Retroflex fricatives in Slavic languages

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The present study explores the phonetic and phonological grounds on which postalveolar fricatives in Polish can be analysed as retroflex, and considers whether postalveolar fricatives in other Slavic languages are retroflex as well. Velarization and incompatibility with front vowels are introduced as articulatory criteria for retroflexion, based on cross-linguistic data. According to these criteria, Polish and Russian have retroflex fricatives (i.e., /ʂ/ and /ʐ/), whereas Bulgarian has a laminal palatoalveolar fricative (/ʃ/). In addition, it is illustrated that palatalization of retroflex fricatives in Slavic languages (and in general) causes a phonetic and phonological change to a non-retroflex fricative.

1 Introduction

The postalveolar series of fricatives in Polish is traditionally described as apical postalveolar and referred to with the symbols /š/ and /ž/ (e.g. Dłuska 1950, Gussmann 1980, Wierzchowska 1980, Rubach 1984). Biedrzycki (1974), Dogil (1990), Jassem (2003), and Spencer (1986) use the IPA symbols /ʃ/ and /ʒ/ for these respective sounds. Nevertheless, the postalveolar fricatives in Polish differ significantly from those usually designated with /ʃ/ and /ʒ/ in English, for example, as the latter are clearly laminal, whereas the Polish phonemes seem to have the apex involved in their articulation (Biedrzycki 1974, Catford 1988). Furthermore, the Polish sounds yield a different perceptual impression than English postalveolars (Hume 1994). These facts led Keating (1991), Ladefoged & Maddieson (1996), and Hamann (2003a) to claim that the postalveolar fricatives in Polish are RETROFLEX, though their articulation does not involve the characteristic curling backwards of the tongue tip found, for example, in Dravidian retroflex stops. A phonological argument that Polish fricatives are retroflex was made by Hall (1997b) and Hamann (2003a). Apart from Polish, Keating (1991: 35) classifies only Russian and Serbian as Slavic languages with retroflex fricatives, but merely on phonetic grounds.

The present article proposes a retroflex analysis for the postalveolar fricatives in Polish and Russian. Furthermore, it tackles the question whether only this subgroup of the Slavic languages has retroflex fricatives or whether other subgroups have this segmental class, too. In order to do so, phonetic and phonological characteristics for retroflex sounds in general and retroflex fricatives in particular from typologically diverse language groups such as Scandinavian, Indo-Aryan, Dravidian, and Australian are presented in section 2. Section 3 compares these characteristics with the postalveolars in Polish, Russian, Bulgarian, and Czech to test the retroflex nature of these sounds. In line with former proposals, it will be argued that Polish and Russian have a retroflex fricative. Bulgarian will be shown to have phonetically and phonologically a laminal postalveolar. The data collected for Czech was not sufficient to

Figure 1 (a) Hindi retroflex stop /ɖ/. (b) Tamil retroflex stop /ɖ/.

make a clear decision on the exact nature of its postalveolar fricative. Section 3 furthermore provides possible answers to the question why certain Slavic languages developed a retroflex from a palatoalveolar fricative whereas others kept the original postalveolar sound of Proto-Slavic. Section 4 illustrates that palatalization of retroflex fricatives in Russian does not simply involve an addition of a secondary articulation, but yields a change in primary articulation to a palatalized palatoalveolar. Section 5 concludes.

2 Retroflex sounds in non-Slavic languages

The phonetic and phonological classification of retroflex sounds in general is problematic as these sounds make up a category with large articulatory variation. Problems in finding a unifying phonetic property were pointed out by Bhat (1973) and Hamann (2003a). Phonologically, the differing proposals for their representations, which include Lin (1989), Hamilton (1993), and Gnanadesikan (1994), indicate the problematic nature of classifying retroflexes. This section presents cross-linguistic data on the articulation, acoustics, and phonological behaviour of retroflexion.

2.1 Articulatory definition

Retroflexes are often defined as sounds articulated with the tongue tip curling in a posterior direction at the postalveolar region (e.g. Trask 1996: 308). However, the class of retroflex sounds shows considerable articulatory variation. Two x-ray tracings of retroflex plosives, one from Hindi (cf. figure 1a), and one from Tamil (cf. figure 1b) – both based on x-ray tracings in Ladefoged & Maddieson (1996: 27) – exemplify this variation. In this and the following descriptions of x-ray tracings it should be kept in mind that the shape of the tongue and the placement of its tip depend very much on the vocal tract anatomy of the speaker, and that there is large variability in anatomy from speaker to speaker. The tracings are represented in similar dimensions and with the same palate and velum in order to facilitate comparisons.

Hindi retroflex stops (figure 1a) are articulated with the tongue tip against the region behind the alveolar ridge, whereas Tamil retroflex stops (cf. figure 1b) involve a placement of the underside of the tongue tip against the postalveolar region. These two types of retroflexion can be interpreted as two extremes on a spectrum of possible retroflex articulations. Ladefoged & Maddieson (1996: 15) introduce two different symbols for these two types of retroflex stops: the Hindi-type of articulation, involving just the tongue tip, is transcribed with a subscript dot beneath the symbol for the alveolar stop /ṭ/, whereas the articulation with the underside of the tongue, as in Tamil and other Dravidian languages, receives the traditional IPA symbol for a retroflex stop /ʈ/. Švarný & Zvelebil (1955) distinguish 'retroflex' from 'cacuminal', where the former involves the use of the underside of the tongue, whereas the latter involves the tongue tip only. In this article, only one term, 'retroflex', and one symbol, the traditional IPA symbol for retroflex, /ʈ/, are used for both kinds of articulation.

The problematic nature of defining retroflexes is reflected in the IPA symbols chart, where 'retroflex' is used along with terms referring to the place of articulation such as 'dental', 'alveolar', etc., though 'retroflex' can be interpreted as describing a gesture of articulation.

Figure 2 (a) Toda retroflex fricative /ʂ/. (b) Tamil retroflex fricative /s̠/.

The literature disagrees on this point: Ladefoged (1975) and Maddieson (1984) use 'retroflex' as a value for the feature 'articulatory place', whereas Catford (1977), Ohala (1983), and Laver (1994) apply the term to an articulatory gesture. Hamann (2003a) argues for an analysis as a gesture rather than a place of articulation, and the present article will follow this line.

Variation in the articulation of retroflexes occurs not only across languages; we also find considerable speaker-to-speaker variation within one language (see, for instance, Dixit's (1990) description of Hindi retroflex stops). Moreover, factors such as vowel context, manner of articulation, and speech rate can influence the exact articulation of retroflex stops, and can lead to language-internal variation (see Hamann 2003a for a detailed discussion of these and further factors).

Unifying articulatory criteria for all retroflex stops are their apicality (the tongue tip is the active articulator), their place of articulation behind the alveolar ridge (i.e. postalveolar), and a sub-lingual cavity, visible in both articulations in figure 1. The front sub-lingual cavity is caused by the raised and somewhat retroflexed tongue tip. All sounds articulated with the tongue tip or blade at or behind the alveolar ridge cause a cavity beneath the front of the tongue. But, as Keating (1991: 43) points out, this cavity is larger for retroflex sounds than for palatoalveolars, and increases from apical to sub-apical retroflex segments.

Furthermore, retroflex stops show a retraction of the tongue body towards the velum, a movement that comprises both secondary articulations of velarization and uvularization. Retraction of retroflex sounds can be explained articulatorily. The tongue, in order to be able to move its tip up and backwards, stretches, which results in a flattening and retraction of the tongue body. For a more detailed discussion of retraction and the above-mentioned properties of retroflex stops, see Hamann (2003a).

For the present study on Slavic fricatives, it is of interest whether retroflex fricatives are articulated at the same place and with the same gesture as retroflex stops. Languages with a large fricative inventory, such as Toda, have a retroflex fricative that involves a raising of the tongue tip towards the postalveolar region (cf. the x-ray tracings in figure 2a, based on Ladefoged & Maddieson 1996: 160). This sound resembles the retroflex stops of Indo-Aryan languages and corresponds to what is traditionally described as retroflex. Cross-linguistically far more common are retroflex fricatives articulated like the Tamil sound in figure 2b (based on Ladefoged & Maddieson 1996: 156). Here the tongue tip does not seem to be involved in the articulation at all, and the place of constriction is by far wider than that of the Toda fricative. Again, Ladefoged & Maddieson (1996: 156) introduce two different symbols for the two retroflex articulations. Whereas the Tamil-type of fricative receives an underlined alveolar symbol /s̠/, the fricative found in Toda is transcribed with the traditional IPA symbol for retroflex fricatives /ʂ/.

It is interesting to note that the two different articulations for retroflex fricatives occur within the same language family (Dravidian). The difference in the realisation of the retroflex fricative might be due to the fact that Toda has a fricative system with four coronals, whereas Tamil has only three coronal fricatives (cf. Hamann 2003a).

A retroflex fricative with a curling backwards of the tongue tip, comparable to the Tamil stop in figure 1b, does not seem to occur in any language. From this we can conclude that
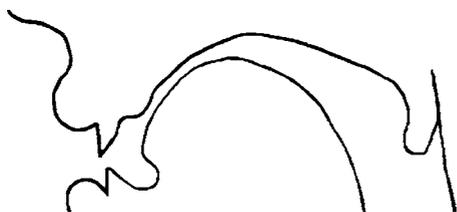
Figure 3   English palatoalveolar fricative /ʃ/.

retroflex fricatives do not involve as much curling backwards of the tongue tip as retroflex stops. Other retroflex manners such as nasal, lateral, and rhotic, behave like the stop, as shown in Hamann (2003a). Furthermore, the x-ray tracing of the Tamil retroflex in figure 2b does not show a clear apical articulation, the tongue tip seems to be withdrawn into the tongue body. Nevertheless, both retroflex fricatives share the postalveolar place of articulation, and the sub-lingual cavity with retroflex stops, and also show a retraction of the tongue body. The difference in articulation between retroflex fricatives and stops is explainable by the different requirements that hold for stops and fricatives. Whereas stops involve a simple ballistic movement and allow some degree of sloppiness in their articulation, fricatives and especially sibilants like retroflex and alveolar fricatives require very precise articulatory gestures that yield a turbulent airstream. Summing up the articulatory criteria for retroflex fricatives, they are all articulated behind the alveolar ridge, show a sub-lingual cavity, are articulated with the tongue tip (though this is not always discernible in the x-ray tracings), and with a retracted and flat tongue body.

In order to determine whether the Slavic fricatives in question are retroflexes or laminal postalveolars, we will now compare retroflex to laminal postalveolar articulations to formulate criteria that differentiate between them. The x-ray tracing in figure 3 illustrates an English laminal postalveolar (based on Laver 1994: 246). This type of sound will henceforth be referred to as PALATOALVEOLAR.

In contrast to the retroflex fricatives in figure 2, the palatoalveolar in figure 3 is clearly laminal and shows a fairly long constriction in the alveolar and postalveolar region. Furthermore, the tongue has a raised and fronted tongue body behind the constriction. For this reason the tongue shape of palatoalveolars is sometimes called 'domed' by, for example, Ladefoged & Maddieson (1996: 148). Lass (1976) and Catford (1977) infer from this tongue shape that the palatoalveolar is inherently palatalized. The present study follows these authors in this assumption.

The palatoalveolar differs from the retroflex in its tongue shape, it is raised and fronted instead of flat and retracted, and in its constriction length, which is far longer than the retroflex constriction. Both articulations share the postalveolar place and a sub-lingual cavity. The two sound classes cannot be distinguished systematically by their active articulator: although palatoalveolars are always laminal, retroflex fricatives are not always clearly discernible as apical (cf. the Tamil retroflex in figure 2b). In the following, a postalveolar place of articulation combined with a retracted, flat tongue body is therefore used as the defining articulatory property for retroflex fricatives.

Reference to the shape of the tongue as a defining criterion for a sound class is not new in phonetics; Ladefoged & Maddieson (1996: 29f.), for example, propose to distinguish between the four coronal stops and nasals in the Australian language Eastern Arrernte by the articulator shape instead of the place of articulation.

When defining retroflex sounds as retracted postalveolars, the Australian language Lardil seems to pose a problem, as it is said to have phonetically and phonologically a non-velarized retroflex fricative (Hall 1997a, 2000, and Wilkinson 1988). As shown in Hamann (2002, 2003a), these assumptions are phonetically incorrect and also unnecessary phonologically,

since an alternative representation for the Lardil data can be given without stating that the retroflex sounds in this language are [−back], i.e. non-retracted.

2.2   Acoustics of retroflexes

The acoustic criteria for retroflex fricatives presented in this section are not going to be applied to all Slavic fricatives in question, but yield some supplementary data.

The following acoustic description is restricted to voiceless fricatives; voiced fricatives usually only differ in having lower intensity than voiceless ones and an additional voicing bar. A problem in describing acoustic characteristics of fricatives is the great discrepancies among the spectra of a given fricative as spoken by different speakers (Ladefoged & Maddieson 1996: 172). The descriptions given here are generalizations across the data and might not hold for every single instance of a retroflex fricative.

In general, the cavity under the tongue in palatoalveolars and retroflexes has a lowering effect on the acoustic resonance, as Keating (1991) points out. For the retroflex fricative the frication noise usually is lower than for the palatoalveolar and shows an energy maximum in the area of the second and third formant of the adjacent vowels, i.e. between 1600 Hz and 2400 Hz. These values are similar to those of the low second and third formant transitions observed for retroflex stops (see Hamilton 1996 and Stevens 1998).

In contrast to the spectral peak of retroflex fricatives, palatoalveolars show a more evenly spread energy up to roughly 5000 Hz (Ladefoged & Maddieson 1996: 174f.), resulting in a flat, plateau-like spectrum. According to Cruttenden (1994: 164), English /ʃ/ has continuous noise in the 2000–7000 Hz region. The peaks discernable in the spectrum are higher than those of retroflexes, namely around 1800 Hz for the peak corresponding to the second formant, and 2600 Hz for that corresponding to the third formant (Stevens 1998: 410).

Despite these differences, [ʃ] and [ʂ] are very similar acoustically when compared to fricatives articulated in the velar or alveolar region. Rounding of the postalveolar fricative enhances the similarity, as lip rounding enlarges the front cavity and results in a lowering of the formant frequencies, especially the third (Johnson 1997: 118). As a result, [ʃʷ] and [ʂ] are perceptually hard to distinguish.

2.3   Phonological behaviour of retroflexes

Cross-linguistically, retroflex sounds occur infrequently in a close – or mid-front vowel – context, which might result in a change of the vowel in retroflex context. In Norwegian we can observe a phonological process of /ɛ/-lowering in retroflex context: The segment /ɛ/ has an allophone [æ] before a retroflex, exemplified in (1). The first column contains words with /ɛ/, (1a), or /eː/, (1b), followed by a dental, the second column contains words with the same vowels followed by a retroflex, where the vowels are realized as [æ] (Kristoffersen 2000: 105f.).

(1)   a.   vett   [ʋɛt]   'intelligence'   vert   [ʋæʈ]   'host'
            helg   [hɛlg]   'weekend'   helg   [hæɽj]   'weekend', less formal register
      b.   hœl   [heːl]   'heel'   hœl   [hæːɽ]   'heel', less formal register

A similar process of front vowel avoidance can be found in Mandarin (Yip 1996). Here, the retroflex series /tʂ, tʂʰ, ʂ/ is in complementary distribution with the palatal series /tɕ, tɕʰ, ɕ/. The retroflex segments occur in the context of the open or back vowels, e.g. [tʂai] and [tʂu]. Before close front vowels, however, the retroflex segments are replaced by the palatal series, [tɕi] and [tɕʏ], but not *[tʂi] and *[tʂʏ].

According to Himmelmann (1991), the Austronesian language Tolitoli spoken in Indonesia shows an alternation between an alveolar lateral approximant /l/ and a retroflex

lateral flap /ɭ/. The retroflex surfaces only after back vowels (cf. (2a)), the lateral /l/ occurs in all other surroundings (cf. (2b)).

(2) a. mo[ɭ]ogo   'wash hands'   b. membembe[l]an   'to tremble'
         u[ɭ]ag   'snake'   [l]abia   'sago'
         to[ɭ]ito[ɭ]i 'Tolitoli'   kiki[l]o   'firefly'

A possible explanation for the phonological process of retroflexes avoiding close and front vowel context (with both possible outputs, a change in the vowel and a change from retroflex to non-retroflex) is their retracted tongue body, which is articulatorily very distant from the fronted tongue body and the close jaw of close front vowels. This articulatory distance leads to the presented avoidance strategies of close front vowel and retroflex sequences (see Hamann 2003a and 2003b for a detailed discussion of this point and further examples).

3 Postalveolar fricatives in Slavic languages

The postalveolar sounds investigated in this study are illustrated with words from Polish, Russian, Bulgarian, and Czech in (3)–(6). The upper row of each language illustrates the voiceless sound, the lower row, the voiced sound, in word-initial, medial, and final position. In all these languages final devoicing occurs, thus the final column of the second row remains empty in each case. The palatoalveolar symbols were used for the sounds in question throughout the phonetic transcription, in order to avoid any implications for possible retroflexion.

	WORD-INITIAL			WORD-MEDIAL			WORD-FINAL		
(3) *Polish*									
	szal	[ʃal]	'scarf'	kasza	[ˈkaʃa]	'groats'	lekarz	[lɛkaʃ]	'physician'
	żal	[ʒal]	'grief'	gaża	[ˈgaʒa]	'fee'			
(4) *Russian*									
	šag	[ʃak]	'step'	pošel	[pʌˈʃol]	'went'	naš	[naʃ]	'ours'
	žar	[ʒar]	'heat'	xožu	[xʌˈʒu]	'I go'			
(5) *Bulgarian*									
	šal	[ʃal]	'scarf'	kaša	[ˈkaʃa]	'groats'	loš	[lɔʃ]	'bad'
	žar	[ʒar]	'heat'	lože	[ˈlɔʒe]	'bed'			
(6) *Czech*									
	šál	[ʃaːl]	'scarf'	šašek	[ˈʃaʃɛk]	'fool'	váš	[vaːʃ]	'your'
	žal	[ʒal]	'grief'	lože	[ˈlɔʒɛ]	'bed'			

Slavic postalveolars are usually transcribed with the symbols /š/ and /ž/ in traditional Slavic literature (e.g. Dukiewicz & Sawicka 1995 and Wierzchowska 1980 for Polish, Bolla 1981 for Russian, Simeonova 1988 for Bulgarian, and Kučera 1961 for Czech). Often the use of the IPA symbols /ʃ, ʒ/ can be found, as in, for example, Spencer 1986, Dogil 1990, and Jassem 2003 for Polish; Bolla 1981 and Jones & Ward 1969 for Russian; Skaličková 1974 and Dankovičová 1997 for Czech; and Ternes & Vladimirova-Buhtz 2000 for Bulgarian.

In order to determine their retroflex status, we will examine, in section 3.1, whether the postalveolars in these languages are articulated with the tongue tip and a flat, retracted tongue body. Furthermore, some acoustic cues and perceptual judgments on the sounds in question will be discussed there. In section 3.2, the phonological behaviour of the Slavic postalveolars is investigated. It will be shown that some of the languages show an incompatibility of the postalveolars with close front vowels, similar to the processes given in section 2.3. Section 3.3 speculates on possible explanations why some Slavic languages developed a retroflex fricative whereas others did not.

Figure 4 Two realizations of the Polish postalveolar.

3.1 Phonetics

The following judgments on the articulation of the postalveolar fricatives in Polish, Russian, Bulgarian, and Czech are based on x-ray studies and phonetic descriptions from the literature. The discussion is usually restricted to the voiceless fricative but holds for the voiced one as well.

In figure 4 (a and b), two schematic figures of the Polish postalveolar voiceless fricative are given, based on x-ray tracings in Biedrzycki (1974: 21) and Wierzchowska (1980: 64), respectively. As can be observed from both tracings in figure 4, the Polish sound is articulated with a flat tongue body that seems to be also retracted, though the lower part of the pharynx is not visible in the tracings. However, see Hamann (2003a) on the compulsory interaction of tongue flatness and retraction. In the tracing in figure 4a, it is clearly the tongue tip that causes the constriction, whereas in the tracing in figure 4b, the active articulator seems to be the tongue blade. In the literature, diverging opinions on the articulator can be found. Biedrzycki (1974: 20ff.), Spencer (1986), Catford (1988: 90f.) and Dogil (1990) all describe the Polish sound as apical. Ladefoged & Maddieson (1996: 154) and Jassem (2003) refer to this sound as laminal. Ladefoged (2001: 151) describes it as a sound articulated with a raised tongue tip, and Keating (1991) says that it varies between apical and laminal. In cases where the shape of the tongue is described (e.g. in Keating 1991 or Ladefoged & Maddieson 1996), there is agreement on its flat, retracted nature. Summing up these descriptions, the phonetic criteria for retroflexion developed in section 2.1 apply to the Polish postalveolar. In addition to the characteristics of the tongue, the Polish sound is described as rounded (Dogil 1990, Keating 1991) or protruded (Ladefoged & Maddieson 1996).

The acoustic measurements attest the retroflex nature of the Polish sound. According to Dogil (1990), the postalveolar Polish fricative has low frequency friction noise. Jassem's (1965) comparison of Polish, American English, and Swedish fricatives shows that the Polish postalveolars have frequency peaks at the height of the second and third formant that are as low as that of the Swedish retroflex fricative (Jassem transcribes this sound with the IPA symbol [ʃ], though the Swedish postalveolar is generally assumed to be retroflex; see Ladefoged & Maddieson 1996: 171). In Jassem's study, the American English palatoalveolars have considerably higher peaks than the Polish postalveolars. As far as perception is concerned, Keating (1991) cites studies showing that the Polish postalveolar fricatives sound more like retroflexes in other languages than like palatoalveolars.

The Russian postalveolar fricative is illustrated in figure 5, based on x-ray tracings of the voiceless sound by Akishina & Baranovskaja (1980) (cf. figure 5a), and Bolla (1981: plate 60) (cf. figure 5b). The tracings of the Russian sound show an apical articulation with flat (or even hollowed) tongue shape and distinct retraction. Phonetic descriptions of the Russian sound explicitly mention the velarization, i.e. retraction, or flattened tongue, for example, Jones & Ward (1969: 134) and Bolla (1981: 90). Maddieson (1984: 226) even uses special diacritics, /ʃ/ and /ʒ^ɣ/, to indicate velarization. Agreement also exists on the apical articulation of the Russian postalveolars. Keating (1991: 35) claims that some x-ray tracings of the postalveolar fricatives in Russian made by Oliverius (1974) show that they are actually articulated with the tongue tip curled backwards. Like Polish, the Russian postalveolar is rounded or protruded
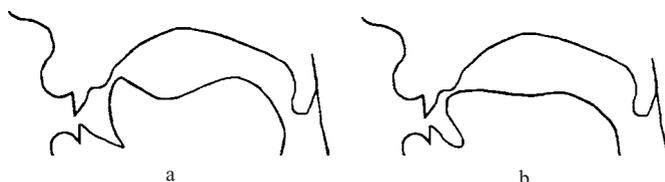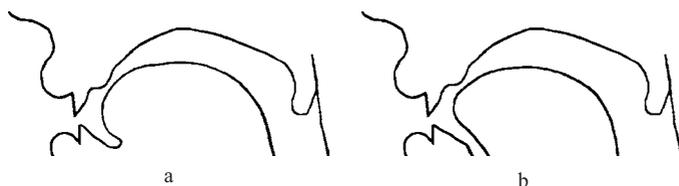
Figure 5 Two realizations of the Russian postalveolar.

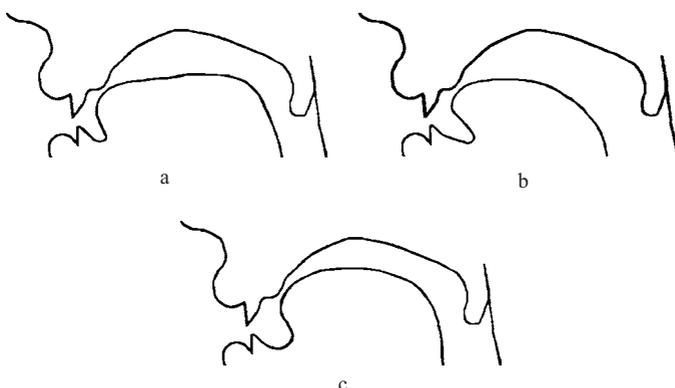**Figure 6** Two realizations of the Bulgarian postalveolar.

Figure 7 Three realizations of the Czech postalveolar.

(Jones & Ward 1969, Bolla 1981). Concerning perception, the Russian sound has a 'darker' or more 'hollow' quality than the English postalveolar, according to Jones & Ward (1969: 134), which is probably due to a large sub-lingual cavity. Altogether, the Russian postalveolar is retroflex according to the previously established criteria.

Two articulations of the Bulgarian postalveolar are given in figure 6 (a and b), based on x-ray tracing of the voiceless sound by Bojadžiev (1982: 87) and Stojkov (1955: 81), respectively. The tongue shape of the postalveolar in Bulgarian differs very much from that of the corresponding Russian and Polish sounds, as it has a raised tongue body, similar to the English palatoalveolar. The Bulgarian fricative is described in the literature as 'prepalatal' (Simeonova 1988: 174) or 'weakly palatalized alveopalatal' (Scatton 1983: 58). We can conclude from this that the Bulgarian postalveolar is not retroflex but palatoalveolar.

For the Czech postalveolar, three x-ray tracings are given in figure 7 (all three tracings of the voiceless sound), as they show a considerable difference in articulation. The tracing in figure 7a is based on Skaličková (1974: 104), the one in figure 7b on Palková (1994: 229), and the one in figure 7c on Polland & Hála (1926: 23). The articulation of the Czech sound in

figure 7a looks similar to the equivalent Russian or Polish sounds, as it has a flatter and more retracted tongue body than the English palatoalveolar. The articulations of the same sound in figures 7b and 7c, however, show a domed tongue body. Judging from figure 7a alone, the Czech sound could be classified as retroflex, as it is articulated in the same way as the Russian and Polish sounds, and fulfils the criteria of retroflexion developed earlier on. Its retroflex nature is confirmed by the fact that the Czech sound is usually described as apical (Kučera 1961: 30). Furthermore, Harkins (1953: 6) describes the Czech postalveolar as 'less palatal' and as having a 'deeper timbre' than the English sound. The x-ray tracings in figure 7b and 7c, however, show a domed and high tongue body, which can be compared to the articulation of the respective Bulgarian sound in figure 6 above.

According to the criteria developed in this article, it cannot be clearly determined whether Czech has a retroflex fricative or not, as the articulations taken as bases for judgment differ too much. Future articulatory research has to clarify this point. It has to be noted that the Czech sound is classified as a postalveolar and is referred to with the symbol /ʃ/ in very recent phonetic descriptions, such as Dankovičová (1997).

In sum, if one assumes postalveolar articulation combined with retraction as defining criteria for retroflexion, the articulatory analysis shows that Polish and Russian postalveolar fricatives are clearly retroflex. This was predicted by previous phonetic studies (such as Keating 1991, etc.) although the grounds on which the Polish and Russian sounds were claimed to be retroflex were not all clear. The two very different articulations of the Czech fricative are surprising, since such a variation has not been mentioned in the literature before. No clear statement on the retroflex status of this sound can be given at this point. The palatoalveolar nature of the fricative in Bulgarian, however, is very obvious and does not come as a surprise, as no suggestion to the contrary has previously been made.

3.2 Phonological behaviour

In this section, phonological evidence for and against the retroflex status of the postalveolar fricative in Polish, Russian, Czech, and Bulgarian will be discussed. We will consider the question whether these sounds undergo rules comparable to those involving retroflexes in other languages, as discussed in section 2.3. The phonological investigation will start with Polish, moving on to Russian, Czech, and Bulgarian.

Dogil (1990: 5) states that the alveolo-palatal fricative /ɕ/ and the retroflex /ʂ/ are in complementary distribution in one context in Polish. Whereas the alveolo-palatal /ɕ/ does not occur before the centralized, close vowel /ɨ/, the retroflex /ʂ/ does. On the other hand, the retroflex does not occur before close front /i/, where the alveolo-palatal /ɕ/ does. Examples for this restriction with the verbalizing suffix /i/ are given in (7).

(7)   ko**s**+**i**+ć   [ɕi] 'mow' inf.
      towarzy**sz**+**y**+ć [ʂɨ] 'accompany' inf.

Thus, Polish has a phonotactic constraint which bans the sequence of a retroflex fricative and the close front vowel /i/, and which leads to a change towards the central vowel [ɨ] if the two segments are joined at morpheme boundaries (this change is incorporated in the Polish orthography). Rubach (1984: 44) terms this phonotactic constraint the Retraction Rule, but this rule comprises the retraction of the close front vowel after all non-palatalized, so-called 'hard' coronal consonants in Polish. Following Hall (1997b), the phonotactic constraint will be taken as phonological evidence for the retroflex status of the postalveolar fricative in Polish.

In Russian, the postalveolar also shows an incompatibility with the close front vowel /i/. Only the central vowel /ɨ/ is allowed after this sound (Hamilton 1980; cf. the actual pronunciations in the second column of (8) as opposed to the impossible pronunciations in the third column):

(8)   šil [ʂɨl] *[ʂil] 'sewed' masc.
      žil [ʐɨl] *[ʐil] 'lived' masc.

Drawing on these data, I assume a phonotactic co-occurrence restriction for Russian that disallows sequences of retroflex fricatives and close front vowels. Hence, in Russian, there is phonological evidence for the retroflex status of its postalveolar fricative just like in Polish. Interestingly, both the Russian and the Polish sounds have a palatalized counterpart in front vowel context (see discussion of these sounds in section 4 below), which further supports the non-palatal nature of these sounds.

Czech has neither a close central vowel nor a phonotactic constraint comparable to the one in Polish and Russian. The Czech language allows sequences of close front vowels and postalveolar fricatives, as exemplified in (9).

(9)   širší   [ʃirʃiː]   'wider'
     úžina   [uːʒina]   'narrowness'

Kučera (1961: 26) mentions that the phonemes /i, iː, e/ have slightly raised allophones in the pronunciation of most speakers when preceded by /tʲ/ /dʲ/ /nʲ/ or /j/. As the postalveolar fricative is not included in the context where vowel raising occurs, it can be concluded that this fricative does not behave like a typical palatalized segment. Recall from section 2.1 that the palatoalveolar /ʃ/ is assumed to be inherently palatalized, following, for example, Lass (1976) and Hall (1997b). On the other hand, Czech has palatalized counterparts for the phonemes /d, t, n/ only (Carlton 1990: 26), the postalveolar does not have a palatalized variant, and therefore no explicit evidence for its retracted/retroflex nature is given either. Altogether, there is no phonological evidence for or against the retroflex status of the Czech sound clarifying the phonetic findings.

In Bulgarian, no process of vowel change or phonotactic restriction for the sequence of postalveolar fricative and front vowel exists. The postalveolar can occur with the front vowel [i], as the words in (10) indicate.

(10)   tišina   [tiʃina]   'silence'
      strašilo   [straʃilo]   'monster'

According to Scatton (1983: 54), the postalveolar fricative even further closes the front vowels /i/ and /e/, i.e. it behaves like a palatalized consonant. Furthermore, the postalveolar fricative and affricate series /ʃ, ʒ, tʃ, dʒ/ does not have any palatalized counterparts, whereas the alveodental series does. This is a phonological argument that the sounds in question are palatoalveolars in Bulgarian.

In sum, the phonological regularities give further evidence for the phonetically attested retroflex status of postalveolars in Polish and Russian, and for the non-retroflex status of the palatoalveolar in Bulgarian. The Czech sound does not undergo any phonological process that could support its retroflex status, but does not show any counter-evidential behaviour either.

3.3   Emergence of retroflexes in Slavic languages

This section speculates on the question of why some Slavic languages developed a retroflex fricative. Diachronically, the postalveolar sounds (both retroflex and laminal palatoalveolar) in Polish, Russian, Czech, and Bulgarian stem from a postalveolar fricative in Proto-Slavic. The Proto-Slavic postalveolar came into existence via two processes. The first one was part of the so-called First Velar Palatalization in Proto-Slavic (Stieber 1969, Carlton 1990, Mareš 1999), where the velar fricative /x/ was fronted towards a postalveolar fricative if followed by front vowels or the palatal glide (cf. (11a) below). The second development involved a retraction of the palatalized dental fricative towards the postalveolar fricative, and was context-independent (ibid.; cf. (11b)).

(11)   a)   x   →   ʃ / _ i, e, j
       b)   sʲ   →   ʃ

Table 1 Slavic coronal fricative systems (allophones are given in parentheses, question mark indicates that the status of the fricative pairs has to be further investigated).

	Dental/Alveolar	Palatalized dental/Alveolar	Retroflex	Postalveolar	Alveolopalatal
Polish	s, z		ʂ, ʐ	(ʃ, ʒ)	ɕ, ʑ
Russian	s, z	sʲ, zʲ	ʂ, ʐ	ʃ, ʒ	(ɕ, ʑ)
Bulgarian	s, z			ʃ, ʒ	
Czech	s, z			? ʃ, ʒ	
Serbian	s, z		? ʂ, ʐ		

When established as a phoneme, the postalveolar caused fronting of back vowels (cf. (12); Carlton 1990: 116).

(12) *ʃuːtiː   >   *ʃiti 'to sew'

The fronting of back vowels in postalveolar context is a clear indication for the palatalized, non-retroflex status of the Proto-Slavic fricative. Why did this palatoalveolar sound then change into a retroflex one in some Slavic languages but not in others?

One possibility of accounting for the difference between Polish and Russian, where it did, and Bulgarian, where it didn't, can be found in the sub-classes of the Slavic language family. Polish (and Czech) belong to West Slavic, Russian to East Slavic, and Bulgarian to South Slavic. The hypothesis that might be proposed here is that only the fricative in South Slavic remained palatoalveolar, whereas the same sound in East and West Slavic underwent a change to a retroflex. Testing this hypothesis involves establishing the exact nature of the Czech sound and further investigating members of all three families. If Keating's (1991) claim is right that Serbian also has a retroflex fricative (recall the introduction), this might refute the hypothesis, as Serbian is a South Slavic language and should have a palato-alveolar according to this hypothesis.

Another explanation for the different development of Russian and Polish versus Bulgarian might be the markedness of the fricative inventory in the respective languages. Hall (1997a) shows that the development of the Indo-Aryan retroflex fricative was caused by the emergence of the alveolo-palatal in Indo-Iranian. He assumes the diachronic developments given in (13).

(13)   Indo-European   Indo-Iranian   Old-Indo-Aryan
         /s, ʃ/   →   /s, ʃ, ɕ/   →   /s, ʂ, ɕ/

According to Hall, the contrast /ʃ/ vs. /ɕ/ is cross-linguistically unattested since both sounds share the same feature specification [−anterior, +distributed, −back]. As a result, the inventory of Indo-Iranian /s, ʃ, ɕ/ is marked. This marked status causes a change to the less marked Old-Indo-Aryan inventory with a retroflex postalveolar.

Rochoń (2001) applies Hall's proposal to Slavic languages, and argues on perceptual grounds that the emergence of an alveolo-palatal fricative triggered the change from postalveolar to retroflex in Polish. The introduction of the phoneme /ɕ/ into the Polish fricative system /s, ʃ/ therefore led to a change from the laminal palatoalveolar /ʃ/ to the retroflex postalveolar /ʂ/ (cf. first row in table 1 of the complete Polish fricative system). This reasoning might hold for the Russian fricative, too, where the alveolo-palatal is introduced as a palatalized allophone of the dental stop (Rochoń, p.c.; cf. second row in table 1). Bulgarian, represented in the third row in table 1, did not undergo the change from postalveolar to retroflex, as it does not have any alveolo-palatals either phonemically or allophonically. Bulgarian thus supports Rochoń's hypothesis. The hypothesis also predicts that Czech has a
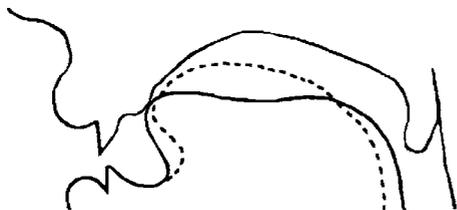
Figure 8 Russian retroflex fricative (solid line) and palatalized postalveolar fricative (dashed line).

non-retroflex fricative (cf. the fourth row of table 1). The status of the Czech sound has to be investigated in order to conclusively test this hypothesis. If Keating's (1991) observation can be attested that the Serbian postalveolar is retroflex, this would refute the hypothesis, since Serbian has no alveolo-palatal to trigger a change from postalveolar to retroflex (cf. the Serbian coronal fricatives in the last row of table 1). In sum, further investigation is necessary to account for the diverging developments of the Slavic postalveolar fricatives.

4 Palatalization of retroflexes

Palatalization in traditional articulatory terms means a supplementary articulatory gesture superimposed upon a labial, dental, alveolar or postalveolar consonant. However, as shown in Scatton (1983) for Bulgarian and Ćavar & Hamann (2002) for Polish, palatalization of dental fricatives and affricates involves a change in primary place of articulation. It will be argued in this section, following Keating (1993), that palatalization of the retroflex fricative in Slavic languages causes a similar change in the major place of articulation, which has an impact on its phonological representation.

Examples of Russian and Polish palatalized postalveolar fricatives are given in (14) and (15), respectively. In the phonetic transcription, I use the symbol [ʃ$^{(j)}$] for the palatalized sound, since I argue below that this sound is not a retroflex but a palatoalveolar. The secondary palatalization is parenthesized, because it is redundant according to the previously made assumption that palatoalveolar fricatives are inherently palatalized (recall section 2.1).

(14)   *Russian*
        ŝči   [ʃ:$^{(j)}$i]   'cabbage soup'

(15)   *Polish*
    a.   masz je   [maʃ$^{(j)}$je] 'you have them'
    b.   Shiva   [ʃ$^{(j)}$iʋɑ]   'Shiva'

In Russian, the palatalized postalveolar can only occur as a geminate. In Polish, two contexts are possible for this sound: it can occur across word boundaries when a retroflex fricative is followed by [i] or [j] (cf. (15a)), and within loanwords with the sequence retroflex plus close front vowel (cf. (15b)).

In figure 8, x-ray tracings of the Russian retroflex fricative (solid line) and its palatalized counterpart (dashed line) are given, based on Bolla (1981: 159). As we can see from this figure, the palatalized sound does not involve a simple addition of an elevated tongue body onto its non-palatalized counterpart, but has changed its primary articulation from an apical to a laminal fricative. Furthermore, the palatalized sound is articulated with a long and narrow constriction and an elevated tongue body, no retraction is involved. This is not in accordance with the criteria for retroflex sounds posed in section 2.1; thus, we must conclude that palatalization changes a retroflex into a (palatalized) palatoalveolar (see Hamann 2002

for a more detailed argumentation and a discussion of languages with allegedly palatalized retroflex sounds). Hume (1994) also claims that palatalization changes a retroflex into a non-retroflex, but her claim is based solely on the featural representation of both sounds.

5 Conclusion

The fricatives of Polish and Russian that are articulated in the postalveolar region are shown to be more similar to retroflex fricatives than to postalveolar fricatives in English. This similarity is based on articulation, in particular retraction, and on the segment's phonological incompatibility with close front vowels, which is phonetically grounded in their retracted tongue body. The fricatives of Bulgarian, on the other hand, are palatoalveolar, as they show no phonetic or phonological retraction. Consequently, the Polish and Russian postalveolar fricatives should be represented by the IPA symbols /ʂ/ and /ʐ/, whereas the Bulgarian postalveolar fricatives are better transcribed as /ʃ/ and /ʒ/.

In the present study, Czech postalveolar fricatives could be classified as neither retroflex nor palatoalveolar, since the phonetic descriptions of these sounds differ widely, and the class behaves as phonologically neutral. Further research on the Czech postalveolar fricative should be carried out in order to answer the question of its status. Although two possible explanations were proposed for the difference in Slavic languages with respect to the postalveolar, neither of them fully accounted for it. Finding a plausible explanation for these differences in Slavic languages thus remains another topic for future research.

With respect to the palatalization of the retroflex fricatives in Polish and Russian, it was argued that these sounds change their primary articulation to a laminal palatoalveolar. Thus, a representation of a secondary palatalized retroflex fricative should employ the IPA symbols /ʃ⁽ʲ⁾/ and /ʒ⁽ʲ⁾/ instead of the articulatorily non-realizable symbols /ʂʲ/ and /ʐʲ/.

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