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THE DEVELOPMENT OF INDO-IRANIAN VOICED FRICATIVES

By Gašper Beguš
University of California, Berkeley

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Abstract

The development of voiced sibilants is a long-standing puzzle in Indo-Iranian historical phonology. In Vedic, all voiced sibilants are lost from the system, but the details of this loss are complex and subject to debate. The most intriguing development concerns the word-final *-aḥ* to *-o* in sandhi. This paper presents a new account of the development of voiced sibilants from the Proto-Indo-Iranian period to Vedic with a special emphasis on Iranian comparative data. I propose a new explanation for the peculiar development of word-final voiced fricatives and motivate the new proposal with a phonetic explanation. I argue that **-s* lenited and voiced to **-ɦ* word-finally which colours the preceding short vowel *ă* to **ɔ* (*o* after lengthening). Word-internally, no debuccalisation occurs. Voiced dental fricative **z* colours the preceding *a*-vowel to **ɛ* (*e* after lengthening). The voiced retroflex fricative **ẓ*, on the contrary, is central enough to cause no colouring. Voiced fricatives thus colour the preceding vowels with respect to their place of articulation. Dental fricatives cause fronting, while breathiness causes backing, which is supported by typological data. This proposal explains several unusual aspects of Vedic and Avestan data.

1. INTRODUCTION

1.1. Indo-Iranian

Proto-Indo-Iranian had two voiced sibilants in the word-internal position: **z* [z] and **ž* [ʒ] (< **z* in the *ruki*-position) that go back to Proto-Indo-European (PIE) **s* before a voiced stop. This is confirmed by Avestan (Av.), where both sibilants are preserved, for example, Av. *zdī* < **h₁z-dhí*; *mižda-* < **mižd^{h}á-* < **mizd$^{(h)}$ó-* (Wackernagel 1896 henceforth AiG I, pp. 273–275; Hoffmann & Forssman 2004, pp. 104–105). There are two additional sources of voiced sibilants. First, **z* results from a cluster **dd$^{(h)}$* that yielded **dzd$^{(h)}$*, and after the deocclusion, resulted in a cluster *zd* in Avestan (e.g., YAv. *dazdi* < **dadd^{h}í*;[1] Mayrhofer 1986–1992 henceforth EWAia, pp. 110–111). Second, **ž* results from PIE palatals before voiced dental stops. The voiced dental stop can go back to a voiceless stop that results from Bartholomae's law (e.g., Av. *važdra-* < **vájd$^{(h)}$ra-* from the PIE root **u̯eĝ$^{(h)}$-* and the suffix **-tra-*).

Besides the plain-voiced sibilants **z* and **ž*, there were also their aspirated counterparts **z^{h}* and **ž^{h}* in Proto-Indo-Iranian, which were the result of Bartholomae's law and, in the case of **ž^{h}*, of the *ruki*-rule.[2] Thus, **d^{h}s* first yielded **dz^{h}*, and after the loss of the dental stop and aspiration, resulted

[1] In Vedic, **z* from in **dzd* (< **dd*) is lost regularly (*s* (*z*) > ∅ / T _ T). In *dhehí* and *dehí*, however, the first **d* of the **dzd* cluster was lost, likely due to the dissimilation as both words begin with another voiced dental stop. The dissimilation must have occurred before the operation of the *s*-loss (*s* (*z*) > ∅ / T _ T). **d(h)addhí* thus yields **d(h)azdhí* and further *d(h)ehí* with the regular *e* for **az* (Hoffmann 1956, p. 21; Mayrhofer 1986–1992 henceforth EWAia, p. 111).

[2] The *ruki*-rule stands for a process in Vedic and elsewhere whereby *s* becomes *ṣ* after the sounds *i, u, r, k* (for a recent treatment, see Beguš 2012).

in a plain unaspirated voiced fricative Av. *z* (*uruuāza-* < **urād^{h}sa-*). Furthermore, **g$^{(u)h}$s* yielded **gž^h* which was deaspirated to *ɣž*, whereas **ĝ^{h}s* yielded **ǰž^h*, which resulted in a plain **ž* after the deocclusion of palatals (EWAia, p. 119; Hoffmann & Forssman 2004, pp. 95, 104–105). Likewise, **b^{h}s* yields Av. *βž*, since the *ruki*-rule operates also after labials in Avestan (Av. *drafša-* vs. Ved. *drapsá-*). At the Indo-Iranian stage, the fricative in this position likely did not yet undergo the *ruki*-rule (Proto-Indo-Iranian **bz^h* < PIE **b^{h}s*).

The development of the aspirated voiced sibilants is fairly unproblematic—in Avestan, they are deaspirated and remain voiced.[3] In Vedic, on the contrary, they always appear in their devoiced and deaspirated variant *s*. This *s* could either be analogically introduced (EWAia, p. 119), or it could be the result of a regular deaspiration and devoicing of **z^h* and **ž^h* to *s* and *ṣ* (Schindler 1976, p. 630), which is a more probable explanation.

In the word-final position and in the final position of first members in compounds, voiced sibilants always result from voicing assimilation if the sibilant appears before a voiced segment. Avestan and Vedic data suggest that this voicing assimilation dates back to Indo-Iranian, at least in compounds, for example, Ved. *dur-itá-*, Av. *duž-ita-* (< **dus-ita-*), *duž-niδāta-* and *ərəž-uxδa-*. Whether voicing assimilation in word-final position before a word boundary occurs already at an Indo-Iranian stage is an open question. Some posit that word-final stops had already lost voicing contrast in the Proto-Indo-European stage and that the resulting word-final stops are [−tense, −aspirated] and as such transcribed as voiced (Lipp 2016). It is unclear whether this loss of contrast can also be posited for final fricatives at such an early stage, but the relative chronology is not crucial for my argument. In Vedic, obstruents are always voiced before word boundaries if the following segment is voiced (including vowels), for example, *yád aṅgá* for *yát aṅgá*. Avestan and Old Persian, on the contrary, do not feature voiced obstruents in these positions. While this can be due to pada-pāṭha-like transmission of Avestan and Old Persian, there is no strong evidence suggesting that final voicing assimilation in the word-final position before voiced segments operated already at the Indo-Iranian stage. It is possible that final voicing assimilation operated only in compounds in Indo-Iranian (e.g., in compounds such as **duž-ita-*) or in analogical formations such as Av. *īžā-* and *yūžəm*), whereas voicing before word boundaries would be a later Vedic innovation. There exist limited traces of voicing of stops in word-final and sandhi positions in Avestan (e.g., *ad-āiš* for **at̰ āiš* and *xšaθrādδā* and *xšaθrāt̰*; Hoffmann & Forssman 2004, p. 112). On the contrary, voicing is not unexceptional even in compounds in Iranian, for example, Y 1.31.12 *miθahuuacah-* (cf. Vedic *mithaḥ* and *vacaḥ*, Hoffmann & Forssman 2004, p. 86) and *ərəšvacah-*.

1.2. The development in Iranian and Indic branches

Word-internal voiced sibilants are generally preserved in the Iranian branch, with the exception of aspirated sibilants that are deaspirated (**z^h* and **ž^h* to *z* and *ž*). In the final position, *z* and *ž* are preserved in compounds (e.g., YAv. *duž-ita-*, *x^{v}arənaz-dā-*, OP. *Vahyaz-dāta-*).[4] No voiced consonants are attested in the pre-pausal position. There are two variants of word-final *-*as* (or *-*ah*) in Avestan: *-ə* and *-ō*. Word-final *-*ās* (*-*āh*) yields *-å̊*. In Old Persian, word-final **s* is lost, but the preceding vowel (if originally short) does not lengthen (cf. Hoffmann & Forssman 2004, pp. 63–64; Vaan 2003, pp. 429–461; Brandenstein & Mayrhofer 1964, p. 42).

[3] According to Hoffmann and Forssman (2004, p. 96), aspirated voiced sibilants are sometimes analogically replaced by their voiceless unaspirated counterpart *s*/*š* (e.g., YAv. *haṇ-gərəfšāne* to the root √*grab*). In this example, the PIE root ends in a laryngeal and not in an aspirated **b^h*. Besides analogy, it is possible that the laryngeal did not cause the preceding voiced labial to aspirate (which would stand in opposition to *dugədar-* < **d^{h}ugh$_2$ter-*, where precisely this happens).

[4] Old Persian cuneiform does not have a character for *ž*, therefore the evidence for a retained *ž* here comes only from Avestan.

In Vedic, on the contrary, all voiced sibilants undergo significant changes. First, *ž undergoes a context-free retroflection to *ẓ (parallel to *š > ṣ).[5] The retroflex voiced fricatives are later lost, but their presence is reflected on the following dentals (e.g., *mīḍhá-* < **miẓḍhá-*). Word-internally, *z and *ẓ are then lost with compensatory lengthening. The outcome of lengthening differs based on the preceding vowel. The sequence **az* yields *e* [*e:*] word-internally, *-a* word-finally before vowels, and *-o* [*o:*] word-finally before voiced consonants. The sequences **iẓ* and **u̯ẓ* yield long *ī* and *ū* word-internally and *ir* and *ur* word-finally before voiced consonants and vowels.[6] Likewise, **r̥ẓ* yields a metrically long *r̥* in the word-internal position. The sequence **aẓ* yields either *ā*, *o,* or *e* word-internally and is not attested word-finally (AiG I, pp. 274–275). In the word-internal position, *ā* is the most common outcome, *o* is the outcome only if **aẓ* is preceded by **u̯*, and *e* is rare and could be analogical (for a thorough treatment of the sequence **aẓ*, see Lubotsky 2000). Long vowels and the diphthongs *e* and *o* (< **ai̯* and **au̯*) do not undergo any changes after the loss of voiced sibilants.

In compounds, the outcome is twofold: either loss with compensatory lengthening (*dū-ḍábha-* < **duẓḍábha-*)[7] or the development to *r* without lengthening (*dur-itá-* < **duẓ-itá-*). There are instances of the first development in the Rigveda even in word-final position (perhaps even in external sandhi), for example, *dū-ṇáśa-* < **duẓ-ṇáśa-*; *svádhitīva* < **svádhitiẓ (i)va*.

2. PRIOR ACCOUNTS

Various proposals have been made in the literature to explain the data presented in Section 1. In the following, I discuss the relevant proposals for the development of voiced fricatives. For a thorough overview of the topic, see Malzahn (2001).

Probably, the most disputed and still unsolved issue is that of word-final **-as* that yields Vedic *-o* before voiced consonants and *-a* before vowels (as opposed to *e* word-internally). In Avestan, the outcome of **-as* is *-ō* (and *-ə̄*) (for proposals, see Allen 1962; Bartholomae 1888; Lazzeroni 1969; Malzahn 2001; Marsh 1941).

One of the influential proposals explains the final *-o* (< **az*) as resulting from a diphthong **au̯* with the change in **-z* to **-u̯* (cf. AiG I, p. 338; Allen 1962). This proposal challenges the assumption that *-o* is the result of compensatory lengthening. The major advantage of the assumption of **z* to **u̯* is that it avoids a pre-Vedic stage with **au̯* and **ō* < **az* with lengthening later merging into *o*. Under other accounts, such a reconstruction is always necessary.

This proposal (**-z* > **-u̯*), however, faces several difficulties. First, after the long vowel *ā*, **z* does not yield **u̯* in word-internal position (e.g., *śaśādhi* from the root √*śās* and not ***śaśaudhi*) or word-finally (e.g., *párvatā nináme* for *párvatāḥ nináme* and not ***párvatau nináme*).[8] Under the assumption of unconditioned **-z* > **-u̯*, the same outcomes would be expected as in the case of the etymological **u̯*: *yónau ní*. Nevertheless, it can be argued that **-z* develops to **-u̯* only after short vowels.

More problematic is the fact that the assumed **u̯* (< **z*) does not behave the same as the etymological **u̯* even after the short vowel *a*. Although **az* and **au̯* both yield *o* before voiced consonants, they show different outcomes in the position before vowels. Thus, **au̯* V yields *av*

[5] For a detailed study of retroflection of *š, see Hall (1997).

[6] The sequences *-iẓ and *-uẓ yield *-ī* and *-ū* word-finally only before words with initial *r*.

[7] Only rarely is lengthening in the literature explained by an intermediate stage of *ẓ to *i̯* (*iẓ > *ii̯ > ī*) or to *u̯* (*uẓ > *uu̯ > ū*).

[8] Word-final *āz and *āu̯ yield different outcomes before vowels as well, for example, *áyā iva* for *áyāḥ iva* vs. *sámitāv iva* for *sámitau iva*. However, before the vowel *ŭ* the outcome is the same, because *v* in *āv* is dropped. *v* is also dropped in the Maitrāyaṇi-Saṃhitā (AiG I, p. 326).

V, whereas **az* V yields *a* V without a glide, for example, *sūnav āhuta* for *sūno āhuta* vs. *ádeva āpad* for *ádevaḥ āpat*. The same is true for compounds: *pura-etṛ́-* for **puras-etṛ́-* vs. *gav-iṣá-* for **gau̯-iṣá-*.

The only context in which **z* and **u̯* do show the same outcome in the pre-vocalic position is before the short vowel *ă*, for example, *vo amba* for *vaḥ amba* vs. *vādhvaryo ándhasaḥ* for *vādhvaryo ándhasaḥ*. Both also show variants with the initial *a* dropped, the so-called abhinihitasandhi, for example, *no 'vitā́* for *naḥ avitā́* and *vaso 'smā́n* for *vaso asmā́n*. This is clearly a later development which is also confirmed by the metre (AiG I, pp. 323–324), since *-o '-* (< **az a* and **au̯ a*) is scanned as two short syllables 1462 times out of 1883 occurrences (77.6%) in the metrically restored text (Nooten & Holland 1994, p. v).[9] Disyllabicity and quantity were thus preserved as suggested by the metrical evidence, but later the newly introduced *-o* was scanned as long (421 occurrences or 22.4%). The same is true for the sandhi of *-e* + *a-*: *e* is scanned short 549-times and long 173-times (see Nooten & Holland 1994, p. v). Presumably, the abhinihitasandhi *-e '-* and *-o '-* are the results of contraction with an intermediate stage **eẹe* and **oọo* (Allen 1962, pp. 37–45). This explanation is preferable to the one positing an analogical transfer of *-e* and *-o* from positions preceding voiced consonants after the elision of *a-*, primarily due to accentuation. The contracted vowel gets the svarita[10] accentuation (*yajñò 'yám* for *yajñáḥ ayám*), which speaks strongly in favour of Allen's (1962, pp. 37–45) assumption. In any case, this outcome is clearly secondary and not decisive for a historical account.

According to the explanation with a glide intermediate stage (**-au̯* < **-az*), the word-internal outcome of **-az* as *e* (e.g., *edhí* for **az-dhí*) can also be accounted for through an intermediate diphthongal stage (**az* > **ai̯* > *e*). However, it is difficult to motivate why **z* would yield *i̯* word-internally and **u̯* word-finally. Additionally, RV 1.34.5d *sū́re duhitā́* for *sū́raḥ duhitā́* suggests that *e* can also be the outcome of **az* word-finally.

Allen (1962) assumes that **-az* yields *-ay* in the pre-vocalic position (e.g., **-az* V- > **-ay* V- > *-a* V-), whereas pre-consonantally the **-az* sequence yields *-av*, from where *av* is analogically transferred to positions before *a-* (according to his assumption, *-e-* < **-ay a-* would be the expected outcome).

Bartholomae (1888, pp. 572–573) assumes *e* and *o* to be the regular outcomes of **aç* before voiced consonants. Bartholomae (1888, pp. 572–573) remains agnostic about the phonetic value of the peculiar **aç*. This **aç* is transferred from the pausa position, where it was a pre-stage of the later visarga, something like a weakened sibilant. The colour of the vowel *e* vs. *o* is assumed to either depend on the preceding consonantal context or on the accent. However, no further explanation for such a distribution is given.

A problematic explanation is given in Marsh (1941), where it is assumed that word-final and word-internal **az* yields *e* (through **ai̯*), whereas word-final and word-internal *aẓ* yield *o* (through the intermediate stage **ō*). Thus, all word-final *-o* (< **-as*) are explained by the assumption that **-az* became **-aẓ* before all voiced phonemes. Not only is this explanation phonetically unmotivated, the regular development of **-aẓ* (unless after **u̯*) is not *o*, but rather *ā* (as has been shown in Lubotsky 2000).

Some proposals allow dialectal origins to underlie the different outcomes of **az* (*e* and *o*) (Kobayashi 2004, p. 49), probably on the basis of the distribution of *-e* and *-o* in Middle Indo-

[9] Further evidence that the original sandhi outcome before *a* was the same as before any other vowel (i.e., *-a* V- for *-e* V-; *-av* V- for *-o* V- and *-a* V- for *-aḥ* V-) can be seen from the sandhi in Rigveda (RV) 8.72.5 *stótava ambyàm* for *stótave ambyàm* where the original outcome is assumed to be preserved. On the contrary, *-o* for **az* before *a* is sometimes spread to positions before vowels, for example, in compounds *gó-ɾ̥jīka-* and *gó-opaśa-* (cf. AiG I, pp. 324–325). This *o* is in both compounds scanned as short: the first compound is attested in the break and the latter in the cadence.

[10] The svarita is a predominantly falling pitch accent type in Vedic (AiG I, pp. 287–291). For a recent treatment on the phonetic value of the svarita, see Beguš (2016).

Aryan. The dialectal origin hypothesis is less successful in explaining the systematic phonological context differences between the two outcomes.[11]

Recently, a new account of the development of Indo-Aryan *-o* was proposed in Smith (2010), which takes the allophonic variation of visarga as the source of the different outcomes (*e* and *o*). According to this assumption, **z* yields **i̯*, **ẓ* yields *r* and the voiced counterpart of upadhmānīya (*ɸ*) yields **u̯*. The latter outcome is then analogically transferred to positions where the first outcome would be expected. According to Smith (2010), there are some remnants of the first outcome in RV1.34.5d *sū́re duhitā̀* and in Middle Indo-Aryan languages. However, this account has problems explaining why *vóḍhar-* is the outcome of **u̯áẓḍʰar-* instead of ***u̯árḍʰar-*. Likewise, the development of the fricatives to **i̯*, **u̯* and **r* does not happen after long vowels for **i̯* and **u̯*, but it does occur after long vowel for **r*. Also, the fact that **-az-* before the *bh*-cases (instrumental, dative, and ablative of dual and plural) appears as *o* (and **-ẓbh-* as *-rbh-*) is not a strong argument in favour of this account, since the *bh*-cases often feature analogical outcomes from the nominative case (see also the discussion on jihvāmūlīya and upadhmānīya below).

Sandell (2014) proposes a different analysis. According to Sandell (2014), the regular outcome of both **-az* (**-əz*) and **-aẓ* (**-əž*) is Vedic *e*. Unlike Lubotsky (2000), Sandell (2014) considers *tr̥ṇedhu* to be the only regular outcome of **aẓ*, while all outcomes with *ā* are considered analogical. As will be argued in this paper, the *ā* outcome of *aẓ* is phonetically motivated and thus does not require analogical explanations. Additionally, *tr̥ṇedhu* can either be analogical or a result of dissimilation (Lubotsky 2000; Milizia 2004, cf. Sandell 2014).

3. A new proposal

*3.1. Evidence for *ɔ and *ɛ*

As already mentioned, there are two sources for IIr. **ẓ* in word-internal position: either **ẓ* is the result of the *ruki*-rule or the result of the sequence palatal + voiced stop. In the first case, only *i*, *u,* and *r̥* can be lengthened, because they are the only short vowels that cause the *ruki*-rule. In the latter case, however, the short vowel *a* can be lengthened as well. The result of this lengthening can either be *ā*, *o* or *e*, for example, *sā́ḍhar-* < **sáẓḍʰar-* < **segʰ̑ter-*; *vóḍhar-* < **u̯áẓḍʰar-* < **u̯egʰ̑ter-*; *tr̥ṇéḍhu* < **tr̥náẓḍʰu* < **(s)tr̥negʰ̑tu*. As it was shown in Lubotsky (2000), the regular outcome is *ā*. It is thus clear that for the loss of **ẓ* no intermediate stage with a glide (**i̯* or **u̯*) is possible. However, besides *ā*, there is also an attestation of *e* in the imperative form once in the Atharvaveda, for example, *tr̥ṇéḍhu*, which is probably analogical to other imperatives in *edhí*, *d(h)ehí* (thus Lubotsky 2000) or a result of dissimilation (Milizia 2004, cf. Sandell 2014).

On the contrary, the regular outcome can also be *o* if **u̯* precedes the sequence **aẓ* (e.g., *vóḍhar-*). This development proves that Vedic *o* is not necessarily the result of monophthongisation, but can as well be the result of compensatory lengthening of *a* [ɐ][12] under certain conditions. In this case, **u̯* obviously caused the following vowel in the sequence **aẓ* [əẓ] to be backed and rounded to **[ɔẓ]*, which, after the lengthening, yielded *o* [ɔ̄] (Lubotsky 2000 and the literature therein). This also shows that a stage in pre-Vedic with **au̯* and **ɔ̄* that later merged needs to be independently reconstructed.

[11] The assumption that *e* and *o* represent the lengthened vowels **ĕ* and **ŏ* (< PIE **e* and **o*) before they merged to *a* (Bloomfield 1882) is improbable.

[12] The phonetic value of Vedic *a* is somewhat difficult to establish. Here, I follow Kümmel (2014) in assuming that *a* represented a near-open central vowel [ɐ]. The proposed explanation works with other qualities of *a* as well.

The *vo* < **u̯az̥* development cannot be explained through a diphthongal intermediate stage with **au̯*. It is clear that **z̥* does not develop into a glide, at least not to **i̯* or **u̯*, since the regular outcome of **az̥* is *ā* (e.g., in *sā́dhar-*). The only possible scenario would be to assume an ad hoc unexplained dissimilation of **z̥* to **z*, which would yield **i̯* and further to **u̯* because of the preceding **u̯*. This, however, is unlikely, as such dissimilation is never found elsewhere (e.g., *véda* < **u̯ái̯da*). The *vo* < **u̯az̥* development thus shows that Proto-Vedic *a* [ɐ] can be coloured to **ɔ* and then lengthened to **ɔ̄* after the loss of the voiced sibilant.[13] The colouring of *a*, which is lengthened to *o*, is a crucial independent piece of evidence for my proposal which will derive different outcomes in Vedic and Avestan via vocalic colouring.

Parallel to the development of *o*, it can be assumed that *e* resulted from the compensatory lengthening of **ɛ̄* < **az*. After the compensatory lengthening, **ɛ̄* merges with the monophthongisation outcome of **ai̯*, that is, Ved. *e* (e.g., *edhí*).

3.2. *A unified account*

Vedic word-final *-s* regularly yields *-ḥ* in the pausa position, as well as before velars and labials if they are not in close syntactic position.[14] Elsewhere, *s* is preserved in Vedic. The same lenition is attested in Iranian, but there the change is not limited to word-final position: **s* > *h* (Av. *həntī*, OP. *ha^{n}tiy* < **santi*). Word-finally, **-h* is actually lost both in Avestan and Old Persian, whereas it is generally preserved in the word-internal or word-initial positions.

The only place in Iranian where the Indo-Iranian word-final **-s* is preserved, with only minor modifications, is before the dental *t* (Avestan), palatal *c* (Avestan and Old Persian), and *n* (Avestan) in close syntactic positions, for example, Av. *kas-tē*, *kas-cīt̰*, OP. *kaš-čiy*,[17] Av. *kas-nā*. This closely resembles the Vedic situation, where *-s* or *-ś* is the regular outcome before *t(h)* and *c(h)*, respectively. In Vedic, *-s* is sometimes preserved also before *k(h)* and *p(h)* (for a detailed study on sequences *-s p(h)-* and *-s k(h)-*, see Hale 1990). In Avestan, this development is even less frequent (Y 43.8 *vasasə.xšaθrahiiā*[18]).

Given the similar outcomes of Iranian **s* > *h* and Vedic **-s* > *-ḥ*, I propose that the lenition of **s* first targets word-final position in both Vedic and Iranian. In Iranian, the tendency for sibilant lenition then spread from the word-final position to word-internal position,[19] whereas

Table 1. Voiceless sibilants in Indo-Iranian

	Indo-Iranian		Indo-Aryan		Iranian	
	**s*	**š*	**s*	**š*	**s*	**š*
Word-internally[15]	**s*	**š*	*s*	*ṣ*	*h*	*š*
Word-finally[16]	**s/ɛ*	**š*	*ḥ*	*ḥ*	**h* > ∅	*š*

[13] Vedic *a* can also be lengthened to *o* in a reciting pronunciation, for example, TS III 2.9.5 *móda ivéti* for *máda ivéti* (Hoffmann 1976).

[14] By "close syntactic position", I refer to the phenomenon analysed by Hale (1990) and Hale (1995), Lowe (2014), and others as the ability of words in a syntactic relationship to be incorporated into larger prosodic domains. For a thorough treatment of close syntactic position, see Hale (1990), Hale (1995), and Lowe (2014).

[15] With the exception of positions before stops and before *n*.

[16] Before *k(h)* and *p(h)* with the exception of close syntactic positions and in pausa position.

[17] Here, the sibilant is *š* and not *s*, similar to Vedic *-ś c-* for *-s c-*.

[18] Thanks to an anonymous reviewer for pointing this out.

[19] Sibilant *s* word-internally is preserved before stops in Old Persian. In Avestan, it is preserved before stops and *n* and after *t* that is later lost (cf. Brandenstein & Mayrhofer 1964, p. 42; Hoffmann & Forssman 2004, p. 104). Elsewhere, **s* is lenited to *h*.

in Vedic, the tendency for lenition spread to word-final *-*ṣ* (that develops to -*ḥ*),[20] but not to word-internal sibilants.[21] I assume that the Indo-Iranian word-final fricative was lost in Iranian precisely because it was lenited considerably earlier than the sibilant **s* in word-internal and initial position.[22] On the contrary, in Indo-Aryan, the tendency for lenition spread to word-final *-*ṣ* instead. This could also have happened late in the pre-Vedic period. The Indo-Iranian stage and the corresponding developments to Indo-Aryan and Iranian are represented in Table 1.

The lenition of *-*s* is difficult to chronologically estimate in the two branches. Here, I propose that word-final *-*s* can potentially weaken to *-*h* (or a pre-stage of *-*h*) already at the Indo-Iranian stage. Despite the external evidence that I provide here, this cannot be definitely proven. It is also possible that the *-*s* > *-*h* sound change operated independently in the two branches.

External evidence for the chronology is inconclusive. In Assyrian, a god name ^{d}*as-sa-ra* ^{d}*ma-za-áš* is attested (Lipp 2009, p. 319). The internal sibilant is written with -*ss*-, while the final sibilant is written with -*š*. The exact phonetic value of -*ss*- vs. -*š* is difficult to establish, especially for loanwords, and especially because it is difficult to date the form precisely. The phonetic value of ⟨*s*⟩ and ⟨*š*⟩ has been a puzzle in Proto-Semitic and the values can vary considerably across time periods and varieties. In Neo-Assyrian, ⟨*s*⟩ stands for [*š*], while ⟨*š*⟩ stands for [*s*] (Luukko 2004, p. 74), but the form is likely older than the Neo-Assyrian text in which it is attested (Mayrhofer 1971; Hintze 1998). In Old Assyrian, ⟨*š*⟩ generally represents [*s*] although some assume the phonetic value is that of [*š*] (for a discussion, see Kogan 2012), while ⟨*s*⟩ stands for an affricate [^{t}*s*]. It is possible that *š* represents a pre-stage of the Iranian weakened *-*h*, perhaps a palatal **ɕ*.[23] However, it is equally or even more possible that final -*áš* simply represents an unweakened [s] as in Old Babylonian, where -*áš* can stand for [*as*] (Kogan 2012, p. 87). The Assyrian ^{mât}*Par-su-aš* (in Streck 1900, p. 308 and Lipp 2009, p. 320) potentially supports such a reconstruction with ⟨-*š*⟩ representing a weakened variant of /*s*/. If the word goes back to the Iranian nominative form **pārćuas* and its ⟨*š*⟩ is not influenced by Kassite *iaš* 'land',[24] the *š* could perhaps represent a weakened *-*s*, probably a fricative articulated somewhere between [*s*] and [*h*] (perhaps a palatalised fricative). Because Ir. **ć* in ^{mât}*Par-su-aš* would have already developed to the sibilant **s*, the final *-*s* must have already undergone lenition. Lipp (2009, p. 322) argues that Assyrian *s* goes back to a sibilant not a fricative, but given that the phonetic value of ⟨*s*⟩ in Old Assyrian is likely an affricate, the ^{mât}*Par-su-aš* form is also inconclusive. The fact that *Parsuaš* also has a more frequent variant *Parsua* could exemplify the loss of *-*h*, but the form can also represent a bare stem. Sound changes that turn a dental or alveolar into a post-alveolar sibilant are well attested in Kümmel (2007), both in the coda position or unconditioned by position. Regardless of

[20] Before *k(h)* or *p(h)*, *ṣ* is preserved in 7.5% of instances in the Rigveda, whereas in other 92.5% it is lenited to -*ḥ*. Before a following *t(h)*-, *ṣ* can either appear as *ṣ* or *s*. The ratio of -*ṣ ṭ(h)*- vs. -*s t(h)*- in external sandhi is 23.6% vs. 76.4% in the Rigveda (Beguš 2012). For a detailed study, see also Hale (1990).

[21] Occasionally, the development of *s* > *h* is found also in Indo-Aryan branch in later languages, for example, Aśoka *dāhiṃti*, *dāhāmi* for Skt. *dāsyāmi*, Māgadhī *kāmāha* for Skt. *kāmasya*. However, the distribution and conditions are unclear (see Hinüber 2001, p. 178).

[22] That the lenition of Iranian **s* to *h* is not a recent development is shown by the fact that *s* is not lenited in positions (i) after dental *t* that is later lost because of the TS-cluster simplification, for example, Av. *masiia-* < **matsiia-*, *stauuas* < **stauuats*; (ii) before a dental that is later lost because of simplification of word-final clusters, for example, *āas* < **āst*; and (iii) *s* that is the result of a deaffrication of PIE palatal, for example, *satəm* < **t^{s}atam* < **ḱm̥tom*. This means that the lenition is earlier than all these three phenomena.

[23] Bartholomae (1888, p. 571) suggests that weakening to what he reconstructs as **aç* is already an Indo-Iranian phenomenon, but does not provide external evidence. He remains agnostic about the phonetic value of this **ç*.

[24] For the explanation with the nominative, see Jensen (1894, p. 476); for explanation with Kassite *iaš* 'land', see Streck (1908, p. 256).

whether this lenition is a common innovation or happens independently in the two branches, the newly proposed account explains the data equally well.

Another change occurred in the history of Indo-Iranian: word-final voicing assimilation. Establishing its chronology is not trivial either. The voicing of consonants is attested in the word-final position in both branches in compounds. It is reasonable to assume that voicing was already an Indo-Iranian phenomenon in compounds. However, it is not clear whether this was also the case in external sandhi. Avestan and Old Persian generally never show voicing in external sandhi, but this could also be due to the pada-pāṭha-like (or a word-by-word) transmission of the texts. Few examples in Avestan seem to show voicing, for example, *ad-āiš* < **aṯ āiš* (Hoffmann & Forssman 2004, p. 112). However, the particle *aṯ* probably goes back to an ablative of a demonstrative which had a voiced dental **ad* (see EWAia, p. 163).[25] On the contrary, for *īžā-* and *yūžəm* it is clear that voicing must have occurred, but it is uncertain whether the voicing here indeed originates in external sandhi. On the contrary, if Av. *ciθīṯ* goes back to **cīṯ īṯ*, it would speak against voicing in external sandhi in Avestan. The evidence is, however, sparse, and no strong conclusion can be made. Again, the exact chronology of the final voicing does not crucially affect my proposal as long as it is active after the lenition of **-s*.

Given all these facts, I assume that the Indo-Iranian stage with word-internal **-s-*, word-final **-s* (that further weakens to **-ɛ/h*), word-internal **-š-* and word-final **-š* (see the Table 1) continued unchanged into the Indo-Aryan period, except that the lenition of word-final **-s* to **-h* is completed by Indo-Aryan. Word-internally, there were also voiced counterparts to these sibilants (**-z-* and **-ž-*) in the position before a voiced consonant. From a certain point on, I argue that final voicing assimilation targeted not only stops, but word-final sibilants and **-h* as well.[26] I thus reconstruct voiced **-ɦ* and **-z* (voiced variants of *-ḥ* and **-s*) as well as the voiced **ž* (counterpart of *-ṣ*) which remains unweakened in the word-final position. I assume that voiced **-z* was the regular outcome of the word-final **-s* in close syntactic positions and before the dental *d(h)*, which would be exactly parallel to *-s* in close syntactic positions and before *t(h)* in non-voicing environments. On the contrary, just like *-ḥ* was the outcome in pausa and before *k(h)* and *p(h)*, I reconstruct**-ɦ* to be the outcome before *g(h)* and *b(h)*, as well as before vowels, nasals and glides (because of the final voicing assimilation) in non-close syntactic positions.[27] Table 2 shows the assumed system for Indo-Aryan. This voiced

Table 2. Sibilants in Indo-Aryan

	Word-internally		Word-finally			
			Close syntactic position and before *t(h)/d(h)*		Elsewhere	
	**s*	**š*	**s*	**š*	**s*	**š*
Voiceless	*s*	*ṣ*	*s*	*ṣ*[28]	*h*	**ṣ*
Voiced	**z*	**ẓ*	**z*	**ẓ*	**ɦ*	**ẓ*

[25] It is unclear whether the voiced stop of the ablative indeed featured voicing or it was an unaspirated non-tense stop (Lipp 2016), but the evidence for voicing in external sandhi given by *ad-āiš* is weakened by the possibility that voicing is of an earlier origin.

[26] We could also assume voicing first (**s* > **z* and **š* > **ž*) and then lenition **z* > **ɦ*, but this is less likely.

[27] This development had to occur after the merger of PIE **e* and **o* to *a* in Indo-Iranian and therefore also after Brugmann's law (for recent treatments of Brugmann's law, see Grestenberger 2024 and Keydana 2012).

[28] The outcome of *-ṣ* can also appear as dental *s* before *t(h)*. This is probably a later assimilation. The ratio of *-ṣ* vs. *-s* in this case is much higher than that of *-ṣ* vs. *-ḥ* before *k(h)* and *p(h)* in the Rigveda: 23.6% vs. 7.5% (Beguš 2012).

Table 3. Sibilants in Avestan

	Word-internally		Word-finally			
			Occasionally in close syntactic position and before *t, c* and *n*		Elsewhere	
	**s*	**š*	**s*	**š*	**s*	**š*
Voiceless	*h*	*š*	*s*	*š*	?	*š*
Voiced	*z*	*ž*	/	/	?	*ž*[29]

*-*ɦ* (< **h*) did not merge with voiced *h* (< **ǧʰ*). At the time of *-*ɦ* (< *-*h*), **ǰʰ* (< **ǧʰ*) was probably still an affricate. When, however, *-*ɦ* was regularly lost, **ǰʰ* deaffricated and filled the empty slot in the phonological system.

In the following, I reconstruct the development from the Indo-Aryan stage (Table 2) to the attested Vedic system. The crucial difference from the prior explanations (as in AiG I) is that I propose an early lenition of *-*s* to -*ḥ* which consequently gives two voiced outcomes of *-*s*: *-*z* and *-*ɦ*. I argue that these reconstructions explain the peculiar vocalic outcomes (-*e* and -*o*) better than alternative approaches.

The voiceless series (in Table 1) generally remains unchanged. The final *-*ṣ* is, however, lenited to -*ḥ* if not in close syntactic position. This can be understood as spreading the tendency for final sibilant lenition from *-*s* to *-*ṣ*.

3.3. *Colouring*

All reconstructed fricatives in the voiced series (**z*, **ẓ*, and **ɦ*; Table 2) are lost without exception in the pre-consonantal position with compensatory lengthening of the preceding vowel. The outcome of the lengthening of the preceding vowel depends crucially on the place feature of the lost voiced fricative. The high vowels and *r̥* do not change their quality. Also, the long vowel *ā* remains unchanged. I argue that short *ă* [ɐ] is coloured according to the following consonant: (i) *a* [ɐ] is fronted to [ɛ] before dental **z* and yields *e* [ɛː] after lengthening; (ii) before glottal **ɦ*, *a* [ɐ] is backed to [ɔ] and yields *o* [ɔː] after lengthening; and (iii) *a* [ɐ] before **ẓ* does not change the place feature, since the retroflex **ẓ* is central enough (middle stage between **z* and **ɦ*) for *a* to be preserved and lengthened to *ā*. If, however, **aẓ* is preceded by **u̯*, *a* [ɐ] is also rounded and backed, which again yields *o* [ɔː].[30] Before the retroflex -*r* (i.e., homorganic to **ẓ*) in front of the following *r*-, *a* is lengthened to *ā* without the change in quality, which is precisely the same outcome as in lengthening before **ẓ*.

There is a clear phonetic motivation for the proposed colouring. Pongweni (1983) shows that in Shona (Bantu), breathy vowels that result from the preceding [ɦ] cause F2 to decrease, especially in central vowels. In other words, the breathiness of [ɦ] causes the backing of the vowel. Similarly, Samely (1991) shows that breathy vowels are more back than modal vowels

[29] Avestan word-final **ž* is seen only in compounds and never in external sandhi.

[30] Osthoff (1884, p. 37) assumes visarga to be analogically transferred from positions before *k(h)* and *p(h)* to positions before voiced consonants where it was voiced to **ḫ* (voiced laryngeal counterpart to visarga), which probably further developed to **u̯*. My explanation differs in the assumption that visarga was not necessarily analogically transferred, but can be the result of earlier lenition of word-final *-*s*. Moreover, no development to **u̯* is needed, although this possibility is not completely abandoned in my analysis. Also, the proposed explanation here better captures the differences in vowel quality. Osthoff (1884) also assumes that **az* and **aź* (or **aẓ*, respectively) yield **ai̯*, which is different from my assumption. Especially improbable is the assumption that both **z* as well as **ź* yield the same outcome *i̯* (see the discussion above).

in Kedang, an unrelated Austronesian language (see also Kuang 2011). Esposito, Sleeper, and Schäfer (2021, p. 375) give a potential phonetic explanation: 'During breathy phonation, the larynx may be lowered, lengthening the vocal tract and, thus, lowering formant frequencies'. This is precisely what I reconstruct for Vedic: *-*ɦ* < *-*h* causes breathiness of the preceding vowel, which in turn causes backing of *a* [ɐ] to [ɔ], similarly to the backing of [ɐ] to [ɔ] under the influence of **u̯* in *vóḍhar-*. Lotto et al. (1997) additionally show that breathiness also affects perception: Breathy vowels are perceived as higher than non-breathy vowels, which would again support my proposal. The assumed small phonetic variation (**ə* > **ɔ* / _ **ɦ*) is lost except when compensatory lengthening causes the lengthening of the coloured **ɔ* vowel. The colouring of **ə* to **ɛ* before **z* is motivated by coarticulatory effects: the tongue moves further towards the front of the vocal tract in anticipation of the dental articulation, which causes fronting effects on the preceding vowels. This colouring process is reconstructed as a phonologised sound change, which is supported by the fact that *-o* and *-e* from **-aɦ* and **-az* merge with *-o* and *-e* from monophthongisation.[31]

The proposal above has the advantage of explaining the distribution of word-internal *e* vs. word-final *o* < **az* in the pre-consonantal position. Thus, *edhí* develops from **ɛzdhí* < **azdhí* and *áśvo náyamāno* from **áśvɔɦ náya○* < **áśvaɦ náya○*. Moreover, *-s* was not lenited to *-ḥ* in close syntactic positions and before *t(h)*. This further means that in these positions, **-z* is the only outcome (and not **-ɦ*). As a consequence, the unusual outcome *-e* in the external sandhi in RV 1.34.5d *sū́re duhitā́* for *sū́raḥ duhitā́* can be explained. This unusual sandhi was probably a remnant of the *sū́rɛz duhitā́* < **sū́raz duhitā́*, where *z* is preserved before *d* like *s* is preserved before *t(h)*. This would be the only case of this kind in the Rigveda (and potentially RV 9.97.38 *sū́re ná dhā́tā*; Jamison 2010),[32] which means that later the outcome *-o* from 'elsewhere' (i.e., non-close syntactic positions) was generalised. However, that *-e* < **-az* was once much more widespread could also be supported by some Prākrits which generalise the close sandhi and *d(h)*-outcomes *-e* to other positions (e.g., Māgadhī). Others generalise the *-o* variant (Pāli, Māhārāṣṭrī; cf. Hinüber 2001).[33]

As already mentioned, examples like *sā́ḍhar-* < **sáẓḍhar-* and *antā́ ródasī* for *antár ródasī* show that **ẓ* and *r* were central enough not to cause any changes on the preceding vowel, unless **ẓ* was preceded by **u̯*, which yields the expected *vóḍhar-* < **u̯óẓḍhar-*. Also, the long vowel *ā* does not undergo any changes after **z*, **ẓ,* or **ɦ*. This is, however, expected, since it was a low vowel and probably articulatorily peripheral enough not to undergo any fronting or backing.

Loss of voiced sibilants and **ɦ* with compensatory lengthening regularly occurs in the pre-consonantal position, which means not only before voiced stops, but also before nasals and glides. This is confirmed by examples like *dū-ṇáśa-* < **duẓ-náśa-*. Later, the outcome with *r* was analogically transferred to these positions from the pre-vocalic position (thus already AV 5.11.6b *durṇáśa-*). Vedic *dū-ṇáśa-* is perhaps the only certain example of this development in the Rigveda. Another possible instance in the Rigveda could be a very early attested RV

[31] Sound changes can cease to be active, which is what I reconstruct for Avestan in Section 3.6.

[32] Migron (1999) reports another such instance: RV 6.18.14 *divé jánāya*. Traditionally, *divé* is parsed as dative, whereas the translation with genitive clearly has advantages. Word-final **-az* (and not **-aɦ*) here could be the consequence of close syntactic relation (note also the 'formulaic character') or due to the fact that the following initial consonant *j-* goes back to the affricate **ʃ* that could trigger the retention of **-z* (like *-ś* is retained before *c(h)-* and *-s* before *-t(h)*). However, since the philological status of *divé jánāya* is not yet established with certainty, I will leave this example out of the main argumentation. For discussion, see also Malzahn (2001, p. 140), where apud Insler and Schindler a possibility of *divé-dive* as **diváz divai* (ablative and dative) is given.

[33] Some Prakrits even have both. Thus in Ardhamāgadhī, *-e* is the outcome in the nom. sg. forms of *a*-stems, whereas *-o* is the outcome elsewhere (cf. Hinüber 2001, p. 99).

5.7.8b *svádhitīva* for *svádhitiḥ (i)va*. It is unclear, however, which variant of the *iva*/*va*[34] particle is the underlying form here. Turner (1970) points out that Middle Indo-Aryan languages show more such examples where the original outcome has not been replaced by the pre-vocalic outcome *r*, for example, Pkt. *ṇī-ṇēi* vs. *ṇiṇṇaya-* for Skt. *nirṇaya-*.[35] However, these forms could perhaps be the result of simplification of geminates and compensatory lengthening. In any case, the evidence from the compound *dū-ṇáśa-* is strong enough to assume pre-consonantal loss with compensatory lengthening, which includes all consonants, that is, also nasals and glides.

3.4. Loss in the inter-vocalic position

In the pre-vocalic position, the outcomes differ from the pre-consonantal position.[36] Apparently, **-ɦ* was lost without any trace (**ɦ* > ∅ / V _ V), for example, *nára ājā́* for *náraḥ ājā́* (**nárɔɦ ājā́*). Also, the preceding short vowel *-a* was not backed, because it was not lengthened and the allophonic variant **[-ɔɦ]* was probably lost after the condition (**-ɦ*) was lost. The loss without lengthening is the regular result both in compounds and in external sandhi, for example, *pura-etr̥̊-* (**purɔɦ-etr̥̊-*), *ádeva āpad* for *ádevaḥ āpat* (**ádevɔɦ āpat*)—as opposed to the pre-consonantal positions where sibilants are lost with compensatory lengthening. The metrical evidence also suggests that loss without lengthening was the regular outcome also before the short vowel *a* (**-ɔɦ a-* > **-a a-*).

Likewise, **ẓ* yields a very different result in the pre-consonantal position from that of the pre-vocalic position. Pre-vocalically, it was rhotacised to *r*, for example, Ved. *írā-*, (cf. Av. *īžā-*), *dur-itá-* (**duẓ-itá-*) and *agnír adād* for *agníḥ adāt* (**agníẓ adāt*). The development **ẓ* > *r* includes only an increase in sonority—other features remain mostly unchanged. Rhotacism is often typologically limited to the inter-vocalic position (cf. Kümmel 2007, pp. 80–81). Moreover, there are further indications to show that the development **ẓ* > *r* in Vedic was limited to the inter-vocalic position. The later post-Rigvedic[37] development of **ḍ(h)* > *ḷ(h)* is very similar to that of **ẓ* > *r*. The two developments together suggest that all voiced retroflex sibilants in Vedic (**ẓ*, *ḍ,* and *ḍh*) were assimilated to the vocalic environment by increasing sonority. Other features, however, remained mostly the same. Apparently, this tendency first started on the sibilant **ẓ*, and later spread to the other two voiced retroflex consonants, but it was in both cases clearly limited to the inter-vocalic position.

[34] For a thorough treatment of *iva* and *va* variants, see Malzahn (2001). If the particle was *va*, this would mean that the form contains an archaic external sandhi outcome, that is, the regular loss of pre-consonantal **ẓ* with compensatory lengthening. If, however, the particle was *iva*, the form would feature a unique irregular loss of **ẓ* in the pre-vocalic position (attested only in such instances) and a later contraction of **-i i-* (double sandhi). This double sandhi does occur in the Rigveda (e.g., *vr̥ṣabháḥ iva* for *vr̥ṣabháḥ iva*), but the difference, in this case, is that the loss of (**-ɦ*) here is regular. Another such example could be RV 9.96.15d *urv ìva* for *urúḥ iva iva* (cf. AiG I, p. 337), but this is a much latter attestation. Here, a reintroduction of *iva* in the place of *va* would have to be assumed unless an irregular pre-vocalic loss of **ẓ* operated here. RV 9.61.10b *bhūmy á́* is probably a locative (see AiG I, p. 337; Oldenberg 1912, p. 164).

[35] Cf. also M. *nivaḷ* for **nī-mala-* < **niẓ-mala-*, Kalasha *niála-* for **nī-yāta- *niẓ yāta-* (Turner 1970).

[36] The fact that *r* is the regular outcome of **ẓ* only in the pre-vocalic position has already been established in the literature—'*[s]icher lautgesetzlich ist* r *für ẓ nur vor Vokalen*' (AiG I, p. 337). Moreover, Brugmann (1897, p. 892) states that '-ž *ging vor den Sonorlauten in irgend welchem Umfang, jedendalls vor Vocalen lautgesetzlich in* -r *über*', which shows that the development to *-r* is not uniformly and strictly limited to the pre-vocalic position everywhere in the literature.

[37] For the discussion on the chronology of the Vedic *ḷ(h)*, see Witzel 1989, pp. 165–168.

From the inter-vocalic position, the outcome with *r* spread to positions before all voiced consonants, for example, *dur-gáha-* and *agnír bhavati* for *agníḥ bhavati*.[38] Only a few compounds and some Middle Indo-Aryan languages preserve the outcome with loss and compensatory lengthening (see above).

The question remains open: what happened to word-final pre-vocalic **z*? The instances of inter-vocalic **z* were probably very rare. They would be expected only in close syntactic positions before words beginning with vowels. Thus, the reflexes (if they were distinct) were most probably lost.

The fact that some Prātiśākhyas (manuals on pronunciation; Scharfe 1977, p. 127) include jihvāmūlīya (a voiceless labial fricative variant transcribed as *ẖ*) and upadhmānīya (a voiceless velar fricative variant transcribed as *ẖ*) as allophonic variants of the visarga[39] is not problematic for my proposed analysis. To challenge the present proposal, one would have to assume that upadhmānīya ([*ɸ*]; a voiceless bilabial fricative in the position before a voiceless labial) developed its voiced counterpart without any intermediate stage, which would prevent *a* [ɐ] from backing. However, it is unlikely that word-final **-s* and **-z* would be directly lenited to **-ɸ* and **-β* in the position before labials *p(h)* and *b(h)*. It is much more likely that **-s* was first lenited to *-ẖ* (and then voiced to **-ɦ*) and only then further assimilated to the following consonants in external sandhi (*-ɸ* or *-x*, respectively, for *-ẖ* or *-ẖ*). During this stage, **-ɦ* had likely already been lost, which means that it could not be assimilated to **-β*. Also, the fact that not all Prātiśākhyas recognise the allophonic variation of visarga and that there are some deviations in their descriptions could speak in favour of the assumption that the allophonic variation was a later development.

The lenition of word-final *-s* to *-ẖ* in Vedic probably occurred later than word-final voicing. Otherwise, ***-iɦ* V and ***-uɦ* V would be expected to yield ***-i* V and ***-u* V instead of the attested *-ir* V and *-ur* V (< **-iẓ* V and **-uẓ* V).

With the established model above, I also explain the peculiar abhinihita sandhi outcome. The fact that the outcome of the contraction is *o* (and *e*) can give additional evidence that the *ă* before **ɦ* was coloured to **ɔ* and preserved as such, until it yielded *o* after the contraction (**-ɔɦ a-* > **-ɔ ɔ-* > **-ɔ̄-*; see the discussion in Section 2 and in Allen 1962, pp. 37–45). Per Allen (1962, pp. 37–45) and the hypothesis that the voiced fricatives develop into glides, it could also be assumed that **i̯* and **u̯* coloured the preceding *ă*, which in turn would yield the same outcome. If **i̯* is assumed to be the regular outcome of **-az* in the pre-vocalic position, however, the expected outcome would be the abhinihita sandhi ***-e-* and not *-o-*, as is attested.[40]

3.5. Summary

In sum, I argue that the lenition of **s* to **h* started in word-final position, possibly already at the Indo-Iranian stage. After the voicing in word-final position, **h* developed its voiced counterpart **ɦ*. The two other voiced sibilants that already existed in the system were **z* and **ẓ*. In the pre-consonantal position, these voiced sibilants were lost in Vedic with compensatory lengthening. The preceding short vowel *a* [ɐ] changed its frontness according

[38] The pre-vocalic outcome with *r* was spread also to positions before *n*. In turn, this *n* first regularly developed into a retroflex *ṇ* in compounds. However, later in the classical language, the retroflexion is not operative anymore and instead a dental *n* is attested in such instances. The tendency of non-retroflexion starts already in the Rigveda, where one such compound is attested fairly late: *dur-niyántu-* in RV 1.135.9f and in RV 1.190.6b (Beguš 2012, p. 72; cf. AiG I, p. 190).

[39] For a discussion on visarga and its variants, see Fry (1941) and the literature therein.

[40] Of course one could claim that *-o-* was analogically transferred from positions before voiced consonants, but for the assumption proposed here, this step is not necessary.

to the place of articulation of the following fricative: (i) before *z it was fronted to *ε (after lengthening *$\bar{\varepsilon}$); (ii) before *$\hbar$ it was backed to *$\mathfrak{o}$ (after lengthening *$\bar{\mathfrak{o}}$); and (iii) before *$\underline{z}$ and r it remained unchanged (a and after lengthening $\bar{a}$), since the retroflex consonants were central enough not to cause backing or rounding. I have also argued that in close syntactic positions and before $d(h)$, the sibilant outcome was *z, whereas elsewhere it was *$\hbar$ (parallel to -s vs. -$\underline{h}$). This explanation has a strong phonetic motivation.

In the pre-vocalic position, on the contrary, the outcomes were quite different. I argue that *$\hbar$ was lost without a trace and that *$\underline{z}$ yielded r, which later spread to all positions before voiced consonants with only a few exceptions. This situation (especially for *$\hbar$) is reminiscent to that of PIE laryngeals that coloured neighbouring vowels, causing compensatory lengthening in the pre-consonantal position and loss inter-vocalically. However, this is only a typological parallel.

I argue that the loss of *z, *$\underline{z}$, and *$\hbar$ proceeded without an intermediate stage with glides.[41] While there exists a possibility that *z and *$\hbar$ were lost through some intermediate stage of *$\underset{\frown}{i}$ and *$\underset{\frown}{u}$, that is, glides with 'lighter' articulation (laghuprayatna) that merged with the weakened glides in word-final position (*$\underset{\frown}{i}$ and *$\underset{\frown}{u}$ < *$\underline{i}$ and *$\underline{u}$), I argue that this is a less likely explanation. It is true that there are a few sporadic instances from various sources of the post-Rigvedic literature (including some manuscripts) that seem to retain the glide y < *z, for example, *dhī́ray emí* for *dhīraḥ emí* (Oldenberg 1888, pp. 457–459; cf. Weber 1858, p. 252; Witzel 1989, p. 190), but they are probably of secondary origin. Most of the reported instances with y are followed by a high vowel i or e, which speaks in favour of the assumption that the glide y here is secondary, caused by the high vowel in the hiatus and not the original remnant of *-z.[42] Witzel (1989, p. 190) also lists a development in the Maitrāyaṇi Saṃhitā and Kapiṣṭhala-Kaṭha Saṃhitā in which final -e V́ and -$aḥ$ V́ both yielded -$ā$ V́ before an accented vowel. However, as Lubotsky (1983) clearly shows, this development must have gone through an intermediate stage -e and -$aḥ$ > *-$ă$, which was followed by the lengthening in the hiatus if this -$ă$ was unaccented and in the position before an accented vowel. This is proven by the fact that -$ă$ in hiatus (before $\underset{\circ}{r}$́-) is lengthened even if it does not go back to -e or -$aḥ$. Consequently, the development -e V́ and -$aḥ$ V́ > -$ā$ V́ in Maitrāyaṇi Saṃhitā and Kapiṣṭhala-Kaṭha Saṃhitā do not show any evidence that the loss of *z (i.e., *$\hbar$ in close syntactic constructions) had an intermediate stage *$\underset{\frown}{i}$. On the contrary, it shows that such seemingly archaic developments can actually be much more recent. On the basis of the fact that y is mostly attested before i and e, the instances with -ay V for -$aḥ$ V can be explained as a recent secondary development to avoid hiatus, rather than an archaic preservation of the 'weak' glide **$\underset{\frown}{i}$.

3.6. *Avestan*

The proposed model above offers an explanation for the Avestan data, although the situation there is even more complex than in Vedic. Avestan has two reflexes for word-final *-as (*-ah): -$ō$ and -$ə$. The latter is attested in Old Avestan and in pseudo-Gāthic texts (Vaan 2003, pp.

[41] The loss of *$\underline{z}$ occurred without any intermediate stage with glides (see the discussion above).

[42] For example, *apay iṣya hotar*, *abhibhūyamānay iva*, *nay ehi* (Oldenberg 1888, p. 457), *anāmay edhi*, *tāy imam* (Weber 1858, p. 252, see also Witzel 1989, p. 190). This was observed already in Hillebrandt 1889, p. 417, where y is explained as a prothetic consonant, that is, an influence of the later language, for example, Pāli *yeva*, *yidaṃ*, Prākrit *jjeva* (cf. also AiG I, p. 338). Examples from the Sāmaveda, however, show y also before initial $ā$, for example, *śūkrāy āhutaḥ* for *śukraḥ āhutaḥ*. It is unusual, that y here is attested even after the long $ā$: *saprāthāy āsai* for *saprathāḥ asi* (Oldenberg, ib.). The glide y < *-z is expected to be lost after the long $ā$, as is the case in word-internal position. This again suggests a secondary origin of y here. Also, it would be problematic to consider phonetic data from the Sāmaveda as decisive for historical analysis. The glide y before $ă$ could thus be analogically generalised from positions before i, e, (Hillebrandt, ib.), or is due to the general tendency of the later language to prevent hiatus by inserting a secondary y (for the treatment of such glides in Middle Indo-Aryan, see Hinüber 2001, p. 208).

429–430). In the Gāthās, eight monosyllabic and 13 disyllabic words with final -*ə̄* < *-*as* are attested (see Vaan 2003, pp. 429–430). Various proposals have been made in the literature. In the following, I will argue that vowel -*ō* is not a later, Young Avestan innovation, but rather a regular development. It involved backing because of the following glottal fricative, similar to Vedic -*o* < *-*ɔ́ḥ*.

The assumption of an intermediate stage with glides is also problematic for Avestan. The outcome -*ō* can in principle be derived from the short diphthong *-*aṷ* < *-*ah*, because the etymological *-*aṷ* also sometimes appears as -*ō* (as opposed to the standard -*uuō*), for example, *daŋ́hō* < **dahi̯aṷ* vs. YAv. *daŋ́huuō* < **dahi̯aṷ* (data from Hoffmann & Forssman 2004, p. 69). However, -*ə̄* cannot go back to **ai̯*, since etymological **ai̯* always yields -*ōi* or -*e*. Even more problematic for the glide assumption is the outcome of *-*āh* > -*å̄*. Etymological **āṷ* yields -*āu*. Two locative forms that go back to *-*āṷ* and show -*å̄, xratå̄* and *pərətå̄*, most likely feature a scribal error, since *å̄* and *āu* are spelled similarly[43] (Vaan 2003, p. 375). There is another source for *å̄* in Avestan, where no glides can be assumed: **ā* before nasals *n̥* and *ŋ* in sequences *n̥k*, *n̥c*, *n̥t* and *ŋh*, *ŋ́h*, *ŋ*^{v}*h*.[44] Although *ā* gets backed and rounded to *å̄* with the same result as in case of *-*āh*, no intermediate stage with glides can be assumed in the nasal environment. It can thus be assumed that *ă* and *ā* are backed and rounded before the glottal *-*h* to *ŏ* and *å̄* independently, that is, without the intermediate stage with glides.

A prominent account of the Avestan data claims that -*ə̄* is the regular outcome of *-*ah*, which was replaced by -*ō* as a later, Young Avestan innovation (Beekes 1988, pp. 27–28, 32–33; Vaan 2003, pp. 429–461; Hoffmann 1967, p. 34; Narten 1986, p. 273). The proposal, however, does not explain how the two variants emerged and what phonetic rationale exists for the development.

According to this line of reasoning, the development Av. *-*ahm*- > -*əhm*- is taken as proof that *ă* can yield *ə̄* before *h*, at least in some environments. This serves as the basis for the claim that the same process spreads to word-final *-*ah* > *-*əh*, which would yield -*ə̄* after the loss of **h*. The development *ă* > *ə̄*, however, occurs only before the sequence *hm*. Elsewhere, *ă* is preserved before *h*. It is possible that *h* was lost early before *m* which would cause the regular development of *ă* > *ə̄* before nasals (in this case *m*). That this is a likely scenario is suggested by the fact that the -*hm*- sequence is often rendered with ⟨*m̨*⟩ in the manuscripts (Hoffmann & Forssman 2004, p. 89). In Old Persian, *h* is regularly lost before *m*,[45] whereas in Avestan, it is lost word-initially before *m*, for example, *mahī* (for **smasi*). Moreover, if there really was a development *ə̄* > *ŏ*, *ə̄* would be expected to develop to *ŏ* also before *hm* in Young Avestan. This is not the case (YAv. *ahma*, OAv. *əhmā*) and can speak against the assumption of *ə̄* > *ŏ*.

I propose that Av. -*ō* and -*å̄* are the results of backing of *ă* and *ā*, respectively, caused by the following glottal *-*h*. The phonetic motivation for this backing is similar to Vedic: breathiness caused by *-*h* causes a decrease in F_2 which effectively results in backed vowels. It is impossible to determine whether the glottal fricative was voiceless (*-*h*) or voiced (*-*ɦ*) in Iranian, but in either case, the fricative can cause breathiness of the preceding vowel. Since Avestan never shows voiced consonants in word-final position, I reconstruct a voiceless variant *-*h* henceforth.

It is possible that this backing in Avestan is additionally motivated and reinforced by the fact that glottal fricatives *-*h* can cause nasalisation of the preceding vowel. Spontaneous nasalisation is rare, but it is particularly attested word-finally before glottal fricatives (Dąbkowski & Beguš 2024), via a phonetic process called rhinoglottophilia (Clayton 2020; for a phonetic explanation, see Matisoff 1975 and Ohala 1975). This would explain the change in

[43] They were probably also pronounced similarly (Vaan 2003, p. 375).
[44] Cf. Vaan (2003, pp. 383–386) for the treatment of *ā* before these nasals.
[45] In Old Persian, *h* is also lost before *r* and *u*, cf. Brandenstein and Mayrhofer (1964, pp. 42–43).

*-*ah* to -*ə̄* and *-*āh* to -*å̄*, since *ə̄* is the regular development before nasals and -*å̄* is the regular development of **ā* in the sequence *-*āhă̄*- before the rhinoglottophilic nasal (e.g., *å̄ŋhar*$^{ə̄}$; Hoffmann & Forssman 2004, p. 106). Rhinoglottophilia is regularly attested in Avestan (OAv. *aŋha*^{i}*tī* < **ahati*; Hoffmann & Forssman 2004, p. 106), and there are several parallel developments between the pre-nasal position and the word-final position before *-*h*. An interstage with rhinoglottophilia is difficult to confirm definitively, and my proposal also works without this additional step.

The backing caused by *-*h* could happen quite early, occurring at the time when the distinction between an early lenited word-final *-*h* and the preserved **s* word-internally and word-finally in close syntactic positions was still present (parallel to the Vedic situation, see Table 2). The fact that the backing and rounding of *ă* and *ā* occur only word-finally provides additional evidence in favour of this proposal. In word-internal position before *h*, *ă* and *ā* remain unchanged, for example, *ahī*, *θβāhū*.[46] I thus assume that backing before *h* operated only before the early weakened, Iranian **h*, whereas it was not active at the time of the later, Iranian word-internal **s* > *h*. A summary of Avestan data is given in Table 3.

According to this account, I also explain why the short *ă* in monosyllabic words (pronouns) along with some disyllabic words did not undergo the rounding and backing to -*ō*, for example, *yə̄*, *kə̄* for Ved. *yaḥ*, *kaḥ*. Frequently, pronouns and monosyllabic words appear in close syntactic positions. In Vedic, for example, monosyllables are more frequently in close syntactic positions than polysyllabic words (Beguš 2012). A similar distribution can be assumed for Avestan as well. This would mean that pronouns often showed variants with not yet lenited *-*as* as opposed to other words where *-*as* was lenited to *-*ah* already at an earlier stage (Table 1). To illustrate this state of affairs, **asurah u̯aiḭda* vs. **kas maiḭ* and **kas taiḭ* are reconstructed. The first reconstruction shows the early word-final lenition of *-*s* to *-*h*, whereas the latter two show retention of *-*s* in close syntactic position in monosyllables. After rounding, the forms can be reconstructed as **asurɔh* (in Vedic, this happens only before voiced **ɦ*),[47] but **kas maiḭ* and **kas taiḭ* remained unrounded. The early weakened *-*h* was further lost, but another lenition started to operate, that is, weakening of word-internal **s*. I propose that in constructions like **kas maiḭ*, **s* was weakened to **h* later than in examples like **asurɔh*—at the same time as the lenition in word-internal position (**s* > *h*). At that time, the backing and rounding were not active anymore, therefore the result of **kas maiḭ* is **kah maiḭ*. On the contrary, **asurɔh u̯aiḭda* yields *ahurō vaēdā* because **h* there had weakened and was also probably lost earlier. According to this assumption, it is predicted that -*s* in **kas taiḭ* is not lenited to *h*, because word-internal lenition of **s* to *h* does not affect sequences *s* + stop, *n* and *c*. This is precisely what it is attested: *kastē*, *kasnā*, *kascīṯ*.[48]

Vowel *a* in **kah maiḭ* is not rounded, which is why, in close syntactic positions, -*ə̄* is the outcome of *-*ah*. It is still unclear why the vowels in *kə̄* (< **kah*) and similar examples centralise to *ə̄* rather than preserve their quality (***ā*) and why **h* is lost rather than preserved (as it is the case word-internally). It is true that in the positions before *m*, this would be the regular outcome (as in *ə̄hmā* for *a* > *ə̄* / _ *hm* and *mahī* for *h* > ∅ / # _ *m*). Thus, in **kah maiḭ* (*kə̄ mōi*), **h* would be lost and *a* would regularly yield *ə̄* before nasals. For other positions, however, *ə̄* is not the expected outcome, unless a stage with rhinoglottophilia is assumed,

[46] Although *ā* appears as *å̄* before *ŋh*, this does not speak against my assumption. The backing here is due to the nasal *ŋ* and not *h*. This can be concluded from the fact that before *h* that does not develop a preceding *ŋ* via rhinoglottophilia, *ā* remains unchanged, for example, *āhūrïia*-. Moreover, the nasal *n̥* causes *ā* > *å̄* without the presence of *h*.

[47] However, it is possible that *h* (-*ḥ*) also causes some phonetic backing, which would not phonologise because loss and lengthening did not follow.

[48] With this assumption, *s* is also expected to be preserved before *k* and *p*, but it can be assumed that pre-dental position blocked the lenition at more regular rates compared with other positions, as is the case in Vedic.

which is phonetically motivated precisely before glottal fricatives. It is possible that the glottal fricative **h* induces spontaneous nasalisation which in turn causes the *ə̄*-outcome. Spontaneous nasalisation would explain the development to *ə̄*: *ə̄* is the regular outcome in the pre-nasal position (Hoffmann & Forssman 2004, p. 63). On the contrary, it is possible that the *ə̄*-outcome is caused by word-final **-h* via some other phonetic mechanism. The development of **-as* > *-ə̄* is attested in some disyllabic words as well. However, this is not surprising since disyllabic words can also appear in close syntactic constructions.

Additional evidence in favour of my proposal can also be seen from the fact that *ə̄* is also found in compounds, which often behave similarly to close syntactic position: Yasna (Y) 2.45.11 *tarə̄-mąstā*, Y 1.33.4 *tarə̄-maiti-* (both precisely before *m*) and Y 2.46.19 *manə̄-vistāiš*. Moreover, *ə̄* is never attested in the pausa position, which also suggests that a close syntactic position is needed for this development. There are three words attested in the Gāthās that show variation in word-final *-ə̄* and *-ō*, according to the position in verse. The word *vacah-* 'word' is attested as *vacə̄* once in the verse-internal position vs. *vacō* twice at the end of a verse. Likewise, *vasah-* 'wish, at will', is attested as *vasə̄* twice verse-internally and *vasō* twice verse-finally. Also, *sar-* 'association' is gen./abl. sg. *sarə̄*[49] once verse-internally and *sarō* once verse-finally.[50] This is expected under my proposal, since the lenition of **-s* to **-h* in close syntactic constructions occurred later and did not cause backing and rounding after the loss, whereas elsewhere (including before pausa), **-h* (**-ḥ*) was older and consequently caused rounding and backing after the loss.

According to the proposal presented here, the less common *ə̄*-variant was then replaced by the more common *ō*-variant in Young Avestan, a process that started already in Old Avestan, where *-ō* is indeed attested in most of the words. This is again reminiscent of the Vedic situation, where *-o* replaces the close syntactic variant *-e* (see above). While the *ō*-variant spread in Young Avestan, other branches feature different outcomes. In Sogdian, for example, **-ah* yields *-i* (Tedesco 1926, pp. 126–130, Gershevitch 1961, p. 62). Parallel to some Prakrits (such as Māgadhī, see Section 3.3 and fn. 33), it is possible that the centralised variant *ə̄* from close syntactic positions spread in some branches of Iranian. The parallel between Prakrits and Middle Iranian front vowel outcomes was already pointed out by Tedesco (1926, pp. 126–130). This could explain the Sogdian *i*-outcome and other Middle Iranian front vowel outcomes of word-final **-ah*, but an additional fronting of the word-final *ə̄* needs to be assumed.

While the distribution of *-ə̄* and *-ō* according to the verse position (Vaan 2003, pp. 429–430) can provide additional evidence in favour of my proposal (*-ə̄* verse-internally and *-ō* verse-finally), it can also result as an influence from Young Avestan. Word-final *-ōi* and *-ə̄m* from Old Avestan seem to be replaced by *-ē* and *-əm* from Young Avestan more often in verse-final position.[51] It is thus possible, that the already winning variant *-ō* would be additionally influenced by Young Avestan, where *-ō* had already won. Nevertheless, as I have argued in the discussion above, a phonetic explanation for the two original variants *-ə̄* and *-ō* < **-ah* has more explanatory power than simply stating that one variant is a younger development. I argue that the two variants stem from different relative chronologies of weakening of **-s*: like in Vedic, the early weakened **-h* caused the backing of the preceding vowel to *-ō* due to breathiness. In close syntactic positions word-finally, **-s* was weakened to **-h* later, together with the word-internal **s* to *h*, which after the loss of **h* causes the outcome *-ə̄* perhaps under the influence of rhinoglottophilia or some other phonetic mechanism.

[49] Parsed as infinitive in Bartholomae (1961, p. 1563).

[50] Word-final *-ə̄* from other sources is possible in verse-final position in the Gāthās: Y 2.43.15 *ādarə̄*.

[51] For the distribution of these variants and for a different explanation of *-ō*, see Humbach (1991, pp. 61–63), Narten 1986, and Vaan 2003, pp. 337, 462–464.

4. Conclusion

This paper proposes a new account of a long-standing puzzle in Indo-Iranian philology. I argue that **s* in word-final position undergoes lenition at an early stage, potentially already at the Indo-Iranian period. The lenition of **-s* to **-h* spread in Vedic to word-final **-ṣ* and in Avestan to word-internal **s*. This early lenited word-final **-h* caused rounding and backing of the preceding *ă* and *ā* in Avestan, which yielded *-ō* < **-ɔh* < **-ah* and *-å̄* < **-å̄h* < **-āh*. In close syntactic constructions, word-final **-s* was preserved longer and was lenited to **h* together with the word-internal **-s-* (but not before stops, *n* and *c*, which is why **-s* surfaces in forms such as *kastē*, *kasnā* and *kascīṯ*). This newly lenited **-h* did not cause any backing or rounding, which is why the outcome is *-ə̄* (potentially via nasalisation). My proposal better explains the fact that the outcome *-ə̄* is attested only in pronouns and verse-internally, whereas verse-finally the outcome is always *-ō*. However, it remains somewhat puzzling why the outcome is a centralised *-ə̄*. I offer a potential solution via rhinoglottophilia or nasalisation before glottal fricatives.

In Vedic, the early lenited **-h* (*-ḥ*) was voiced in external sandhi to **-ɦ*. Later, it was lost together with the two voiced sibilants **z* and **ẓ*. I propose that this loss occurred without the intermediate stage with glides, but that voiced sibilants caused qualitative changes on the preceding vowels. Vedic *ă* [ɐ] was fronted to **ɛ* before **z*, remained unchanged before **ẓ*, and was backed to **ɔ* before **ɦ*. I provide parallels and phonetic motivation for this shift: the breathy voice from **-ɦ* causes the vowels to increase in backness. After the loss and compensatory lengthening in the pre-consonantal position, the coloured vowels lengthen to **ɛ̄*, *ā*, and **ɔ̄*. The first and the latter then merged with the diphthongal *e* and *o*. I have also argued that in pre-Vedic, the regular outcome of word-final **-s* before *d-* and in close syntactic positions was **-z*, whereas elsewhere it was **-ɦ* (parallel to the outcomes *-s* and *-ḥ*).

In the pre-vocalic position, the outcomes are different from the pre-consonantal ones. Here, **ɦ* was lost without a trace and the allophonic variation *-ɔ* V- was lost as well (retained only in the abhinihita sandhi *-o-*). Vedic **z* was either not attested pre-vocalically or the outcomes (if distinct) have been lost. Retroflex **ẓ* became *r* in the pre-vocalic position. The latter development can in fact be understood simply as increasing the sonority, which also later caused the development of *ḍ(h)* to *ḷ(h)*.

Correspondence
Gašper Beguš
Department of Linguistics
University of California, Berkeley
1203 Dwinelle Hall #2650
Berkeley
CA 94720-2650
USA.
Email: begus@berkeley.edu

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