A fraction too much friction

The phonological status of voiced fricatives

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Typological work shows that voiced fricatives like /β ð/ occur more often without their voiceless counterparts than with them, contrary to what would be expected on the basis of markedness relations between voicing and obstruents. This paper suggests that many of the offending fricatives are more appropriately viewed as sonorants, whose unmarked status is to be voiced. This view has an important consequence for the interpretation of intervocalic voicing (e.g. *afa* > *ava*), which we suspect is the diachronic origin of most of the fricatives in our corpus. We propose that intervocalic voicing is sonorization, formalized in terms of the suppression of melodic material.

Keywords: markedness, fricatives, sonorants, intervocalic voicing, lenition, Element Theory

1. Introduction

In phonology, an oft-cited diagnostic for markedness is implication: A segment X is more marked than a segment Y if the presence of X implies the presence of Y. For example, the presence of voiced plosives in a language implies the presence of voiceless ones, but not vice versa. Thus we find languages like Pitta Pitta with the plosive system in (1a), languages like Dutch with the plosive system in (1b), but, as far as we are aware, no languages with the plosive system in (1c).[1]

(1) a. Pitta-Pitta (Dixon 1980: 143)

voiceless	p	t̪	t	ʈ	c	k
voiced						

b. Dutch (Booij 1995: 7)

voiceless	p	t	k
voiced	b	d	

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c. unattested

voiceless			
voiced	b	d	g

The markedness relation between plosives and voicing is likely to be phonetically grounded, given the antagonistic effect of supralaryngeal closure on vocal cord vibration (see for instance Ohala 1983; Westbury 1983).

Interestingly, typological evidence suggests that the markedness relation between plosives and voicing is not observed for fricatives. For example, in the UCLA Phonological Segment Inventory Database (UPSID, Maddieson 1984), a database of 317 languages, "bilabial, dental and palatal non-sibilant fricatives are found to occur without a voiceless counterpart more often than with one" (Maddieson 1984: 48) (and about ⅓ of the languages in UPSID with /ɣ/ lack /x/). The same picture emerges from more recent typological work, such as P-Base, a database of phonological patterns of 628 languages (Mielke 2008). An example of a language in UPSID with voiced, but not voiceless, non-sibilant fricatives is Mixtec, whose (oral) fricative inventory is given in (2).

(2) Mixtec (Maddieson 1984: 377; based on Hunter & Pike 1969)

Sibilant	voiceless			s	ʃ
	voiced				ʒ
Non-sibilant	voiceless				
	voiced	β	ð		

One interpretation of the patterning of voiced non-sibilant fricatives is that the markedness relation between voicing and obstruency is limited to plosives. However, we believe that a more attractive hypothesis is that many of the 'offending' fricatives are not in fact obstruents but sonorants, whose unmarked status is to be voiced. The advantage of this interpretation is that it maintains the markedness relation between voicing and obstruency, and that it accords well with the phonetic and phonological properties of offending fricatives, as we will see below. Incidentally, notice that our use of the word 'many' implies that we take the sonorant status of offending fricatives to be a strong tendency rather than an absolute fact (an absolute view of markedness seems to be contradicted in any case by the Zina Kotoko and Ura data, discussed in Section 3.2).

The paper is organized as follows. Section 2 argues that an analysis of offending fricatives as sonorants is not unreasonable from both a typological and a phonetic perspective. Section 3 shows that the analysis is also supported by phonological evidence: Inspection of P-Base reveals that offending fricatives frequently pattern as sonorants, while (exclusive) class behaviour with obstruents is at best marginal. Section 4 considers one important implication of our hypothesis, viz.

the status of intervocalic voicing. We propose that this process receives a straightforward interpretation in Element Theory (Harris & Lindsey 1995), using insights from the Modulation Theory of Speech (Traunmüller 1994).

2. Sonorant fricatives: typological and phonetic evidence

We begin our discussion by making a number of general observations about the typological distribution of fricatives, and by pointing out that the observed patterns are not unexpected in light of the phonetic properties of different types of fricative articulations.

First, the markedness anomaly between fricatives and voicing holds for non-sibilant fricatives only. Inspection of UPSID shows that sibilants display the same markedness relation with voicing as do plosives, in that the presence of a voiced sibilant in an inventory almost always implies that of its voiceless counterpart, but not vice versa. The Mixtec inventory in (2) is a case in point: Non-sibilant /β ð/ occur without their voiceless counterparts while of the sibilants, /ʒ/ occurs with /ʃ/, and /z/ is absent. We take the observation that sibilants pattern like plosives to mean that sibilants are more obstruent-like than non-sibilants; a claim that is consistent with our hypothesis that offending non-sibilants tend to be sonorants.

Typological evidence also suggests that sibilants are less marked than non-sibilants. Data from UPSID shows that if a language has a fricative, this fricative is a sibilant. The unmarked status of sibilants appears to be grounded in perception. Ladefoged & Maddieson (1996: 145) observe that "the principal noise source [in sibilants] is the turbulent airstream produced when the jet of air created by the dental or alveolar constriction strikes the teeth, which form an obstacle downstream from the constriction itself." As a result, sibilants display a spectrum with virtually no damping, whereas non-sibilants, which lack this noise source, display energy reduction in various frequency bands. This suggests that perceptually, a sibilant is the optimal fricative articulation.

The markedness relation between sibilants and non-sibilants can be used as a diagnostic to evaluate the phonological status of offending fricatives. Consider Uradhi, a Northern Paman language of Cape York, in which Proto-Paman **p *t *k* have the reflexes /β ð ɣ/ (Hale 1976; Crowley 1983). According to Crowley, Uradhi has the obstruent inventory in (3).

(3) Uradhi (Crowley 1983: 316)

Stop	voiceless	p	t̪	t	ʈ	k
	voiced					
Fricative	voiceless					
	voiced	β	ð			ɣ

However, classifying /β ð ɣ/ as fricatives would imply that Uradhi violates the markedness relation between obstruency and voicing, and the typological requirement that the fricative inventory of a language minimally contains a sibilant. (It is worth noting that fricatives are in general marginal in Paman languages.) From a markedness perspective, classifying /β ð ɣ/ as sonorants therefore seems appropriate. In Section 4, we argue that the historical origin of /β ð ɣ/ — intervocalic voicing — also supports their sonorant status.

Phonetically, it is not surprising to find voiced fricatives patterning as sonorants. Voiced fricatives present an aerodynamic challenge, as vocal cord vibration leads to lower airstream velocity, making it relatively difficult to produce turbulence. We suspect, therefore, that some (perhaps many) voiced fricatives reported in the literature do not in fact involve strong friction, but have a realization that is more approximant-like. This is of course an empirical question. However, it is encouraging that recent work has uncovered evidence, both phonetic and phonological, that /v/ in German (Hamann 2006) and Hungarian (Bárkányi & Kiss 2006) has sonorant-like properties. For example, Hamann provides acoustic measurements (duration, intensity and harmonics-to-noise ratio) which show that German /v/ is phonetically a narrow approximant. In German and Hungarian, /v/ contrasts with /f/; but there is no reason why we should not find similar phonetic evidence in languages that have voiced fricatives only. With respect to Uradhi, Crowley (1983: 316) does not give any phonetic detail other than that /β ð ɣ/ "are always realized as voiced sounds", and that /ɣ/ is "a 'smooth' velar fricative, i.e. one without noticeable accompanying vibration of the uvula." This is at the very least not inconsistent with the hypothesis that the sounds involved are sonorants.

We conclude this section with another typological argument against the obstruent status of offending fricatives. The data in UPSID and P-Base suggest that the place distinctions of non-offending fricatives tend to parallel those of plosives. (Phonetically, labial fricatives tend to be labiodental while velar fricatives tend to have a more posterior articulation than velar stops.) This is not surprising since fricatives often result from diachronic spirantization of plosives. The distribution of offending fricatives across the major places of articulation is much more scattered, however (see also Section 3.2). An illustrative case is observed in Kpelle, a Mande language spoken in Liberia and Guinea (Welmers 1962). Kpelle has unpaired /ɣ/, which patterns with /ɓ l j w/. These sounds are in complementary

distribution with nasals, with the former occurring before oral vowels (4a), and the latter before nasalized vowels (4b).

(4)	a.	ɓɔɔ	'bag'	(*ɓɔ̃ɔ̃)	b.	mĩ	'where'	(*mi)
		luu	'fog'	(*lũũ)		nĩnã	'new'	(*nina)
		ja	'water'	(*jã)		ɲɛ̃ɛ̃	'fish'	(*ɲɛɛ)
		ɣila	'dog'	(*ɣĩla)		ŋĩnã	'rat'	(*ŋina)
		wee	'white clay'	(*wẽẽ)		ŋʷãnã	'bitter'	(*ŋʷana)

Following among others Rice (1993) and Botma (2011), we take such oral–nasal alternations as an argument for the sonorancy of the segments involved. In Kpelle, typological evidence for the sonorant status of /ɣ/ thus converges with evidence from class behaviour. In Section 3, we consider the phonological patterning of offending fricatives in some more detail.

3. Sonorant fricatives: phonological evidence

So far, we have seen that there are reasonable typological and phonetic grounds for treating unpaired voiced fricatives as sonorants. But is this analysis also backed up by phonological evidence? A detailed discussion of this issue is clearly beyond the scope of this paper. Here we offer a preliminary investigation of the class behaviour of offending fricatives, based on information extracted from P-Base (Mielke 2008).

3.1 Methodology

P-Base was searched for languages containing a voiced fricative without the corresponding voiceless counterpart, for every major oral place of articulation (labial, coronal, dorsal). Minor place differences were ignored. (For example, a language with /β/ but not /ɸ/ was checked manually for the presence of /v/ and /f/. The language would then be included if it had /v/ only, or both /v/ and /f/; but it would be excluded if it had /f/ only, on the grounds that /f/ and /β/ might be contrastive.) A total of 127 languages fitted this criterion for at least one place of articulation. From this total, we selected one representative for every language for which different dialects were included, provided no relevant dialect differences were observed. Languages in which the criterion was met by sibilants only were also discarded (see Section 2 for motivation), as were languages in which the criterion was met only by pharyngeals and glottals. This yielded a final selection of 70 languages (see Appendix).

For each of the languages in our sample, the phonological patterning of the offending fricatives was examined. Languages in which offending fricatives pattern exclusively with sonorants provide direct evidence for our hypothesis. Languages in which offending fricatives pattern with obstruents and sonorants also support our hypothesis, on the assumption that these sounds share features with both segment types (i.e. they are 'sonorant obstruents' in the sense of Rice 1993). Languages in which offending fricatives pattern neither with obstruents nor with sonorants provide no evidence for their phonological status. Finally, languages in which offending fricatives pattern exclusively with obstruents provide counter-evidence to our hypothesis.

3.2 Results

The first point to note is that offending fricatives are not evenly distributed across the world's languages. More than half of the languages in our sample belong to just three linguistic families, viz. Niger-Congo (n=16), Austronesian (n=14) and Dravidian (n=9). Another general observation concerns the place of articulation of the offending fricative: The fricative was labial (/v/, /β/, or both) in 45 languages, coronal (/ð/) in 5, and dorsal (/ɣ/ or /ʁ/) in 29. Of the languages in our sample, 61 have just one offending fricative (labial: n=37, dorsal: n=22, coronal: n=2).

As noted in Section 3.1, we examined whether the offending fricatives display class behaviour with sonorants, with obstruents, with both, or with neither. (Segments display class behaviour if they jointly trigger or undergo some phonological process, or are subject to some distributional constraint.) Unless otherwise noted, all relevant information is taken from P-Base.

In 13 of the 70 languages in our sample, the offending fricatives display class behaviour with sonorants only. Examples include Epie, where /ɣ/, together with /l j w/, alternates with nasals under harmony, much like in Kpelle (see Section 2).[2] In Tiv, /ɣ/ can be syllabic, parallel to /v l n/ (while /z/, which contrasts with /s/, cannot). Another example of sonorant class behaviour comes from Malayalam, where /v/ patterns with /j/: Both sounds are hiatus fillers, and they are banned from word-initial position.

Phonological patterning of offending fricatives with both sonorants and obstruents is observed in 15 languages in our sample. For example, in Wiyot, the second member of initial clusters is limited to /β w l/ and non-labialized dorsals, including obstruents. A similar restriction is observed in Marathi, where /v/ patterns with liquids and /j/, but also with /k/.

For 34 of the languages, P-Base contains phonological activity that is specific to the class of offending fricatives itself, but gives no information on class behaviour with sonorants or obstruents. Pending further research on these languages,

support for the sonorant status of the offending fricatives is therefore limited to typological considerations.

For our purposes, the final and most important group of languages in our sample is that of (apparent) counter-examples: Languages in which offending fricatives pattern with obstruents. At first glance, P-Base contains 8 such languages. This amounts to slightly more than 10% of our sample, which seems reasonable if, as we assume, markedness is a reflection of common linguistic tendencies. However, closer inspection suggests that for 5 of these languages the evidence is rather uncompelling, and that one (Inupiaq) in fact appears to confirm our hypothesis. We will consider each of these languages below.

First, in Inupiaq, /v/ and /p/ alternate in a pattern of intervocalic lenition, a process which affects all stops (/p t k q/). In Section 4, we argue that this is precisely the type of process that is best analyzed as sonorization, rather than voicing. If this is correct, Inupiaq is not a counter-example but in fact supports our hypothesis.

Muna has a restriction on the co-occurrence of oral consonants and homorganic nasals in CVCV roots. This pattern includes the offending fricative /ʁ/ (e.g. *ʁVŋV/), but not the liquids /l r/. One interpretation of this restriction is that /ʁ/ patterns with obstruents. However, another possibility is that /l r/ are unspecified for place, and so escape the homorganicity restriction (for other arguments in favour of this approach to liquids, see for instance Goad & Rose 2004; van 't Veer 2013). We believe that there is some support for the latter analysis. Muna has the sonorant inventory /m n ŋ l r w/. Coetzee & Pater (2008) include /w/ in the class of segments that is subject to the homorganicity restriction (P-Base is less explicit about the patterning of /w/). This would suggest that the restriction is not limited to just obstruents, and hence that there is no compelling evidence against analyzing /ʁ/ as a sonorant.

In Urhobo, the targets of nasal harmony are restricted to sonorants, while obstruents remain unaffected. Unpaired /ɣ/ is not a nasalization target; but since nasalization also fails to target /r/, this does not necessarily mean that /ɣ/ is an obstruent.

In Xhosa, the class of 'inaspirates' undergoes aspiration in post-nasal context. Unpaired /ɣ/ is part of this class. However, rather than treating /ɣ/ as voiced (a contrast that is limited to obstruents), it seems more appropriate to analyze it as unaspirated. According to this analysis, /ɣ/ is not in fact unpaired but functions as the unaspirated congener of /ɣʰ/. Thus, while /ɣ/ does not appear to pattern as a sonorant, the fact that it is paired with /ɣʰ/ means that it does not contradict our hypothesis.

In Pulu Annian, an Austronesian language, a process of consonant gemination affects plosives and unpaired /ð/, but not non-nasal sonorants. This might suggest that /ð/ is not a sonorant but a fricative. In this case, /ð/ would be the only

voiced obstruent in the language (Pulu Annian has the obstruent inventory /p pʸ t k s ð/). Given this, an alternative interpretation would be to say that voicing in Pulu Annian is not a phonological property — perhaps /ð/ is 'lenis'. Another possibility would be that /ð/ functions as the voiced counterpart of /s/. In either case, Pulu Annian would not be a counter-example to our hypothesis.

Sie, another Austronesian language, has two offending fricatives, /v/ and /ɣ/. These pattern with /s/ in pre- and post-nasal hardening, a process that does not target glides (and so does not target continuancy per se). On the other hand, Sie has no voicing contrast at any place of articulation, neither for stops nor for fricatives. This could mean that /v/ and /ɣ/ are not phonologically voiced (perhaps they, too, are 'lenis'), in which case the language is not a counter-example.

This leaves us with 2 languages in which the unpaired voiced fricatives seem to pattern exclusively with obstruents. Zina Kotoko displays a complicated system of tonal depression in which some segments trigger lowering of a high tone to a mid tone in some contexts, and lowering of a mid tone to a low tone in others. In one context, voiced fricatives, including unpaired /ɣ/, act as depressors. In Ura, finally, /ɣ/ patterns with voiced obstruents in that both are banned from word-final position.

Summarizing, our investigation suggests that P-Base contains little compelling evidence against the hypothesis that offending fricatives are sonorants. For 6 of the 8 languages in the P-Base sample which display class behaviour of offending fricatives with just obstruents, we have shown that a reasonable alternative interpretation is available. However, it will be clear that a more detailed examination of the languages in our sample is needed to substantiate our hypothesis, and to determine whether the class behaviour of /ɣ/ in Zina Kotoko and Ura is truly limited to obstruents.

4. Discussion

In the preceding sections, we have offered some fairly general arguments for an analysis of offending fricatives as sonorants. However, we have so far sidestepped the question of how this analysis can be integrated into phonological theory. This section sketches a preliminary account of this. We do so against the backdrop of intervocalic voicing, which we suspect is the diachronic origin of most of the offending fricatives in the P-Base sample.[3]

Intervocalic voicing is a process whereby a voiceless consonant is realized as voiced in the context of two flanking vowels. The process is rather common diachronically; it is observed, for example, in the development from Latin to Spanish (see for instance Campbell 2013):

(5)

Latin		*Spanish*	
lupu	>	lobo	'wolf'
vīta	>	vida	'life'
ficu	>	higu	'fig'

A synchronic example is found in West Greenlandic (and in other Inuit languages such as Inupiaq; see Section 3.2), where the initial consonant of the 3SG-IND marker is /v/ between vowels and /p/ elsewhere (Fortescue 1984).

Intervocalic voicing bears all the hallmarks of lenition (for recent discussion of this term, see Honeybone 2008). Like spirantization and vocalization, it involves an increase in sonority, and it applies in a context where lenition is typical. Intervocalic voicing also complies with Vennemann's definition of lenition ("a segment X is said to be weaker than a segment Y if X goes through a Y stage on its way to zero", cited in Hyman 1975), as is illustrated by the development of Old Danish *pipær ~ piber* to Modern Danish *pe*[(w)]*er* 'pepper', for example.

The theoretical interpretation of intervocalic voicing is not straightforward, however. Lenited sounds are usually assumed to undergo assimilation and/or co-articulation with surrounding sounds. According to this view, the vocal cord vibration and open vocal tract shape of the flanking vowels are imposed to varying degrees on the affected consonant (e.g. Lavoie 1996; Kirchner 1998), although Kingston (2008) shows that the relative openness of the flanking vowels does not correlate with the likelihood of lenition. In phonological terms, intervocalic voicing would thus seem to involve the addition of voicing to the targeted stop, e.g. through spreading of the feature [voice].

Such an analysis is unattractive for a number of reasons, however. One problem concerns the origin of the voicing: If intervocalic voicing is interpreted as assimilation, then the trigger could be (1) the preceding vowel, (2) the following vowel, or (3) both. Options (1) and (2) fail to limit the voicing context to intervocalic position (they also predict final and initial voicing, respectively), while option (3) leads to a proliferation of possible assimilation processes that seems excessive.

Another problem is that voicing in vowels is normally considered redundant. In traditional generative phonology, this is usually formalized by underspecifying vowels for [voice]. In such an account, intervocalic voicing would involve rule-ordering, since spreading of [voice] to the consonant can apply only after the triggering vowels have been specified for it. This scenario has been proposed to account for post-nasal voicing assimilation (see Itô & Mester 1986), but has been shown to be problematic (cf. Rice 1993).

Finally, an account in terms of voicing assimilation is incompatible with the hypothesis put forward in this paper: If intervocalic voicing creates unpaired voiced

fricatives in a language, specifying these sounds for [voice] would incorrectly identify them as obstruents — assuming we want to restrict [voice] to this class.

Given these problems, we feel that a more promising approach to intervocalic voicing is to take seriously the idea that the process is a type of lenition. In the remainder of this section, we consider briefly how intervocalic voicing can be formalized in Element Theory (Harris & Lindsey 1995). Element Theory provides a unified account of lenition phenomena such as spirantization, vocalization and debuccalization in terms of the deletion of elements from the affected sound. For example, Harris & Lindsey (1995: 71) assume that the representation of /p/ contains three elements, as in (6), where |U| denotes labial place, |ʔ| a drop in amplitude, and |h| oral release (if |ʔ| is also present; if not, |h| denotes friction).

(6) *p* |h, U, ʔ|

Lenition of *p* to *w* then involves the loss of one or more elements. A possible trajectory is given in (7), where the plosive goes through an intermediate stage of spirantization:

(7) *p* |h, U, ʔ| > *f* |h, U| > *w* |U|

The result of vocalization is a segment that is specified for |U| only, which in nonnuclear position is realized as [w]. (Alternatively, debuccalization of *f* would involve the loss of |U|, which results in a segment specified for |h|, which is interpreted as /h/.) One advantage of this analysis is that it ties in with the observation that lenition typically occurs in 'weak' positions, i.e. positions in which languages allow only a subset of contrasts.

How does intervocalic voicing fit into this picture? It is not immediately obvious how the emergence of voicing can be reconciled with the deletion of elements. (An account in terms of the 'voicing element' |L| would face the same problems as the voicing assimilation analysis discussed above.) We believe that the key to this puzzle is supplied by an assumption of Harris and Lindsey's which has received comparatively little attention in subsequent work: The idea that in vowels, there is "a base line on which the elemental patterns associated with |A|, |I| and |U| are superimposed" (Harris & Lindsey 1995: 60). In Harris and Lindsey's approach, this base line is represented by the 'neutral element' |@|, and appears to be restricted to vowels. In our conception, a more promising avenue is to equate the base line with the notion of the 'carrier signal' from the Modulation Theory of Speech (Traunmüller 1994; see also Ohala 1992; Harris 2006). According to this theory, speech involves linguistically informative modulations of a carrier signal — the periodic sound produced by a neutrally open vocal tract. We speculate that this carrier signal is manifested phonetically in sonorants, but is masked in obstruents due to their greater articulatory constriction. Intervocalic voicing, in this

view, is therefore not the reflection of a voicing feature (or element), but the automatic result of the suppression of melodic material from the affected consonant. We believe that this is an attractive interpretation, since it maintains a unified account of lenition in terms of a reduction in complexity. We further believe that the carrier signal offers a straightforward phonetic correlate of sonorancy, whose exponence continues to be a matter of debate (see Botma 2011 for discussion), and that it provides a straightforward explanation for why voicing in sonorants is not contrastive.

5. Conclusion

This paper has offered a preliminary study on the phonetic and phonological properties of voiced fricatives. Based on the observation that fricatives do not display the same markedness relation with regard to voicing as do plosives, we have argued that there are good grounds to analyze many of these 'unpaired' voiced fricatives as sonorants. Our preliminary results suggest that such an analysis is typologically feasible, phonetically reasonable, and also supported by the phonological behaviour of these sounds.

Our hypothesis has a number of implications, of which we have discussed one: If we are right in thinking that 'offending' voiced fricatives typically result from intervocalic voicing, then this process cannot be viewed as voicing assimilation. We believe that this is a welcome result, since this interpretation is also problematic for other reasons. We propose instead that intervocalic voicing involves the suppression of melodic material from the affected sound, a property which intervocalic voicing shares with other types of lenition. The voicing which results from this suppression is the manifestation of the carrier signal — a non-contrastive property manifested by all sonorant sounds.

Notes

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1. We are concerned here with 'true' voicing languages, i.e. languages like Dutch in which the phonological contrast between the two plosive series can be reasonably analyzed as involving a feature [voice] (or element |L|).

2. Though note that in P-Base, Kpelle /ɣ/ is described as patterning with neither sonorants nor obstruents. We do not agree with this classification.

3. Eugeniusz Cyran (p.c.) notes that another development that may give rise to offending fricatives is hardening of approximants. This is the diachronic origin of /v/ (< /w/) in languages like Russian and Polish, where /v/ displays sonorant-like behaviour.

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Appendix

Sample of languages with one or more offending fricatives (source: P-Base).

	Language	*Family*	*Fricative*	*Patterning*
1	Capanahua	Panoan	β	both
2	Dhaasanac	Afro-Asiatic	ð	both
3	Evenki	Altaic	v	both
4	Gikuyu	Niger-Congo	β	both
5	Inupiaq	Eskimo-Aleut	v	both
6	Kilivila	Austronesian	β	both
7	Kuvi	Dravidian	v	both
8	Malayalam	Dravidian	v	voth
9	Marathi	Indo-European	v	both
10	Mixe	Mixe-Zoque	v	both
11	Nalik	Austronesian	β, v	both
12	Pengo	Dravidian	β	both
13	Shambala	Niger-Congo	ɣ	both
14	Tepecano	Uto-Aztecan	β	both
15	Wiyot	Algic	β	both
16	Banoni	Austronesian	v	neither
17	Chemehuevi	Uto-Aztecan	v	neither

Sample of languages with one or more offending fricatives (source: P-Base). (*continued*)

	Language	*Family*	*Fricative*	*Patterning*
18	Cofán	Chibchan	ɣ	neither
19	Georgian	South Caucasian	v	neither
20	Gondi, Adilabad	Dravidian	v	neither
21	Gondi, Koya	Dravidian	v	neither
22	Igbo	Niger-Congo	ɣ	neither
23	Inuktikut	Eskimo-Aleut	ʁ	neither
24	Irula	Dravidian	v	neither
25	Isoko	Niger-Congo	ɣ	neither
26	Kanakuru	Afro-Asiatic	ɣ	neither
27	Karimojong	Nilo-Saharan	ð, ɣ	neither
28	Kedang	Austronesian	v	neither
29	Kiribati	Austronesian	v	neither
30	Kpan	Niger-Congo	ɣ	neither
31	Kpelle	Niger-Congo	ɣ	neither
32	Kporo	Niger-Congo	ɣ	neither
33	Kui	Dravidian	v	neither
34	Lusi	Austronesian	β, ɣ	neither
35	Mojave	Hokan	v	neither
36	Mwera	Niger-Congo	β	neither
37	Okpe	Niger-Congo	ɣ	neither
38	Pima Bajo	Uto-Aztecan	v	neither
39	Rapanui	Austronesian	v	neither
40	Sinaugoro	Austronesian	ɣ	neither
41	Tacana	Tacanan	β	neither
42	Tepehuan	Uto-Aztecan	v	neither
43	Tiri	Austronesian	ɣ	neither
44	Tzotzil	Mayan	v	neither
45	Usarufa	Trans-New Guinea	β, ɣ	neither
46	Wolio	Austronesian	v	neither
47	Yavapai	Hokan	v	neither
48	Yukuben	Niger-Congo	ɣ	neither
49	Danish	Indo-European	ð, ɣ	neither
50	Muna	Austronesian	ʁ	obstruents
51	Pulu Annian	Austronesian	ð	obstruents
52	Sie	Austronesian	v, ɣ	obstruents
53	Ura	East Papuan	ɣ	obstruents
54	Urhobo	Niger-Congo	ɣ	obstruents
55	Xhosa	Niger-Congo	ɣ	obstruents
56	Yurok	Algic	ɣ	obstruents

Sample of languages with one or more offending fricatives (source: P-Base). (*continued*)

	Language	*Family*	*Fricative*	*Patterning*
57	Zina Kotoko	Afro-Asiatic	ɣ	obstruents
58	Coatzospan Mixtec	Oto-Manguean	β, ð	sonorants
59	Daga	Trans-New Guinea	v	sonorants
60	Ekigusii	Niger-Congo	β, ɣ	sonorants
61	Epie	Niger-Congo	ɣ	sonorants
62	Kamba	Niger-Congo	β, ɣ	sonorants
63	Kolami	Dravidian	v	sonorants
64	Koraga, Mudu	Dravidian	v	sonorants
65	Mikir	Sino-Tibetan	v	sonorants
66	Mongolian	Altaic	β	sonorants
67	Ostyak	Uralic	ɣ	sonorants
68	Popoluca	Mixe-Zoque	v	sonorants
69	Tiv	Niger-Congo	ɣ	sonorants
70	Tukang Besi	Austronesian	β	sonorants

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