THE RISE AND FALL OF ASPIRATED FRICATIVES*

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1. Introduction

This paper discusses the diachronic changes observed in phonemic aspirated fricatives, as an avenue for investigating the rarity of these segments cross-linguistically. It focuses specifically on the mechanisms through which these segments arise in phonological inventories; I also address their loss over time, although this is a more difficult phenomenon to find data on.

In the following section, I begin by briefly discussing the cross-linguistic distribution of aspirated fricatives, and provide evidence that they do occur phonemically. In §3, I examine the phonemic inventories predicted to be possible by different rankings of the features [continuant] and [spread glottis] in a Contrastive Hierarchy approach. In §4, I describe the mechanisms through which aspirated fricatives may develop or be lost in the world's languages, as well as how one might identify phonological systems that have lost aspirated fricatives. Finally, §5 offers some discussion of why aspirated fricatives might be so rare, and suggests directions for future research.

2. An Unexpected Gap

Laryngeal features are one of the most basic elements of phonological inventories: nearly three quarters of the world's languages have a phonemic voicing distinction, and more than a quarter have a phonemic aspiration distinction Maddieson (1984). However, within languages with phonemic aspiration, not all manners of articulation are equally likely to display aspiration contrasts.

Using the UCLA Phonological Segment Inventory Database (UPSID; Maddieson, 1984; Maddieson and Precoda, 1990) and Mielke's P-Base database (2008), we can get a general sense of the distribution of aspirated segments found across languages; while these data are by no means exhaustive or reliably authoritative, they are still useful for forming an overall impression. In Tables 1 and 2 below, the grey bars indicate the number of languages in the database that have phonemes with the corresponding manner of articulation; the black portions of the bars indicate the number of languages with *aspirated* segments with that manner of articulation.

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Table 1: Segment frequency by manner and laryngeal features (UPSID, n=451)

Total %	Asp. %		Segment Type
100%	26.6%		all
98.9%	25.7%		voiceless stops
91.6%	0.9%		voiceless fricatives
62.5%	17.5%		voiceless affricates
1.1%	0.9%		clicks

Table 2: Segment frequency by manner and laryngeal features (P-Base, n=548)

Total %	Asp. %		Segment Type
100%	15.7%		all
95.8%	15.1%		voiceless stops
93.8%	0.4%		voiceless fricatives
58.2%	9.3%		voiceless affricates
1.3%	0.7%		clicks

The black bars in these tables show that 96–97% of the languages that make use of aspiration for phonological contrasts have aspirated stops, and 59–66% have aspirated affricates, but only 2–3% have aspirated fricatives. The number of languages with aspirated fricatives in these two databases is roughly equal to the number with aspirated clicks.

As theoretical models can more easily account for impossibility than extreme rarity, one may be tempted to hypothesize that the handful of reports of aspirated fricatives are not actually cases where aspiration is contrastive on fricatives, but merely phonetically present. However, upon closer inspection this turns out to not be the case; in many cases, a phonological contrast clearly exists between aspirated and unaspirated fricatives, which cannot be explained away by appealing to voice quality, tone, or morphological effects. Table 3 provides a list of languages which do have phonemic fricative aspiration.

One of the clearest cases of an aspiration contrast on fricatives is observed in Burmese, where two morphophonological processes involved in compounding (known as *juncture* in the literature) confirm the phonemically aspirated nature of /s^{h}/, and indicate that it patterns phonologically with the aspirated stops. The first of these is a voicing process in which plain and aspirated obstruents at the onset of the second word in the compound become voiced, summarized in (1). This process occurs only when the two elements become a compound, and not in general across a word boundary (Thein-Tun, 2010). The process is summarized in (1), with examples given in (2).

Table 3: Languages with contrastive aspiration on fricatives

LANGUAGE	S^h	SOURCE(S)
Southern Subanen	s^h	Lobel and Hall (2010)
Burmese	s^h	Watkins (2001); Wheatley (2003)
Sgaw, Pwo, Palaychi, Kayah Li Karen	s^h	Gilmore (1898); Kato (1995); Jones (1961); Bennett (1992)
Pumi	s^h, $ʂ^h$, $ɕ^h$	Jacques (2011)
Cone, Melung Tibetan	s^h, $ʂ^h$, $ɕ^h$, x^h	Jacques (2012); Suzuki and mTshomo (2009)
Kami Tibetan	s^h, $ʃ^h$, $ɕ^h$	Chirkova (forthcoming)
Mazatec (6 langs.)	s^h, $ʃ^h$	Pike and Pike (1947); Kirk (1966)
Ixcatec	$ʃ^h$	Rensch (1976); DiCanio (2011)

(1) *Burmese juncture voicing*

a.	p	p^h	→	b
b.	t	t^h	→	d
c.	tɕ	$tɕ^h$	→	dʑ
d.		θ	→	ð
e.	k	k^h	→	g
f.	s	s^h	→	z

(2)

a.	/kō/	/tɔ̄/	→	[kōdɔ̄]
	body	royal		monk
	/lē/	/t^hî/	→	[lēdî]
	wind	umbrella		parachute
b.	/m̥jɔ̄/	/sɪ̃̄/	→	[m̥jɔ̄zɪ̃̄]
	to look out	tower		watchtower
	/lū/	/s^hô/	→	[lūzô]
	man	to be bad		criminal

The second morphophonological process, known in the Burmese literature as *weakening* or *internal juncture*, involves reduction of the vowel in the first element of a compound to a toneless [ə]; this process occurs in derivational compounds. The original identity of the vowel, as well as the lexical tone it bears, are completely lost; in spite of this, the onset consonant remains unaffected, even in the case of the aspirated alveolar fricative, as seen in (3). This confirms that the aspiration is phonologically part of the consonant itself, and not a property of the following vowel or tone.

(3)	/pʰâ/	/laũ̂/	→	[pʰəlaŭ̂]
	frog	embryo		tadpole
	/sʰâ/	/pɔ́/	→	[sʰəbɔ́]
	salt	to be light		something lightly salted

Additional evidence of phonemic aspirated fricatives exists for Burmese and the other languages in Table 3, but is tangential to this paper. The data presented here seek only to support the claim that these segments are phonologically real in some languages. A more detailed discussion is available in Craioveanu (2013).

Providing phonological rather than impressionistic or acoustic evidence of aspiration is crucial, as phonetic aspiration is not necessary for phonological aspiration, nor vice versa. Languages with phonological [+spread glottis] on fricatives can have overt phonetic aspiration as in Burmese, or lack it as in Spanish, where /s/ is realized as [s] but spreads [+sg] to adjacent stops (Vaux and Miller, 2011). Similarly, languages with fricatives unspecified for [sg] may exhibit optional phonetic aspiration.

In the section below, hierarchical feature ranking is used to make predictions about possible phonological systems involving fricatives and aspiration.

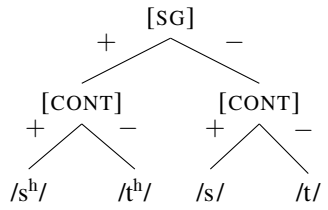
3. Synchronic Predictions

The approach used in this paper follows Modified Contrastive Specification (MCS; Dresher et al., 1994; Dresher, 2009) and the Contrastivist Hypothesis, assuming that only *contrastive* features are phonologically active. In other words, the only elements present in a language's phonology should be those necessary to account for its phonological patterns.

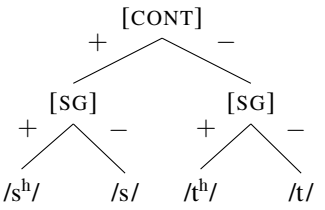
Under MCS, the contrastive status of features can be determined procedurally through the Successive Division Algorithm, which progressively subdivides a phonemic inventory into contrasting sets of phonemes until each set contains only one phoneme (Dresher, 2009: 16). These featural divisions can be represented in a hierarchical ranking, and we can use these contrastive feature hierarchies to make predictions about the kinds of inventories that should be possible, and determine whether these are actually attested.

The trees in (4)–(8) illustrate the possible phonological systems for different combinations of the features [continuant] and [spread glottis]. This output has been restricted to show only systems that have a licit phonemic inventory: languages with fricatives must also have stops, and languages with aspirated fricatives must also have aspirated stops and unaspirated fricatives. A phonemic inventory like /t s sʰ/ (without /tʰ/) or /t tʰ sʰ/ (without /s/) is ill-formed, and the feature ranking that results in it will not be considered. When using contrastive hierarchies to predict possible phonological patterns, it is necessary to restrict the output in this way to avoid overgeneration.

(4) *Contrastive aspiration A*

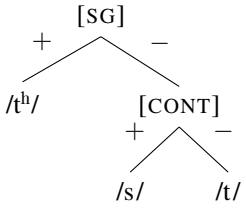


(5) *Contrastive aspiration B*



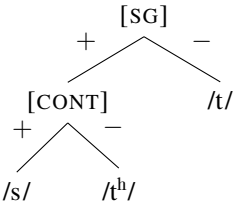
Burmese, Karen, Tibetan,
S. Subanen

(6) *Phonologically unaspirated*



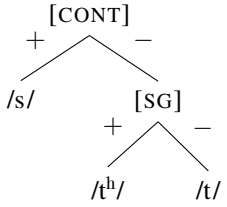
(unattested)

(7) *Phonologically aspirated*



Armenian, Spanish, Thai & other
Tai langs., Sanskrit, Mongolian

(8) *Unspecified for aspiration*



Korean, Thai Karen dialects,
Mazatec

Each of the predicted phonological systems above has a few examples of languages that fall into that category. Note that there are three possible rankings for a language with phonetic [sʰ]—one of (4), (5), or (7)—depending on whether it has a contrasting unaspirated counterpart. In Mongolian for instance, /s/ is phonetically realized with aspiration, and is very likely [+sg], but it has no unaspirated counterpart, so I do not count it as an instance of a true contrastively aspirated fricative (Svantesson et al., 2005). This paper focuses on the diachronic patterns

observed for contrastively aspirated fricatives, so the relevant rankings are those in (4) and (5). Full rationale, language data, and discussion for the others can be found in Craioveanu (2013).

It is important to note that rankings (4) and (5) predict the exact same consonant inventory and featural specifications, and are therefore nearly identical. However, they allow for different diachronic merger patterns. For this reason, I tentatively group all of the languages in Table 3 under ranking (5). The assumptions about diachronic change in a Contrastive Hierarchy approach are explained further in the following section.

4. Diachronic Mechanisms

The operative principle of contrast in sound change, formalized as the *Sisterhood Merger Hypothesis* (SMH) by Oxford (2012), is that phonemic mergers apply to 'contrastive sisters'—namely features that share the same parent node in the hierarchy. This requires the merged feature to be the lowest-ranked in the hierarchy. As an extension of this principle, newly-contrastive features must also begin at the bottom of the hierarchy—that is, phonemic splits must result in contrastive sisters. These principles are summarized in (9).

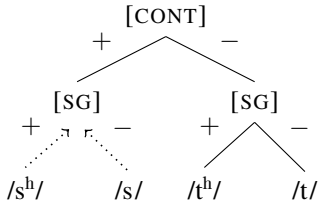
(9) *Sisterhood Merger Hypothesis:*

a. Phonemic mergers apply to contrastive sisters.
b. Phonemic splits result in contrastive sisters.

Thus, the [cont]>[sg] feature ranking chosen above is preferable for languages that contrast [spread glottis] on voiceless fricatives, under the assumption that an aspiration contrast on fricatives is less stable diachronically than the contrast between fricatives and stops. Ranking [spread glottis] below [continuant] in the hierarchy simulates this instability by representing [spread glottis] as the contrast that is more likely to be lost in those phonological systems.

When an aspiration merger does occur for fricatives, an inventory like (5) collapses to (8), which is otherwise identical but lacks the fricative aspiration contrast; this merger is illustrated in (10). This is predicted to have occurred in the Thai dialects of the Karen languages, as discussed below in §4.4.

(10) *Collapse of fricative [spread glottis] contrast*



In cases where aspirated fricatives develop, [spread glottis] enters the bottom of the hierarchy, becoming contrastive by splitting the former [+cont] /s/ into two new phonemes, [+cont, +sg] /s^{h}/ and [+cont, –sg] /s/.

There are three mechanisms through which aspirated fricatives have been found to arise in the languages that I have examined: deaffrication, degemination, and a chain shift process. These are briefly outlined in (11); I will discuss them each in greater detail below.

(11) a. *Degemination*
ss → /s^{h}/
b. *Deaffrication*
ts^{h}→ /s^{h}/
c. *Chain shift*
s → /s^{h}/
z → /s/

4.1 Degemination

In this process, voiceless geminates obstruents become aspirated singletons. The relationship between geminates and aspiration is a close one in many languages, even synchronically. For instance, in Andalusian Spanish, the debuccalization of coda /s/ can affect both the length and aspiration of a following consonant. A /st/ cluster can be realized phonetically as a pre- or post-aspirated singleton [^{h}t / t^{h}], an unaspirated geminate [tt], or a preaspirated geminate [^{h}tt] (Gerfen, 2002; Torreira, 2007). In Icelandic, an aspirated geminate /tt^{h}/ is degeminated to [ht]; this can be seen in the data in (12) (from Thráinsson, 1978: 10), where the neuter is formed by adding /–t/ to the stem.

(12)

FEM. SG.		NEUT. SG.		
mæta	[mai:t^{h}a]	mætti	[maihti]	*'fat'*
veita	[vei:t^{h}a]	veitti	[veihti]	*'ugly'*
nýta	[ni:t^{h}a]	nýtti	[nihti]	*'sweet'*

Finally, in the Chumashan languages, morphological geminates also degeminate to an aspirated singleton; unlike Spanish or Icelandic, this synchronic process does yield aspirated fricatives, although these segments do not exist phonemically in the Chumashan languages. This process is most commonly observed with the pronominal prefixes /p–/, /t–/, and /s–/, but may also occur word-internally. Examples from Ineseño Chumash are shown in (13) (data from Applegate, 1972; The Santa Ynez Band of Chumash Indians, 2007).

(13) *Chumash aspiration resulting from degemination*

a.	/p-popotʃ'/	[p^{h}opotʃ']	*'your paternal grandfather'*
b.	/s-se/	[s^{h}e]	*'its bone'*
	/s-ʃuʃ/	[ʃ^{h}uʃ]	*'his/her hair'*
	/s-was-sisin/	[swas^{h}isin]	*'the terrain is rugged'*
c.	/k-kuti/	[k^{h}uti]	*'I see'*
	/no-k-tak-kuj-ʃ/	[noktak^{h}ujʃ]	*'I will send'*
	/k-qoʔ/	[q^{h}oʔ]	*'my pet'*

Given the appearance of this process synchronically in three unrelated language families, it is unsurprising that it would also be a mechanism through which aspiration could arise diachronically. Degemination is observed historically in Southern Subanen, where aspiration arose from two historical processes of regressive cluster assimilation and degemination affecting *p, *t, *s, and *k, whereby *gC clusters underwent voicing assimilation to *kC, became *CC geminates, and then degeminated to *C^{h} (Lobel and Hall, 2010). This is illustrated in (14).

(14)

*gp	→	*kp	→	*pp	→	/p^{h}/
*gt	→	*kt	→	*tt	→	/t^{h}/
*gs	→	*ks	→	*ss	→	/s^{h}/
*gk	→	*kk		⟶		/k^{h}/

The development of the aspirated fricative mirrors that of the aspirated stops, suggesting that all of the voiceless obstruents pattern together phonologically in Southern Subanen. Tone and voice quality do not play a role in the language, and aspirated /p t s/ contrast synchronically with unaspirated /p t s/, further confirming that fricative aspiration is phonological.

4.2 Deaffrication

Deaffrication may result in aspirated fricatives if a language had a historical aspiration contrast on affricates, which is then preserved in the fricative series after the initial closure is lost. This process is observed in the Karen languages, as shown in (15) and (16) below (data from Jones, 1961). The appearance of aspirated fricatives is largely the same across the Karen languages, but Sgaw and Palaychi kept *ts before glides, and lost aspiration on obstruents where a final proto-laryngeal was also lost. A nearly identical deaffrication process occurred in Burmese, shown in (17) (data from Bradley, 2011).

(15) *Pwo Karen deaffrication*

*ts	→	/s/
*ts^{h}	→	/s^{h}/
*s	→	/θ/

(16) *Sgaw Karen & Palaychi*

*ts	→	/s/, /ts/
*ts^{h}	→	/s^{h}/
*s	→	/θ/

(17) *Burmese deaffrication*

*ts	→	/s/
*ts^{h}	→	/s^{h}/
*dz	→	/z/
*s	→	/θ/
*hr,*hj	→	/ʃ/

In these languages, a [spread glottis] contrast did not develop on fricatives as it did with the degemination mechanism; rather, it was preserved when the fricatives developed in order to maintain existing contrasts.

4.3 Chain Shift

The final process discussed here is a chain shift whereby voiced fricatives lose their voicing, and the previous voiceless fricatives become aspirated. In Kami and Cone Tibetan, for fricatives at all coronal places of articulation, unprefixed voiceless fricatives became aspirated, voiced fricatives became plain voiceless, and prefixed fricatives maintained their original laryngeal properties (Jacques, 2012; Chirkova, forthcoming). This is schematized in (18), and example data from Kami Tibetan are given below in (19).

(18) *Chain shift in Tibetan*

*s	→	/s^{h}/	*Cs	→	/s/
*ɕ	→	/ɕ^{h}/	*Cɕ	→	/ɕ/
*z	→	/s/	*Cz	→	/s/
*ʑ	→	/ʑ/	*Cʑ	→	/ʑ/

(19)

	OLD TIBETAN	KAMI	
a.	*sa	/s^{h}ɔ́/	*'earth, land'*
	*ɕi	/ɕ^{h}ə́/	*'to die'*
b.	*zag	/sà/	*'to shed (tears)'*
	*ʑim	/ɕɛ̀/	*'tasty, delicious'*
c.	*bsad	/sé/	*'to kill'*
	*bzi	/zə̀/	*'to be drunk'*
	*bʑi	/ʑə́/	*'flour'*

It is interesting to note that the Old Tibetan *s appears to have been phonologically [+spread glottis], as a sonorant devoicing process occurred in the evolution of Kami Tibetan was triggered by a preceding *h, *s, or aspirated stop. This fact makes this chain shift less puzzling. It is not that aspiration spontaneously appeared on *s: rather, the [spread glottis] values of *s and *z are actually pre-

served through the shift, and are simply realized differently. The motivation for this change is still unclear, but keeping in mind the rarity of aspirated fricatives cross-linguistically, it was likely a "push" chain shift driven by the reduction of the historical consonant clusters.

Given these processes, and the fact that the Old Tibetan consonant clusters have been greatly simplified in most of the modern Tibetan languages, it would be valuable to investigate historical patterns within this language family further. It is possible that some related languages show a similar shift, but without a modern fricative aspiration contrast; this might suggest that such a contrast developed and was later lost.

4.4 Loss of Aspiration Contrast

Aspirated fricatives are not often reconstructed for languages historically, so it is hard to say for certain what happens when consonant systems with contrastive fricative aspiration destabilize. The scant data available suggest that some dialects of the Karen languages have lost aspiration on fricatives, and that Burmese may be in the process of doing so as well. Bradley (2011) notes that the contrast between /s/ and /s^{h}/ is disappearing in modern Burmese, calling the voiceless aspirated fricative "unstable" (49). Unfortunately, he does not provide any data to illustrate this.

With respect to the Karen languages, data on Burmese dialects describe a contrast between /s/ and /s^{h}/; however, studies of these languages in Thailand make no mention of /s^{h}/ as a phoneme (e.g., Kaewsilpa, 1986, cited in Chuensukon, 1995; Pattanaporn, 2012). This is unlikely to merely be an oversight, as Pattanaporn's phonetic description of Chiang Mai Sgaw Karen is quite detailed and thorough. As the Karen languages are minority languages in both Burma and Thailand, it is conceivable that this difference is a result of influences from the Burmese and Thai languages, as the latter does not have /s^{h}/ but the former does.

In the Thai Karen languages, the loss of the aspiration contrast on fricatives results in the ranking in (8), discussed earlier in §4. The merger of /s s^{h}/ in dialects spoken in Thailand suggests that the closely-related Burmese Karen dialects might also have [sg] ranked quite low.

Apart from Karen and Burmese, little concrete evidence has been turned up regarding the loss of aspirated fricatives. If these segments are indeed diachronically unstable, we expect that they would have developed but been lost in other languages as well. The deaffrication process suggests an avenue of investigation for locating potential historical aspirated fricatives which have since been lost. In a process that changes the manner of articulation of obstruents, but otherwise preserves the aspiration contrast, we might expect that cases where historical *ts^{h}corresponds to modern /s/ to have had an aspirated intermediate; finding this intermediate aspirate seems more likely for deaffrication than the degemination discussed above, since an existing aspiration contrast is more likely to be pre-

served. While I have not encountered this in any of the languages investigated thus far, this is an interesting pattern to pursue in future research.

5. Discussion & Conclusions

In this paper, I have outlined three diachronic processes that result in aspirated fricatives, as well as put forth some theories about where we might find historical aspirated fricatives. One point that has been demonstrated by the feature rankings above is that there is no purely phonological argument for the rarity of aspirated fricatives: featural combinations resulting in these phonemes are both predicted and attested in the languages surveyed. The previous section has also demonstrated that the historical processes resulting in aspirated fricatives are in no way unexpected or anomalous.

Since we cannot account for the under-representation of this pattern on purely phonological grounds, we must make some reference to the articulation or acoustics of aspirated fricatives. For instance, it is possible that a fricative aspiration contrast is less perceptually salient than one on stops or affricates, or that it is more articulatorily demanding to realize aspiration on a fricative than on a stop or affricate. An articulatory influence on phonological specification would provide an explanation for both the tendency of voiceless fricatives to be [+spread glottis] (described by Vaux and Miller (2011) and others) and the typological rarity of languages where voiceless fricatives are [–sg], be it independently or in contrast with [+sg] aspirated fricatives. Further research on the synchronic and diachronic phonological patterns observed for fricative laryngeal features, as well as instrumental investigation of aspirated fricatives, will help us further understand why the distribution of these segments is so limited.

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