The heuristic of Economy and Proto-Iranian stop clusters

Shuan Osman Karim

Goethe University of Frankfurt

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 significant 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 palatovelars), addressing problems with the proposals of past scholars, e.g., Lubotsky (2017), Cantera (2017), Beekes (1988), and Kortlandt (2007). Ultimately, I show that current accounts have violated important principles of historical-comparative linguistics, such as the heuristics of naturalness and economy. Additional proposed changes are typologically rare and can be explained otherwise. Other proposed changes are shown to be redundant and may be subsumed under independently attested developments.

KEYWORDS

historical phonology, Comparative Method, Indo-Iranian, laryngeals, stop clusters, economy, directionality, relative chronology

1. INTRODUCTION

There are several competing proposals for the phonological development of Indo-Iranian from Proto-Indo-European (PIE) through Proto-Indo-Iranian (PIIr.) to the attested 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 of one branch may explain the observed changes without assuming additional machinery. Furthermore, some evidence points to independent developments from an early stage. In this paper, I address some of the issues concerning Proto-Indo-European stop-laryngeal clusters and the reflexes of the PIE palatovelars.

The reflexes of the PIE palatovelars *$\hat{k}$, *$\hat{g}$, and *$\hat{g}^h$ 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 passed through an intermediate stage in Proto-Iranian (PIr.) with *ts, *dz, and *dz, preserved as such in Nuristani languages (a third branch of Indo-Iranian; Strand 2000). Additionally, the 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 *$\hat{k} \rightarrow \Theta$ and *tH $\rightarrow \Theta$ violates the heuristic of Economy, by which one must assume the fewest changes when

reconstructing phonological developments. In this case, a previously proposed set of sound changes and their 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 apply these heuristics to explore the standard accounts of the reflexes of PIE stop-laryngeal clusters (TH and DH) and palatovelars (K̂).[1]

2. HEURISTICS IN PHONETIC RECONSTRUCTION

Following Campbell (2021: 146–152), four heuristics may be 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." These heuristics are principles the linguist can factor in when building a case for a particular reconstruction. However, the interpretation of these heuristics is dependent on assumptions such as subgrouping. The heuristics should not be seen as evidence of a particular outcome, but rather as guidelines for justifying a particular proposal.

2.1. MAJORITY WINS / OCCAM'S RAZOR

Campbell's (2021: 148–149) 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.

2.2. 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.

2.3. FACTORING IN FEATURES HELD IN COMMON

This heuristic is used in scenarios where there is no majority and naturalness is not immediately apparent. For example, (1) is a correspondence set with no clear winner in the majority.

(1) ɢ : ʔ : ɢ : k : k : χ : q

1 I use capital letters as cover symbols representing natural classes, e.g., T for all voiceless stops, H for all laryngeals, K̂ for all palatovelar stops, etc.

Here naturalness eliminates the glottal stop /ʔ/ and possibly the uvular fricative /χ/ as the original phonetic value. However, there is still no clear winner among the remaining outcomes /k/, /q/, and /ɢ/. A winner can be discerned by looking at the consonantal features in Table 1.

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 in a correspondence set (from Campbell 2013)

Of the seven consonantal values, five are voiceless, four uvular, and six stops. Based on the heuristic "factoring in features held in common" alone, we can reconstruct the voiceless uvular stop /q/ as the source of these reflexes.

2.4. ECONOMY

This heuristic stands apart from the other three in that it operates at two levels, i.e. changes within a language and over a family. Over a family, if we are faced with a choice between a set of daughter languages undergoing the same sound change independently or once together before a subsequent split, we must prefer the latter, which assumes the fewest possible changes. Likewise, we must choose the hypothesis that involves the fewest changes when reconstructing phonological developments within a single language.

Proposal 1	**Proposal 2**
(2) $C^{ʕ} \rightarrow C$	(1) $C^{ʕ} \rightarrow C$
ð → d	(2) ð → d
(1) $ð^{ʕ} \rightarrow d$	

TABLE 2: Economy (Arabic to Maltese)

For instance, Proposal 1 in Table 2 violates the principle of economy. The rules (1) $C^{ʕ} \rightarrow C$ and (2) [ð] → [d] are enough to turn [$ð^{ʕ}$] into [d] without including an additional rule [$ð^{ʕ}$] → [d]. This use of Economy within and across languages makes it a valuable tool for reconstruction and assessing the validity of subgroupings and the phonological innovations on which they are founded. This function of Economy is vital to the discussion and proposals in the following sections.

3. PROTO-INDO-IRANIAN VOICELESS ASPIRATES

According to Cantera (2017: 490), the outcomes of the PIIr. "voiceless aspirates" *p^h, *t^h, and *k^h are *f*, *θ*, and *x* in Iranian. In Nuristani they yielded *p*, *t*, and *k*, thereby falling

together with the respective PIIr. voiceless stops.[2] 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 first glance, Cantera's claim is both true and adheres to the heuristic of Economy. A single change TH → T^h occurs in Proto-Indo-Iranian. Subsequently, Nuristani deaspirates, and Iranian shifts voiceless aspirates to fricatives, making three changes in total, as in 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: PIIr. TH clusters in Iranian, Nuristani, and Indic (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. These will be discussed in turn below.

(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, e.g., Persian *xirs* `bear,' Kurdish *hirç* < PIE *Hŕtḱo- (Kümmel 2014: 2). Additional support for laryngeals in word-initial and intervocalic position comes from "laryngeal hiatus," poetic syllable structures reflecting the existence of a laryngeal-initial syllable despite the coalescence of the vowels in the text. For instance, the genitive-plural ending *-ām/-ąm* is always to be scanned as *-a'am* in Old Avestan and one-third of the time in Vedic (Kümmel 2014: 3). Additionally, the presence of a laryngeal in coda position causes compensatory lengthening of the previous vowel, e.g., Old Persian *[h]ūnara-* 'good manliness' < PIE *H_1su-H_2nér-* (Cantera 2017: 487). Between consonants, the laryngeals vocalize, yielding several outcomes, including the *H* → *i* shift also 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 later periods 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 principle of Economy because it is assumed that this is a natural change, even though we are not entirely sure of their pronunciation.[3] With laryngeal loss as

2 Although often assumed, it is not necessarily the case that Nuristani (unaspirated) voiceless stops were unaspirated since antiquity (Kümmel 2020: 239).

3 According to Byrd (2017), the most likely phonetic values of the laryngeals 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 for the laryngeals comes from Hittite, which uses the character <ḫ> for the laryngeals *H_2 and *H_3. <ḫ>

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) 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.

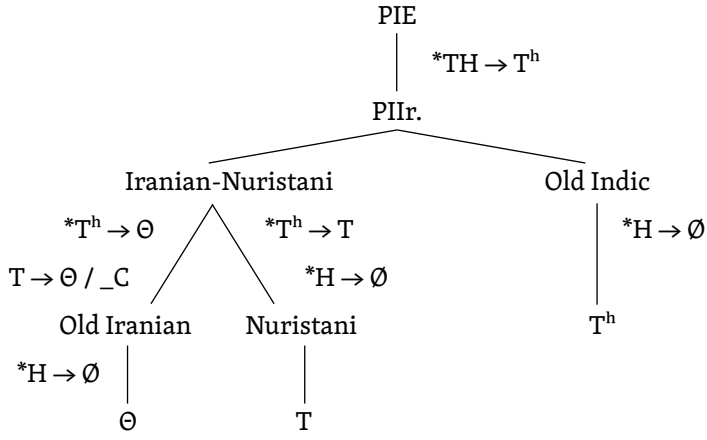

FIGURE 1: Standard account of the evolution of *TH clusters

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 after Vedic but before Classical Sanskrit and 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 outcomes 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 the modern languages. In Iranian, we know from laryngeal hiatus and compensatory lengthening, just as in Indic, that laryngeals were lost after the Old

is the same character used to represent the velar fricatives /x/ and /ɣ/ in Akkadian (Karim 2022). Additional evidence for a uvular realization comes from Luvian borrowings in Akkadian, which uses <q> to represent Luvian <ḫ̭> as well as Arabic <q>. The latter likely had a uvular place of articulation at this period, suggesting that the former did as well (Weiss 2016). For additional arguments for a uvular realization, see Simon (2014).

Iranian period. By the standard account, sequences of voiceless consonants followed by laryngeals (*TH) would have become voiceless aspirates (T^h), and there would be an additional change turning these voiceless aspirates into fricatives. However, this medial stage is unnecessary to explain the spirantization of voiceless stops. We know from other clusters involving voiceless stops (PIIr. *TC) that voiceless stops spirantize before consonants, as in, for example, Avestan *miθra-* compared to Sanskrit *mitra-*. To be sure, it is not necessarily the case that this would occur as such before H_2, which likely was realized as [χ] (see, e.g., Weiss 2016). However, it is a reasonable hypothesis considering that the spirantization occurs before other voiceless fricatives as in, e.g., Avestan *fšupā* 'shepherd' (cf. Sanskrit *paṣupā* 'id.'), Old Persian *maθiya* 'fish' (cf. Sanskrit *matsiyā* 'id.').

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 in Iranian). Fig. 2 illustrates a proposed Economical solution involving just five sound changes.

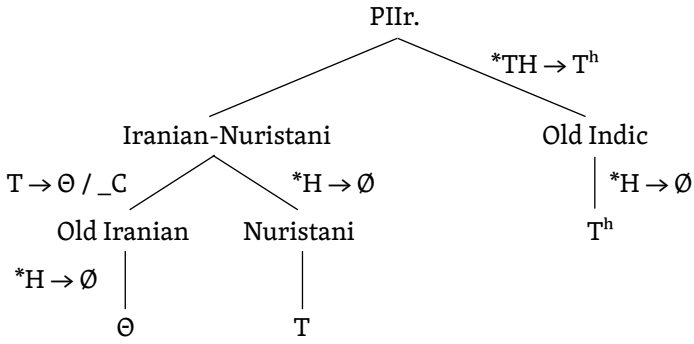

FIGURE 2: Economical Solution *TH clusters

The five similar sound changes involving laryngeals that independently occurred in all three branches are likely due to naturalness (loss of syllable-final laryngeals with compensatory lengthening of preceding vowels). In Indic, the changes proposed are the same as in the standard account, except that the shift from voiceless stop-laryngeal clusters to voiceless aspirates occurs only here. Nuristani loses laryngeals without the additional steps aspirating and then deaspirating voiceless stops. 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 voiceless fricative (Θ).

The redundancy of proposing voiceless aspirates in Proto-Indo-Iranian was recognized by Lubotsky (2017: 1879), who cited Economy as one reason. The idea that the fricative outcome of PIIr. *TH clusters in Iranian is the result of the preconsonantal spirantization of voiceless stops with a medial [ΘH] phase is not new. In his grammar of Old Avestan, Beekes (1988: 88) stated that "it seems better to explain the fricatives as due to the general development of voiceless stops to fricatives before a consonant

in Iranian." Joseph (2014) then (re)introduced the idea following a suggestion from his advisor and mentor, Jochem Schindler. Joseph's proposal mainly focused on issues with the account of Beekes (1988), many of which continue into that of Lubotsky (2017).[4] The latter, however, assumes a number of controversial laryngeal developments, such as deletion of *H before a cluster of a voiced unaspirated stop D plus any consonant (i.e., *H > Ø /_DC, e.g., Avestan *yasna* < PIE *(H)i̯eh$_2$ĝ-; Lubotsky 1981; 2017: 1881). In that position, there would be no Laryngeal Hiatus and no consonantal effects (e.g., voice assimilation, typically regressive). Since laryngeals were eventually lost in all positions except word-initially (Kümmel 2014), there is thus no independent motivation for proposing a separate treatment of *HD- clusters.

Lubotsky (2017) also proposes that all three laryngeal consonants had merged to a glottal stop, which was lost before voiced stops because they were glottalic, following the controversial Glottalic Theory which reconstructs PIE *t, *d', *d instead of the more widely assumed *t, *d, *d^h (see Byrd 2017: 2061ff. for discussion). A relevant complication here is that he assumes that the voiced aspirates were originally plain 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, and indeed the great majority of Indo-Europeanists agree that Indo-Aryan retains the breathy-voiced articulation of the PIE "voiced aspairates."

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

1. It ignores the fact that Bartholomae's Law (Bartholomae 1895) takes place in both Indic and Iranian. The typical direction of voicing assimilation in Indo-Iranian is regressive. However, voiced aspirates assimilate progressively, from left to right. 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 indicates the existence of voiced aspirates at a prehistoric stage of Old Iranian.[5]

4 Joseph (2014: 125) points out flaws with dismissing the claim that there were voiceless aspirates (T^h) in PIIr. without further examination. He points out that there are several forms with cognates featuring voiceless aspirates (T^h) 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 possibly onomatopoeic by Mayrhofer (1956–1980 I: 302). Note that in Modern Iranian languages the word occurs with the reflex of **kara-* (e.g., Kurdish *ker* 'donkey') as well as the expected **k^{h}ara-*/**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 of the current article.

5 Bartholomae's Law can be understood as a PIIr. change that became a remnant of the voiced aspirates in Iranian. The progressive assimilation of Bartholomae's Law is restricted

2. The idea that glottal stops are lost in contact with glottalized consonants is reasonable, as glottal dissimilation is documented in Cuzco Quechua and other languages (Bennett 2013). However, the opposite, deglottalization of glottalized consonants in the presence of a glottal stop, is not documented outside this reconstruction. Lubotsky (2017: 1882) gives the example of PIE *d^hugh$_2$-ter-, i.e. *dug'h$_2$-ter- by the Glottalic Theory. The following changes subsequently occurred: 1. *h$_2$ → ʔ, 2. *g' → g / _ʔ, and *e → a. This yields the form *dugʔ-tar for PIIr. Subsequently, in Indic, the voiced stops aspirate, followed by the vocalization of the laryngeal to *i* and palatalization of the preceding consonant, yielding Sanskrit *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 according to Bartholomae's Law.
3. Lubotsky's (2017) argument rests on the proposal that all three laryngeals merged into a glottal stop in Proto-Indo-Iranian. However, directionality may 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, as noted above there are New Iranian languages spoken today that have preserved word-initial *h$_2$- as *h-* or *x-*. The changes *χ → *ʔ → *x* violate the principle of Naturalness. Additionally, the heuristic of Economy suggests *χ → *x* as a more likely change.

In fact, the Glottalic Theory is not necessary to explain the shift from voiced consonants to voiced aspirates in contact with a laryngeal, i.e. D → D^h / _H, as the *h*-like *H could have imparted the aspiration just as it did to voiceless stops in Indic (T → T^h / _H). This possibility is dismissed by Lubotsky (2017: 1882) because the laryngeal in words like Sanskrit *duhitar-* 'daughter' causes the aspiration of the previously voiced consonant and vocalizes, i.e., undergoes 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. However, in present-day languages like Tashlhiyt Berber (Coleman 1999) where underlying representations often do not include vowels, the vocalization strategy is vowel epenthesis, and adjacent segments determine the quality and duration of the epenthetic vowel. I propose therefore that a shift from H → *i* 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 in illegal consonant clusters, and that its quality and placement were determined by the cluster that it broke up. If the laryngeal occurred in a syllable onset, the previously voiced consonant was spirantized; if it occurred in the coda, there was compensatory lengthening. In other words, it was

to stops in Indic. By contrast, in Iranian, fricatives are also subject to Bartholomae's Law. One interpretation is that this is a further development, showing that the voiced aspirates survived into prehistoric Iranian, with only remnants surviving into the oldest attested languages, primarily Old Avestan.

not a shift from consonant to vowel but rather an epenthetic vowel inserted to break an unpermissable consonant cluster followed by a loss of a consonant.

In summary, the PIE *TH clusters that result in voiceless aspirtates T^h in Indic, voiceless unaspirates in Nuristani, and voiceless fricatives Θ in Iranian did not need a medial stage of *T^h to achieve the outcomes in all three branches. In Nuristani, the extant voiceless unaspirates T are already produced by the independently attested loss of laryngeals across the board. In Iranian, the voiceless fricatives Θ are already produced by the independently attested preconsonantal spirantization of voiceless stops followed by loss of laryngeals. Developing voiceless aspirtates T^h would be an independent innovation of Indic, the only branch with them. Moreover, further tangentially related developments, like the loss of laryngeals before voiced stops, need to be accounted for in the standard account (traditional or glottalic). However, they are subsumed by these same independently attested changes.

4. THE DEVELOPMENT OF PIE PALATOVELARS

Another standard account violating the heuristic of Economy concerns the Indo-Iranian reflexes of the PIE palatovelars *$\hat{k}$, *$\hat{g}$, and *$\hat{g}^h$. Table 4 gives the outcomes of the PIE palatovelars, which in Indic are the voiceless post-alveolar fricative *ś* [ʃ], the post-alveolar affricate *j* [$\widehat{dʒ}$], and the voiced glottal fricative *h* [ɦ]. Both Iranian and Nuristani are reconstructed as passing through an affricate stage represented by *ts* and *dz* in Nuristani and *c and *j (presumably also [ts] and [dz]) in Iranian following the orthography in Kümmel (2020). The Iranian affricates have split outcomes in Old Iranian, with *θ*, *d* in Old Persian and *s*, *z* in Avestan. According to Lipp (2009: 146), the PIE palatovelars had already become affricates by Proto-Indo-Iranian. Additionally, the PIE (plain) velars and labiovelars, which had already merged in PIIr., had become affricates before the 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-* 'to deceive' ← PIIr. *d^hib^h-sa- (Cantera 2017: 490).

PIE	PIr.	Avestan	Old Persian	Nuristani	Sanskrit
*$\hat{k}$	c	s	Θ	c	ś
*$\hat{g}$	j	z	d	j	j
*$\hat{g}^h$	*j^h	z	d	j	h

TABLE 4: PIE palatovelars in Indo-Iranian

The standard view is illustrated in Fig. 3, following the orthographic conventions of Kümmel (2007, 2020). The velars become affricates between PIE and PIIr. as described by Kobayashi (2017: 333), assuming postalveolar affricates as the reflexes of plain and labiovelars before front vowels, and alveolar affricates (as proposed by Mayrhofer 1983) or prepalatal affricates (following Kümmel 2020: 244) for the reflexes of palato-

velars. The secondary palatals resulting from a combination of a plain velar (also resulting from delabialized labiovelars) followed by a front vowel become palatalized, thereby differentiating the prepalatal affricates Ć from palatalized velars Ḱ.

The standard account proposes a chain shift to explain how the two affricate series do not completely merge. In Indic, the voiceless prepalatal affricate *ć becomes a voiceless postalveolar [ʃ] or palatal fricative [ɕ] <ś>, changing the place and manner of articulation. The voiceless (secondary) palatalized velar *ḱ becomes *ć, replacing the primary. In the words of Lubotsky (2017: 1880), "[w]hen Indo-Iranian palatalization led to the rise of new palatal stops *č *ǰ *ǰh, the old palatals had to move more to the front in order to remain distinct." This shift happened in parallel to the shift in Iranian, where the prepalatal affricate became an alveolar affricate, and the (secondary) palatalized velar took its place.

The following stage in the chain shift is difficult to discern from Kümmel's (2020) orthographic conventions. The prepalatal affricate *ć from PIE palatovelar *ḱ becomes *c, refected in the Sanskrit post-alveolar affricate <c>, and the voiced and breathy-voiced counterparts merge with the reflexes of the voiced and breathy-voiced velars and labiovelars before front vowels. However, Kümmel (2020) uses the same orthography for the alveolar africates present in Proto-Nuristani and Proto-Iranian.

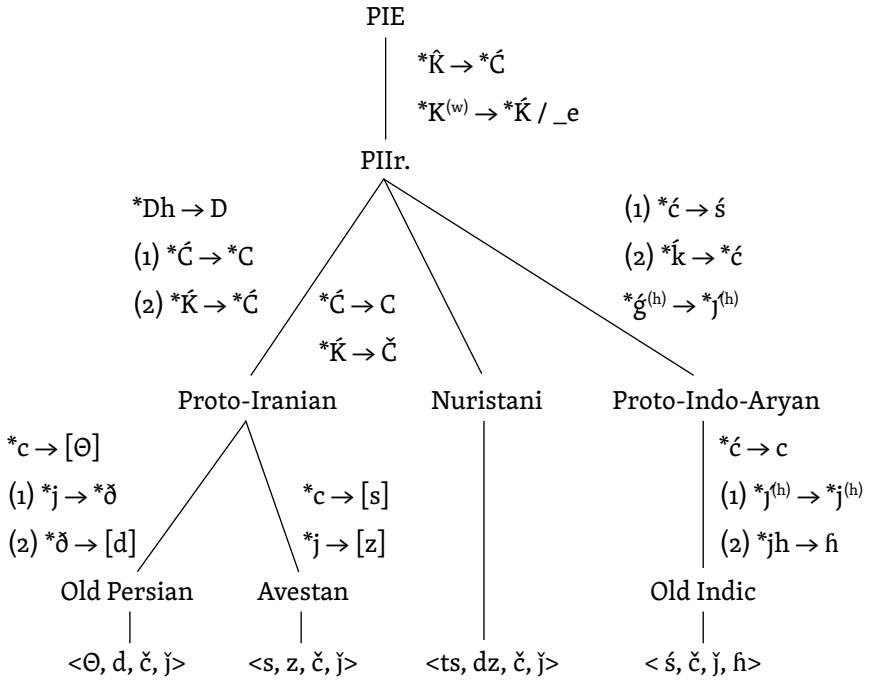

FIGURE 3: Standard account of PIE *Ḱ in Indo-Iranian[6]

6 Following Kümmel (2020), I use the following orthographic conventions in this section: k and g are velar stops; ḱ and ǵ are palatalized velars; ć and ǰ are disputed prepalatal affricates; c and j are alveolar affricates (or perhaps postalveolar in the Indic examples).

Ostensibly, the proposed chain shift with parallel tracks in Indic and Iranian is necessary to prevent the total merger of PIE palatovelar and palatalized plain velar stops. According to Kobayashi (2004: 74)Old Indo-Aryan made the following innovations which are not commonly found in other Indo-European languages: (i, "if [the primary palatals] were affricated already in Proto-Indo-Iranian, they would merge with, or at least be confused with, the primary palatals; hence they are assumed to have been palatalized velars or palatal stops." However, this solution seems to contain unnecessary steps given that the reflexes of the secondary palatals (i.e., from palatalized plain velars) are postalveolar affricates in all three branches, e.g. Sankrit *cárman-*, Old Persian *carman-* 'skin'; Sanskrit *jáni-*, Old Avestan *jə̄ni-* 'wife', etc., and that this palatalization occurred before the merger of post-PIE **a*, **e*, and **o* as *a*, also shared by all three branches. Additionally, the shifts to alveolar affricates in Iranian and Nuristani would not lead to confusion with post-alveolar affricates, and the voiced variants merge in Indo-Aryan. The only reflex that needs explaining is Indo-Aryan <ś>.

Given the naturalness of the shift from a palatovelar, understood as [kʲ], to a postalveolar fricative [ʃ], no medial step is required for **k̂* to become the attested Sanskrit *ś*. Note the similar development in French *chevre* 'goat' < Latin *cabra* 'id.' One may consider the heuristics of Naturalness and Economy in rejecting the reconstruction of these medial stages. Strengthening the bond between Indic and Iranain with additional shared innovations should not be considered as a motivation for proposing medial phases.

Other than those shared by all three branches in the standard account, the changes in Nuristani relevant to this discussion are also shared by Iranian, pointing to a closer affiliation between the two. However, this interpretation is contingent on the accuracy of the proposed sound changes. In Iranian, voiced aspirated stops are lost after Bartholomae's Law, including fricatives in addition to the stops seen in Indic. From Proto-Iranian to Avestan there is nothing objectionable: the alveolar affricates deaffricate, yielding fricatives. However, the reflexes in Old Persian do not show an exact parallel. The objective truth is that the outcome of the voiceless palatovelar **k̂* is *θ* (with a medial stage **ts*, or **c* in Kümmel 2020). Compare the similar development in Romance, where Proto-Romance **ʧ* (from Latin *k* before front vowels) becomes **ʦ* and eventually French *s* and Spanish *θ* (Cantera 2017: 492). The issue here is not that the standard account is implausible, but rather that it is unnecessary given independently attested innovations.

The standard account becomes more problematic when the shift from alveolar affricate to dental fricative is extended to the voiced series (**ĝ* → **dz* → **ð* → *d*). According to Cantera (2017: 492), "[t]he voiced /dz/ (from the primary palatal ** ĝ*) shows a parallel evolution to ** k̂*, e.g., ** k̂* → **ts* → *θ*)." In all Iranian languages except those of the Southwest, /dz/ evolves to /z/. In the Southwest, /dz/ evolves to [ð], but due to the lack of a phoneme /ð/, it merged with /d/. However, this solution overcomplicates the shift from **dz* to *d*, which needs no medial step; there is after all a **d* in the original affricate/cluster **dz*. Crucially, this proposal is built upon the valid assumption that changes affect natural 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 as such. Rather, preconsonantal spirantization preceded cluster reduction.

I have revised the standard account in favor of Economy, reducing 18 separate changes to 11. In Fig. 4, the only relevant change attested in all three branches is the palatalization of the plain velars (and labiovelars), resulting in postalveolar affricates in all subbranches. On the way from PIIr. to Indic, the voiceless palatovelar *ḱ becomes the attested outcome [ʃ]. The voiced palatovelars merge with the palatalized plain velars and labiovelars, including the later debuccalization of the voiced aspirates. From PIIr. to Iranian-Nuristani the palatovelars are affricated, as is the outcome in Nuristani and supported by the Iranian evidence. The major update to this account is that we already know that 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 *Θs because of the independently attested preconsonantal spirantization of voiceless stops. Furthermore, this is the case for both *ts from PIE *ḱ and *ts from *t + *s clusters; cf. Sanskrit *matsiyā* 'fish' with Avestan *masiia-*, Old Persian *maθiya-*, New Persian *māhī* 'id.' < PIIr. *matsi̯a-.

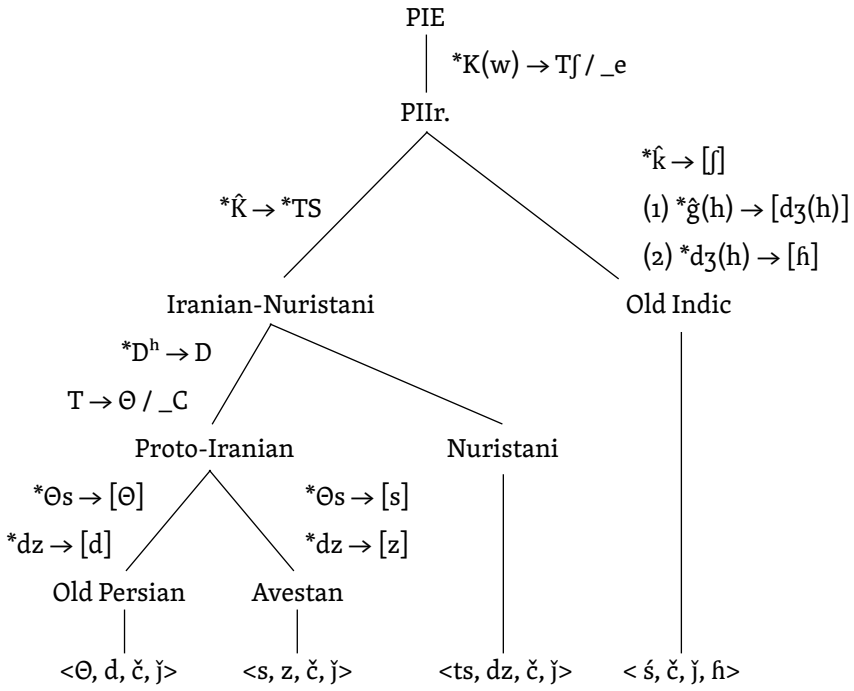

FIGURE 4: Economical account of PIE *Ḱ in Indo-Iranian

5. CONCLUSION

The reflexes of PIE phonemes in the Indo-Iranian languages are well attested, and consensus on the reconstructed phonemes of Proto-Indo-European is nearly total (though there are still some proponents of the Glottalic Theory). However, the recon-

structed sound changes between PIE and the daughter languages of Old Iranian and Old Indic have been argued to 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 attested outcome. Additionally, scholars have proposed shared changes demonstrating a hypothesized relationship like Indo-Iranian, even if that change decreases the overall economy.

$*K^{(w)} \rightarrow T\int$ / _e			
$*DH \rightarrow *D^h$			
$*\hat{K} \rightarrow *TS$			$*\hat{k} \rightarrow [\int]$ (1) $*\hat{g}^{(h)} \rightarrow [dʒ^{(h)}]$ (2) $*dʒ^{(h)} \rightarrow [ɦ]$ $*TH \rightarrow *T^h$
$D^h \rightarrow D$ $T \rightarrow Θ$ / _C		$*H \rightarrow Ø$	$*H \rightarrow Ø$
$*Θs \rightarrow Θ$ $*dz \rightarrow d$ $*H \rightarrow Ø$	$*Θs \rightarrow s$ $*dz \rightarrow z$ $*H \rightarrow Ø$		
Old Persian	**Younger Avestan**	**Nuristani**	**Sanskrit**

TABLE 5: Summary of changes and relative 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 has not 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) $TH \rightarrow T^h$, (2) $T^h \rightarrow Θ$ was removed because the sequence (1) $T \rightarrow Θ$ / _C, (2) $H \rightarrow Ø$ produces the same result. In other words, the change $*tH \rightarrow *t^h \rightarrow θ$ was rejected to avoid redundancy, whereas $*tH \rightarrow *θH \rightarrow θ$ is independently supported.

REFERENCES

Bartholomae, C. (1895) Awestasprache und Altpersisch, in: W. Geiger (ed.), *Grundriss der iranischen Philologie*, Strassburg: Trübner, 152–246.

Beekes, R. S. P. (1988) *A Grammar of Gatha-Avestan*, Leiden — New York: Brill.

Bennett, W. G. (2013) Dissimilation, consonant harmony, and surface correspondence (Ph.D. dissertation, Rutgers University). https://doi.org/doi:10.7282/T36W98SZ.

Buddruss, G. (1977) Nochmals zur Stellung der Nuristan-Sprachen des afghanischen Hindukusch, in: *Münchener Studien Zur Sprachwissenschaft* 36, 19–38.

Byrd, A. M. (2017) The phonology of Proto-Indo-European, in: J. S Klein — B. D. Joseph — M. Fritz (eds.), *Handbook of Comparative and Historical Indo-European Linguistics*, Vol. 3, Berlin: De Gruyter Mouton, 2056–2079.

Campbell, L. (2021) *Historical Linguistics: An Introduction*, Cambridge, Mass.: The MIT Press (fourth edition).

Cantera, A. (2017) The phonology of Iranian, in: J. S Klein — B. D. Joseph — M. Fritz (eds.), *Handbook of Comparative and Historical Indo-European Linguistics*, Vol. 1, Berlin: De Gruyter Mouton, 481–503.

Coleman, J. (1999) The nature of vocoids associated with syllabic consonants in Tashlhiyt Berber, in J. J. Ohala — Y. Hasegawa — M. Ohala — D. Granville — A. C. Bailey (eds.), *Proceedings of The XIVth International Congress of Phonetic Sciences, San Francisco, 1–7 August 1999*, Vol. 1, Berkeley: Linguistics Department, University of California, 735–738.

Joseph, B. D. (2014) Aspirates, fricatives, and laryngeals in Avestan and Indo-Iranian, in: Sh.-F. Chen — B. Slade (eds.), *Grammatica et Verba — Glamor and Verve: Studies in South Asian, Historical, and Indo-European Linguistics in Honor of Hans Henrich Hock on the Occasion of his Seventy-Fifth Birthday*, Ann Arbor: Beech Stave, 122–127.

Karim, S. O. (2022) Akkadian [e], in: *JAOS* 142(1), 177–191. https://doi.org/10.5913/jaos.142.1.2022.ar010

Kobayashi, M. (2004) *Historical Phonology of Old Indo-Aryan Consonants*, Tokyo: Research Institute for Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies.

Kobayashi, M. (2017) The phonology of Indic, in: J. S Klein — B. D. Joseph — M. Fritz (eds.), *Handbook of Comparative and Historical Indo-European Linguistics*, Vol. 1, Berlin: De Gruyter Mouton, 325–344.

Kortlandt, F. (2007) *Italo-Celtic Origins and Prehistoric Development of the Irish Language*, Amsterdam: Rodopi.

Kümmel, M. J. (2007) *Konsonantenwandel: Bausteine zu einer Typologie des Lautwandels und ihre Konsequenzen für die vergleichende Rekonstruktion*, Wiesbaden: Reichert.

Kümmel, M. J. (2014) The development of laryngeals in Indo-Iranian (paper read at "The Sound of Indo-European 3: Phonetics, phonemics, and morphophonemics," Opava, 12 November 2014), accessible at: https://www.academia.edu/9352535/The_development_of_laryngeals_in_Indo_Iranian.

Kümmel, M. J. (2020) Substrata of Indo-Iranic and related questions, in: T. Olander (ed.), *The Indo-European Language Family: A Phylogenetic Perspective*, Cambridge: Cambridge University Press, 237–278.

Lipp, R. (2009) *Die indogermanischen und einzelsprachlichen Palatale im indoiranischen* (2 vols.), Heidelberg: Winter.

Lubotsky, A. (1981) Gr. *pḗgnumi*: Skt. *pajrá-* and loss of laryngeals before mediae in Indo-Iranian, in: *Münchener Studien zur Sprachwissenschaft* 40, 133–138.

Lubotsky, A. (2017) The phonology of Indo-Iranian. In J. S Klein — B. D. Joseph — M. Fritz (eds.), *Handbook of Comparative and Historical Indo-European Linguistics*, Vol. 3, Berlin: De Gruyter Mouton, 1875–1888.

Mayrhofer, M. (1956–1980) *Kurzgefasstes etymologisches Wörterbuch des Altindischen* (4 vols.), Heidelberg: Winter.

Mayrhofer, M. (1983) Lassen sich Vorstufen des Uriranischen nachweisen? in: *Anzeiger der Österreischischen Akademie der Wissenschaften* 120, 249–255.

Simon, Zs. (2014) Der phonetische Wert der luwischen Laryngale, in: P. Taracha (ed.), *Proceedings of the Eighth International Congress of Hittitology, Warsaw, 5–9 September 2011*, Warsaw: Agade, 873–895.

Strand, R. F. (2000) Nurestâni languages, in: *Encyclopaedia Iranica*, accessible at: https://iranicaonline.org/articles/nurestani-languages-archive.

Weiss, M. (2016) The Proto-Indo-European laryngeals and the name of Cilicia in the Iron Age, in: A. M Byrd — J. DeLisi — M. Wenthe (eds.), *Tavet Tat Satyam: Studies in Honor of Jared S. Klein on the Occasion of His Seventieth Birthday*, Ann Arbor: Beech Stave, 331–340.