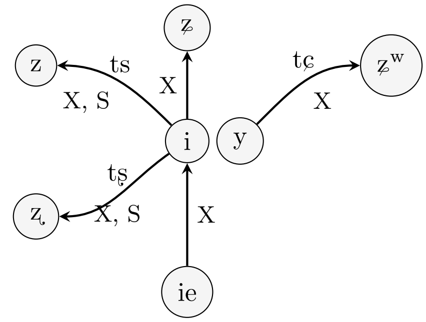


Figure 9: Sound changes affecting Standard Mandarin (S) and Xining Mandarin (X), with the latter undergoing an additional chain shift *ie → *i → ʑ(vertical lines). Note that the other assimilation patterns (non-vertical lines) are largely shared between both, with the exception of /y/ spirantization.

The result in Xining is a vowel system where a newly created phoneme /ʑ/ contrasts with /i/ in a limited set of environments, namely following palatal affricatives and fricatives, as well as bilabial and zero initials.[6] Note that no other series of onset segments (velar, alveolar, etc.) are actually permitted preceding high front vowels in Xining.

## 2.3 Detailed case study: languages of the northern Grassfields

In §2 above, I have illustrated the typological domain of fricativizing chain shift with data compiled from several distinct linguistic-genetic lineages and application of shallow phonological reconstructions. I have benefited in this effort from a thorough dialectological literature for several distinct subgroups of Chinese. It also goes without saying that at least some historical reconstruction and research into subgrouping has been carried out on each of these families, which greatly aids in finding the relevant chain shift patterns.

This section attempts to add to this set of attested fricativizing chain shifts. The primary argument below, that high vowel fricativization (HVF) as part of a spirantizing chain shift has spread among numerous Southern Bantoid languages of the northern Grassfields, is necessarily more laborious than for the relatively brief discussions in §2. Although a great deal of phonological reconstruction has been done for Proto-Bantu, Grassfields Bantu is not a member of this group but rather a close relative. As such, the developments discussed below in Sections 2.3.1–2.3.6 are built up from new intermediate reconstructions based on assorted documentary sources from the past several decades, including recent fieldwork of my own on the Ring languages. The available data converge on several related findings:

(1) a. Languages in multiple unrelated subgroups within Grassfields Bantu (GB) exhibit high vowel fricativization.

[6] It is also possible that the fricativized vowel sounds [z ʑ̩ ʐ̩] are simply treated as allophones of a single phoneme, based on their similarity and complementary distribution.

b. GB languages with high vowel fricativization also exhibit mid vowel raising.

c. GB languages with HVF are an innovative minority in this respect within their subgroups.

d. GB languages with HVF are from several subgroups but are geographically contiguous.[7]

The recurrent patterns in (1) taken together suggest that language contact within Southern Bantoid—and specifically between Grassfields Bantu and non-Grassfields Bantu languages—is the root cause of the present-day distribution of HVF in the area. Understanding the particulars of the sound change, including its geographical distribution and the patterns of diffusion that lead to this distribution, provides an especially detailed confirmation of the above paths of sound change and additionally provides a case study of its surprisingly robust diffusion among languages.[8]

### 2.3.1 Grassfields overview

The geographical area known as the Grassfields is centered in the West and North West Provinces of Cameroon. It is best defined geographically by the edges of the Western High Plateau, which is notable for its numerous mountainous areas and inactive volcanoes (Gwanfogbe & Azobi, 1990). Perhaps due in part to this geography, it is a linguistic accretion zone in the sense of Nichols (1997), given that languages from outside the area tend to move in over time without entirely displacing the existing languages. This gradual accretion has led to extreme diversity in parts of the Grassfields—although not "lineage diversity", as Good et al. (2011) notes, since nearly all languages contained therein are known to be Grassfields Bantu. Given the overwhelming prevalence of multilingualism throughout the area, this has led to an especially tangled linguistic history for most languages spoken in the area (Warnier, 1979; Di Carlo & Good, 2012).

The geographic and linguistic region described above lends its name to a linguistic family, Grassfields Bantu (GB). GB languages happen to occupy most of the physical area of the Grassfields (Fig. 10) and can be defined as a subgroup with great confidence; they are thought to be a close relation to Narrow Bantu proper (Piron, 1995; Schadeberg, 2003), which is spoken to the south and further on into most of the rest of sub-Saharan Africa. Internal classifications of Southern Bantoid and its close relatives tend to vary from researcher to researcher, as can be seen in Figures 11–12, but generally converge on a structure by which Grassfields Bantu is a member of a subgroup coordinate with Bantu proper.[9]

[7]This is limited to the northern Grassfields area: other Bantoid languages have HVS but are spoken some distance away. These are briefly discussed in §4.3.

[8]Note that several papers in the Chinese-language literature have brought up the idea of contact-induced high vowel fricativization in Mongolic and Tibetan languages. Again, however, Standard Mandarin (or, in this case, contact with it) dominates the literature; my intent is to provide an additional case involving languages not demonstrably related to Sinitic languages.

[9]More recent phylogenetic studies have suggested some major revisions to the tree diagrams in Figures (11–12), most notably the grouping of Jarawan with Bantu A40, A60, and A31 (Mbam-Bubi). The latter adjustment is not represented in either of the classificatory schemes given here, but further information can be found in Blench (2006) or Grollemund (2011).

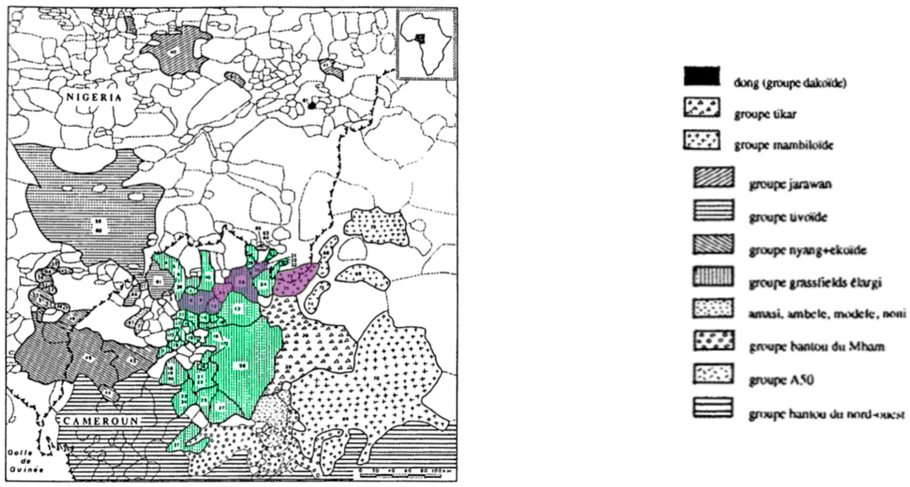


Figure 10: The Grassfields Bantu languages in Cameroon, centered over the Grassfields region. Genetically Grassfields Bantu languages are in striped green; the specific languages under discussion (including several non-Grassfields Bantu languages) are shown in purple. Map modified from Piron (1995).

Not all languages of the Grassfields area are GB languages; there are a number of more distantly related Bantoid languages that have entered into the linguistic area or reside on the edge of it. These groups include the Eastern Beboid and Mambiloid languages, speakers of which seem to have migrated in from points further north (Richards, 1991; Connell, 2007; Good et al., 2011). All are genetically within Southern Bantoid, with two of the groups to be discussed—Ring and Limbum-Mfumte—within Grassfields Bantu more specifically. The other two groups, Eastern Beboid and Mambiloid, are thought to be coordinate branches of Southern Bantoid, more distantly but still ultimately related to the Grassfields Bantu languages.

### 2.3.2 The northern Grassfields chain shift

Throughout the northern part of the Grassfields, an apparent chain shift causes a reconstructible seven-vowel system to collapse into a different seven-vowel system with only five cardinal vowels and two spirantized vowels (Fig. 13).[10] This relates interestingly to Schadeberg (1994)'s account of the *7-to-5* sound change in the vowel space of Narrow Bantu languages, in which a seven-vowel system similar to Figure 13a changes to one similar to Figure 13b, but crucially lacking the fricativized vowels. For the time being, it is sufficient to note that the consonantal spirantization effects that Schadeberg discusses for Narrow Bantu may be attributed to, and possibly better explained by, the influence of fricativized vowels.

The description of the northern Grassfields chain shift below has its limitations. In this region, HVF is more robustly attested for the back rounded vowels—which ultimately tend to become an unrounded high

[10]Note that in (13), vowels are given as centralized high vowels given their probable tongue position, but they could just as well be removed from the vowel chart entirely given that they might no longer contrast with non-spirantized vowels in the same $n$-dimensional space. See the earlier Figure 4, in which this is done.

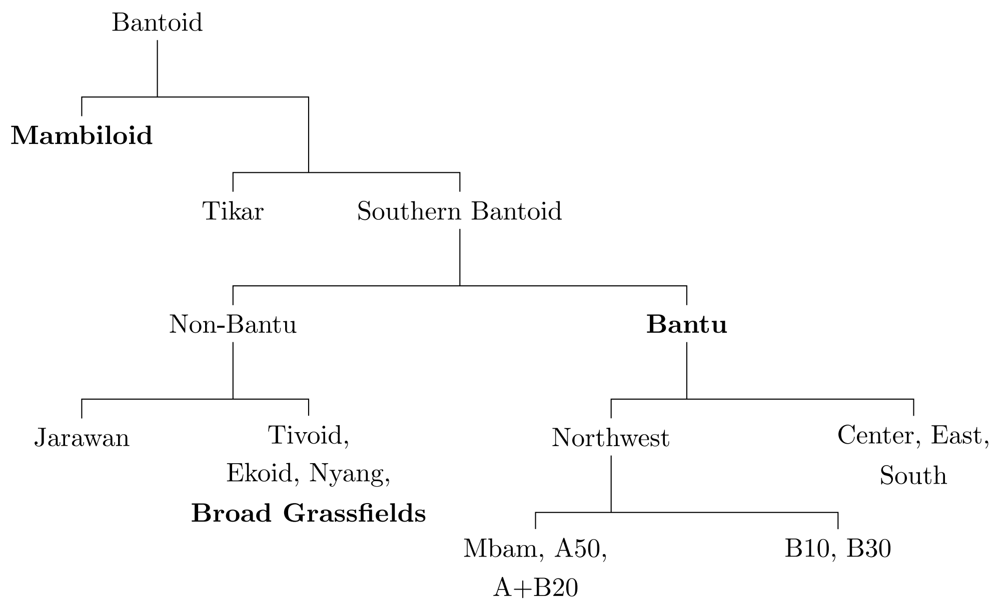


Figure 11: Lexicostatistical classification of Southern Bantoid and other related groups, adapted from Piron (1995, 5).

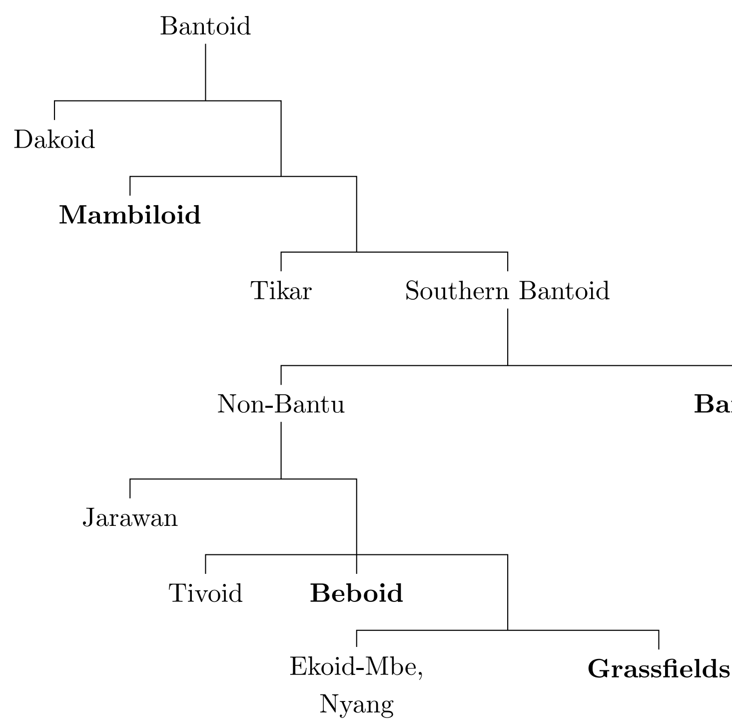


Figure 12: Classification of Southern Bantoid and other related groups, adapted from Schadeberg (2003).

vowel with some accompanying labiodental frication (e.g. [v͡ɯ], [və̰])—and less so for the front unrounded vowels, primarily due to a lack of a clear signal one way or the other in the available lexical material.[11] The former will be the focus of analysis here and the latter are likely to be included in analysis if more reliable data becomes available. Below, I progress from sugroup to subgroup to describe the chain shift as it unfolds in each.


a. *7-vowel system    b. '5+'-vowel system

Figure 13: The reconstructible Proto-Grassfields vowel system, with a three-way non-low height contrast (a), undergoes change to the two-non-low-height system seen primarily in the Ring and Limbum-Mfumte languages (b).

### 2.3.3 Ring

The first subgroup to be considered, and one of the more important for the argument at hand given the relatively good quality of data for a broad number of languages, is the Ring group. Ring is a subgroup of Grassfields Bantu spoken at the northern end of the area, usually said to be part of a broader "Western Grassfields" group (Hyman, 1980). Ring is divisible into four subgroups, of which we are concerned with two: the Central Ring languages, discussed first below, and the Western Ring languages, discussed subsequently.

(2) ***o in open syllables**

| | **Babanki** | **Kom** | **Oku** | **Bum** | **Mmen** |
|---|---|---|---|---|---|
| ***-o** | -u | -u | -ɔɔ | -o | -o |
| ***ɣo** Hand | kə̀-vú` | ā-wú` | kə̄-wɔ̂ɔ | ā-wô | ā-ɣó` |
| ***mo** Water | mú | ə̄-mû ˚ | m̄-mɔ̂ɔ ˚ | m̄-mô ˚ | m̄-mô ˚ |
| ***lo** To Leave | ə́-lù | lù | lɔ̀ɔ | lò | ndò |
| ***so** To Stab | sŭ | sù | sɔ̀ɔ | sò | sò |

[11] In particular, I have found that at least one split occurs for pre-Kom *i, which variably has its reflex as present-day /ɯ/ or /z̩/.

(3) ***ʊ in open syllables**

| | Babanki | Kom | Oku | Bum | Mmen |
|---|---|---|---|---|---|
| ***-ʊ** | -ʉ | -u | -uu | -o | -u |
| ***tʊ** Head | kə̀-tʉ́` | ā-tú` | kə̄-tûu | ā-tô | ā-tú` |
| ***sʊ** To Wash | ʃʉ̆ | sù | sùu | sò | ʃù |
| ***lʊ** Honey | ə̀-lʉ̀ | ə̄-lû | ndûu | ū-lô | ī-ndû |

(4) ***u in open syllables**

| | Babanki | Kom | Oku | Bum | Mmen |
|---|---|---|---|---|---|
| ***-u** | -ʉ | -v | -(v)əə | -u | -u / -ɯ |
| ***gu** Hen | m̀-bvʉ́` | ə̄-ŋgv̄ | ŋ̄-gvə̄ə ˚ | ā-ŋgʷû | ə̄-mbvū |
| ***su** Fish | ʃʉ̀ ˚ | ə̄-ʃv̂ ˚ | sə̄ə | — | ə̄-sɯ̆ ˚ |
| ***yu** To Rest | ʒʉ̀-tə́ | ʒv̀-tə̀ | zə̀ə-tè | yù-tì | zɯ̀-tə̀ |
| ***ɲu** To Drink | ɲʉ́ | ɲv̄ | ɲə̄ə ˚ | ɲū ˚ | m̄ |
| ***fu** Leaf | ə̀-fʉ́` | ī-fv̂ ˚ | ī-fúu | ī-fû ˚ | ī-fô ˚ |
| ***bu** Ashes | kə̀-bʉ́` | ā-bź` | — | ū-bvû | ə̄-pfó-ʧī |

As can be seen in (2–4), Kom and Oku have raised back vowels relative to their neighbors', with Babanki tending to raise further than most—Kom and Oku each raise *ʊ to /u/. Babanki, in a different development entirely, raises *o to /u/ and centralizes *ʊ and *u to its /ʉ/. This resembles a more common Pattern III chain shift (Labov, 1994)—centralization of the highest vowel in a raising chain is a frequently observed occurrence.

Rather than engage in the Pattern III shift seen nearby, fronting *u, Kom and Oku undergo high vowel fricativization for both *u and *i. In Kom, this is fairly straightfoward: the reflexes of *u and *i are most often, respectively, syllabic voiced fricatives often produced with a slight frication-free centralized offglide, z̩ and v̩. Oku's having undergone HVF is considerably less obvious, given that it has only affected one vowel *u, and the reflex of this vowel is a central and lowered vowel /ə/. However, this vowel is analyzed in (Davis, 1992, 78–84) as "affricat[ing]" or spirantizing most initial consonants (5).

(5) **Oku /ə/-conditioned C- spirantization and affrication**

a. /wə/ → [və]

b. /jə/ → [ʒə]

c. /βə/ → [βvə] (?)

d. /kə/, /gə/, /ɣə/ → [kfə], [gvə], [ɣvə]

e. /tə/, /də/ → [tsə], [dzə] ∼ [tə], [də]

This unusual pattern of initial consonant affrication and spirantization happens to resemble, on the one hand, the "breaking" that is present in Kom in free variation with fully syllabic fricatives, although phonologized as the norm. I argue that Oku exhibited an intermediate *v, similar to and mostly cognate to Kom's labiodentalized vowel /v̩/, which then "diphthongized" into *və. Subsequent cluster simplification likely led to the Oku phenomena noted in (5). To summarize, I map out the sound changes shown above in Figure 14.

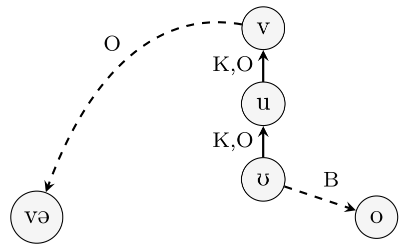


Figure 14: Summary of sound changes within the chain shift posited for Central Ring.

In the related Western Ring subgroup, which is not directly adjacent to Kom and Oku geographically, there are traces of HVF that appears to have operated along the same lines as in Oku. Unlike in Oku, however, HVF appears to have resulted in the imposition of fixed co-occurrence restraints on the reflexes of the fricativized vowels.

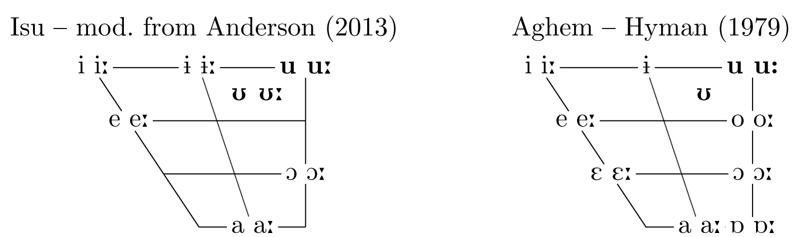


Figure 15: Western Ring vowel inventories with the two high back vowels at issue bolded. The high central/lax vowels Isu and Aghem are obligatorily preceded by fricative or affricate segments and in Isu are typically fricatiivzed themselves.

On the one hand, there are passing observations in descriptive sketches that strongly suggest vowel spirantization as a *conservative* feature in at least two West Ring languages, Isu and Aghem. In Isu, Anderson (2013) notes, older speakers have a centralized vowel phoneme that is often realized with "very heavy friction" (13), which is left unspecified in the sketch but has been clarified to me as labiodental or [v]-like (Anderson, p.c.). When not fricated the backness and height of this vowel is such that it is realized as [ʊ]; this is interpreted in Anderson (2013) as a second high back vowel phoneme in contrast with /u/, which is never realized with turbulent airflow. Parallels to this set of observations are apparent in nearby Aghem (Fig. 15), where there are two corresponding phonemes given in Hyman (1979) as /ʉ/ and /u/. Hyman (p.c.) clarifies that the usual realization of the former is [ʊ], and that no frication is observed in this vowel.

Moving beyond surface detail, there are also compelling phonotactic and systematic similarities between the West Ring high back vowels and the Central Ring high back vowels, especially those of Oku (6). In both Isu (Anderson, 2013, 12) and Aghem (Hyman, 1979, 6), the vowels /ʊ/ (or /ʉ/), which correspond regularly, only occur in lexemes that have initials from the subset of consonants /f v pf bv s z ts dz/, all of which involve frication. Oku, by way of comparison, has place-conditioned "labiodentalization" of initial consonants before a centralized vowel /ə/. This suggests that high vowel fricativization (HVF) has actually operated in Aghem and Isu prior to the cited documentary work, and that the consonant spirantization and vowel centralization seen in West Ring and Oku are reflexes of the same HVF.

In spite of the wide spread of HVF within Ring, which includes the Central and West subgroups and most of Ring's internal diversification, it is not reconstructible to the entire Ring group. The deciding point is that although numerous languages do undergo HVF, a plurality in each subgroup do not. In Central Ring, we have seen that Babanki, Mmen, and Bum fail to undergo HVF. In Western Ring, likewise, while Isu and Aghem appear to show aftereffects of HVF—in Isu's case, some of the appropriate high vowels are even still fricativized—the remainder of the documented languages in the subgroup (Bu, Weh, Zhoa, etc.) do not appear to exhibit similar effects. As such HVF appears to be a local innovation peculiar to a set of the Ring languages rather than the whole group.

(6) **Comparing Western and Central Ring first-degree vowels**

| | Aghem – ʉ | Isu – ʊ, u | Oku – (v)ə, uo | Kom – v̩ | PCR – *u |
|---|---|---|---|---|---|
| Chicken | mbvʉ́ | mbvʊ̀ | ŋgvəə | ŋgv | *-gu |
| Death | é-vʉ́ | vːʊ | ɛy-kuo | ə-kv | *-kuo |
| Cloth | ndzʉ́ | ndzʊ́ | ndəy | ndz | *-d(u)i |
| Lake | é-ɲʉ̂ | í-ŋû | — | ə-lv | *-lui |
| Oil | ń-vʉ́ | mə̀-mbvʊ̀ | əm-gvəl | mə-vl | *-wul |
| To Chew | é-pfʉ́ | í-fú | — | kvl | *kul |

### 2.3.4 Limbum-Mfumte

High vowel fricativization is also seen to be a recent innovation in a nearby subgrouping of the Grassfields Bantu languages which I refer to here as "Limbum-Mfumte" after the two numerically dominant languages of the group.[12] Limbum-Mfumte is a member not of Ring but of the larger Eastern Grassfields group, with two major linguistic zones, one broadly to the south of the Ring area and one to its east (Elias et al., 1984).

[12]This is after Elias (1980)'s term for the subgroup; a more widely circulated publication, Elias et al. (1984), uses the term "Northern Mbam-Nkam". The term "Mbam-Nkam" is generally now dispreferred and "Eastern Grassfields" used, as in this paper.

The latter zone contains the Limbum-Mfumte languages, which are separated from the remainder of Eastern Grassfields along a large number of isoglosses, including several distinctive lexical innovations (e.g. "rope" and "water") (Elias et al., 1984, 72–3). In this section I show that the PGB first-degree vowels develop HVF in areas *directly adjacent* to HVF-having languages in the Central Ring group, suggesting contact-induced spread of HVF. This differs strikingly from the more typical development of first-degree vowels in Eastern Grassfields, most often called *aspiration* (Hyman, 1972; Nissim, 1981; Bird, 1999), in which a period of voiceless noise precedes a fully voiced, turbulence-free high vowel, usually in the Bamileke languages well to the south of the Ring group and Limbum-Mfumte.

Comparative data is, fortunately, available for this group, and proves to be fairly comprehensive, in particular a comparative list that has been circulated in manuscript form (Elias, 1980). Several hundred lexical items are given for five languages, most of them forming complete cognate sets. I focus on only three of the languages with available data that have the most regular transcription: Mbat, Adere, and Limbum. Particular emphasis is placed on Limbum, the lone language in the group that exhibits high vowel fricativization.

Elias (1980) reconstructs two back vowels for Proto-Limbum-Mfumte (henceforth PLM), *o and *u. I present his reconstructions, along with cognate lexical items representative of the correspondence sets involved, in Figure 16. It is clear that there is one major discrepancy between Elias' reconstructions and the attested correspondence sets: where Elias reconstructs a single category *u there are in fact two major correspondence sets which can be seen in Figure 16, Set 2 and Set 3. All three languages seen below have distinct vowels between correspondence sets 2 and 3, with the exception of Mbat having [ə] in both sets if the vowel in question is in a closed syllable. Furthermore, no factors that might condition a split in all three languages are obviously present. Thus, for Sets 2 and 3, I propose to reconstruct two vowels *ʊ and *u, respectively.

I propose, in line with most other Grassfields Bantu languages (as well as the consensus reconstruction for Proto-Bantu), that PLM more likely possessed three non-low vowel heights and thus a symmetrical seven-vowel system *i *ɪ *e *a *o *ʊ *u . This provides us with an additional set of reconstructible units (17) that lines up with the extra correspondence set in Elias' data. This is a significant departure from Elias (1980), who reconstructs a five-vowel system **i *e *a *o *u*.

Crucially, the third set proposed in (17) exhibits HVF in Limbum ( **u* → /v̩/). Limbum has additionally been the subject of at least two further phonological analyses (Fiore, 1987; Fransen, 1995), the former of which goes into considerable detail. The nature of the Limbum segment /v̩/ could well be called into question given its variable representaton in these sources: Fiore represents the phoneme as /ɨ/, and Fransen follows suit, transcribing the phoneme's usual realization as [vɨ], including a vowel. However, both Fransen

| PLM *o<br>Set 1 | | Mbat<br>o | Limbum<br>ɔ | Adere<br>o |
|---|---|---|---|---|
| ***-bo** | Hand | -bo | -bɔ | -bo |
| ***-nto** | Rooster | -nto | -ntɔ | --- |
| ***-bok** | Pumpkin | m-boʔ | ɾ-bɔʔ | li-bok |
| ***-ton** | Intestines | n-ton | -tɔ | -to |
| PLM *ʊ<br>Set 2 | | Mbat<br>u, ə / __C | Limbum<br>uu | Adere<br>o |
| ***-tu** | Head | -tu | -tuu | -to |
| ***-cu** | Mouth | -tsu | -ʃuu | -tso |
| ***-kun** | Beard | ŋ-k͡pən | m-kuu | fiŋ-kon |
| ***-tum** | Message | n-təm | n-tuu | n-tom |
| PLM *u<br>Set 3 | | Mbat<br>ɨ, ə / __C | Limbum<br>v̩ | Adere<br>u |
| ***-bu** | Ashes | -vɨ | -bv̩ | -bu |
| ***-gud** | Oil | m-vəɾ | m-gv̩ɾ | muŋ-gut |
| ***-tuk** | Night | — | -ʧv̩ʔ | -tuk |
| ***-gun** | Cadaver | m-vən | -gv̩ | -gun |

Figure 16: Selected correspondence sets for Proto Limbum-Mfumte, adapted from (Elias, 1980). I propose that sets 2 and 3 be reconstructed as *ʊ, *u, respectively. Note that Mbat reflexes differ in open and closed syllables.

| | | Mbat | Limbum | Adere |
|---|---|---|---|---|
| Set 1 | *o | o | ɔ | o |
| Set 2 | *ʊ | u, ə / _C | uu | o |
| Set 3 | *u | ɨ, ə / _C | v̩ | u |

Figure 17: Revised correspondence sets for Proto Limbum-Mfumte.

and Fiore concede that the segment tends to be mostly fricative over its duration, “especially in closed syllables” (Fransen, 1995, 35), and other more limited descriptions of the language assume syllabic /v/ (Van Reenen & Voorhoeve, 1980). Available audio recordings (courtesy of Larry Hyman) and my own limited fieldwork on Limbum also confirm that, for at least the speakers recorded, the realization is essentially entirely fricativized.[13]

In sum, Limbum appears to be an innovative minority in Eastern in having HVF. The presence of this feature alone, of course, does not suggest that HVF is a change that can be attributed to contact alone. Rather, the most convincing evidence comes in the form of Fiore (1987)’s discussion of Limbum dialect geography. Here, we see that some dialects of Limbum lack HVF (Figure 18): the closer the dialect of Limbum to the Ring languages or Noni (a Beboid language discussed below), the more prominent the labiodental frication on its /u/ phoneme (Fiore, 1987, 33–5). That is, only the southern Ndu dialect is seen to exhibit completely regular fricativization of its /u/ phoneme, and the northern dialect spoken at Chup has a more or less cardinal [u] for the same.[14] This aligns well with speaker intuitions on outside influence

[13]Further examination of these recordings is pending; it should also be noted that the coronal fricativized vowel is also a syllabic fricative [z] in Fiore (1987)’s data, but not for my own consultant, who regularly produces [i] for PLM *i.

[14]While the discussion of HVF here mostly bears on the back rounded vowels, it also happens that the front vowels undergo

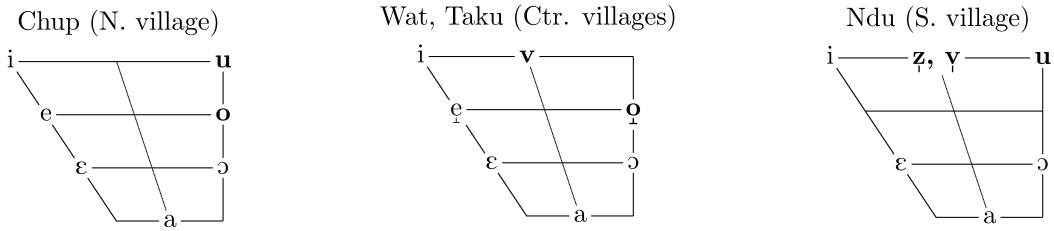


Figure 18: Back vowel centralization and fricativization in dialects of Limbum varies directly with distance from Ring and Noni (to the south). Vowel inventories from Fiore (1987, 35).

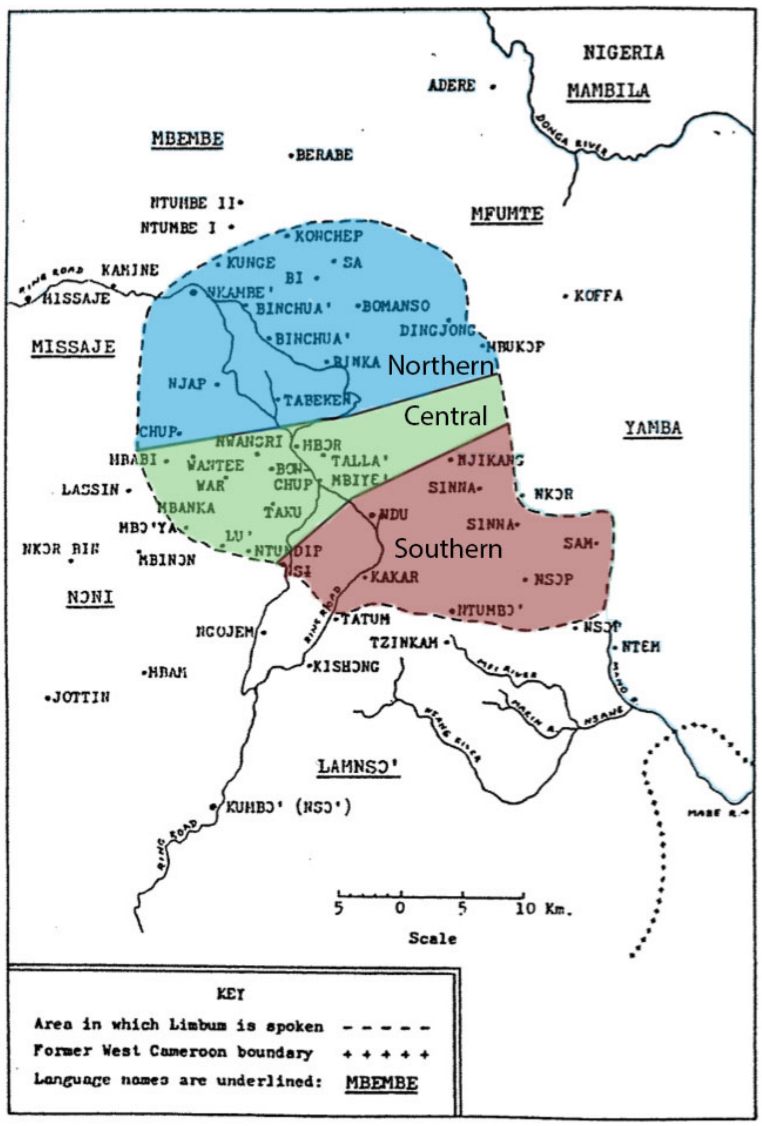


Figure 19: Map of the Limbum-speaking area, modified from Fransen (1995). The southern dialects (red), at bottom, are the most fricativized.

on the Limbum language, as the northern dialect zone's cardinal [u] is thought to be "a foreign element or oddity" due to influence from the Mfumte language spoken to the north (Fiore, 1987, 35); Mfumte is not known to have undergone HVF. All together, the dialectal evidence suggests that different dialect zones, in contact with different neighboring languages to varying degrees, have gained HVF in corresponding degrees.

Both within Eastern Grassfields and the Limbum-Mfumte group more specifically, HVF is unusual and confined to the Limbum-Mfumte languages located closest to the Ring languages and Noni. This is especially unusual given the presence of a radically different development in the high vowels of other languages within Eastern Grassfields: the Bamileke languages, spoken in a more southern zone well separated from the Limbum-Mfumte languages, often exhibit "aspiration" preceding high vowels in open syllables. The effect is that of sandwiching a brief period of *voiceless* frication between the initial consonant and its following vowel, often but not always matching the consonant or vowel for place of articulation (Anderson, 2013; Bird, 1999). HVF differs markedly from this development in that the vowels are consistently voiced and have frication with a definite place that does not vary with respect to adjacent segments (see the discussion of the Ring languages, above).

#### 2.3.5 Eastern Beboid

A similar distribution of HVF can be found in the nearby Eastern Beboid group. Of the several languages for which material is readily available, only the two spoken furthest south—closest to the Ring languages and Limbum—have spirantized high vowels, in patterns analogous to these languages. A significant difference is present, however, in that the Eastern Beboid languages belong to the larger Beboid branch of Southern Bantoid, and despite their proximity to the Grassfields region they are not thought to be Grassfields Bantu languages in a genetic sense (Piron, 1995). Given this arrangement, there is much less of a possibility of high vowel fricativization arising in this group by common descent from an ancestor shared with the other Grassfields Bantu languages, leaving contact as a more likely explanation.

Available materials do not provide much lexical material for most Eastern Beboid languages, and in fact I opt not to do a comprehensive reconstruction for this group at the time being. The primary reliable sources in this area are Hyman (1981), a broad descriptive overview of Noni, the southernmost Eastern Beboid language, and Richards (1991), a phonological description of three Beboid languages, providing information on Noni and two others (Ncanti and Sali). Beyond these three languages, unfortunately, little in the way of comprehensive description exists, and the little material available suggests that the other Eastern Beboid languages are phonologically divergent from the three with more material (Boutwell, 2011; Cox, 2005). The latter data points are fragmentary and are only discussed here with considerable skepticism.

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an analogous change in Limbum, also exactingly reported by Fiore (1987), with the same geographical extent (33–4).

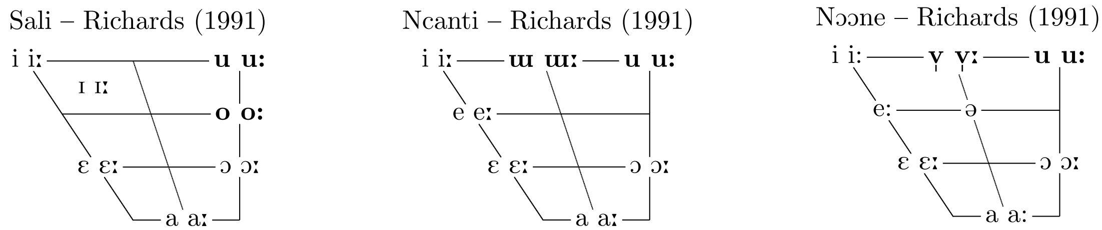


Figure 20: Vowel inventories of three Eastern Beboid languages. Note lack of fricativization and centralization in Sali, the northernmost language among the three.

Despite a patchy record of evidence, the sum of available data suggests that at least Noni and Mungong, a dialect of Ncanti, have realizations of a high back vowel with significant labiodental frication. In the various authors' analyses, this is usually analyzed as a fricativized realization of some phoneme /u/. Figure 20 shows the comparative inventories of several Eastern Beboid languages, in which it can be seen that Noni, as described by both Hyman (1981) and Richards (1991), has a labiodentalized realization for this phoneme: Hyman represents this orthographically as *vu* or *fu*, the latter if the preceding consonant is voiceless, while Richards represents this as [v͡ɯ] in his transcription. Boutwell (2011) briefly notes that Cung, another Beboid lect, also has fricativization and centralization of its /u/ that it and also states that other dialects of Ncanti have the same fricativization and centralization. This was not reported in Richards (1991), possibly suggesting that fricativization has emerged in the past 20 years as an innovative feature more generally in Ncanti, or that [ɯ] as a reflex of *u in Richards' Ncanti is in fact due to an intermediate stage involving labiodental fricativization, much as appears to have occurred in Oku in the Ring group.

Lacking fricativization still appears to be conservative, however, since Kemezung (Cox, 2005) and Sali (Richards, 1991) are both described as having no fricativization of /u/. The languages at issue also happen to be geographically contiguous and located immediately north of the Ring languages; much of the phonological remodeling seen in Noni and to some extent Ncanti could be attributed to Ring influence. Noni in particular bears the mark of strong and persistent contact with the Ring languages in particular: Hyman (1981, 15–16) observes that Noni appears to have borrowed demonstrative pronouns from Oku or Kom, both of which are Central Ring languages spoken immediately nearby, and repurposed them as logophoric pronouns.

### 2.3.6 Mambiloid

A third apparent case of contact-based spread of /u/ fricativization is seen in the Mambiloid languages, which are located decidedly outside of the genetic unit of Grassfields Bantu (see Figures 11–12). The Mambiloid languages are not extensively documented, with the only comparative data for the group taking the form of a short comparative list (Bruce Connell, p.c.). This list and existing description of Len Mambila (Connell, 2007), however, make it clear that Len Mambila has two fricativized vowels, approximately [ʒ] and [v], which contrast with more typical [i] and [u]. Len is the closest of the Mambiloid languages to the Grassfields area, nearly abutting the Limbum-Mfumte group; the other Mambiloid languages are spoken either further east within Cameroon or across the Nigerian border. As such, contact is also a likely source of HVF in Len.

Despite the surface similarity between Len's vowels and the vowels of nearby Grassfields languages, there are also noticeable differences in phonological analysis and lexical distribution that merit further discussion. First, there is some debate over *how many* fricative vowel phonemes there are in Len, with Connell (2007) analyzing the two fricativized vowels as allophones of a single fricativized vowel phoneme. In this account, the specific type of frication is determined by co-occurring initial consonants. This intuitively clashes with the other descriptions given above, where two contrastive fricative vowel phonemes are typically present, often with few distributional restrictions. I find it more likely that Len has two distinct categories /ʒ/ and /v/ whose distributions happen to not overlap in terms of the co-occurring initial consonant due to historical happenstance.[15] Kom provides an instructive, and minimally different, case (Figure 21): it also very nearly has its two vowels /z v/ in complementary distribution, but it does exhibit a small number of contrasts in the environments of /t d/ and Ø syllable initials. I thus find it likely that Len Mambila contrasts two fricative vowels /ʒ/ and /v/ with likely origins in two, rather than one, high vowels, possibly *i and *u coordinate with the vowels found in GB languages.

| Onset C | | f | b m | t d n l | tʃ dʒ | k g | Ø |
|---|---|---|---|---|---|---|---|
| Len | /v/ | x | | x | | x | |
| | /ʒ/ | | x | | x | | |
| Kom | /v/ | x | (x) | x | x | x | x |
| | /z/ | (x) | x | x | | | x |

Figure 21: A comparison between Kom and Len Mambila fricative vowel phonotactics; note role of the coronal initials in proving contrastiveness in Kom. For Kom, (x) is used to indicate an onset-vowel pairing that is attested but which I have not been able to verify with my own consultants.

Although not critical to the conclusions drawn here—that the pattern of HVF was borrowed in some fashion from a GB language—the case of Len Mambila allows us to argue for a more detailed account of actuation for this particular sound change, given that Connell makes a specific argument for the way HVF entered Len:

> ...it becomes apparent that there is a considerable number of lexical items in Len that entered the language via contact with a variety of Grassfields [Bantu], in the form of a substratum. The fricative vowels of Len are neither a result of developments internal to Len itself, nor are they inherited from Proto-Mambila or Mambiloid. Rather, they came into Len as a part of this substratum. (Connell, 2007, 21)

[15] The parade example of this phonological arrangement—contrasted, but in completely complementary distribution due to historical accident—is the English contrast between /h/ in onset-only position and /ŋ/ in coda-only position.

I adopt this account with some reservations.[16] In particular, although many of the fricative vowels are indeed found in several lexical items that also appear in GB languages, it is obvious that the presence of these vowels is *not* limited to GB-derived lexemes; they can also be found in lexemes that are clearly not present in any Grassfields Bantu language to my knowledge. Lexical information is quite sparse, however, such that my account must be regarded as speculative, and any more serious analysis of a substratum in Len Mambila must await more material.

## 2.4 Notes on Swedish

Here, I give some notes on vowel fricativization in Swedish, which paradoxically has one of the more widely known and better-researched examples of fricativized vowels but perhaps the most complex and difficult documentary data. Several dialects of Swedish, including the standard dialect to an increasingly large extent, exhibit fricativized vowels in their inventories.[17] More specifically, an unrounded coronal fricativized vowel variously called the *Viby-i* or more rarely the *Göteborges-i* is commonly produced (Engstrand et al., 2000), and appears in all cases to correspond with the standard /iː/, more usually produced as [iː]. While available evidence suggests that these are broadly similar to the Chinese fricativized vowels illustrated above, there is little evidence available that these vowels have developed through similar mechanisms, and no evidence that a connected chain shift is occurring. In the event that such evidence for a chain shift comes to light, some information on the Swedish situation is provided here.

Fricativized high vowels have been discussed in the Swedish dialectology literature for some time, with researchers commenting as early as Noreen (1903) and Gjerdman (1916) on fricativized *i* as an unusual regional variant. Karlgren (1926) even notes the impressionistic similarity of the Swedish *Viby-i* to the fricativized vowels common in Mandarin and Wu Chinese dialects.[18] More recently, fricativization of /iː/ has diffused throughout the standard variant of Swedish, including younger standard speakers more generally (Riad, 2013, 21). Fricativization of /yː/ is also attested, but is more rarely studied (Engstrand et al., 2000; Schötz et al., 2013), and is still restricted to regional dialects (Riad, 2013, 21).

At least two fricativized vowel variants appear to exist, the central-eastern *Viby-i* and *-y* or *Lindigö-i*, and the southern coastal *Göteborges-i*; only the former appears to be of direct interest to studies of HVF. The acoustics and articulation of the *Viby-i* and *Viby-y*, named for the central-eastern Swedish city where they are canonically found, are relatively well described (Engstrand et al., 2000; Schötz et al., 2011, 2013).

[16]Beyond what is written here, a further problem exists in that the provenance of fricative vowels in the GB languages themselves is still somewhat unclear. This is discussed at some length later.

[17]This should not be confused with preaspiration overlapping with vowels, which is a distinct phenomenon more prominent in different Swedish dialects; see Helgason (2002).

[18]The symbols that Karlgren proposed to represent the Viby-i and Viby-y, [ɿ] and [ʮ], and their retroflex (right-tailed) variants, are convenient representations of fricativized vowels, but regrettably are not included in the IPA and as such are excluded here for the time being.

Acoustically, the "Viby-colored" vowels consistently have centralized high-vowel-like formant values (e.g. [ɨː]), with a lower F2 and higher F1 than would be expected of a cardinal [i] for both the Viby-i. The Viby-y, where included, is likewise typically transcribed as central [ʉː] (Schötz et al., 2013). Curiously, these more recent studies typically do not comment on any fricativized quality of the Viby-i, despite the fact that it has historically been described as such impressionistically (Noreen, 1903; Borgström, 1913; Gjerdman, 1916); this may simply be due, however, to a focus on formant values to the exclusion of non-canonical vowel properties. The Göteborges-i is less well-studied than the Viby-i, but is generally noted to have a centralized quality as well. Schötz et al. (2013) does not observe frication in typical productions of the vowel.

While the aforementioned acoustic qualities are broadly consistent with other fricativized vowels, some confusion remains on their articulation and the resultant articulatory-acoustics mapping. From the earliest discussion of these sounds, there has been debate over whether the Viby-colored vowels are fairly canonical central high vowels (Borgström, 1913) or have a more frontwards constriction with a raised tongue tip (Noreen, 1903), making them "basically alveolar" (Schötz et al., 2011, 2). Given the investigation here on fricativized vowels, this debate is clearly connected to another debate over the impressionistic quality of the vowels, with some researchers but not others noting a "buzzing, dampened" quality (Gjerdman, 1916). It stands to reason that there may be two distinct variants of /iː/ and /yː/ that are impressionistically 'Viby-colored' in quality, one with a raised tongue tip and one without; this accords with the observation that the acoustic qualities of Viby-colored vowels can be accomplished with several distinct articulations (Björsten & Engstrand, 1999, 1959). From this, it also stands to reason that some of these variants may be consistently dampened and fricated, and others not. As such, given the current state of documentation, it is hard to say precisely which Swedish vowel(s) are of interest for further study of HVF.

More problematically for the research here, the existence of an associated chain shift (with raising of mid vowels) has not been investigated at all to my knowledge. A lone note on Göteborg's *e* suggests that it may be produced closer to cardinal [i] (Holmberg, 1976), setting up a simple chain shift [eː] > [iː] > [ɨː]. However, it is not clear if the Göteborges-i is fricated in participating in this shift, and as such the disconnect between the two phenomena remains. Barring the existence of more data on the realization of mid vowels by Swedish speakers who do fricativize /iː/ and /yː/, it is difficult to characterize this change as a fricativizing chain shift *per se*.

## 2.5 Summarizing the pattern: mid vowel raising and HVF

As a summary to the preceding sections, it should be noted that HVF, when it can be said to affect an entire vowel category, occurs surprisingly frequently, if not always, in concert with a raising chain shift. Recall that some instances of HVF are restricted to particular segmental contexts, where the HVF itself can be attributed to the coarticulatory influence of an adjacent consonant. While the latter is more commonly discussed in the literature on fricativized vowels, particularly due to its high prevalence in the Sinitic languages, we concern ourselves here with HVF that affects entire categories and does not appear to be restricted to a particular segmental context. In cases with sufficient data to make the observation, this particular type of HVF routinely occurs with the raising of mid vowels, forming a short, consistent chain shift. I speculate here that HVF as such may not be the leading movement in the chain shift but rather a movement triggered by raising or close proximity of mid vowels.

The general profile of HVF with chain shift does appear to have one exception, discussed above: Swedish, where variation between normal and "Viby-colored" /iː/ and /yː/ occurs with no observations of concomitant raising of /eː/, /øː/. However, this is unsurprising given the typical emphases of Swedish vowel research: Swedish's high vowels are well studied, with even dialectal variation in how they are produced receiving attention, but there is little data on any *co-occurring* variation in its mid vowels. For our purposes, description of the mid vowels alone is not sufficient; rather, it must be ascertained that speakers who fricativize /iː/ *also* raise their /eː/ towards [iː]. Given the lack of such evidence, at present I do not pursue whether Swedish actually lacks a category at the phonetic [iː] vacated by "Viby-colored" vowels, or if this is also filled by /eː/ at present.

Setting the case of the Swedish front vowels aside for the moment, the co-occurrence of HVF and mid-vowel raising has two logical possibilities in chronology. The first is that HVF "leads" the chain shift, analogous to a diphthongization (Pattern I) or centralization (Pattern III) of a high vowel preceding the raising of mid vowels to occupy the position of high vowels. All of these changes have in common a departure from the set of steady-state, peripheral high vowels, leaving an empty area in the possible vowel space that gradually tends to be filled by productions of a (formerly) mid vowel category. For HVF, this is seemingly the most desirable assumption to make given that it is the least exotic: if HVF leads, then the subsequent raising of mid vowels simply reflects a general movement of vowels towards "unassigned" areas in the vowel space, as modeled in (Ettlinger, 2007). However, there is no compelling evidence from historical data to suggest that HVF must necessarily lead the chain shifts described above, which leaves us to consider other possibilities.

Rather than the leading change in the chain shift, HVF may best be modeled a possible *responses* to the raising or encroachment of the next-highest vowels. Under this model, high vowels fricativize under the influence of some category-external pressure from lower vowels. In the following sections, I discuss what this category-external pressure *might* be: essentially, a crowded high vowel space that reduces efficient identification of high vowels. This crucially can be modeled as a force quite distinct from that assumed in "billiard ball models" (King, 1969) of push chain shift, and so sidesteps the criticism leveled at "encroachment" entirely.

# 3 Modeling the phonologization of fricative noise in high vowels

To account for chain shifts that involve the fricativization of high vowels, I propose a series of necessary preconditions for the sound change and discuss their substantive bases.[19] First, I note that high vowels are variably peripheral in their realization, with more peripheral realizations generally being less common than less peripheral realizations; I also observe a further tendency for vowel peripherality to be mediated—but not strictly determined—by inventory size and number of high vowels. Secondly, peripheral vowels may be variably produced with a *wall noise source*, again depedent on language-specific phonetic implementation and inventory arrangement. As a final step, and only in rare cases, regularly noisy, very peripheral high vowels may acquire frication as the major cue to the category, in response to displacement of formant information as a major cue to category contrastiveness. Subsequently, stridency emerges as a characteristic of fricativized vowels, and reasons for this are discussed in the closing part of this section.

Advantages to the model discussed here include its prediction of the low frequency of this sound change, which would otherwise appear to be at odds with its regularity across diverse languages: a chain shift, or analogous pressures that lead to such a sound change, can result in a large number of different outputs, and as seen in Figure (5) other outputs are far more common. A number of factors must simultaneously exist in concert with one another in order to predispose a language to tend toward spirantizing its high vowels. The sound changes are summarized and ordered with respect to one another in Figure 22; each step is discussed in greater detail below.

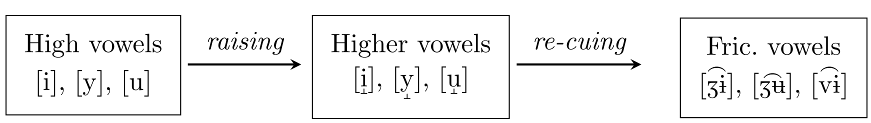


Figure 22: A multi-part schema for the sound changes seen in high vowel spirantization.

## 3.1 Frication in peripheral high vowels

Syntagmatic factors have been better studied relative to paradigmatic factors in the development of fricativized vowels: it is well-known that peripheralization towards a more fricative-like articulation may occur when there is syntagmic pressure to coarticulate with an immediately preceding fricative or affricate consonant.[20] Under this type of assimilation, the frication-producing constriction "extends" over the vowel until

[19]This section incorporates material discussed in Faytak (2013).
[20]Local assimilations of high vowels to initial strident sounds have been discussed for Xining and Standard Mandarin in Section 2.2.

it completely occludes it; only the nucleus' voicing remains. However, HVF connected with chain shifts typically involves entire vowel categories moving to a new fricativized production, regardless of consonantal context.

I argue that a major precondition for "across-the-board" HVF of a category is a language's having a high vowel that is articulated in a *peripheral* position towards the upper corners of the articulatory vowel space: the vowel must involve a degree of constriction that produces significant fricative noise. Several factors are expected to feed into this tendency, some paradigmatic and others syntagmic—that is, resulting from interaction with contrasting vowel categories and temporally adjacent segments in the speech stream, respectively. The outcome, regardless of inputs, is that high vowels are frequently produced with constriction apertures that are conducive to the production of turbulent airflow and fricative noise, and that these productions are antagonistic to maintaining laminal airflow and voicing.

A key observation is that vowels with sufficiently peripheral category centers frequently have airflow that is not perfectly laminar. This is another precondition for HVF—not only must the vowel be peripheral (whether pushed there or not), but it must also consistently be realized with some detectable amount of turbulent airflow. This turbulent airflow typically generates a *wall noise source*: air moving through the vocal tract striking the walls of the vocal tract at a wide angle causes some audible turbulence in the flow of air through the vocal tract (Shadle, 1990). Louder wall noise sources are characteristic components of, for instance, non-sibilant fricatives (e.g. interdentals, velars, pharyngeals); the resulting fricative noise is typically broadly distributed across the audible spectrum and of low intensity at most frequencies along this spectrum.

High vowels' intrinsic aerodynamics are the primary "seed" for HVF in cases where no coarticulation can consistently be indicated as the cause for turbulent airflow. However, at this point, it is necessary to briefly argue against the interpretation of data on high vowels that says that devoicing, turbulent airflow, and a number of related sound changes are due primarily to a spreading laryngeal gesture inherited from adjacent obstruent consonants (Beckman & Shoji, 1984): that is, that high vowels' becoming more obstruent-like or aspirated is primarily due to coarticulatory influence rather than some property inherent to high vowels themselves. This type of coarticulation is well attested in a variety of languages in prosodically weak positions: Japanese, for instance (Maekawa & Kikuchi, 2005), commonly devoices unstressed vowels when they stand between voiceless obstruent segments. As argued in Mortensen (2012), however, devoicing and frication of vowels are also well attested in prominent positions, for instance in phrase-final position in French (Fagyal & Moisset, 1999; Smith, 2003). Strong positions (and particularly vowels in strong positions) are expected to be resistant to coarticulatory influence (and particularly phonatory coarticulation), and voiceless consonant segments do not appear to condition the devoicing in this type of case. Since high vowel fricativization may occur essentially free of consonantal context, it appears to have more in common with this type of devoicing than the sort that Beckman discusses.

It is known known from numerous studies of the distribution of vowels in articulatory vowel spaces that more crowded spaces will result in an increase in the typical articulatory excursion for—and a corresponding increase in the F1 and F2 range covered by—some vowel categories (Liljencrants & Lindblom, 1972; Flemming, 2004; Becker-Kristal, 2010). This peripheralization is expected to occur regardless of segmental context, and this is precisely what is seen in HVF. It could be said that raising chain shifts frequently producing fricativized vowels simply reflects chain shift's tendency to peripheralize high vowels, which is a necessary prerequisite for the former change.

In reality, it seems to be more likely that high vowels' characteristic aerodynamic properties are generally enough to consistently induce some non-periodic component in their acoustic signals without terribly much inducement. This fricative noise component should frequently be present in high vowels regardless of, but perhaps sometimes augmented by, coarticulation from neighboring segments. In fact, vowels of all tongue heights have minor aperiodic spectral components (Lively & Emanuel, 1970, 82), and high vowels again behave as a class apart, this time perceptually, in that they are consistently perceived as less "rough" (hoarse) than low vowels at a given level of acoustic roughness (59–60). Actively disregarding aperiodic noise in high vowels may well be a sort of adaptive strategy toward ignoring noise from wall frication noise sources that is frequently present, due both to coarticulation and acoustic properties inherent to high vowels.

## 3.2 Chain shift and phonologizing frication

High vowels with some turbulent airflow are common cross-linguistically, but the languages examined in the following sections appear to exhibit a further, less common development: the turbulent airflow commonly present in sufficiently high vowels is phonologized as *strident* frication. This is a complex change that likely does not happen in one "step" through, e.g., misperception and reinterpretation of a category, in the Ohalian sense (Ohala, 1993). Rather, it appears that two distinct events are required: phonologization or enhancement of the wall frication common in high vowels as a primary feature and *then* a subsequent change to the *z*-like strident frication most often found in fricativized vowels. Strident frication is produced by an *obstacle noise source* that differs radically in articulation from wall noise sources like that possibly generated during a high vowel: a jet of air is directed at an obstacle, usually the lower teeth (Shadle, 1990).

In the following section I posit an account for HVF that separates these two distinct events: first, cues for a high vowel category must be reweighted, such that canonically high-vowel-like formant information becomes a less informative cue to the vowel category and fricative noise increases in relative informativeness. I find that an "encroaching," raising mid vowel category is a likely driver of this loss of informativeness.[21] At the same time, fricative noise is probabilistically enhanced (Kirby, 2011) and becomes an even more important cue to the high vowel category. Finally, as most (if not all) fricative vowels are strident in production, some bias towards *strident* articulation in particular, rather than a less precisely articulated wall frication, must be factored in; I speculate as to some possible sources for this change.

### 3.2.1 Cue reweighting and bias

Below, I show that the data on HVF suggest a trade-off in the *informativity* of acoustic information that typically strongly cues vowels and the informativity of acoustic information that cues a high degree of vocal tract constriction. As formant information becomes less useful in identifying vowels in a chain shift, other cues may rise to the fore, including the turbulence often seen in high vowels. In analyzing the chain shifts and phonologizations at issue, I employ new accounts of these phenomena (Ettlinger, 2007; Kirby, 2011) that assume—and, in some cases, are rendered far less stipulative and teleological overall by assuming—detailed, exemplar-based phonological categories (Pierrehumbert, 2002; Johnson, 2007). A more teleological model is typically used when discussing chain shift in particular, with languages' category centers shifting to maintain stability or optimal dispersion in paradigmatic arrangements (Liljencrants & Lindblom, 1972; Flemming, 2004). In contrast, category dispersion is a side effect (and *not* the result of some universally applying optimization process) if exemplar-based categories are assumed (De Boer, 2000; Wedel, 2004), and chain-shift-like tandem movements of multiple categories also straightforwardly result (Ettlinger, 2007).

For a single dimension in which they exist, exemplar-based phonological categories can be displayed as probability density curves, which mark the probability of an exemplar having the value of that point on the curve. The resulting probability distributions are approximately Gaussian (normal).[22] Along any one dimension, multiple categories may exist, and a series of categories is best modeled as a mixture Gaussian distributions (Figure 23) that overlap to varying extents. Phonological categories are discrete, but spoken language is decidedly continuous, and the distributions in contrastive categories may even substantially overlap. How users of language classify incoming exemplars as members of these contrastive categories is thought to be based on the acoustic information that informatively correlates with membership in a category. Cues, which may be defined as acoustic information that allow for positive identification of a contrastive category (Wright, 2004, 36), may be more or less *informative* depending on the proximity of other categories or the extent of overlap. In other words, the more definitely an acoustic cue implies membership in a

[21] See also Mortensen (2012), whose account of postvocalic obstruent emergence (POE) similarly revolves around the phonologization of precursor noise caused by aerodynamic factors particular to high vowels, and which can be triggered by chain shift (462–65).

[22] Phonetic bias does cause persistent deviation of these distributions from normality, in this case a slight skew towards having more outliers in one direction or another, as determined by gestural mechanics (Garrett & Johnson, 2013, 69–70).

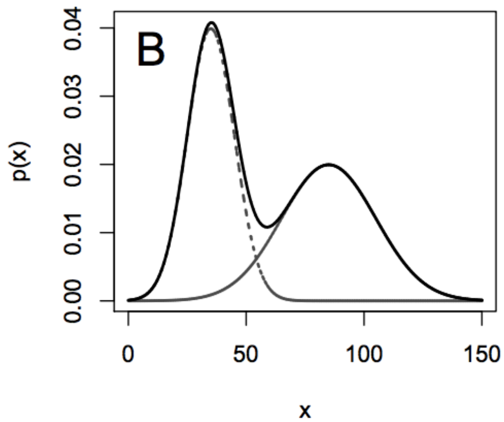


Figure 23: Two overlapping Gaussian distributions; phonological categories distributed along a continious dimension (for instance, vowels along an F1 continuum) can be illustrated in this way. Adapted from Kirby (2011), p. 7

particular category, the more heavily its value will be used to sort exemplars into categories (Toscano & McMurray, 2010, 454-55).

What is actually identified as a member of a particular category may change due to external perturbations. Here, I argue that the most likely external perturbation is something like a push chain shift, but not as it has typically been modeled, with categories encroaching on one another or “bumping into” one another (King, 1969): it is a loss of cue informativity for vowel-like cues that produces the “push” into fricativization. In an exemplar model, *informative* cues to phonological categories heavily influence the makeup of the categories themselves, affecting their maintenance and the contours of their change (Wedel, 2004). In particular, phonological categories are best modeled as changing to center about whatever values most informatively cue the cloud of exemplars they contain. Put another way, since in an exemplar model a category will be identified based on the properties of the exemplars that populate it, “a category will evolve to be more specific for those percepts *most often identified* as members of that category” (Wedel (2004, 2), emphasis added). If vowel-like cues become less informative and fricative noise-related cues are held constant, frication may be enhanced as the primary cue to the high vowel category. Thus, a loss of informativity of a vowel-like cue (here, perhaps F1) can in theory push a less vowel-like cue (in this case, fricative noise) to the fore.

As such we must model category center movement *away from* another category or cluster of categories in some dimension or dimensions. This is quite distinct from exemplar-theoretic work that has been explicitly done on chain shifts: Chain shifts *toward* a retreating category have been discussed from an exemplar-theoretic perspective in Ettlinger (2007). Interacting-agent simulations carried out with exemplar-based categories show that perturbation of one category in a simplified system of contrasts results in movement in the same direction on the part of other contrastive categories (Ettlinger, 2007, 4). This appears to be closely related to the finding that over time in similar interacting-agent simulations, two categories will tend to track each other's random variation along a one-dimensional continuum of values (Wedel, 2004, 3); illustrations indicative of both findings are given in Figure (24). Under Ettlinger (2007)'s analysis and in keeping with a similar analysis in Wedel (2004), this tandem movement occurs because a change in location for one category changes the likelihood that exemplars falling somewhere between the two category means will be identified as one or the other category. Taking the right half of Figure (24) as an example, a movement of /i/ away from /e/ is followed by a movement of /e/ in this same direction, since the space between the two becomes incrementally better identified with /e/ as /i/ moves away. The increase of lower-F1 /e/ exemplars in the /e/ category then drives the movement even further (given that lower F1 values become increasingly prototypical for /e/).

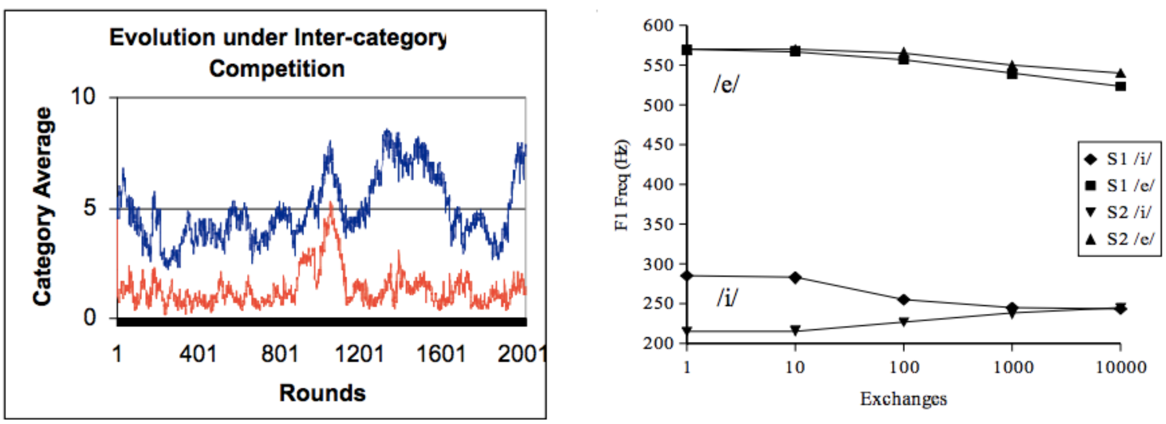


Figure 24: Left: values for two categories competing for assignment of exemplars over a large number of simulations; note in particular the near-simultaneous spike for both categories mid-simulation. Adapted from Wedel (2004), p. 3. Right: in a separate simulation, change in F1 values for two vowel categories following a perturbation to the F1 of /i/ for one of the interacting agents (lowering by 70 Hz, visible at bottom left). Adapted from Ettlinger (2007), p. 4.

To model a push rather than a pull, we seemingly require a simulation that is to some extent the reverse of that simulated in Ettlinger (2007). Rather than one category being perturbed away from the other and the latter's following suit by moving in the same direction, a category would have to be perturbed *towards* another category, and that category would have to move away in response. Category encroachment has historically been conceived of as pairs of "billiard balls" richocheting off of each other in the vowel space (King, 1969), which is a less than realistic model and not what I am proposing here. Rather, movement of a vowel category away from a crowded or *uninformative* part of the vowel space might better be understood as driven simply by the cue reweighting described above, rather than some teleological drive to avoid merger of vowel categories. There are clear analogues of this approach in studies of dispersion rather than chain shift

(Liljencrants & Lindblom, 1972).

With this model proposed, a question remains: given the complex acoustics of fricativized vowels—which have both fricative noise and a prominent formant structure—to what extent is the frication actually used to cue these categories? The limited evidence available suggests that the frication of fricativized vowels is an important cue for their identification, perhaps somewhat more important than the vowel-like formants. Cheung (2004) is the only real source at present to identify the relative importance of the various possible cues to fricativized vowelhood, in this case in Standard Mandarin. Her results indicate that F3 is used to distinguish *between* the plain and retroflex allophones of the fricativized vowel, [z̩] and [ʐ̩], which are conditioned by frication of a matching place of articulation in the syllable onset. The ratio of F1-F2, on the other hand, is used only occasionally to distinguish between the two and is "not always significant for all stimuli" (24). The most consistent effect is seen in the initial frication, which strongly facilitates identifying the vowel if it matches (18–19). One could well conclude that frication quality is an important—if not the most important—cue for identifying fricativized vowels, although further studies are clearly needed on this point.[23]

### 3.2.2 Stridency as an enhancement

As frication is reweighted to fill a role of greater informativity, there appears to be another factor at hand in the subsequent phonologization: attested fricative vowels are all produced with strident coronal or labiodental articulation, rather than a less highly modified articulations resulting in (for instance) wall frication of a greater intensity. This marks a subtle but significant change in articulation for fricativized vowels at the coronal place of articulation, as illustrated in Figure (25). High vowels such as /i/ and /u/ are typically articulated with a downward-pointing tongue tip and a domed and raised tongue body (Stone & Lundberg, 1996, 3732–33), while strident fricatives tend to be articulated with a raised, upward-pointing tip and a lowered tongue body that is often midsagittally grooved (Narayanan et al., 1995; Stone & Lundberg, 1996). For fricativized vowels at the labiodental place of articulation, the changes in the source of frication are more visually obvious and involve noticeable subduction of the lower lip under the upper teeth.[24] As such, I argue for a tendency for the phonologized frication discussed above to "snap" (or adjust in a discontinuous fashion) to strident productions, with all of the attendant articulatory consequences. An additional bias toward stridently articulated fricativized vowel categories must then be introduced to the phonologization

[23] It should be noted that Mandarin is less than typical in the specific phonetics of its fricativized vowels in that they are usually not truly fricativized: Lee-Kim (to appear), for instance, observes that the Standard Mandarin fricativized vowels are not fricated despite showing substantial coarticulation with their fricative or affricate initials in the area of a raised tongue tip. It is likely that Standard Mandarin's fricative vowels have re-phonologized vowel-like qualities with the loss of frication.

[24] It is not known at this time if there is accompanying readjustment of the tongue body, but at any rate the frication-producing constriction is of primary interest here.

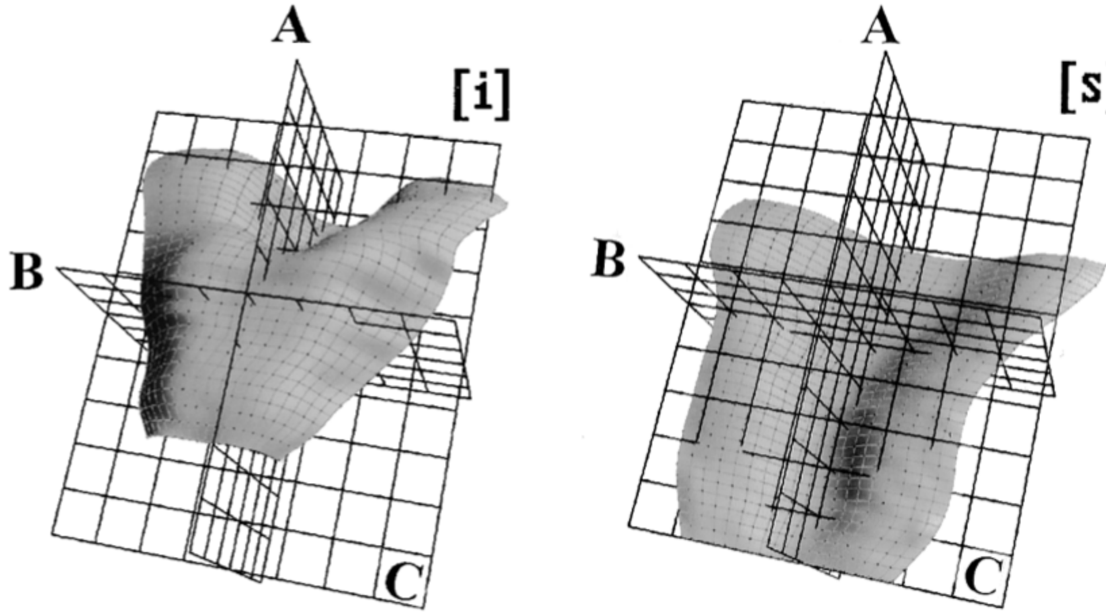


Figure 25: Three-dimensional tongue shapes reconstructed from ultrasound scans of one American English speaker's prolonged productions of [i] and [s]. From figures in Stone & Lundberg (1996), pp. 3732–33.

process described here.

This bias towards strident fricatives should not be confused with the *production* biases, which Garrett & Johnson (2013) use to refer to the major drivers of skew in a phonological category's variability—and, subsequently, the characteristic directionality of sound change (58–60). Rather, the *bias* at hand is more likely present in the form of an *enhancement* as both Garrett and Johnson and Kirby (2013) happen to define the term.[25] Garrett & Johnson (2013) use the term to refer to the amplification of a small bias in production to a less incremental and ultimately categorically distinctive change (78). Kirby (2011) uses the term in a slightly different sense to refer to the actions a speaker may take to make a phonetic contrast *more precise* (5). These definitions are complementary in a sense, and appear to be approaching a unified concept: Garrett & Johnson (2013)'s focuses on the magnitude and direction of the change involved, while Kirby (2011)'s focuses on its motivation. Elsewhere, in fact, Garrett and Johnson agree that distinctiveness of contrasts can be implicated in many cases of enhancement (80). Crucially, since both definitions of the process are probabilistic and assume exemplar-based categories, enhancement may operate due to the nature of exemplar-based categories themselves, since more distinctly categorizable tokens are expected to have a "privileged status in listeners' exemplar memories, and are then more frequently propagated" (Garrett &

[25]The *enhancement* discussed is inclusive of the classic sense of the term, enhancement of primary phonological features by supporting or secondary features, for instance rounding as enhancement of backness (Stevens & Keyser, 1989, 2010). It additionally encompasses, however, a much wider variety of cases in Garrett & Johnson (2013)'s definition, including further dislocation of a segment along some articulatory dimension and temporal realignment of the expression of a feature to yield greater perceptual saliency (79).

Johnson, 2013, 80).

While the general nature of the term enhancement is fairly clear, the *specific form* this enhancement takes in HVF is yet to be determined. One possibility is that stridency is an enhancement, in the classic phonological sense, of turbulent noise in general. There is rather strong typological evidence that stridents are preferred as fricatives: for the places of articulation capable of producing both strident and non-strident frication (labial and coronal), a language's having a non-strident fricative phoneme almost always presupposes the presence of a strident fricative phoneme. This suggests that strident fricatives are a better fit for a category defined by fricative noise. What makes stridents "better" as fricatives could simply be intensity: frication from an obstacle noise source (as is a good deal louder than wall frication at the equivalent place of articulation (Shadle, 1990). However, this makes some undesirable predictions for what sorts of fricative vowels should emerge from the phonologization of noise in high vowels: labiodental fricativized vowels should not emerge at all, given their relatively low intensity. Frication is a very robust cue only if it is *sibilant*: sibilants are robustly cued for their place of articulation from their frication noise alone, whereas other non-sibilant frication does not have the same perceptual advantage (Wright, 2004, 37–38). As non-sibilants, labiodentals are not expected to emerge as a direction for enhancement as discussed above; this is in spite of their being thought of as strident in opposition to non-strident bilabials (see, for instance, the discussion on Ewe in (Utman & Blumstein, 1994)). As such, any account that attempts to predict the outputs of high vowel fricativization using only overall saliency of the output will fall short of predicting the actual range of fricativized high vowels, and crucially that they may be produced by articulators other than the tongue.

A second possibility is that speakers enhance the frication in HVF along system-dependent lines: in other words, the means of producing frication that exist at the time of enhancement influence how segments using novel combinations of articulators produce frication. I dub this influence *motor plan analogy*, given that it would most likely have its roots in the organization of motor planning in human speech. The "motor plans" at issue are known in the motor control literature as *internal models*, which are typically thought to be "associations" of groupings of muscle activations with a desired output (Shadmehr & Brashers-Krug, 1997, 409). Outputs include a broad range of perceptible phenomena, including trajectories of movement or, as in this case, speech percepts. Following Wedel (2004), I note that both motor control research (Shadmehr & Brashers-Krug, 1997) and research on lexical activation (Bybee, 2003) suggests that particular motor plans have a tendency to influence other motor plans. Influence is largely seen to affect less-performed motor plans, and the influence largely arises from frequently-performed motor plans (Wedel, 2004, 4). Put another way, frequently articulated segments will tend to "draw in" less-frequently articulated segments, resulting in category merger.

A different way of thinking of this particular pattern, however, is that it may possibly also result in the reduction of *components* of motor plans that have similar consequences for output: components of articulatory gestures may have a "magnet effect" on similar, less-practiced components. For HVF, this "magnet effect" would play out as the remodeling of the frication-producing high vowel after a fricative consonant producing a similar percept. The concept of motor plan analogy thus bears some resemblance to several previously proposed principles of organization for systems of phonological categories: Feature Economy (Clements, 2003) or the Maximum Utilization of Available Features (Ohala, 1979), which state that languages maximize a ratio of categories to features.

Motor plan analogy as an important stage in vowel fricativization does predict the attested frequent emergence of labiodentally fricated fricative vowels from high back vowels, despite the fact that it is the tongue body that is raising on the way to phonologization. Backness and rounding commonly co-occur, such that multiple acoustically similar unrounded back vowels are extremely rare. This makes raising chain shifts considerably more likely to occur with rounded back vowels than with unrounded back vowels. Back vowels participating in fricativizing chain shifts tending to be rounded, if a rounded vowel undergoes significant raising to the point of producing wall frication, this wall frication is expected to be "filtered" through the labial constriction. The resulting motor plan may "snap" to a labiodental articulation if that segment type is already present in the language.

# 4 Unresolved issues and future directions

## 4.1 Mechanics of HVF

Referring back to Figure (22), each stage (in boxes) is well-attested in a number of different languages, but much speculation may still be had over the second "arrow" in the diagram, between the second and third boxes; this is taken to be inclusive of the category reshapings discussed above, which are easily modeled or simulated but not easily "observed in the wild," taking place in a natural language. This is true of chain shifts in general; in fact, much of the specific chronology of marquee cases of vocalic chain shift are subject to debate, even with substantial chronology inferrable from observations over the decades in which they occur. Particularly notable in this regard is the Northern Cities Vowel Shift in American English (Labov, 1994; Samuels, 2006).

There are several distinct avenues of inquiry that one might explore emerging from the issues discussed here. First, wall noise sources for high vowels can be inferred from a broad range of acoustic studies and from sound changes that appear to result from turbulent airflow, but there is little direct observation of this property of high vowels, and no real evidence that individuals perceptually integrate this wall noise source with the rest of the vowel's acoustic characteristics. Some predictions can be made from the model at issue here. In particular, the reorganization of high vowel categories as being cued primarily by frication predicts that frication must be usable *in some way*, if not strongly, as a cue to the greatest degree of vowel height in some languages. That is, the wall noise source produced by turbulent airflow must be reliably associable with one category versus another in order to allow for its fairly consistent enhancement. It is *also* expected to be a more useful cue if there are non-high vowels that nearly abut the high area of the vowel space (as opposed to a less crowded system). A perception study could be used to single out this cue.

A second prediction relates to the nature of the "stridency enhancement" discussed, by which phonologized frication is inevitably realized as *strident* frication. It is speculated above that this may be due to the prior existence in a language of motor plans to produce strident fricatives, and these motor plans' influence over other less regularized motor plans. Enhancement based on system-dependent factors such as prior phonological inventory, rather than enhancement based on perceptual salience of stridency, is crucial given that the class of fricativized vowels is seen to include two very different types of strident fricatives, coronal and labiodental. This makes a specific, strong prediction about which sort of strident frication should arise in which languages: fricative vowels will "mimic" a pre-existing fricative consonant category, albeit only in place specification. We should expect languages without postalveolar or retroflex fricatives, for instance, to not develop these sorts of articulations in their fricativized high vowels. More work is needed in this area: in order to properly assess this hypothesis, information on motor planning would need to be collected for a number of languages, although a survey of the phonological typology would also accomplish this in more gross terms with significantly less labor, similar to the research in Clements (2003).

## 4.2 High vowel fricativization *vs.* other chain shift types

A question that remains unaddressed thus far is why HVF happens at all in a given language, given the availability of other suitable directions for category evolution to proceed in. In most cases of HVF and associated chain shift presented here, high vowel diphthongization and centralization would each presumably be suitable, rather than the considerably more unusual high vowel fricativization. Each would solve the proposed systemic problem of reduced cue informativity by phonologizing a new cue (internal dynamicity, in the case of diphthongization) or modifying an existing one (F2, in the case of centralization). Both of these furthermore correspond to a type of chain shift that is considerably more common, the Pattern I chain shift and Pattern III chain shift, respectively. Figure 26 illustrates that in a quick search for attestation of different chain shifts (from Labov (1994) unless noted), Pattern I and Pattern III chain shifts match or exceed in number the cases of HVF with mid vowel raising that can solidly be proposed here.

| Pattern I | Pattern III | HVF (this paper) |
|---|---|---|
| Middle English | Swedish | NW Mandarin |
| Old Prussian | São Miguel Portuguese (Martinet, 1955) | Northern Wu |
| Middle High German | Akha | N. Grassfields |
| Romansh | Albanian | |
| E. Lettish | Lithuanian | |
| | Wenzhou, other Wu (Baron, 1983) | |
| | Babanki (own notes) | |

Figure 26: A brief survey of well-known cases of Pattern I and III chain shifts (left two columns) compared with the HVF shifts shown here (right column).

One way of addressing this problem is to determine what may make HVF the optimal adjustment for a given language's vowel system. The languages surveyed above have several shared typological similarities to their vowel systems, suggesting that the presence of particular category types in a vowel inventory will predispose a language towards HVF. All languages undergoing HVF surveyed here have both back unrounded, front rounded, or central vowels of either rounding that may "block" phonologization of a high vowel's change in F2 by preventing innovative exemplars in that direction from being successfully incorporated into the pressured high vowel category. Put another way, HVF languages tend to have more high vowel categories with typical F2 values between the usual extremes of cardinal /i/ and /u/. For instance, Kom has a central or back unrounded vowel /ɯ/; its /e/ phoneme also has a major allophone [ɘ] in closed syllables (Jones, 2001). Swedish has an extremely crowded front-central space populated at present (for non-HVF varieties) with high /i y ʉ̟/ and fairly close /e ø/ (Schötz et al., 2013). Furthermore, all of these languages have a fairly rich inventory of upgliding diphthongized vowels, particularly Chinese, presumably reflecting a situation that pertained at the time of HVF. Kom additionally has rising diphthongs conditioned on any non-front vowel by a historical coda **-n*, i.e. [aj], [ɔj], [uj], [ɘj], [ɯj] (Jones, 2001); most of Swedish's long vowels are in fact upgliding In this case as well, i.e. [iːj], [eːɪ], [yːɥ], [øːʏ], [ʉ̟ːβ̞] (Schötz et al., 2013). In these cases, iit appears that the presence of numerous internally dynamic categories may have cut off diphthongization as an exit from the top of the vowel space. System-internal factors such as the presence of internally dynamic vowels or heavy population of the low-F1, intermediate-F2 vowel space, in other words, may be necessary conditions for forcing HVF rather than some other phonologization.

However, these conditions are necessary but far from sufficient to determine whether a language will undergo HVF, since numerous languages with these categories *do* undergo chain shifts that involve the genesis of *more* of the same categories. Numerous languages that have diphthongs, for instance English at various stages in its historical development, have developed diphthongs through Pattern I shifts in spite of the fact that diphthongs existed at the time (for instance, during the Great Vowel Shift) (Labov, 1994). Swedish, an HVF language itself, underwent a Pattern III centralization of its *u to present-day /ʉ̟/ (presumably raising its typical F2 value) in spite of the fact that umlaut-conditioned front rounded vowels (e.g. *y, with a lower F2 than front unrounded vowels) were already present in the language (Haugen, 1976, 196). We can perhaps produce a more moderate statement from all of this: if a language already has vowel categories of the same type that might result from a given type of phonologization, there is an *increased* likelihood of some other phonologization. Under these circumstances, HVF is likely to occur a good deal more often. Given the limited scope of this study and the presently limited research on. and attestation of, fricativized high vowels, it may well turn out that HVF is *the* most common change under these circumstances, and that languages like English or Swedish, which phonologize more of an already crowded category type, comprise the exceptions to a general pattern.

Another avenue for determing why HVF occurs in a given location is to seek out areal or extra-linguistic factors that may encourage the repeated generation of a given type of vowel system, in this case with HVF. It is striking that both in the northern Chinese and northern Grassfields Bantu linguistic areas, HVF has occurred multiple times in multiple languages not immediately related to one another, and not always having all of the "blocking" categories mentioned above. It seems likely that once one language, against all odds, undergoes HVF, others may follow suit in its linguistic area, as if fricativized high vowels have entered part of the acceptable local repertoire of sounds. Further research needs to be carried out on this possibility, particularly as pertains to local attitudes toward fricativized vowels: a striking possibility is that fricative noise on vowels is stigmatized to some extent, and phonologization of fricative noise on vowels may be tamped down by extralinguistic factors unless there is some precedent for the category in the area.

### 4.3 Southern Bantoid reconstruction

Taking into account the nature of High Vowel Fricativization and its known distribution in the northern Grassfields, we are presented with a paradox: a recent innovation that lines up with a much older reconstructed feature of Southern Bantoid. HVF appears to be an innovation restricted to Ring and northern Eastern Grassfields within Grassfields Bantu, with additional contact-induced spread to several nearby non-GB languages. As such it has been shown above that all spirantized vowels in this region are a relatively recent innovation with some local wave-like spread. However, there is *also* considerable evidence for reconstructing something akin to HVF at the much deeper time-depth of proto-Southern Bantoid: the so-called Bantu Spirantization of consonants preceding first-degree high vowels is widely attested throughout the family (Schadeberg, 1994), and it has been argued that this is due to some consonant-like characteristic of the first-degree vowels (Zoll, 1995; Maddieson, 2003). In fact, the aftereffects of fricativized vowels are broadly similar in non-Bantu languages like Oku. The presence of this phenomenon and HVF in two coordinate groups of Southern Bantoid—in cognate lexical items, no less—suggests that they are related at some time depth, and that some much older characteristic of the Southern Bantoid vowel system led to these developments.

In fact, as pointed out in Hyman (2011), areal features of Grassfields Bantu are often mistakenly thought of as retained characteristics of proto-languages spoken in the Grassfields area: Proto-Bantu, Proto-Grassfields Bantu, and their putative parent language, Proto-Southern Bantoid. Proto-Bantu could be argued to have exhibited HVF itself: a careful argument in this direction comes from Connell (2007):

> "[W]hile it may still be premature, or ultimately even wrong, to claim that the first-degree vowels of PB were 'fricative vowels,' there clearly was something in their phonetic makeup that triggered or led to spirantization. This 'something' seems not to be present in the phonetics of the symmetrical seven-vowel systems found today in Bantu languages which are usually assumed to mirror the system of Proto-Bantu." (Connell 2007:27)[26]

As Hyman points out, however, this line of argumentation does not always consider (or outright ignores) the full evidence of strong areal spread effects within the so-called Macro-Sudan Belt (Güldemann, 2008), which contains the Grassfields within a wide swath of savannah and coastal forest across sub-Saharan west Africa. Numerous other phonological and morphological characteristics of the languages of the Macro-Sudan Belt are actually interpretable as innovations that have recently spread or which tend to recur frequently given the area's typical phonological systems: Hyman lists labiovelar consonants, third tone heights, and ATR harmony systems as examples. It is feasible, then, that HVF is another recurrent innovation that happens to have occurred coincidentally one or more times in the history of the Southern Bantoid languages, including Grassfields Bantu.

In the above discussions of HVF and its distribution within the northern Grassfields, I find reason to agree with Connell on this point. I put foward that some additional information can be gained in reconstruction if we assume that HVF as an innovation is restricted in scope to a *small subset* of the Southern Bantoid languages, but that the *precursor* to this change was more broadly present in the antecedent phonological system of PSB: a tendency towards extremely peripheral high vowels with substantial wall frication. HVF is limited in this account to being an areal feature of the northern part of the Grassfields originating within Grassfields Bantu proper; it also sporadically arises in areas further afield. However, HVF is also more decisively linked to Bantu Spirantization and several other related phenomena (Bamileke aspiration, for instance) through the common trigger of vowels commonly realized with wall frication; such a phonetic tendency could easily be inherited from a common parent language.

[26]Elsewhere, Connell adds that Proto-Bantu is intended here to refer to "the parent language not only of Narrow Bantu, but also of Grassfields [Bantu], as well as other South Bantoid groupings not discussed here" (25). As such, his "Proto-Bantu" is the same as the Proto-Southern Bantoid we have considered here.

## 5 Conclusions

Fricativized high vowels, which in acoustic and articulatory terms have elements of both voiced strident fricatives and high vowels, are generated by local assimilations to strident fricative consonants, as well as high vowel fricativization. The latter is argued to be a phonologization triggered by reduced informativity of vowel-like cues to vowelhood under pressure from other parts of the vowel system. Motor planning is also argued to play a role, with approximation to "magnet" motor plans leading to strident articulations that are, in a sense, structure-preserving since they conserve and re-use the same relatively small number of motor plans used elsewhere.

This proposed process of *motor plan analogy* is potentially worthy of further investigation, but this investigation is at present not possible with the materials assembled here. In particular, detailed information on motor plans for a particular language would need to be known for the point in time *at which* high vowel fricativization produced the relevant fricativized inputs to the process. If this information were known, however, it would be possible to implement detailed simulations of the sound change in the same way that Kirby (2011) uses historical information on Seoul Korean stop phonation to generate the starting point of his simulations. More generally, it would also be useful to evaluate the chronology of various hypotheses put forward here: much of the work here also attempts, with varying degrees of success, to compartmentalize the span of possible acoustic outputs between fricatives and high vowels, and additionally attempts to pin a definite chronological ordering on phenomena that are difficult to reconstruct in order without more detailed historical documentation. As such, many details for the proposed sound changes involved are speculative. Documenting a fricativizing chain shift "in the wild," as it unfolds in real time in a heterogenous speaker population, may really be the only way to fully address some of the questions posed here.

Finally, it is notable that most fricativized vowels, on a language-by-language basis, have yet to be investigated articulatorily or even acoustically: much research on these sounds is focused on Standard Mandarin, with a small program of research on Swedish. With so few points of entry to investigation of the topic in terms of phonetics, the discussion above should be considered tentative. Broadening the scope of this documentation to properly generalize description of the category would be a major undertaking in and of itself, given known variability in language-specific phonetic implementation (in both acoustic and articulatory senses) found within the fricativized vowels. In the second half of this paper, I have attempted to do just that for a group of related and under-investigated languages spoken in Cameroon, in addition to a number of better-documented examples that have not been fully evaluated previously, but instrumental work on these languages would further improve our understanding of the phenomena discussed in this paper.

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