The heuristic of Economy and Proto-Iranian stop clusters

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Abstract

The oldest reconstructed Proto-Indo-European phonemes are mostly agreed upon, and the reflexes of those phonemes in Indic and Iranian are well-attested. However, there are severe problems with the proposed changes that led from PIE to Proto-Indo-Iranian and the subsequent daughter languages. This article reexamines the reflexes of PIE consonant-laryngeal clusters and the affricates (reflexes of PIE palato-velars), addressing problems with proposals of past scholars, e.g., Lubotsky (2017), Cantera (2017), Beekes (1988), and Kortlandt (2007). Ultimately, I show that the current accounts have violated important principles of historical-comparative linguistics, like the heuristics of naturalness and economy. Many proposed changes are typologically rare and can be explained without proposing those changes. Many proposed changes proved redundant; other independently attested changes subsumed them.

Keywords: Historical phonology, Comparative method, Indo-Iranian, Laryngeals, Stop clusters, Economy, Directionality, Relative chronology

Introduction

There are several competing proposals for the development of Indo-Iranian languages. Scholars have attempted to demonstrate the closeness of these languages by recognizing mutually shared innovations. This is arguably the correct approach. However, in some cases, independently attested shifts in the daughter languages on one branch explain the observed changes without adding additional machinery. Furthermore, some evidence points to independent development from an early stage. Here, I address some of the issues concerning Proto-Indo-European stop laryngeal clusters and the reflexes of the palatovelars.

The reflex of PIE palatovelars ḱ, ǵ, and ǵʰ form an isogloss separating Persian from non-Persian Iranian (represented in this article by Avestan). Old Persian shows *θ, d,* and *d*, respectively. In contrast, Avestan has *s, z,* and *z*. These reflexes are thought to have an intermediate stage in Proto-Iranian, showing *ts, *dz, and *dz, preserved in Nuristani languages (a third branch of Indo-Iranian, Strand 2000). Additionally, stop laryngeal clusters *pH, *tH, *kH became *f, θ,* and *x* in Old Iranian, a development parallel to the Indo-Aryan reflexes p^h, t^h, and k^h. I assert here that proposing sound changes like *ḱ → θ and *tH → θ violates the heuristic of Economy. When

reconstructing sounds, one must assume that the fewest changes took place. In this case, a previously proposed set of sound changes and relative chronology are enough to explain the reflexes of all stop-initial consonant clusters in Iranian.

In section 2, I discuss some foundational concepts in Historical Linguistics, including the four heuristics Majority wins, Directionality/Naturalness, Factoring in features held in common, and Economy. In sections 3 and 4, I explore the standard accounts of the reflexes of PIE stop laryngeal clusters (TH and DH) and palato-velars (Ḱ).[1]

Economy

Following (Campbell, 2013), four heuristics are used to justify the reconstruction of proto sounds (step 3 of the comparative method): Majority wins, Directionality/Naturalness, Factoring in features held in common, and Economy.

"Majority wins"/ Occam's Razor

Campbell's (2013) term "majority wins" is a somewhat unscientific way of describing what may be characterized as an argument from parsimony and/or as an Occam's Razor argument. This heuristic assumes that the most likely outcome is no change. The most common reflex, therefore, reflects the proto phoneme.

"Directionality/Naturalness"

This heuristic employs our collective knowledge of linguistic typology and articulatory phonology to identify commonly occurring changes and changes likely to occur in a given phonological context. The most likely change is probably the one that took place.

"Factoring in features held in common"

This heuristic is used in scenarios where there is no majority and naturalness is not immediately apparent.

(1) ɢ : ʔ : ɢ : k : k : χ : q

[1] Here I use capital letters as variables representing natural classes, e.g., T for all voiceless stops, H for all laryngeals, Ḱ for all palato-velar stops, etc.

For example, (1) is a correspondence set with no clear winner in the majority; naturalness eliminates the glottal stop /ʔ/ and possibly the uvular fricative /χ/. However, there is still no clear winner.

IPA	ɢ	ʔ	ɢ	k	k	χ	q
Voicing	voiced	**voiceless**	voiced	**voiceless**	**voiceless**	**voiceless**	**voiceless**
Place	**uvular**	glottal	**uvular**	velar	velar	**uvular**	**uvular**
Manner	**stop**	**stop**	**stop**	**stop**	**stop**	fricative	**stop**

Table 1:Shared features (from Campbell, 2013)

A winner can be discerned by looking at the consonantal features in Table 1. Out of these consonants, 5/7 are voiceless, 4/7 uvular, and 6/7 stops. We can confidently reconstruct the voiceless uvular stop /q/ based on these data.

"Economy"

This heuristic stands apart from the other three heuristics, operating at two levels: changes within a language and over a family. Over a family, if we must choose between a set of daughter languages undergoing the same sound change independently or once together before a subsequent split, we must choose the latter, reflecting the fewest possible changes. Likewise, we must choose the fewest changes when identifying sound changes within a single language.

Proposal 1	Proposal 2
(2) $C^{\S} \rightarrow C$	(1) $C^{\S} \rightarrow C$
$ð \rightarrow d$	(2) $ð \rightarrow d$
(1) $ð^{\S} \rightarrow d$	

Table 2:Economy (Arabic to Maltese)

For instance, Proposal 1 in Table 2 violates the principle of economy. The rules (1) $C^{ˤ}$ → C and (2) [ð] → [d] are enough to turn [$ð^{ˤ}$] into [d] without including an additional rule [$ð^{ˤ}$] → [d]. This use of Economy across and within languages makes it a valuable tool for reconstruction and checking the validity of subgroupings and the phonological innovations that form their foundation. This function of Economy is vital to my proposals in this article.

PIIr. Voiceless Aspirates

According to (Cantera, 2017:490), the outcome of the PIIr. "voiceless aspirates" *p^h, *t^h, and *k^h are *f, θ,* and *x* in Iranian. Additionally, these were lost in Nuristani, yielding *p, t,* and *k*. However,

Cantera claims that "since the loss of the voiceless aspirates in Nuristanī does not lead to the appearance of voiceless fricatives, both are probably independent" (following Buddruss, 1977). At a glance, this claim is both true and adheres to the heuristic of Economy. A single change TH → T^h occurs in Proto-Indo-Iranian. Subsequently, Nuristani de-aspirates and Iranian shifts voiceless aspirates to fricatives (three changes in total, see Table 3).

PIE	PIIr.	Iranian	Nuristani	Indic
*pH	*p^h	f	p	p^h
*tH	*t^h	θ	t	t^h
*kH	*k^h	x	k	k^h

Table 3: TH clusters (based on Cantera, 2017)

However, there are several issues with these assumptions: (1) there is evidence of the retention of laryngeals long after the split between Indic and Iranian; (2) there is no record of or need for a medial stage in Iranian or Nuristani; (3) other independently motivated sound changes subsume the explanatory power of the TH → T^h shift.

(1) Laryngeals were preserved in Iranian after the split from Indic. We have evidence for laryngeal consonants in word-initial position persisting to the modern day. For instance, MP. *xirs* `bear,' Kurd. *hirç*, Xwar. *hrs* < *Hŕtḱo- (Kümmel, 2014:2). Additional support for laryngeals in word-initial and intervocalic position comes from "Laryngeal Hiatus," poetic syllable structure reflecting the existence of a laryngeal-initial syllable despite the coalescence of the vowels in the text. According to (Kümmel, 2014:3), the genitive-plural ending *-ām/-ą̄m* is always pronounced as *-a'am* in Old Avestan and one-third of the time in Vedic. Additionally, the presence of a laryngeal in the coda position causes the compensatory lengthening of the previous vowel, e.g., Old Persian: [h]ūnara- `good manliness' *$H_1$su-$H_2$nér (Cantera, 2017:487). Between consonants, the laryngeals vocalize, yielding several outcomes, including the H → i shift present in Indic, e.g., *sterH$_3$s `bedding' Avestan *stairiš-* (Cantera, 2017:488). This preservation into the Old Iranian period and, in some instances, into the New Iranian period makes it clear that proposing a loss of laryngeals before the split of Indic and Iranian is impossible. The loss of laryngeals as independent developments is not a problem for the economy because it is assumed this is a natural change, even though we are not entirely sure of their pronunciation.[2] With laryngeal loss as a separate development, the TH → T^h shift would be the only shared laryngeal development despite its different outcomes in Iranian, Indic, and Nuristani. However, this is problematic as well (see below).

[2] According to Byrd (2017), the most likely outcomes are a glottal stop for H_1, a voiceless uvular or pharyngeal stop for H_2, and a voiced uvular or pharyngeal stop for H_3. Note that the best direct ancient Indo-European evidence of the laryngeals comes from Hittite, which uses the character <ḫ> for laryngeals H_2 and H_3. <ḫ> is the same character used to represent the velar fricatives /x/ and /ɣ/ in Akkadian (Karim, 2022).

(2) There is no record of or need for a medial stage in Iranian or Nuristani. "[O]nly the loss of the voiceless aspirates can be attributed to Proto-Iranian. Nuristanī also shares this characteristic. Nevertheless, since the loss of the voiceless aspirates in Nuristanī does not lead to the appearance of voiceless fricatives, both evolutions are probably independent (Buddruss, 1977)." This standard account is reflected in Fig. 1, where I have added the proposed changes next to independently attested sound changes affecting laryngeals represented by *H and voiceless stops represented by *T.

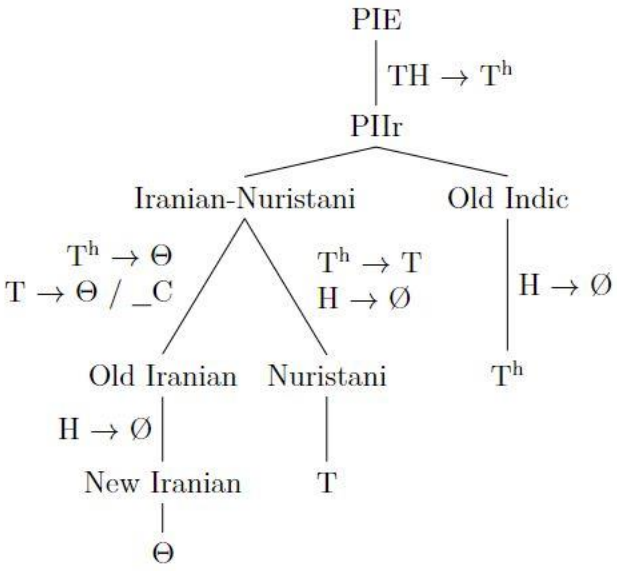

Figure 1: Standard Solution *TH clusters

In Indic, the Shift from TH clusters to voiceless aspirates is attested from the oldest extant Vedic texts. Due to phenomena such as laryngeal hiatus and compensatory lengthening, we must assume that the rest of the laryngeals were lost at a later stage before Middle (and New) Indo-Aryan. There was no attestation of Nuristani in the Old or Middle periods. From the modern spoken languages, we know that laryngeals were lost, and the outcome of voiceless consonant-laryngeal clusters (TH) are voiceless consonants (T). Because the laryngeals were lost, the medial step where TH clusters become T^h is unnecessary. If the laryngeals were lost as we know they were, the result of TH clusters would be T, as is attested in modern languages. In Iranian, we know from laryngeal hiatus and compensatory lengthening, just like Indic, that laryngeals were lost after the Old Iranian period. By the standard account, laryngeals only after voiceless consonants (TH) would have become voiceless aspirates (T^h), and there would be an additional change where these voiceless aspirates become fricatives. Note that this medial stage is unnecessary to explain the spirantization of voiceless stops. Additionally, we know from other clusters involving voiceless stops (TC). For example, we see Avestan: *miθra-* compared to Sanskrit: *mitra-*. The standard proposal requires seven sound changes related to the reflexes of

TH clusters throughout the history of Indo-Iranian (including the independently attested preconsonantal spirantization of voiceless stops).

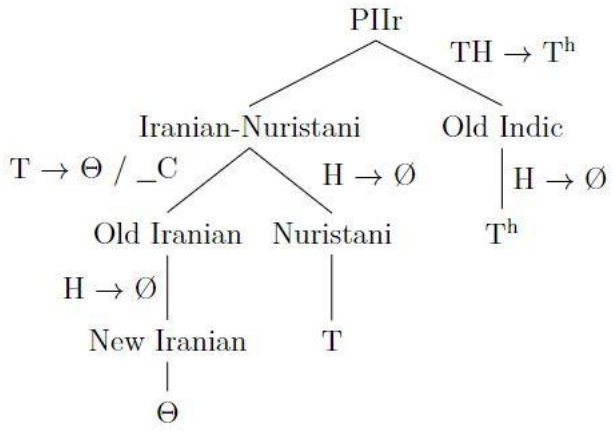

Figure 2: Economical Solution *TH clusters

In Fig. 2, I show a proposed Economical solution involving five sound changes. The five similar sound changes involving laryngeals that independently occurred on all three branches are likely due to naturalness (laryngeal loss with compensatory lengthening of preceding vowels). In Indic, the changes proposed in the standard solution are the same, except that the shift from voiceless stop-laryngeal clusters to voiceless aspirates occurs only on the Indic branch. Nuristani loses laryngeals without the additional steps where voiceless stops aspirate then de-aspirate. Likewise, in Iranian, there is an independently attested preconsonantal spirantization of voiceless stops, leading voiceless stop-laryngeal clusters (TH) to become voiceless fricative-laryngeal clusters (ΘH). The independently attested loss of laryngeal consonants in all but initial positions reduced the cluster to a single voiceless fricative (Θ).

The redundancy of proposing voiceless aspirates in Proto-Indo-Iranian was recognized by Lubotsky (2017:1879), citing Economy as one reason to think so. The idea that the fricative outcome of TH clusters in Iranian is the result of the preconsonantal spirantization of voiceless stops with a medial ΘH phase is not new. Joseph (2014) introduced this idea following a suggestion from his advisor and mentor, Jochem Schindler. Beekes (1988:88) said, "it seems better to explain the fricatives as due to the general development of voiceless stops to fricatives before a consonant in Iranian." Joseph's (2014) proposal mainly focused on issues with Beekes's (1988) account, many of which continue into Lubotsky's (2017).[3] Lubotsky's (2017) view has a

[3] Joseph (2014:125) points out flaws with dismissing the claim that there were voiceless aspirates (Th) in PIIr without further examination. He points out that there are several forms with cognates featuring voiceless aspirates (Th) in Indic and voiceless fricatives (Θ) in Iranian that may not have laryngeals in their roots. One example is the word for `donkey' Sanskrit *khara-* Avestan *xara-*; this form was dismissed as possible onomatopoeia by Mayrhofer (1956). Note that in Modern Iranian languages, the word occurs with the reflex of *kara- (e.g., Kurdish *ker*

few flaws concerning his treatment of laryngeals. He proposes a deletion of *H before voiced consonant-initial clusters (DC) (Lubotsky, 2017:1881). In that position, there would be no Laryngeal Hiatus and no consonantal effects (e.g., voice assimilation, typically regressive). Eventually, laryngeals were lost in all except word-initial position (see Kümmel, 2014). So, there is no reason to propose a separate treatment for HD clusters.

Additionally, Lubotsky (2017) proposes that all three laryngeal consonants had merged to a glottal stop, which was lost before voiced stops because they were glottalic, following the problematic glottalic theory (*t, *d', *d instead of *t, *d, *d^h; for more on the state of the Glottalic theory, see Byrd, 2017:2061ff). One problem relevant here is that Lubotsky (2017) assumes that the voiced aspirates were originally voiced, and the aspiration component was an unconditioned change in Indic (Kortlandt, 2007:150). As breathy-voiced consonants are more typologically marked than voiced consonants, one might argue that the heuristic of naturalness suggests this shift is unlikely.

Lubotsky's (2017) theory assumes a relative chronology where voiced stops became voiced aspirated (breathy) stops after the glottal stop (< *H) caused the de-glottalization of the previous glottalized (implosive) stops, e.g., D' → D / _H. This theory is problematic for several reasons:

1. It ignores the fact that Bartholomae's (1895) law takes place in both Indic and Iranian. The typical direction of voicing assimilation in Indo-Iranian is regressive. However, voiced aspirates assimilate progressively. This has an articulatory explanation as the increased airflow during the stop causes the burst indicative of these phonemes, which necessarily occurs on the release after the cluster. Essentially, Bartholomae's law also suggests the existence of voiced aspirates in Old Iranian.
2. The idea that glottal stops are lost in contact with glottalized consonants is reasonable (glottal dissimilation is documented in Cuzco Quechua and other languages; see Bennett, 2013). However, the opposite glottalized consonant deglottalizing in the presence of a glottal stop is not documented outside this reconstruction. (Lubotsky, 2017:1882) give the example *d^hugh$_2$-ter- (*dug'h$_2$-ter) by the glottalic theory. These subsequent changes would occur: 1. h_2 → ʔ, 2. *g' → g / _ʔ, and e → a. This yields the form *dugʔ-tar for PIIr. Subsequently, in Indic, the voiced consonants aspirate, followed by the vocalization of the laryngeal and palatalization of the preceding consonant, yielding *duhitar*. In Iranian, there is no such aspiration according to the theory proposed by (Kortlandt, 2007:150) and elaborated by (Lubotsky, 2017:). This is problematic as the Old Avestan reflex of *dug'h$_2$-ter is *dugədar* showing the progressive assimilation caused by the preceding voiced aspirate (Bartholomae's law).

'donkey') as well as the expected *k^hara-/*xara- (e.g., Hewramî *hær*. Joseph (2014:126) concludes that "there are at least a few words, and maybe more, for which a reconstruction with a PIIr. voiceless aspirate cannot be dismissed out of hand." Addressing, each of these problematic words is beyond the scope and ability of the current article.

3. Lubotsky's (2017) argument rests on the proposal that all laryngeal merged into a glottal stop in Proto-Indo-Iranian. However, directionality may also suggest that this is unlikely. Kümmel (2014) tentatively proposes these correspondences: *h_1 = *h, *h_2 = *χ, and *h_3 = *{γ} [ʁ]. Assuming that all three merged to a glottal stop (h, χ, γ → ʔ) is not unreasonable. However, there are New Iranian languages spoken today that have preserved word-initial h_2 as *h* or *x*. The changes from *χ → *ʔ → *x* violates naturalness. Additionally, the heuristic of Economy suggests * χ → *x* as a more likely change.

The glottalic theory is not necessary to explain the shift from voiced consonants to voiced aspirates in contact with a laryngeal D → D^h / _H, as the h-like *H could have imparted the aspiration just as it did to voiceless stops in Indic. This possibility is dismissed because the laryngeal in words like Sanskrit *duhitṛ* `daughter' causes the aspiration of the previously voiced consonant and vocalizes, i.e., two crucially ordered changes (1) D → D^h / _H and (2) H → I / C_C. This assumes that vocalization is the process of a consonant becoming a vowel and not the insertion of a vowel in syllables without them. Note that in languages like Tashlhiyt Berber (Coleman, 1999), where underlying representations often do not include vowels, the vocalization strategy is vowel epenthesis. Adjacent segments determine the quality and duration of the epenthetic vowel. A shift from H → i, therefore, violates the Uniformitarian Hypothesis; languages in the ancient world have the same basic properties as languages today. A better solution is that a vowel was inserted between illegal clusters. The vowel's quality and placement were determined by the cluster that it was breaking. If the laryngeal occurred in the onset, the previously voiced consonant was spirantized; if it occurred in the coda, there was compensatory lengthening.

Palatovelars

PIE	PIr.-Nur.	Avestan (Ir.)	Old Persian (Ir.)	Nuristani	Indic
*k̂	*ts	*s*	θ	*ts*	*ś*
*ĝ	*dz	*z*	*d*	*dz*	*j*
*ĝʰ	*dzʰ	*z*	*d*	*dz*	*h*

Table 4: Palatovelars

Another standard account violating the heuristic of Economy concerns the reflexes of PIE palatovelars *ḱ, ǵ, and *ǵʰ. In Table 4, I show the outcomes of the PIE palatovelars: the voiceless post-alveolar fricative *ś* [ʃ], the post-alveolar affricate *j* [d͡ʒ], and the voiced glottal fricative *h* [ɦ]. The branch containing Iranian and Nuristani is reconstructed going through an intermediate stage as an affricate based on the affricate outcomes in Nuristani and the split

outcomes in Old Iranian with stop (e.g., *d*) in Old Persian and the fricative (e.g., *z*) in Avestan. According to Lipp (2009:146), PIE palatovelars had already become affricates by Proto-Indo-Iranian and the plain and labiovelars before front vowels *i and *e (for more on these developments in Indic, see Kobayashi, 2017:333). Additionally, the voiced aspirates are lost in Iranian, but not until a later stage. This is based on the fact that Bartholomae's law, progressive assimilation of voiced aspirates, also applies to fricatives, which is not attested in Indic, e.g., Avestan: diβža- → PIIr. *$d^{h}ib^{h}sa$- (Cantera, 2017:490).

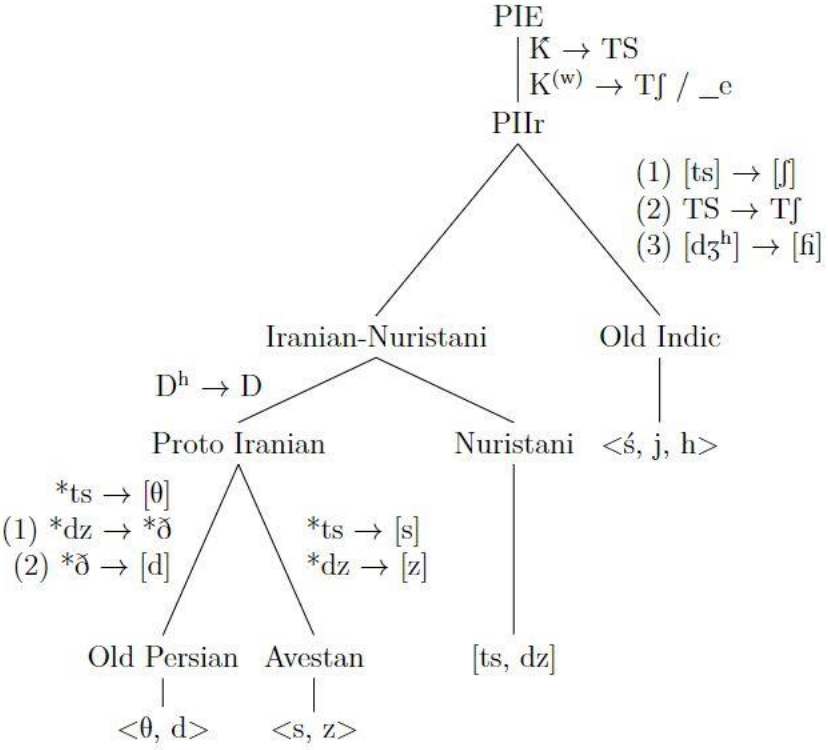

Figure 3: Standard Solution *Ḱ

The issues in the standard view are illustrated in Fig. 3. The velars become affricates between PIE and PIIr as described by (Kobayashi, 2017:333), assuming post-alveolar affricates as the reflexes of plain and labio- velars before front vowels and alveolar affricates for the reflexes of palatovelars (as proposed by Mayrhofer, 1983). This is where the first set of problems comes into play. A complicated chain shift must be posited to explain how the two affricate series do not completely merge. First, the voiceless alveolar affricate must become a voiceless post-alveolar fricative, changing the place and manner of articulation. Then, the remaining voiced alveolar affricates become voiced post-alveolar affricates, changing their place but not their manner. This is odd because the voiceless post-alveolar affricate gets passed over unchanged, while consonants with similar features seem to shift around it. No such medial step is required for a palatovelar stop to become post-alveolar. One might assume that the place of articulation of the palatovelars is closer to the post-alveolar than the alveolar.

There are no additional changes in Nuristani relevant to this discussion other than those shared by all three branches in the standard solution. On the Iranian branch, voiced aspirated stops are lost after the advanced Bartholomae's law, including fricatives and stops. From proto-Iranian to Avestan, there is nothing objectionable; the alveolar affricates de-affricate, yielding fricatives. However, the reflexes in Old Persian are problematic. The objective truth is that the outcome of the voiceless palatovelar *ḱ is *θ* (with a medial *ts stage). The theory becomes more problematic when the shift from alveolar affricate to dental fricative is extended to the voiced series (*ǵ → *dz → *ð → *d*). According to Cantera (2017:492), "[t]he voiced /dz/ (from the primary palatal *ǵ) shows a parallel evolution (to ḱ). In all Iranian languages except those of the SW, /dz/ evolves to /z/. In the SW, /dz/ evolves to [δ], but due to the lack of a phoneme /δ/, it merged with /d/. This solution over-complicates the shift from *dz to *d*, which needs no medial step; there is a *d in the original formative. Crucially, this proposal is built upon the valid assumption that changes affect classes of sounds. If the voiceless alveolar affricate becomes a voiceless dental fricative, the voiced counterpart should do the same. However, the foundational assumption that *ts became *θ* likely never occurred.

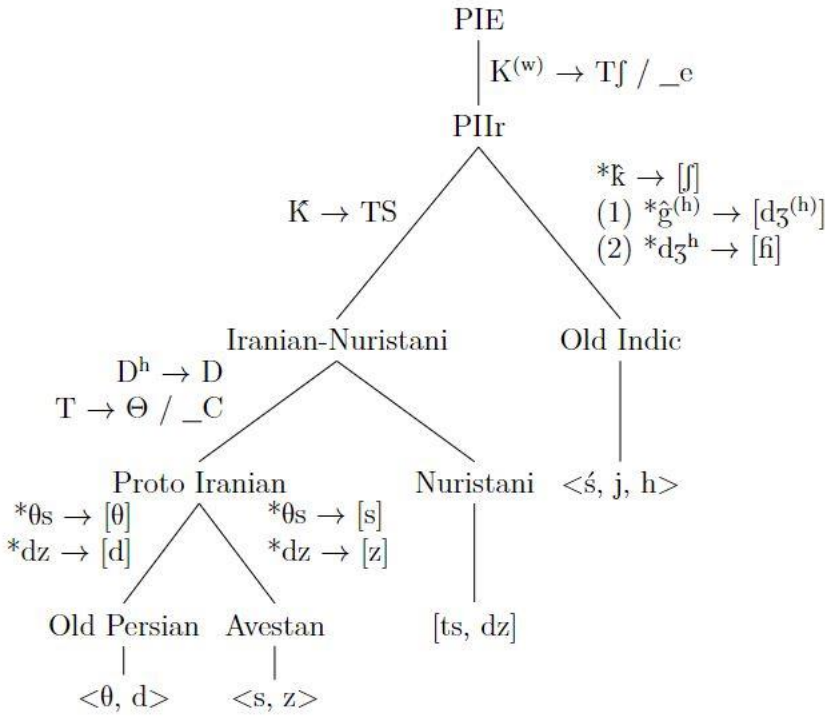

Figure 4: Economical Solution *Ḱ

I have revised the standard solution in favor of Economy in Fig. 4. From PIE to PIIr, the only relevant change attested in all three branches is the palatalization of the plain (and labio-) velars. On the way from PIIr to Indic, the voiceless palatovelar *ḱ becomes the only attested outcome *ʃ*. The voiced palatovelars merge with the palatalized plain and labio- velars, including the later

debucalization of the voiced aspirates. From PIIr to Iranian-Nuristani, the palatovelars are affricated as is the outcome in Nuristani and supported in Iranian. The major update to this account is that we already know voiceless stop-consonant (TC) clusters become voiceless fricative-consonant (ΘC) clusters. Old Iranian inherited the voiced affricate *dz. However, the affricate *ts would have necessarily become *θ s because of the independently attested preconsonantal spirantization of voiceless stops. Furthermore, this is the case for both *ts, the reflex of PIE *ḱ, and *ts, the reflex of *t-*s clusters, compare Sanskrit: *matsiyā* `fish,' Avestan: *masiia-* `idem.,' New Persian: *māhī* (Old Persian: *maθya-*) `idem' (< PIE *matsi̯a-).

Conclusion

The reflexes of PIE phonemes in the Indo-Iranian languages are well-attested. Consensus on the reconstructed phonemes of Proto-Indo-European is near total (though there are still some proponents of Glottalic Theory). However, the reconstructed sound changes between PIE and the daughter languages of Old Iranian and Old Indic violate some foundational tools and hypotheses of historical linguistics, i.e., Economy and the Uniformitarian Hypothesis.

The problem can be summarised thus: often, scholars have proposed sound changes to deal with special circumstances without realizing that the other independently motivated changes already capture the outcome. Additionally, scholars have proposed shared changes, demonstrating a hypothesized relationship, like Indo-Iranian, even if that change decreases the overall economy.

<table>
<tr><td colspan="4">$K^{(w)} \rightarrow T\int$ / _e
$DH \rightarrow D^h$</td></tr>
<tr><td colspan="3">$\hat{K} \rightarrow TS$</td><td>$\hat{k} \rightarrow \int$
(1) $\hat{g}^{(h)} \rightarrow dʒ^{(h)}$
(2) $dʒ^{(h)} \rightarrow \hat{n}$
$TH \rightarrow T^h$</td></tr>
<tr><td colspan="2">$D^h \rightarrow D$
$T \rightarrow \Theta$ / _C</td><td>$H \rightarrow Ø$</td><td>$H \rightarrow Ø$</td></tr>
<tr><td>$\theta s \rightarrow \theta$
$dz \rightarrow d$
$H \rightarrow Ø$</td><td>$\theta s \rightarrow s$
$dz \rightarrow z$
$H \rightarrow Ø$</td><td></td><td></td></tr>
<tr><td>Old Persian</td><td>Younger Avestan</td><td>Nuristani</td><td>Sanskrit</td></tr>
</table>

Table 5: Summary of Changes and Chronology

I have summarized the changes described in this article in Table 5. The two significant innovations here are (1) that no sound change is proposed to be shared that hasn't left traces in the subsequent daughter languages and (2) that sound changes subsumed by independently

motivated changes are eliminated. For instance, the sequence of changes (1) TH → T^h, (2) T^h → Θ was removed because the sequence (1) T → Θ / _C, (2) H → ∅ produces the same result. In other words, the changes *tH → *t^h → *θ* were rejected to avoid redundancy; *tH → *θH → *θ* is independently attested.

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