KANSAI GAIDAI UNIVERSITY

Sanskrit RUKI Revisited

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Yasuko Suzuki

Abstract

In Sanskrit the dental sibilant *s* became retroflex *ṣ* after the two consonants *r* and *k* and vowels other than *a/ā* when, as a rule, it is not word-final and not followed by *r*. From this unique environment arises the name 'RUKI' and a number of studies have been dedicated to the interpretation of the environment, which apparently does not form a natural class, a number of exceptions, and variability.

This paper tackles the problem of the interpretation and implications of the unique conditioning factors of the Sanskrit RUKI rule and claims that RUKI is partial place assimilation with multiple origins. While all the four triggers are behind dental in place, they are phonetically heterogeneous, i.e. vowels and consonants that in turn consists of an obstruent and a sonorant with varying distances from the dental. They also show distinct phonological behaviors: while *r* and *u* are common retroflexion triggers, *i* often triggers palatalization and deretroflexion, and *k* is not known as a retroflexion trigger. A careful examination of Ṛgveda shows further that irregularities and phrase-level application depend on whether the triggers are vowels or consonants. These phonetic and phonological differences, together with comparative evidence, suggest that RUKI originally consisted of a series of retraction processes, whose outcomes eventually merged as a retroflex sibilant in Sanskrit. The nature of the triggers has implications on how the process as a whole arose and developed.

Keywords: Sanskrit, RUKI, retroflexion, natural class, assimilation

1. Introduction

Indo-Aryan, as other branches of Indo-European languages, originally lacked retroflex consonants but has developed them by several processes of retroflexion beginning with RUKI or *s*-retroflexion in addition to some other sources. The retroflex *ṣ* has further triggered retroflexion of the dental nasal and stops. As a result, Sanskrit has obtained a series of retroflex consonants comparable to other places.

As the name RUKI indicates, the sibilant retroflexion affected the medial dental sibilant

after the syllabic and non-syllabic *r*, *k*, and vowels other than short and long *a*. For example, the dental sibilant in the locative plural suffix *-su* becomes retroflex after the afore-mentioned sounds but remains dental after other consonants and *a*-vowels: *gīrṣu* 'voice', *dhenuṣu* 'cow', *vākṣu* 'speech', and *agniṣu* 'fire', but *marutsu* 'wind' and *senāsu* 'army' (Whitney 1889: §§61–62, 180–188; Wackernagel 1896: 231–238; Macdonell 1910: 47–50, 1916: §67; Burrow 1973: 80–81, 97–99; Kobayashi 2004: §§102–103). Among other Indo-European languages, similar changes of the dental sibilant are observed in Iranian, Lithuanian, and Slavic although the outcome and the restrictions differ.

The process is known for its idiosyncratic environment, which has convinced historical linguists of the common development in Indo-Iranian and Balto-Salvic (Burrow 1973: 80–81; Collinge 1985: 143–145; Hock 1991: 442–444; Szemerényi 1996: 51–52; Meier-Brügger 2000: 95–97). In phonology, RUKI is known for the environment that apparently does not form a natural class and attempts have been made to define the set of triggering sounds in terms of phonological features (Zwicky 1970; Vennemann 1974; Cho 1999: 77–80) and to define its domain (Kiparsky 1973: 61–66, 84–85, 1993: 284–285; Selkirk 1980: 122–125).

Among various controversial issues of *s*-retroflexion in Sanskrit, this paper reexamines how the seemingly heterogeneous sounds triggered the same phonological process and what this pursuit implies on the historical development of *s*-retroflexion. Section 2 below examines triggers of sibilant retroflexion and discusses their similarities and differences. Section 3 discusses the degree of irregularities and extensiveness depending on the triggers. Section 4 argues that *s*-retroflexion has resulted from a series of sibilant retraction in different contexts and that the retroflex was not likely to be the original outcome.

This study focuses mainly on the earliest attested stage of Old Indo-Aryan and is based on my own examination of the Ṛgveda. Examples with the book-hymn-verse numbers are cited from the text and those without the numbers from Whitney (1885, 1889), Wackernagel (1896), Monier-Williams (1984), and other secondary sources of the references. The text examined in this paper was downloaded from the following site of Detlef Eichler through GRETIL or Göttingen Register of Electronic Texts in Indian Languages and related Indological materials from Central and Southeast Asia: http://www.detlef108.de/Ri.htm.

2. RUKI or the environment

The sounds that induce retroflexion of the dental sibilant are two consonants, i.e. the voiceless velar stop *k* and the sonorant *r*, and vowels other than the short and long *a*, i.e. high

vowels *i* and *u*, which may either be long or short, mid vowels *e* and *o*, diphthongs *ai* and *au*, and the syllabic *ṛ*, both long and short.

In (1) below is given consonants and vowels in Sanskrit in the arrangement by the native grammarians and the conventional transliteration (Whitney 1889: §5; Cardona 2003: 110; Kobayashi 2004: 13). Those sounds that trigger retroflection are in bold and those that do not are in non-bold and unshaded. There are, however, a number of sounds that do not occur before the target *s* within a word and they are shaded in (1). More specifically, voiced obstruents are not allowed before *s*, which excludes all the voiced stops and *h*. Aspirated stops are also not allowed, which excludes voiceless and voiced aspirated stops. Nasals are debuccalized and become anusvāra preceding *s*, which excludes all the nasal stops. Palatals also do not occur before the dental sibilant. Semivowels *y* and *v* occur only before vowels and cannot precede sibilants. Therefore, *s* may be preceded by the unaspirated voiceless stops other than the palatal, *s*, *ṛ*, visarga, and anusvāra among consonants and any vowels except *ḷ* that occurs only in one root *kḷp* 'be in order'. These distributional restrictions are confirmed by Turner and Turner (1971).

(1) a. Vowels

a, ā; **i**, **ī**; **u**, **ū**; **ṛ**, **ṝ**, **ḷ**; e, o; **ai**, **au**

b. Consonants

		velar	palatal	retroflex	dental	labial	no oral place
Stops							
voiceless	plain	**k**	c	ṭ	t	p	
	aspirate	kʰ	cʰ	ṭʰ	tʰ	pʰ	
voiced	plain	g	j	ḍ	d	b	
	aspirate	gʰ	jʰ	ḍʰ	dʰ	bʰ	
Nasals		ṅ	ñ	ṇ	n	m	
Sibilants			ś	ṣ	s		
Semivowels			y	**r**	l	v	
(V that alternate with			i	**ṛ**	ḷ	**u**)	
semivowels							
Voiced fricative							h
Voiceless fricative							ḥ (visarga)
Nasal							ṁ (anusvāra)

The next two subsections discuss consonant triggers vowel triggers in turn.

2.1. Consonant triggers

Of those consonants that may occur before the target, examples are given in (2) below where both the target and the preceding sound are in bold. Unless otherwise stated, the examples are locative plural forms with the suffix-initial sibilant with or without retroflexion. The consonant triggers are *k* and *r* in (2a) and non-triggers are the stops *ṭ*, *t*, and *p* in (2b) and visarga and anusvāra in (2c). Note that visarga and anusvāra do not trigger retroflexion themselves, but are transparent in terms of retroflexion, thus allowing retroflexion of the following *s* triggered by the preceding vowel. That is, when the vowel before the visarga or anusvāra is *a/ā*, the following sibilant remains unchanged. However, when the preceding vowel is not *a/ā*, then the following sibilant is retroflexed.[1]

(2) a. Triggers

    stop   *vā**kṣ**ú* 'speech'
    semivowel   *gī**rṣ**u* 'voice'

    b. Non-trigger
    stops   *dvi**ṭs**u* 'enemy', *marú**ts**u* 'wind', *a**ps**ú* 'water'

    c. Transparent
    visarga   *mána**ḥs**u* 'mind' vs. *daví**ḥṣ**u* 'oblation', *dhanu**ḥṣ**u* 'bow'
          cf.   *mána**ss**u* 'mind' vs. *daví**ṣṣ**u* 'oblation'
    anusvāra   *vidvā̃**ṁs**am* 'knowing' ACC.SG.MASC.
                vs. *daví̃**ṁṣ**i* 'oblation' NOM./ACC./VOC.PL., *parū̃**ṁṣ**i* 'joint' NOM./ACC./VOC.PL.

As the table in (1) above shows, the consonants that trigger *s*-retroflexion, i.e. *k* and *r*, are behind the dental in place. Although *r* is categorized as retroflex in the traditional arrangement of sounds, native grammarians give varying descriptions: dental, alveolar, or retroflex (Whitney 1889: §52a; Allen 1953: 53; Cardona 2003: 109). While *k* and *r* are apparently a peculiar group of sounds, they are both behind the dental in place, though with varying distances, among the consonants that may occur before the target.

Retroflexion of the dental sibilant in turn causes retroflexion of the directly following

dental *t*, *th*, and *n*: *tuṣṭāva* 3SG.PERF. as opposed to non-retroflexed **staúti** 3SG.PRES.IND.ACT. from *stu* 'praise', *tíṣṭhati* 3SG.PRES.IND.ACT. as opposed to non-retroflexed *tasthau* 1/3SG.PERF. from *sthā* 'stand', and *siṣṇeha* 3SG.PERF. from *snih* 'be sticky' (Whitney 1885: 193–195, 1889: §197; Wackernagel 1896: 166). Retroflexion of sibilants is consistently accompanied by retroflexion of the following dentals in compounds and phrases as well: see below section 3.

On the other hand, those consonants that do not trigger retroflexion are retroflex, dental, and labial stops, i.e. *ṭ*, *t*, and *p* in (2b). An apparent contradiction would be that, while the retroflex semivowel *r* triggers retroflexion, the retroflex stop *ṭ* does not. This difference can be attributed to the articulatory difference between consonants with a stricture and those with a closure: while the retroflex place of *r* can be retained throughout its articulation to the end where the articulation of *s* begins, the retroflex place of *ṭ* characterizes its closure and at its release the tongue tip moves slightly forward where it flanks the following *s*. Thus, the tongue tip is slightly more forward at the release of *ṭ* than *r*. That is, *k* and *r*, which trigger retroflexion, are more backward in place at the outset of the following *s* than *ṭ*, *t*, and *p*, which do not trigger retroflexion. Therefore, as Cardona (2003: 119) considers *s*-retroflexion 'retraction', retroflexion after *k* and *r* can be characterized as backness assimilation (Allen 1973: 103–105). There is, however, an important difference between *k* and *r* as a trigger. Cross-linguistically, *r* is a common trigger of retroflexion (Hamann 2003: 81–89), but *k* does not seem to be known as a retroflexion trigger.

The same asymmetry between consonants with and without closure is observed in retroflexion of the dental nasal or NATI by which the dental nasal becomes retroflex when it is preceded by a retroflex sibilant *ṣ*, semivowel *r*, or vowel *ṛ* or *ṝ*, e.g. *siṣṇeha* from *snih* just cited, *kárṇa-* 'ear', *śṛṇóti* 'hear' 3SG.PRES.IND.ACT., and *pitṝṇām* 'father' GEN.PL. (Whitney 1889: §§189–194; Wackernagel 1896: 186–191; Cardona 2003: 119). Unlike RUKI, the target and the trigger do not have to be adjacent, but the process is blocked when a lingual (i.e. dental, retroflex, and palatal) consonant except *y* intervenes between the two. For example, in *váriṇā* 'water' INS.SG., *kṣóbhaṇa-* 'shaking, agitating', *brāhmaṇá-* 'relating to or given by Brahman', the nasal is retroflexed because none of the intervening sounds block the process. While the triggers are the retroflex sounds without closure, not only do retroflex stops, i.e. *ṭ*, *ṭʰ*, *ḍ*, *ḍʰ*, and *ṇ*, fail to trigger retroflexion in parallel with RUKI, but even block retroflexion. Thus, for example, in *kṣaṇana-* 'hurting' from *kṣan* 'wound', the root-final nasal is retroflexed by the presence of *ṣ* in the onset cluster, but this *ṇ* in turn blocks retroflexion of the nasal in the suffix. Nasal retroflexion is also blocked by the dental stops and *r* that directly follow the target (Wackernagel 1896:

187–188).

So far two types of consonants have been distinguished in relation with *s*-retroflexion among those that occur before the target, i.e. those that trigger retroflexion and those that do not. Yet the third type is visarga and anusvāra in (2c) that do not trigger retroflexion themselves but let the preceding triggering sound cause retroflexion of the following *s*. They both lack a specific place and the oral gesture of the preceding vowel is taken over to the following visarga or anusvāra although anusvāra may also be assimilated to the following sound or be velar in place as a default (Whitney 1889: §§67, 71; Allen 1953: 40–46; Cardona 2003: 110; Suzuki 2013). Therefore, when they are preceded by a triggering vowel, the following *s* is retroflexed. When they are preceded by *a/ā*, however, then the following *s* remains unaffected. Thus, visarga and anusvāra are transparent in terms of *s*-retroflexion. Alternatively, visarga may be assimilated to the following retroflexed or non-retroflexed sibilant to produce geminate sibilants as in *havíṣṣu* in (2c). In a different interpretation, the final *s* is retroflexed by the preceding high vowel and the following initial sibilant assimilates to this *ṣ*.

2.2. Vowel triggers

Among vowels that trigger retroflexion, high vowels are of Indo-European origin with Indo-European schwa as an additional source of the high front vowel, mid vowels *e* and *o* go back to Indo-Iranian *ai* and *au*, respectively, and diphthongs *ai* and *au* go back to earlier *āi* and *āu*, respectively (Mayrhofer 1978: 18–20; Szemerényi 1996: 37–44; Cardona 2003: 109). Mayrhofer (1978: 20) states that *e* and *o* were still pronounced as diphthongs *ai* and *au* at the beginning of the Old-Indo-Aryan period. Retroflexion chronologically preceded monophthongization because it was at least common Indo-Iranian and, given that it is also observed in Slavic and Baltic, in part earlier. This chronology implies that retroflexion was uniformly triggered by the directly preceding high vowel, be it an independent vowel or part of a diphthong (Allen 1973). Further, the syllabic *ṛ* is described as *r* flanked by short vocalic elements (Cardona 2003: 108–109). Thus, the tongue position of both consonantal *r* and vocalic *ṛ* must have the same effect on the following sibilant and, in fact, vocalic and consonantal *r* behaves in a parallel fashion in terms of retroflexion. On the other hand, the two vowels that do not trigger retroflexion are different in quality and not just in quantity: *ā* is an open vowel while *a* is 'close central' (Cardona 2003: 108) and 'the neutral vowel' in Whitney's (1889: §21) characterization. They derive historically from *a/ā*, *e/ē*, *o/ō*, and syllabic nasals. The vowels that do not trigger retroflexion are non-high in contrast to high vowels that trigger retroflexion at least when it applied originally. Unlike

consonants, any vowel may occur before the target: the fact that *l̥* does not occur before *s* is an accidental gap.

In (3) are given examples, again nouns with the locative plural suffix *-su* unless otherwise stated, to show the effect of each vowel on the following dental sibilant.

(3) a. Triggers

i, ī; u, ū	*agnÍṣu* 'fire', *devÍ́ṣu* 'goddess', *dhenúṣu* 'cow', *bhūṣú* 'earth'
r̥	*pitŕ̥ṣu* 'father'
e, o	*devéṣu* 'god', *góṣu* 'bull, cow'
ai, au	*nauṣú* 'ship'

b. Non-triggers

a, ā	*vádasi* 'speak' 2SG.PRES.IND.ACT., *sénāsu* 'army'

In parallel with consonants, retroflexion caused by vowels is partial place assimilation similar to palatalization. Front and back vowels are characterized as palatal and labiovelar, respectively, and the following dental sibilant is retracted in accordance with the palatal or velar position of the preceding high vowels. In contrast to non-high vowels, high vowels are more likely to cause changes of the adjacent consonants. Moreover, front and back high vowels have different effects. According to the cross-linguistic study of palatalization by Kochetov (2011: 1672–1673), palatalization can either be regressive or progressive and that the trigger is most often high front vocoids rather than mid or low and can also be high back vocoids though rare (also Hock 1991: 74–75; Blevins 2004: 138, 142). On the other hand, according to Hamann (2003: 81, 90–96), retroflexion is often caused in back vowel context while front vowels normally triggers deretroflexion. These cross-linguistic tendencies suggest that, although the outcome is identical, *i* and *u* as retroflexion triggers must have different effects on the following *s* at least originally. That is, the apparent retroflexion after front vowels in Sanskrit is likely to have been a partial place assimilation comparable to palatalization in origin while change after back vowels is either velarization or genuine retroflexion. Similar consonant changes caused by high vowels are observed in consonant allophones in Japanese (Vance 2008: 74–86). In Japanese, some of the consonants undergo change in place and/or manner depending on the following vowel. That is, the sibilant /s/ is palatalized before /i/ and /j/ and is realized as [ɕ]. The dental stop /t/ is realized by affrication as [tʃ] before /i/ and [ts] before /u/ but remains

a dental stop before other vowels. Further, [h] before /a, u, o/ alternates with palatal [ç] before /i/ and labial [ɸ] before /u/. The changes occur before high vowels only and different outcomes are expected before front and back vowels.

3. Exceptions and irregularities

Retroflexion is systematically blocked by *r/ṛ* that follows the target as in (4a) (Whitney 1889: §181a; Wackernagel 1896: 232; Burrow 1973: 81). This blocking effect of *r/ṛ* is described as dissimilation and observed only in Sanskrit but not in the other RUKI dialects. Retroflexion is blocked not only by the directly following *r*, but a vowel and/or a stop may intervene between the target and *r* as in (4b). There are also exceptions of this blocking effect as in (4c). The blocking effect of rhotics appears extensive and applies to reduplicated forms and compounds as will be shown below.

(4) a. *tisrás* NOM./ACC.FEM., *tisŕ̥bhiḥ* INS.PL.FEM., *tisṝṇ́ā́m* GEN.PL.FEM.,
     but *triṣú* LOC.PL.MASC. from *tri-* 'three'; *usrás* GEN.SG. from *uṣar-* 'dawn';
     sísrate 3SG.PRES.IND.MID. from *sṛ* 'flow'

   b. *sísarti* 3SG.PRES.IND.ACT. from *sṛ* 'flow', *késara-* 'Haar, Mähne',
     tistiré 3SG.PERF. from *str̥* 'strew', and *pispŕ̥śas* 2SG.ACT.AOR. from *spṛś* 'touch'

   c. *viṣṭír* 'expansion', *niṣkr̥tá-* 'done away, removed' RV 9.86.16, *víṣpardhas* 'emulating, envious'

As noted by Whitney (1889: §181b), the facts that the preceding *r/ṛ* triggers retroflexion but that the following *r/ṛ* blocks it appear to be odd (Hale 1998), but *r/ṛ* also blocks retroflexion of the dental nasal and stops as discussed in section 2.1 above (Wackernagel 1896: 166–167, 187). As for other possible blockers, retroflex stops and nasals do not occur after the dental *s*, so vocalic and consonantal *r* is the only retroflex that may occur after the target. The dental stops and nasals may occur after *s*, but, in contrast to NATI, they fail to block retroflexion of the preceding sibilant but undergo retroflexion themselves when the preceding sibilant is retroflexed by RUKI: see again section 2.1 above. Palatal stops do not occur after *s*. Velar and labial stops and nasals, semivowels *y* and *v*, and vowels other than *ṛ* may occur after the target and do not block retroflexion. The dissimilatory effect of *r/ṛ* distinguishes *r/ṛ* from the other

triggers, but it is unequivocally retroflex (though, phonetically, possibly dental or alveolar) as opposed to the other triggers, which are either palatal or velar. While *s*-retroflexion itself is local, affecting the directly following sibilant, the blocking effect of *r/ṛ* allows both intervening sounds and unaccountable exceptions.

In the position after *k* and *r/ṛ*, retroflexion is almost without exceptions. The irregularities and exceptions, for which RUKI is known, are found mainly in the positions after vowels other than *ṛ* as will be shown shortly. Moreover, in external combination, input of retroflexion with consonant triggers is rare due to phonotactic restrictions. That is, because only one consonant is allowed finally, the word-final position does not allow possible input clusters **ks* or **rs*. As to the possibility of the word-fianl *k* or *r* as a trigger, final *r* must be devoiced before *s* of the following word and thus cannot be a trigger in external combination: it is realized either as a visarga or a sibilant. On the other hand, *k* may occur in word-final position before a sibilant. However, only a small number of words end in *k* and thus the possible input cluster *k#s* is far less common than the comparable sequences with a vowel as a trigger. Kobayashi (2004: 149) notes that final *k* of the first element of compounds does not trigger retroflexion of the following *s*: *ṛk-sāmá-* 'ṛc and sāman' although a retroflexed variant is also quoted: *ṛ́k-ṣāmam* 'equal to ṛc' TS 4.3.2.2 (also Wackernagel 1896: 237). At the phrase-level, the word-final *k* does not seem to trigger retroflexion: for example, in *ṛ́dhak* **sā** 'separately'-'that/she' NOM.SG.FEM. RV 7.57.4 the initial *s* of a pronoun is not retroflexed although the pronoun-initial *s* is a common target of the phrase-level retroflexion (Whitney 1889: §188; Wackernagel 1896: 237). Thus, retroflexion in external combination is again restricted to the cases with a vowel trigger. As early as Vedic, therefore, retroflexion by *k* and *r* appears to have been grammaticalized as an internal sandhi.

In contrast to consonant triggers, retroflexion by vowel triggers allow numerous exceptions. There are both dental *s* in RUKI environment and the retroflex *ṣ* in non-RUKI environment. The dental *s* in RUKI environment is restricted to the position after vowels and *r*, more often after *i* and *u* than *r/ṛ* according to Burrow (1976), and not after *k*, e.g. *ṛbísa-* 'a hole in the earth (from which hot vapors arise), RV', *kīstá-* 'a praiser, poet, RV', *busá-* 'vapor, mist, fog, RV', *bṛ́saya-* 'name of a demon, RV', *barsá-* 'knot, TS' (Whitney 1889: §181d; Wackernagel 1896: 233; Burrow 1976). On the other hand, while retroflex also arose from palatal *ś* before the dental stop, which may follow *a/ā*, e.g. *draṣṭum*, *caṣṭe*, *tvaṣṭar*, there are still unexplained retroflex after *a/ā*, e.g. RV *áṣa*, *caṣâla-* 'Knauf', *jálāṣa-* 'Heilmittel' and the initial and final retroflex in *ṣaṣ* 'six' (Whitney 1889: §182; Wackernagel 1896; 238–239). Wackernagel (1896: 238–239) explains these exceptions as either as originally deriving from roots containing

a liquid or stems of non-Indo-Aryan origin and Whitney (1889: §§146b, 182c) considers the last example as deriving from *ṣakṣ although the initial ṣ is still not accounted.

In inflexion, suffix-initial s such as the locative plural -su exemplified in (2) and (3) above and root/stem-final s tend to be regular in terms of retroflexion. Complication arises in verbal formation and especially in reduplication with two or more targets where the trigger is a vowel. Thus, there are cases where s in roots remains dental even after the triggering vowels in addition to s that is followed by r/ṛ by the restriction already discussed. Examples are given in (5a), where s is retroflexed regularly, in (5b), where the retroflex ṣ is expected after i or u but where s occurs instead, and in (5c), where retroflexion is blocked by the following r/ṛ as expected.

(5) a. *yā* 'go'   *yāsiṣṭam* 1SG.SIṢ-AOR.

 sac 'follow'   *siṣakti* 3SG.PRES.IND.ACT. RV 6.68.3

 san 'gain'   *síṣāsan* NOM./VOC.SG.MASC.PRES.PPL.DESID. RV 10.102.4

 siṣāsasi 2SG.PRES.IND.DESID. RV 10.102.12

 b. *yā* 'go'   *yāsisīṣṭhās* 2SG.PREC.MID. RV 4.1.4

 sac 'follow'   *sisakṣi* 2SG.PRES.IND.ACT. RV 1.73.8

 sic 'pour out'   *sisicus* 3PL.PERF.ACT., *sisice* 1/3SG.PERF.MID. RV 3.32.15

 snu 'distil'   *susnuṣe* 2SG.PERF.MID. RV 10.86.13

 c. *sṛ* 'flow'   *sisarṣi* 2SG.PRES.IND.ACT. RV 3.32.5, *sisṛtam* 2DU.IMPV. RV 7.62.5

 sisrate 3PL.PRES.MID. RV 10.35.5, *sisīrṣati* 3SG.PRES.IND.ACT.DESID.

 stṛ 'strew'   *tistire* 3PL.PERF. RV 3.41.2

 sru 'flow'   *susrot* 3SG.INJ. RV 10.101.8

According to Whitney (1889: §181c) and Wackernagel (1889: 233), retroflexion in successive syllables is prohibited in avoidance of the sequence s – ṣ – ṣ, for example, *yāsisīṣṭhās* and *sisakṣi* in (5b) with the dental s after i as opposed to *yāsiṣṭam* and *siṣakti* in (5a), respectively. In general, however, inflected words with two occurrences of ṣ (though not necessarily in successive syllables and/or preceded by s) are not uncommon in Ṛgveda, e.g. *kṣariṣyati* 3SG. FUT.IND.ACT. from *kṣar* 'flow', *rīriṣīṣṭa* 3SG.PREC.MID. RV 6.51.7 from *rī* 'flow' (Whitney 1889: §925b), *mánuṣeṣu* 'belonging to mankind' LOC.PL. RV 7.2.7, *várṣiṣṭhakṣatrā* (*várṣiṣṭha-kṣatra-*)

'having the greatest power' RV 8.101.2.

While RUKI is an internal sandhi as a rule, it also applies in the external environment, that is, across the boundary between a preverb and a verb or between two elements of compounds especially in earlier stages. Thus, it applies both to the initial *s* of a verb preceded by a preverb ending in a high vowel (e.g. *ní ṣedus* 'down'-'sit' 3PL.PERF.ACT. RV 4.6.11, etc.) and to the preverb-fianl *s* followed by a verb (e.g. *níṣ ṭatakṣus* 'out'-'hew' 3PL.PERF.ACT. RV 4.58.4 from *takṣ* 'hew'), but the application is not consistent: e.g. *pári sánti* 'around'-'be' 3SG.PRES.IND.ACT. RV 10.115.4 (Whitney 1889: §185; Wackernagel 1896: 233–234). Application tends to be determined by the verbal prefixes (Hock 1979), but it may overapply in spite of the intervening augment *a-* in examples such as *atyaṣṭhāt* 'beyond'-'stand' 3SG.AOR. and *nyaṣadāma* 'down'-'sit' 1PL.AOR., where *s* is not in RUKI environment. Application in compounds is also not consistent: examples in Vedic include both the initial *s* of the second element, e.g. *agní-ṣómā* 'Agni and Soma' RV 10.66.7, *páriṣkṛta-* 'prepared, adorned' RV 9.86.24, *anuṣṭúbh* 'anuṣṭubh (a kind of meter)', *agniṣṭomá* 'praise of Agni', *pitṛṣvasṛ* 'a father's sister' and the final sibilant of the first element, e.g. *páruṣ-parus* RV 10.97.12 from *párus* 'joint, knot' (Whitney 1889: §§186–187).

Retroflexion frequently applies also at the phrase-level in Ṛgveda (Whitney 1889: §188; Wackernagel 1896: 237–238; Hock 1979). Both word-initial and -final *s* preceded by a vowel trigger can be the target of retroflexion. Application tends to be lexically determined and in the case of word-initial *s*, the common targets are particles, pronouns, and frequently occurring verb forms such as *as* 'be', *sad* 'sit' and *stu* 'praise', e.g. *u ṣú* 'and, also, further'-'well' RV 1.26.5, etc., *hí ṣma/ṣmā* 'surely'-'indeed' RV 1.26.3, etc., *abhí ṣyāma* 'to'-'be' 1PL.OPT.ACT. RV 1.105.19, etc., although the target may be nouns and other content words as in *ádhi ṣṇúnā* 'upon'-'the level summit of a mountain' INS./ABL.SG. RV 4.28.2, etc. Examples of the word-final *ṣ* include: *agníṣ ṭvā* 'fire' NOM.SG.-'you' ACC.SG. RV 3.53.4, 3.55.10, *āvíṣ kṛṇoti* 'openly'-'do' 3SG.PRES.IND.ACT. RV 9.3.5.

As a summary, retroflexion is fully regular after *k* (Wackernagel 1896: 233) and almost regular after *r/ṛ*, but after originally high vowels there are irregularities, variations, and extensiveness. While all the triggering sounds share the same articulatory feature, difference in terms of failure in application suggests that the three groups of trigger, i.e. the consonant trigger *k* without exceptions, the syllabic and non-syllabic sonorant with fewer exceptions, and the other vowel triggers with more exceptions, have varying degrees of retroflexing effect. On the other hand, the retroflex in non-RUKI environment is observed only after *a/ā* and not after any of the non-triggering consonants. This fact is reasonable: non-high vowels tend to lack assimilatory force and thus they neither trigger nor are incompatible with retroflexion in

parallel with visarga and anusvāra. However, non-triggering consonants, in having an oral stricture at a specific place, cannot trigger and fail to allow retroflexion.

4. Origin and development of *s*-retroflexion

In section 2 above, I have attempted to pursue an articulatory denominator of RUKI triggers: although the bond may not appear strong enough, they are all behind dental at the beginning of the sibilant articulation. Due to the difficulty in defining the shared articulatory features of RUKI triggers, there have been attempts to define RUKI in perceptual and acoustic terms. First, Vennemann (1974: 95) assumes that the triggers form an "acoustic natural class" by "the property of lowering the frequencies in the energy concentration of a following *s*." Later, Longerich (1998: 26–27) shows based on the spectrographic data obtained by her experiments that /r, u, k, i/ but not /l, t, p, a, ʌ, ɔ/ "lower the initial noise frequency of a following /s/", which may be perceived as /ʃ/. She notes that /r/ has a strongest such tendency, then /k/ and /i/, and /u/ the weakest (Longerich 1998: 50). Longerich (1998: 27, 50) thus concludes that these four triggers form a natural class and that RUKI is a uniform process rather than a series of processes with the same effect but with different contexts.

In more general terms, Blevins (2004: 136) discusses "the shift between labialized, velarized, pharyngealized, and retroflex sounds" as "context-free sound changes with perceptual bases", where the common acoustic feature is "flat" (Ohala 1985). This observation is in accordance with Longerich's (1998) findings. The perceptual similarity caused by RUKI triggers, therefore, appears to have cross-linguistic foundation. The fact that RUKI triggers have a shared perceptual property, however, does not necessarily lead to the conviction that sibilant retroflexion with four different triggers is a uniform process. Although the retroflex outcome is shared by all the four triggers, there is strong evidence that *s*-retroflexion in Sanskrit consists of four independent retraction processes of the following dental sibilant, each with a different trigger instead of RUKI being a uniform process as a whole.

The previous two sections have shown that, although the four triggers are all behind the dental in place, they are still heterogeneous both phonetically and phonologically. First, *r* and the high back vowel are cross-linguistically common retroflexion triggers. On the other hand, the high front vowel is a typical palatalization trigger and causes deretroflexion. Further, as far as I am aware, *k* is not known for causing retroflexion. These differences of the four triggers suggest that, even with a shared property and the same outcome, there is enough

difference to consider that the four triggers each had different effects on the following dental sibilant.

In fact, there have been several studies on RUKI that suggest or even posit different outcomes for the four triggers (Morgenstierne 1929: 200; Allen 1951, 1954: 564–565; Martinet 1951; Vennemann 1974: 94–95; Gnanadesikan 1993: 47 fn.22; Flemming 1997; Hamann 2003: 109–111). Most recently, Hamann (2003: 109–111) has suggested, based on a cross-linguistic study of retroflexion, that the outcomes of /r/, /u/, /k/, and /i/ as triggers are [ṣ], [ṣ/sʷ], [ʃ/x], and [ʃ], respectively. At any rate, RUKI outputs must have started with somewhat retraced allophones of s in each of the four contexts rather than unequivocally and uniformly retroflex in all contexts.

Second, only $r/ṛ$ that follows the target blocks retroflexion but no other triggers. This is a curious fact given that high front vowels often cause deretroflexion in general (Hamann 2003: 81, 94–96). The blocking effect involves some idiosyncrasy in allowing intervening segments between the target and the blocker as in (4b), though retroflexion itself is triggered by the directly preceding sound, and there are also exceptions as in (4c).

Third, retroflexion by vowel triggers other than $ṛ$ involves irregularities and variations, part of which is lexically determined, but there still remain unaccountable exceptions. Also, retroflexion by originally high vowels is extensive in Vedic and applied also in external combination including phrase-level. On the other hand, retroflexion by consonant triggers and $ṛ$ tends to be regular and does not apply in external combination. Failure to apply in external combination and the low ratio of irregularities with k and $r/ṛ$ can largely be attributed to phonotactic restrictions, that is, infrequent occurrences of the target sequences. However, there are no exceptions of retroflexion after k and very few after $r/ṛ$ and these facts contrast sharply with irregularities of retroflexion after high vowels.

In addition to the facts already discussed, comparative evidence suggests that retroflex does not have to be and is not likely to be the original outcome at least in part. As is known, RUKI is observed in Iranian, Lithuanian, and Slavic as well as Indo-Aryan. Given the idiosyncrasy of the context, the change has been assumed to be a common development of Indo-Iranian, Baltic, and Slavic or an areal feature. However, there are enough differences among the four branches that require further developments beyond this peculiar context. First, Indo-Aryan is the only branch among the four that has developed a full series of retroflex consonants. Thus, while the retroflex outcome is characteristic of Indo-Aryan, other languages have different outcomes: $š$ in Iranian and Lithuanian and x in Slavic. Comparable to the Sanskrit

examples in (2) and (3) above are Slavic examples with the locative plural suffix OCS *trĭ-xŭ* 'in three', *synŭ-xŭ* 'in the sons' (Szemerényi 1996: 52). Some other examples are: from PIE **ters-* 'dry' Skt. *tr̥ṣyati* 'thirst' 3sg.pres., Avest. *taršna-* 'thirst', Lith. *tirštas*; from PIE **wers-* 'top, protrusion' Skt. *varṣman-* 'height, peak', Lith. *viršus* 'summit', OCS *vrĭxŭ* 'summit, height'; Skt. *uṣ-ás-*, Avest. *ušå*, Lith. *auš-rà* 'dawn'; Avest. *uši*, OCS *uxo* 'ear' but Lith. *ausìs* (Szemerényi 1996: 52; Hock 1991: 442–444, Meier-Brügger 2000: 96).

There are some further differences, which suggest that sibilant retroflexion has developed during a certain span of time and has multiple origins. In Iranian, there is retroflexion also after labial consonants *p* and *b* (Skjærvø 2009: 49, Brugmann and Delbrück 1930: §834). In Lithuanian the process was apparently not carried through: RUKI is regular after *r* but not after high vowels (Brugmann and Delbrück 1930: §§906, 911–912; Fraenkel 1950: 113–114; Andersen 1968; Hock 1991: 442–444). In Slavic, retroflexion is blocked when directly followed by *t* or *k* according to Brugmann and Delbrück (1930: §§909, 913) and allowed only when followed by a vowel according to Bräuer (1961: §100). On the other hand, in Indo-Aryan retroflexion is blocked by the following *r/r̥* as discussed above.

Retroflexion after labial consonants in Iranian apparently provides evidence against the generalization given in section 2 that the triggers are all behind the dental in place. The fact that labial consonants trigger retroflexion is accounted for by Blevins's (2004) observation given above in this section that labialization causes perceptually similar effects as retroflexion. Thus, labialization caused by the labial triggers yields similar acoustic effects to retroflexion that results from the other RUKI triggers. In articulatory terms, moreover, labial consonants lack a specific lingual gesture and thus may be neutral in terms of retroflection in parallel with *a*-vowels. Addition of labial consonants as triggers in Iranian, therefore, provides strong evidence for the assumption that changes after four different triggers of RUKI are also separate processes.

Together with the fact that the four triggers show different phonological behaviors in general, therefore, retroflex was not the original outcome in common Indo-Iranian/Balto-Slavic. In Pre-Indo-Aryan, the outcomes of retraction by different triggers merged as the retroflex with the introduction and development of the retroflex series from other sources (Wackernagel 1896: 164–177, 186–195, 229–241; Burrow 1973: 96–99; Mayrhofer 1978; Deshpande 1979). Only in Indo-Aryan the outcome ended up in retroflex, which has plausibly introduced further retroflection of the dental nasal and stops and the blocking effect of *r/r̥*. In the other RUKI dialects a comparable restriction did not develop largely because the outcome was not retroflex.

Another relevant factor for the development of RUKI would be the proliferation of the sibilant system: while there was only the dental sibilant in the proto-language, Pre-Indo-Aryan has developed additional two places for sibilants, i.e. retroflex and palatal, through retroflexion/ retraction and other sources (Wackernagel 1896: 224–242; Mayrhofer 1978; Hall 1997; Kobayashi 2004: 54–55). At the earliest attested stage of Indo-Aryan, retroflexion was stable after k and $r/ṛ$ but was variable and extended to phrase-level after high vowels. RUKI has become less extensive during Old Indo-Aryan period: retroflexion ceased to apply across word-boundaries and eventually grammaticalized as an internal sandhi process.

5. Conclusions

With the insight from the phonetic properties and phonological behaviors of the RUKI triggers and by examining irregularities and variations in Ṛgveda, I hope to have shed light on the vexing questions of whether the RUKI triggers form a natural class, how a group of seemingly heterogeneous sounds yields the same outcome, and how RUKI originally developed.

While triggers of the sibilant retroflexion are all behind the dental in place, given different phonological behaviors and varying degrees of irregularity and extensiveness of the four triggers and given comparative evidence where other branches show different conditioning factors and restrictions, Sanskrit RUKI must have begun as a series of independent but similar retraction processes and developed during a certain span of time. The outcome eventually merged as the retroflex with the development of retroflex series and proliferation of sibilants in Indo-Aryan.

Notes

1)   Abbreviations used are the followings:
      Languages: Avest. Avestan; Lith. Lithuanian; PIE Proto-Indo-European; OCS Old Church Slavic; Skt. Sanskrit
      Texts: RV Ṛgveda; TS Taittirīya-Saṁhitā;
      Grammatical categories: 1 first person; 2 second person; 3 third person; ABL. ablative; ACC. accusative; ACT. active; AOR. aorist; DESID. desiderative; FEM. feminine; GEN. genitive; IMPV. imperative; IND. indicative;

INJ. injunctive; INS. instrumental; LOC. locative; MASC. masculine; MID. middle; NOM. nominative; OPT. optative; PERF. perfect; PL. plural; PPL. participle; PREC. precative; PRES. present; SG. singular; VOC. vocative.

References

Allen, W. Sidney. 1951. "Some prosodic aspects of retroflexion and aspiration in Sanskrit." *Bulletin of the School of Oriental and African Studies* 13: 939–946.

——. 1953. *Phonetics in ancient India*. London: Oxford University Press.

——. 1954. "Retroflexion in Sanskrit." *Bulletin of the School of Oriental and African Studies* 16: 556–565.

——. 1973. "χθών, 'RUKI', and related matters: A reappraisal." *Transactions of the Philological Society* 1973: 98–126.

Andersen, Henning. 1968. "IE *s after *i, u, r, k* in Baltic and Slavic." *Acta Linguistica Hafniensia* 11: 171–190.

Blevins, Juliette. 2004. *Evolutionary phonology: The emergence of sound patterns*. Cambridge: Cambridge University Press.

Bräuer, Herbert. 1961. *Slavische Sprachwssenschaft: I Einleitung, Lautlehre*. Berlin: Walter de Gruyter.

Brugmann, Karl, and Berthold Delbrück. 1930. *Grundriss der vergleichenden Grammatik der indogermanischen Sprachen. I Einleitung und Lautlehre*. Zweite Bearbeitung. Berlin: Walter de Gruyter.

Burrow, Thomas. 1973. *The Sanskrit language*. New and revised edition. London: Faber and Faber.

——. 1976. "Sanskrit words having dental *-s-* after *i, u*, and *r*." In A. M. Davies and W. Meid (eds.), *Studies in Greek, Italic and Indo-European linguistics offered to L. R. Palmer*, 33–41. Innsbruck: Institut für Sprachwissenschaft.

Cardona, George 2003. "Sanskrit." In George Cardona and Dhanesh Jain (eds.), *The Indo-Aryan languages*, 104–160. London: Routledge.

Collenge, N. E. 1985. *Laws of Indo-European*. Amsterdam: Benjamins.

Deshpande, Madhav. M. 1979. "Genesis of Ṛgvedic retroflexion: A historical and sociolinguistic investigation." In Madhav M. Deshpande and Peter Hook (eds.), *Aryan and non-Aryan in India*, 235–315. Ann Arbor: Center for South and Southeast Asian Studies, University of Michigan.

Flemming, Edward. 1997. "Phonetic detail in phonology: Towards a unified account of assimilation and coarticulation." In Keiichiro Suzuki and Dirk Elzinga (eds.), *Proceedings of the* 1995 *South Western Workshop in Optimality Theory*. Tucson, AZ: Department of Linguistics, University of Arizona.

Fraenkel, Ernst. 1950. *Die baltischen Sprachen: Ihre Beziehungen zu einander und zu den indogermanischen Schwesteridiomen als Einführung in die baltische Sprachwissenschaft*. Heidelberg: Winter.

Gnanadesikan, Amalia. 1993. "The feature geometry of coronal subplaces." *University of Massachusetts Occasional Papers in Linguistics* 16: 27–67.

Hale, Mark. 1998. "Postlexical RUKI and the tisrá-rule." In Jay H. Jasanoff, H. Craig Melchert, and Lisi Oliver

(eds.), *Mír curad: Studies in honor of Calvert Watkins*, 213–222. Innsbruck: Insitutut für Sprachwissenschaft der Universität Innsbruck.

Hall, T. Alan. 1997. "The historical development of retroflex consonants in Indo-Aryan." *Lingua* 102: 203–221.

Hamann, Silke Renate. 2003. *The phonetics and phonology of retroflexes*. Ph. D. dissertation, University of Utrecht.

Hock, Hans Henrich. 1979. "Retroflexion rules in Sanskrit." *South Asian Languages Analysis* 1: 47–62.

——. 1991. *Principles of historical linguistics*. 2nd edn. Berlin: Mouton de Gruyter.

——. 1996. "Pre-Rgvedic convergence between Indo-Aryan Sanskrit and Dravidian? A survey of the issues and controversies." In Jan E. M. Houben (ed.), *Ideology and status of Sanskirt*, 17–58. Leiden: Brill.

Kiparsky, Paul. 1973. "Phonological representations." In Osau Fujimura (ed.), *Three dimensions of linguistic theory*, 1–136. Tokyo: TEC.

——. 1993. "Blocking in nondrived environments." In Sharon Hargus and Ellen M. Kaisse (eds.), *Studies in lexical phonology*, 277–313. San Diego: Academic Press.

Kobayashi, Masato. 2004. *Historical phonology of Old Indo-Aryan consonants*. Tokyo: Research Institute for Languages and Cultures of Asia and Africa.

Kochetov, Alexei. 2011. "Palatalization." Chapter 71 in Marc Oostendorp, Colin J. Ewen, Elizabeth V. Hume, and Keren Rice (eds.), *The Blackwell companion to phonology* 2, 1666–1690. Chichester: Wiley-Blackwell.

Longerich, Linda. 1998. *Acoustic conditioning for the RUKI rule*. M.A. thesis, Memorial University of Newfoundland.

Macdonell, A. A. 1910. *Vedic grammar*. Strassburg: Trübner.

——. 1916. *A Vedic grammar for students*. Oxford: Oxford University Press.

Martinet, André. 1951. "Concerning some Slavic and Aryan reflexes of IE *s*." *Word* 7: 91–95.

Mayrhofer, Manfred. 1978. *Sanskrit-Grammatik mit sprachvergleichenden Erläuterngen*. Dritte, durchgesehene Auflage. Berlin: Walter de Gruyter.

Meier-Brügger, Michael. 2000. *Indogermanische Sprachwissenschaft*. 7. Aufl. Berlin: Walter de Gruyter.

Monier-Williams, Sir M. 1984. *A Sanskrit dictionary: Etymologically and philologically arranged with special reference to cognate Indo-European languages*. New edition, greatly enlarged and improved. Reprint Delhi: Motilal Banarsidass. [First edition by Oxford University Press, 1899]

Morgenstirne, Georg. 1929. "The language of the Ashkun Kafirs." *Norsk Tidsskrift for Sprogvidenskap* 2: 192–289.

Ohala, J. J. 1985. "Around *flat*." In Victoria A. Fromkin (ed.), *Phonetic linguistics: Essays in honor of Peter Ladefoged*, 223–241. Orlando, FL: Academic Press.

Selkirk, Elizabeth O. 1980. "Prosodic domains in phonology: Sanskrit revisited." In Mark Aronoff (ed.), *Juncture*, 107–129. Saratoga, CA: Anma Libri.

Skjærvø, Prods Oktor. 2009. "Old Irnian." In Gernot Windfuhr (ed.), *The Iranian languages: Typology and syntax*, 43–195. London: Routledge.

Suzuki, Yasuko. 2013. "On characterizing Sanskrit anusvāra." In Shu-Fen Chen and Benjamin Slade (eds.), *Grammatica et verba, Glamor and verve: Festschrift for Hans Henrich Hock on the occasion of his seventy-fifth birthday*, 282–298. Ann Arbor: Beech Stave Press.

Szemerényi, Oswald. 1996. *Introduction to Indo-European linguistics*. Translated from *Einführung in die vergleichende Sprachwissenschaft*, 4th edn., 1990 with additional notes and references. Oxford: Clarendon.

Turner, R. L., and D. R. Turner 1971. *A comparative dictionary of the Indo-Aryan languages, Volume 3: Phonetic analysis*. London: Oxford University Press.

Vance, Timothy. 2008. *The sounds of Japanese*. Cambridge: Cambridge University Press.

Vennemann, Theo. 1974. "Sanskrit *ruki* and the concept of a natural class." *Lingusitics* 130: 91–97.

Wackernagel, Jakob. 1896. *Altindische Grammatik. Band I. Lautlehre*. Göttingen: Vandenhoeck & Ruprecht.

Whitney, William Dwight. 1885. *The roots, verb-forms, and primary derivatives of the Sanskrit language*. Leipzig: Breikopf and Härtel.

——. 1889. *A Sanskrit grammar*. 2nd edn. Cambridge, MA: Harvard University Press.

Zwicky, Arnold. 1970. "Greek-letter variables and the Sanskrit *ruki* class." *Linguistic Inquiry* 1: 549–555.

（すずき・やすこ　外国語学部准教授）