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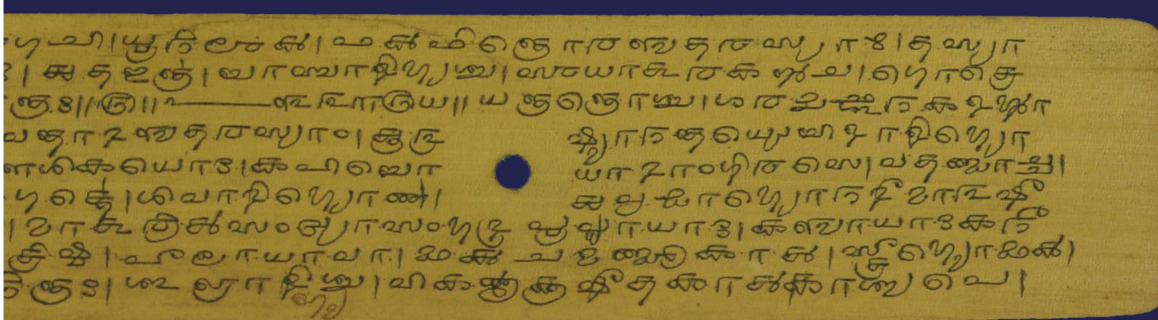
The Indo-European Syllable

Andrew Miles Byrd



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By

Andrew Miles Byrd

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This book is printed on acid-free paper.

To Brenna,
whose patience, support, and sleepless nights
made this book possible.

Contents

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Andrew M. Byrd
Lexington

List of Symbols and Abbreviations

Symbols

C	consonant	V	vowel
C̥	syllabified consonant	V̄	long vowel
F	fricative	*	reconstructed as, violation
H or h_x	laryngeal	x	non-occurring
K	tectal	>	diachronically develops into
L	liquid	<	diachronically derives from
N	nasal	→	becomes by sound law
O	obstruent	⤳	becomes by analogy
P	stop	μ	mora
R	sonorant	σ	syllable
R̥	syllabic sonorant	ω	prosodic word
T	dental stop	$ or $]_\sigma$ or .	syllable boundary
U	high vowel	#	word boundary
U̯	glide	+	morpheme boundary

Abbreviations

acc.	accusative
Alb.	Albanian
aor.	aorist
Arm.	Armenian
Av.	Avestan
Bal.	Balochi
Boeot.	Boeotian
Bret.	Breton
Corn.	Cornish
Cret.	Cretan
Cyp.	Cypriot
dat.	dative
Dor.	Doric
du.	dual
Eng.	English
EWAia	Mayrhofer 1985–2001

Gaul.	Gaulish
GAv.	Gathic Avestan
gen.	genitive
Germ.	German
Gk.	Greek
Gmc.	Germanic
Goth.	Gothic
Hitt.	Hittite
HLuv.	Hieroglyphic Luvian
IE	Indo-European
IEW	Pokorny 2005
impfct.	imperfect
instr.	instrumental
Ion.	Ionic
Ital.	Italian
iter.	iterative
Jap.	Japanese
Khot.	Khotanese
Lac.	Laconian
Lat.	Latin
Latv.	Latvian
Lith.	Lithuanian
LIV	Rix et al. 2001
loc.	locative
Luv.	Luvian
Lyc.	Lycian
masc.	masculine
MBret.	Middle Breton
MIr.	Middle Irish
M/P	mediopassive
MWel.	Middle Welsh
NIL	Wodtko et al. 2008
nom.	nominative
NPers.	Modern Persian
nt.	neuter
OCorn.	Old Cornish
OCS	Old Church Slavic
OE	Old English
OHG	Old High German
OIce.	Old Icelandic

OIr.	Old Irish
OLat.	Old Latin
OLith.	Old Lithuanian
OPhryg.	Old Phrygian
OPruss.	Old Prussian
OSax.	Old Saxon
Osc.	Oscan
Osc.-Umb.	Osco-Umbrian
OT	Optimality Theory
Parth.	Parthian
PGmc.	Proto-Germanic
PIE	Proto-Indo-European
PIIr.	Proto-Indo-Iranian
PInd.	Proto-Indic
PIran.	Proto-Iranian
PItal.	Proto-Italic
pl.	plural
pres.	present
PSlav.	Proto-Slavic
RCS	Russian Church Slavic
Russ.	Russian
RV	Rig Vedic
sg.	singular
Skt.	Sanskrit
Slav.	Slavic
subj.	sub unctive
TA	Tocharian A
TB	Tocharian B
Toch.	Tocharian
Umbr.	Umbrian
Ved.	Vedic
Wel.	Welsh
Yagh.	Yaghnobi
YAv.	Young Avestan

The Indo-European Syllable

Preliminaries

PART 1

Preliminaries

CHAPTER 1

An Overview of the Indo-European Sound System

The primary focus of this book is the analysis of syllabification in Proto-Indo-European (PIE) and the processes affected thereby. Syllabification, as is well known, is a crucial component within the phonologies of all of the world's languages. It can drive phonological rules, dictate what are possible sequences in languages, and direct the shape of a language throughout its history. The reconstruction of PIE syllabification is traditionally presented as a marginal phonological phenomenon that has been solved to scholars' satisfaction; however, in this book I will demonstrate that the Indo-European (IE) syllable is a central problem within IE linguistics with many unanswered questions and will do so in a non-circular fashion. Moreover, we will discover that there were a number of phonological processes within PIE directly driven or indirectly affected by the constraints of syllable structure. Of course, before we investigate the problem at hand, we must first understand what methodological tools are at our disposal as well as review the past scholarship devoted to the study of IE syllabification. In these first two preliminary chapters we will begin by examining the initial assumptions about the phonology of PIE followed in our analysis, with particular focus on key issues relevant for the reconstruction of PIE syllable structure. We will then proceed to a brief overview of the workings and benefits of Optimality Theory, the primary phonological framework used in this book, and subsequently examine the fundamentals of Syllable Theory, which assumes the syllable as a unit of phonological analysis. We will conclude this section with a review of the past views of syllabification in the Indo-European literature, leading us to the firm conclusion that a great deal more needs to be said regarding the IE syllable and PIE phonology in general.

1.1 The Reconstruction of Proto-Indo-European

PIE was a language that was never recorded, whose form may be inferred ("reconstructed" in the parlance of historical linguists) through the comparison of attestations of its descendant languages, which include Latin, Russian, Hindi and English, among others.[1] This analysis, primarily completed by

1 See Watkins 2000:vii–xxxv, Meier-Brügger 2003 and Fortson 2010 for excellent overviews of Indo-European linguistics and the Indo-European languages.

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means of the Comparative Method (Fortson 2010:1–4), creates for us in modern times a window into the past, showing us not only a highly complex prehistoric culture but also a fully-formed language, complete with an extensive lexicon and grammar. We may gain insight into such complexity in culture and language through the reconstruction of just a single word, such as **h₃rḗk̂s* 'king, leader'. This etymon may be reconstructed on the basis of a number of words in the IE daughter languages that mean 'king' or the like: Latin *rēx*, Gaul. *-rix* (PN *Dumno-rix*, lit. 'World-leader'), and Skt. *rāṭ*. Through comparison of these words (while being mindful of other words of similar structure), one arrives at the reconstruction **rḗk̂s* 'king, leader'. Scholars have recognized that this word was an agent noun formed to the root **h₃reĝ-* 'to rule, organize' (thus, 'the ruler'), a root continued by Germ. *Reich* 'kingdom',[2] Av. *razeyeiti* 'directs', Gk. ὀρέγω 'I rule', and Eng. *regular, regulation* (< Lat. *rēgula* 'rule'), and so we may modify our reconstruction to **h₃rḗk̂s* accordingly. Put together, the reconstructions **h₃rḗk̂s* and **h₃reĝ-* teach us a great deal about the structure of the PIE language. Not only may we identify particular sounds to have existed in PIE (*[h₃, r, e, ē, k̂, ĝ, s]), we may also identify specific phonotactic sequences as having been licit (**h₃r-* and **-k̂s*). Moreover, the reconstruction **h₃rḗk̂s*, not *ˣh₃rḗĝs*, requires that we assume the cross-linguistically common neutralization of laryngeal features (i.e. voicing assimilation) in obstruent sequences, thereby accounting for the change of underlying */ĝ/ to surface *[k̂] in 'king'. Laryngeal feature neutralization also occurs in **h₃rek̂tós* 'upright, just', a form continued by Gk. ὀρεκτός 'stretched out' and Eng. *right*.

1.2 The Indo-European Sound System

It is through the analysis of secure etymologies like **h₃rḗk̂s* that we may construct a grammar for PIE, word by word. The following represents a concise but comprehensive synchronic sketch of the phonological component of that grammar, both at the surface and below.[3] By 'surface' I simply mean how the forms in question were pronounced by native speakers of late PIE; by 'below' I mean how the speakers in question *thought* about those sounds. I will therefore make a clear notational distinction between the two in this book. Underlying (i.e., phonological) forms will be written in slants: */h₂eĝtós/ 'driven'. Surface

2 Note that due to its vocalism, the Germanic root **rīk-* must be a Celtic borrowing.

3 The material presented in section 1.2 is an abridged version of Byrd, forthcoming a and builds upon Byrd 2010:1–13.

(phonetic) forms will be written in either italics (the most common practice in IE studies) or brackets (the most common practice in theoretical phonology): *h_2aḱtós* or *[$\mathrm{h_2}$aḱtós].[4] The phonological grammar assumed in this book is based primarily on the attested facts of the daughter languages. For this reason what follows is an incomplete (and therefore imperfect) sketch, and it is likely that more surface variation existed within the proto-language, for which the evidence is lacking.

1.2.1 *Phonemic Inventory*

Let us begin with a look at the complete phonemic inventory of PIE, as it is typically reconstructed. Most Indo-Europeanists today continue to follow the traditional Neogrammarian reconstruction with minor alterations. Thus, for the consonants one usually assumes three distinct series of stops (voiceless, voiced, and voiced aspirated),[5] three sets of dorsal consonants (palatal, velar, and labiovelar), six sonorants, and a single sibilant, with the most significant change being the addition of three distinct postvelar fricatives, known as "laryngeals", written here as */$\mathrm{h_1}$, $\mathrm{h_2}$, $\mathrm{h_3}$/. The segmental phonemic inventory of PIE assumed here is, for the most part, uncontroversial. It closely resembles the views presented in Mayrhofer 1986 (unless explicitly stated otherwise), to which I refer the reader for all phonological matters not discussed here in depth.

1.2.1.1 Vowels

I assume the standard PIE inventory of vowels, as set forth in Mayrhofer 1986:90. Note that each segment represents a vocalic allophone; the phonemic inventory will be presented at the end of this section.

(1) Surface Proto-Indo-European Vowel Inventory

*[i], *[ī]				*[u], *[ū]
	*[e], *[ē]	*[ə]	*[o], *[ō]	
		*[a], *[ā]		

Since the early twentieth century, the short mid vowels */e/ and */o/ have been universally accepted as phonemes for PIE; cf. *déḱm̥* '10' (Gk. δέκα, Lat. *decem*) and *pódm̥* 'foot (acc.sg.)' (Gk. πόδα, Arm. *otn*). The high vowels *i and

4 For the reasoning behind such notational practices, I refer the reader to Byrd, forthcoming b.

5 In other words, I do not follow the glottalic theory. For a thoroughly convincing argument in favor of the traditional reconstruction, see Garrett 1998. See also Job 1995.

**u* were not phonemically vocalic, but rather syllabic allophones of the glides */i̯/ and */u̯/, respectively; cf. the zero-grade variants of */di̯eu̯-/ 'shine': **diu̯és* 'sky (gen.sg.)' vs. **di̯ut-* 'shining'.[6] While most present-day Indo-Europeanists reconstruct **a* as a phoneme for late PIE, some (most famously the "Leiden School" [LS]; see Beekes 2011) do not, eschewing typical reconstructions such as */sals/ 'salt' (Ved. *salilá-* 'salty', Gk. ἅλς, Lat. *sal-*, etc.) in favor of laryngealistic reconstructions: **sh$_2$als* (← /*sh$_2$els/). Thus, for such proponents **a* was always a surface allophone of */e/, colored by an adjacent */h$_2$/ (see 25 below). It is, however, very difficult to avoid the reconstruction of certain forms with */a/ vocalism. For example, Hitt. *apa*, Gk. ἀπό, and Lat. *ab* 'away, off' may only be traced back to */apó/, not */h$_2$epó/, and it is quite difficult to derive Skt. *nasa-*, OCS *nosŭ* 'nose' from */nh$_2$es-/, as one would expect the syllabification **n̥h$_2$es-* (cf. 8 below), though perhaps one may explain these latter forms through sound law (Beekes 1988:43) or analogy.

The long mid vowels */ē/ and */ō/ are also uncontroversially reconstructed as phonemes, as the long vocalism of forms such as **h$_3$rēĝ-* 'rule' (Lat. *rēx*, OIr. *rí*, Skt. *rāj-*) and perhaps **su̯ésōr* 'sister' (Ved. *svásā*, Lat. *soror*, OIr. *siur*) must have been lexicalized or morphologized in late PIE. Long high *ī* and *ū* are well attested in the daughter languages, but most derive from a sequence of glide + laryngeal in PIE (**pih$_2$u̯erih$_2$* > Skt. *pī́varī* 'fat (fem.)', **puh$_2$rós* > Lat. *pūrus* 'pure'). There are certain isolated forms which may have possessed */ī/ and */ū/: **u̯īs-* 'poison' (Av. *vīš*, Lat. *vīrus*) beside **u̯is-* (Ved. *viṣá-*, Av. *viša-*), PIE **mūs* 'mouse' (OE *mūs*) beside **mus-* (Lat. *musculus* 'muscle'). Were one to reconstruct */u̯ih$_x$s-/ and */muh$_x$s-/, the short vowel variants would be difficult to explain. Likewise, while **nās-* 'nose' (Lat. *nārēs* 'nostrils') may certainly be mechanically derived from */neh$_2$s-/, it would be difficult to connect this form with the short-vowel variant **nas-* cited above. Additional instances of **ā* were also derived by Stang's Law (see 10 below): */-eh$_2$m/ → **-ām* (Skt. *sénām* 'army').

6 An anonymous reviewer reminds me, however, that both Mayrhofer 1986:160–1, 168 and Ringe 2006:9 consider the possibility that **i* did derive from an underlying */i/ in certain cases within PIE, such as **u̯oi̯koï* 'house (loc.sg.)' (Gk. οἴκοι 'at home') and **neu̯io-* 'new' (Wel. *newydd*). While I do not have a firm view about Ringe's reconstruction **neu̯ios*, I propose (with some hesitation) that the syllabic nature of the locative ending **-i* in the thematic **-oï* is due to the fact that **i* (*/i̯/) was originally a non-cohering case suffix. See section 4.6 and chapter 7 for further.

The reader should note one important difference with Mayrhofer 1986 that I make throughout this monograph: the vowel *[ə] will indicate both epenthesis in certain consonant sequences containing laryngeals (schwa primum)[7] and in the word initial sequence #PPR- (schwa secundum), as I assume *[ə] to be the go-to 'fix-it' vowel in PIE for any illicit consonant cluster that requires repair. Thus, in PIE (as in many languages), *[ə] was an allophone of zero. For example, in my reconstructions *[ə] is given both in the oblique stem of 'father' (**pəh₂tr-*, with schwa primum), as well as in forms such as */kʷtu̯ṓr/ 'four' → **kʷətu̯ṓr* > Lat. *quattuor* 'four' and */dʰĝʰmés/ 'earth, ground (gen.sg.)' → **dʰəĝʰmés* > Hitt. *taknaš* 'id.' (with schwa secundum). This use of **schwa indogermanicum** will be touched upon at multiple points throughout this book, especially in (34) below.

These facts allow us to postulate a more precise phonemic inventory of vowels for late PIE:

(2) PIE Vowel Phonemic Inventory

*/e/, */ē/		*/o/, */ō/
	*/a/, */ā/	

1.2.1.2 Consonants

A rich array of consonants (similar to that which is presented in Mayrhofer 1986:91ff.) will be assumed for the surface level. We may reconstruct fifteen stops that contrasted along five places of articulation (bilabial, dental, palatal, velar, and labiovelar) and three distinct combinations of laryngeal features (voiceless unaspirated, voiced unaspirated, voiced aspirated),[8] eight sonorants, and four fricatives.[9] While affricates were conspicuously absent in PIE, some scholars (such as Melchert 2003) have suggested that the affricate *[t͡s] surfaced under certain conditions, such as the double dental rule (see 18 below) and thorn clusters (22 below). This position will not be followed here, as I consider *[ts] to be a sequence of two discrete sound segments, not a single complex one. For arguments against *[ts] as an affricate, see Sandell & Byrd, forthcoming.

7 Also known as a 'vocalized' or 'syllabic' laryngeal.

8 In reality, voiced aspirated stops were not aspirated per se, rather murmured. See Garrett 1991, Clackson 2007.

9 See also Kümmel 2007.

(3) Surface Proto-Indo-European Consonant Inventory

	Labial	Dental	Palatal	Velar	Labiovelar	Pharyngeal	Glottal
voiceless stop	*p	*t	*k̂	*k	$*k^w$		
voiced stop	*b	*d	*ĝ	*g	$*g^w$		
voiced aspirate	$*b^h$	$*d^h$	$*ĝ^h$	$*g^h$	$*g^{wh}$		
fricative		*s, *z				$*h_2$, $*h_3$	$*h_1$
nasal	*m	*n	*ɲ	*ŋ			
liquid		*r, *l					
glide	*u̯		*i̯				

There were six phonemic resonants in PIE: two glides */i̯/ and */u̯/, two liquids */r/ and */l/, and two nasals */m/ and */n/. It is likely that */n/ assimilated in place before stops, a rule maintained by all of the ancient IE languages, thus Lat. *quī*[*ŋ*]*que*, Skt. *pá*[*ɲ*]*ca*, Gk. πέμπε (Aeol. πέμπε), and Goth. *fi*[*ɱ*]*f*, all from PIE **péŋkʷe* 'five' (← */penkʷe/). It is for this reason that I assume the surface nasals *[ɲ] and *[ŋ] to have existed in PIE. The *boukolos* rule (23) suggests that */n/ did not assimilate to *[ŋʷ] before a labiovelar; as for the absence of pharyngeal and glottal nasals, these types of sounds are cross-linguistically non-existent, and therefore will not be assumed for PIE (in case one is wondering how a nasal had been articulated before a laryngeal consonant). In addition to this type of variation in place, each resonant had (at least) two allophones, one that occurred in syllable margins, another in nuclei. All resonants were underlyingly non-syllabic; syllabic allophones were derived by rule (8) below.

There was a single sibilant */s/ in PIE that had at least two allophones: *[s] and *[z]. *[z] surfaced before voiced obstruents; cf. */sed-/ > **sed-* (Arm. *hecanim*, Lat. *sedeō*) but */-sd-/ > *[-zd-] as in **ni-zd-ó-* (OCS *gnězdo*, Lat. *nīdus*, Eng. *nest*). It is quite possible that */s/ was a prepalatal hushed spirant (Vijūnas 2010).

Let us now turn to what is perhaps the most exotic aspect of the consonantal inventory: the laryngeals. After a contentious century of research, scholars now with few exceptions posit three laryngeals for PIE (*/h_1, *h_2, *h_3/), each corresponding to a different vocalic reflex in Greek: θετός (< $*d^h əh_1 tó$- ← */$d^h h_1$-tó-/ 'placed'), στατός (< $*stəh_2 tó$- ← */sth_2-tó-/ 'standing'), and δοτός (< $*dəh_3 tó$- ← */dh_3-tó-/ 'given'). Note that the vowel of each initial syllable derives from a sequence of *[ə] + *[h_x] and was unlikely to have been an instance of true vocalization (i.e., *[$\mathring{h}_x$]), despite the frequent use of this term here and elsewhere (see 34 below). Although */h_x/ was vocalized in a variety of environments in the prehistory of many IE languages, it appears that in PIE this was only the case in word-initial sequences of the shape */CHC(C)/, as seen in */$d^h h_1$s-/ → *[$d^h ə h_1$s-] 'divine'> Gk. θεός 'god', Lat. *fānum* 'shrine' (< **fasno-*), Skt. *dhíṣṇya-* 'pious', and HLuv. *tasan-za* 'votive stele'. In all other environments daughter languages treat */h_x/ in different ways—word-medially (*/$h_2$enh_1mV-/ 'soul, breath, wind' > Gk. ἄνεμος, Lat. *animus* but GAv. *ąnman-*), word-finally (*/méĝh_2/ 'great' > Ved. *máhi*, Gk. μέγα but Hitt. *mēk*), and in other word-initial sequences (*/$h_2$ster-/ 'star' > Gk. ἀστήρ, Arm. *astł* but Lat. *stēlla*, Ved. *stṛ́bhis*). Similarly, the loss of coda */h_x/ with compensatory lengthening was not a PIE process: */peh_2s-/ 'protect' → **pah_2s-* > Hitt. *paḫ̬s-* but Lat. *pās-tor* 'shepherd'.

The aforementioned presence of Gk. ε, α, and ο, continuing a contrast which was present in PIE, illustrates a fundamental property of the laryngeals: */h_2/ and */h_3/ change the quality of an adjacent */e/-vowel. */h_2/ + */e/ → *[a] (*/steh_2-/ 'stand'→ **stah_2-* > Doric Gk. ἵστᾱμι 'I set up'); */h_3/ + */e/ → *[o] (*/deh_3-/ 'give' → **doh_3-* > Lat. *dōnum*). */h_1/ had no such 'coloring' effect: cf. */$h_1$ésti̯/[10] → **$h_1$ésti* 'is'. Moreover, at least in Greek, */h_2/ and */h_3/ had a coloring effect on a preceding *[ə]: */$d^h h_1$-tó-/ → **$d^h ə h_1$tó-* > Gk. θετός;[11] */sth_2-tó-/ → **stə$h_2$tó-* → **stă$h_2$tó-* > Gk. στατός; */dh_3-tó-/ → **də$h_3$tó-* → **dŏ$h_3$tó-* > Gk. δοτός. While these three structurally reduced vowels remain distinct from each other in Greek, merging with the structurally full vowels ε, ο, and α, respectively, they show a merged unitary outcome in all other branches: in Indo-Iranian, **əh_x* > *i* (Skt. *hitá-*, *sthitá-*, *-di-* [rare]), everywhere else, **əh_x* > a (cf. Lat. *factus, status, datus*). No other vowels were colored by an adjacent laryngeal: cf. PIE **h_2óĝmos* (Gk. ὄγμος 'furrow') and **mḗh_2u̯r̥* (Hitt. *meḫ̬ur* 'time') (as per Eichner's Law).[12]

Though continued exclusively as vowels in many of the daughter languages, it is very likely that the laryngeals were all fricatives of some sort, both phonetically and phonologically. We therefore reject the arguments of Reynolds, West and Coleman (2000), who propose that the laryngeals were prosodically weak vowels. That these segments were consonants is of course very important for a study of IE syllabification: whether these segments were syllabic or nonsyllabic determines how many syllables are to be posited for a particular word that contains them. We believe that the laryngeals were fricatives for three main reasons. First, laryngeals pattern like consonants in our reconstructions:

10 Recall that all surface **i* derive from an underlying non-syllabic */i̯/.

11 It is not the case that */h_1/ colored an adjacent *[ə], but rather that a moraic schwa developed into Gk. ε. See (34) below for further discussion.

12 Eichner 1973.

they were more sonorous than stops but less sonorous than resonants,[13] occupied the same position as */s/ within roots,[14] and (at least) */h$_3$/ participated in voicing assimilation (a process restricted to obstruents; see (16) below), most famously in */pi̯-ph$_3$-e-ti̯/ → _*pibh$_3$eti_ 'drinks' > Ved. _píbati_, OIr. _-ib_, Lat. _bibit_, Arm. _əmpē_.[15] Second, two of the laryngeals are directly continued in the most ancient Anatolian languages (Hittite, Luvian, and Palaic) as dorsal or pharyngeal fricatives, written as < ḫ(ḫ) > (Melchert 1994:55): Hitt. _ḫant-_ 'front', cf. Lyc. _xñtawa-_ 'rule' (< PIE _*h$_2$ant-_), Hitt. _ḫappariye-_, cf. Lyc. _epirije-_ 'sell' (< _*h$_3$op-_), and it is clear that _*h$_2$_ triggered aspiration on preceding stops in Indo-Iranian (e.g. PIE */pleth$_2$món-/ > _prathimán-_ 'width'), a process that only really makes sense if _*h$_2$_ was originally featurally similar to [h] in some way. According to Kloekhorst (2004) _*h$_1$_ was also continued as a glottal stop in Hieroglyphic Luvian (_á-ma/i-_ 'my' < _*h$_1$me_, _á-sú-_ 'horse' < _*h$_1$eḱu-_), though this view is not universally held.[16] Lastly, through the examination of possible phonotactic structures in PIE, we find that word-medially, there are only two attested medial consonant sequences of the shape *[-PCO-]: *[-PsO-][17] and *[-Ph$_x$O-].[18] Since there are no reconstructable sequences of the shape *[-PPO-] (^{X}_-eḱpto-_), nor of the shape *[-PRO-] (^{X}_-eḱrto-_), the existence of *[-Ph$_x$O-] as a possible medial cluster suggests that the PIE laryngeals were neither stops nor sonorants—hence they were fricatives.[19]

Let us now summarize the facts presented thus far. */h$_1$/ was a non-coloring consonant and is perhaps continued by [ʔ] in Anatolian. */h$_2$/ lowered */e/ and *[ə] and aspirated stops in Indo-Iranian. */h$_3$/ rounded and backed */e/ and *[ə] and was voiced. All three were typologically 'marked', resulting in their frequent deletion in both PIE (see below) and the daugh-

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13 Thus, as an anonymous reviewer reminds me, PIE */strh$_3$no-/ → _*str̥h$_3$no-_ > Skt. _stīrṇa-_, not ^{X}_striṇa-_; see Mayrhofer 1986:121ff. for further discussion, with references.

14 The laryngeals pattern with the one assured fricative in PIE, _*s_, in the general root template *{s, h$_x$}PRVR{s, h$_x$}P{s, h$_x$}. Should we assume the laryngeals to be fricatives, we may simply posit a template *FPRVRFPF. It is of course undeniable that both may occur within the same root: cf. _*h$_2$ster-_ 'star'.

15 This form (among others) suggests that laryngeal coloring was blocked across a morpheme boundary; cf. Weiss 2009:50.

16 Cf. Melchert 2010.

17 For example, _*h$_1$etsḱé/ó-_ 'eat (iter.)', _*su̯eḱsto-_ 'sixth'.

18 Cf. virtual _*u̯ed^{h}h$_1$sm̥_ > Ved. _ávadhiṣam_ 'I slew', _*d^{h}ugh$_2$ter-_ > Ved. _duhitár-_ 'daughter', _*h$_2$aḱh$_3$tu-_ > Skt. _aśitum_ 'to eat'.

19 On the other hand, if Jasanoff 2003:77[37] is correct in assuming loss of _*h$_1$_ in the cluster *-Oh$_1$O-, then perhaps this gives weight to the idea that _*h$_1$_ was a glottal stop (see Kessler, n.d. for references), since the sequence *-PPO- was blocked in PIE.

ter languages. Lastly, all three were more sonorous than stops, but less sonorous than resonants and patterned like */s/ in roots, which suggests that they were most likely fricatives.[20] The vowel coloration effects point to a post-velar place of articulation (uvular or pharyngeal), leading us to the most common reconstruction: */h_1/ = /h/ or /ʔ/, */h_2/ = /ħ/, a voiceless pharyngeal fricative, and */h_3/ = /ʕ$^{(w)}$/, a voiced pharyngeal fricative with possible rounding coarticulation. As /h/ is typically present in the phonemic inventories of languages with aspirated stops, I prefer to reconstruct */h_1/ as a voiceless glottal fricative. These views will be particularly important (and in my opinion validated) through the analysis of Pinault's Law put forth in chapter 6.

(4) PIE Consonant Phonemic Inventory

	Labial	Dental	Palatal	Velar	Labiovelar	Pharyngeal	Glottal
voiceless stop	*p	*t	*k̂	*k	*k^w		
voiced stop	*b	*d	*ĝ	*g	*g^w		
voiced aspirate	*b^h	*d^h	*$ĝ^h$	*g^h	*g^{wh}		
fricative		*s				*h_2, *h_3	*h_1
nasal	*m	*n					
liquid		*r, *l					
glide	*u̯		*i̯				

1.2.2 *Consonant Clusters*

Now that we have identified the phonemic and allophonic inventories of PIE, let us turn to its phonotactics, with specific regard to the sequencing of consonants. For in order for us to reconstruct syllabification for PIE in a secure fashion, it is crucial that we have a clear conception of what is and what is not a consonant cluster in the proto-language. We may distinguish three types of reconstructed consonant clusters: those directly attested, those indirectly attested and those reconstructed for structural and/or etymological reasons.[21]

20 Following Kessler (n.d.), Weiss (2009:50), Keydana (2011) and many others.

21 The following is an abridged presentation of Byrd, forthcoming b.

a. Directly attested
Language *α* (*β*, *γ*, etc.) has a cluster XY(Z), which we reconstruct as *XY(Z) (vel sim.) in the proto-language. This cluster need not be continued in all languages.
This is the most secure type of reconstructable consonant cluster. Examples of directly attested clusters include:

Word-Initial

tr-*: ***tréi̯es*‘three’ > Ved. *tráyaḥ*, Gk. τρεῖς, Eng. *three*
pt-*: ***ptero-* ‘feather’ > Gk. πτερόν ‘id.’, Arm. *t’ert’* ‘leaf’
st-*: ***stah₂-* ‘stand’ > Ved. *sthitá-*, Gk. στατός, Eng. *stand*
str-*: ***streu̯-* ‘spread’ > Lat. *struō* ‘build’, OCS *-strujǫ* ‘destroy’, Eng. *strew*
pst-*: ***psten-* ‘breast, nipple’ > Av. *fštāna-*, Skt. *stána-*, OIce. *speni*[22]

Word-Medial

**-rsn-*: **(t)persnV-* ‘heel’ > Ved. *pā́rṣṇi-*, Gk. πτέρνη, Lat. *perna*, Goth. *faírsna*
**-kst-*: **s(u̯)eksto-* ‘sixth’ > Ved. *ṣaṣṭhá-*, Goth. *saihsta*, Lith. *šẽštas*
**-tsḱ-*: **h₁etsḱé/ó-* ‘eat (iterative)’ > Hitt. *azzik-, azzak-* /at͡sk-/
**-i̯str-*: **(h₁)oi̯stro/ah₂* > Gk. οἶστρος ‘gadfly; madness’, Lith. *aistrà* ‘vehement passion’

Word-Final

**-ns*: **-ons* ‘*o*-stem acc.pl.’ > Goth. *-ans* ‘id.’, Cret. *-ons*[23]
**-ḱs*: **h₃rḗḱs* ‘ruler’ > Ved. *rā́ṭ*, Lat. *rēks*, Gaul. *-rīx* (*Dumnorix*, etc.)
**-kʷts*: **nékʷts* ‘evening (gen.sg.)’ > Hitt. *nekuz* /nekʷt͡s/
**-rst*: Virtual **dʰḗrst* ‘fastened (3sg. aor.)’ > GAv. *dārᵊšt* ‘held (3sg. aor.)’[24]
**-kst*: **h₂u̯ékst* > GAv. *vaxšt̰* ‘made grow (3sg. aor.)’

b. Indirectly attested
If language *α* has the sequence X(Z) and language *β* has the sequence Y(Z), we may infer the existence of the cluster *XY(Z) or *YX(Z), if X does not originate from Y and vice versa.
For example, we may reconstruct the onset **ksn-* for PIE in **ksneu̯s-* ‘sneeze’, which according to Pokorny (IEW 953) is a contamination of

22 Cf. PIE **pster-* ‘sneeze’ (IEW 846–7).
23 Cf. Cret. *tons eleutʰerons* ‘the free men’.
24 According to LIV 145, this *s*-aorist is an Avestan innovation, but I see no reason to doubt this cluster’s existence within PIE.

**pneu̯-* ‘breathe’ and **ksēu̯-* ‘sneeze’. The root **ksneu̯s-* is reconstructable through comparison of PIran. **(k)sn-* in NPers. *išnōša, ašnōša* and Gmc. **hn-* (< **kn-*), continued by OIce. *hnjōsa*, OHG *niosan* (IEW 953).[25] A reconstructed *ˣskneu̯s-* may be ruled out because there are no reconstructable words of the shape **sPN-* in PIE, whereas the onset **ksn-* is clearly found in **ksneu̯-* ‘sharpen’ (LIV 373).

In reconstructing PIE, a significant number of indirectly attested consonant clusters contain at least one laryngeal. If one language has VC or CV and another only C, the V is typically reconstructed as going back to an original laryngeal $*h_x$, part of an earlier PIE sequence $*h_xC$. For example, word-initially one finds such alternation with the ‘prothetic vowel’ of Greek, Armenian and Phrygian:[26]

#C(C)-	**#VC(C)-**
Lat. *stella*, Ved. *stár-*	Gk. ἀστήρ, Arm. *astł*
Lat. *nōmen*, Ved. *nā́ma*	Lac. ἔνυμα, Arm. *anown*, OPhryg. *onoman*
Goth. *riqis*	Gk. ἔρεβος, Arm. *erek*

The contrast between vowel-initial forms in Greek, Armenian and Phrygian and vowel-less forms elsewhere has led scholars to reconstruct the forms as $*h_2ster$- ‘star’, $*h_1n\acute{o}h_3m\underset{\circ}{n}$[27] ‘name’ and $*h_1reg^wos$ ‘darkness’,[28] respectively.

Were initial sequences of the shape $*h_xC(C)$- true consonant clusters in PIE? They need not have been so: it is entirely conceivable that the $*h_2$ was ‘vocalized’ in $*h_2ster$-, *[h_2əster-] or the like, whose vowel was continued in Greek, Armenian and Phrygian but deleted elsewhere in IE:[29]

$$\text{PIE } *\#h_x\text{əC(C)-} \begin{cases} \text{\#VC(C)- in Greek, Armenian and Phrygian} \\ \text{\#C(C)- elsewhere.} \end{cases}$$

This is not the most economical explanation, however. Should we view $*h_2ster$- as having been phonetically *[h_2əster-] in PIE, we must assume

25 Eng. *sneeze* comes from OE *fnēosan*, from PIE **pneu̯-* ‘breathe, gasp’ (Southern 1999:71).

26 These examples (and countless others) are discussed in Beekes 1969:18ff. The form ἔνυμα is Laconian, attested in the PN Ἐνυμακρατίδας and Ἐνυμαντιάδας.

27 Or similar. The true shape of this word is actually highly contentious, though few would dispute the presence of an initial laryngeal, which is the point here.

28 See Olsen 1999:764 for an alternative explanation of Arm. *erek*.

29 Cf. Keydana 2011.

independent laryngeal deletion and aphaeresis in seven of the ten main Indo-European branches (Albanian, Balto-Slavic, Celtic, Germanic, Indo-Iranian, Italic and Tocharian), with Greek, Armenian and Phrygian deleting the initial laryngeal but retaining the inherited vocalized laryngeal as a short vowel.[30]

The second option is to assume that clusters of the shape $*\#h_xC(C)$- were originally bi- and tripartite consonant clusters in PIE.

$$\text{PIE } *\#\text{h}_x\text{C(C)-} \begin{cases} \#\text{VC(C)- in Greek, Armenian and Phrygian} \\ \#\text{C(C)- elsewhere.} \end{cases}$$

This is the simplest explanation, as it requires the fewest number of steps in the daughter languages. In Greek, Armenian and Phrygian, a schwa was epenthesized in the initial cluster $*\#h_xC(C)$-, with later deletion of pre-vocalic laryngeal: PIE $*\#h_xC(C)$- > $*\#h_x\partial C(C)$- > $*\#\partial_x C(C)$-.[31] Whether this was an innovation shared between the three languages (not an unreasonable scenario, given their proximity to one another) or an independent innovation is immaterial for the topic at hand; the crucial point is that there was NO laryngeal vocalization in PIE in this particular consonant sequence.[32] In the other IE languages, initial $*\#h_xC(C)$- > $*C(C)$-, with simple deletion of the initial consonantal laryngeal.

In short, if a laryngeal is to be reconstructed in PIE due to the continuation of a vowel in one language but ∅ in another, and there is no independent evidence for a process of vowel deletion in the second language (or any other language with laryngeal deletion), then a non-syllabic $*h_x$ should be reconstructed for PIE.[33]

To some readers, this observation might seem trivial. It does, however, hold important consequences for laryngeal clusters in other positions of the PIE word. For example, the PIE word 'great (nt.nom./acc.sg.)' is

30 Anatolian, of course, retains the laryngeal (*ḫaštēr-*), likely with vowel epenthesis [ḫaštēr-] (Melchert 1994:111).

31 Deletion of pre-vocalic laryngeal also occurred before 'true' vowels inherited from PIE: cf. $*h_2a\hat{g}$- 'drive' > Gk. ἄγω, Arm. *acem* 'I drive'. For Phrygian, cf. $*h_1ei̯tōd$ > *eitou* 'let it be(come)'.

32 Laryngeal 'vocalization', as we will see below, *did* exist as a synchronic phonological process in PIE—just not here.

33 See Kessler, n.d. and Kobayashi 2004:132–3 for similar assumptions regarding PIE laryngeal 'vocalization'. Ringe (2006:137–8) finds evidence of deleted schwa primum (vocalized laryngeal) in PGmc., which would require us to assume laryngeal vocalization in early Proto-Germanic, followed by a later process of syncope.

uncontroversially reconstructed as **méĝh*$_2$ (NIL 468). This form is continued by Gk. μέγα and Skt. *máhi*, with laryngeal 'vocalization', and by Hitt. *mēk*, with laryngeal deletion. The lack of a vowel in the Hittite form points to an original consonant cluster **-ĝh*$_2$. Similarly, PIE **h*$_2$*anh*$_1$*mV-* was pronounced with a tripartite medial cluster **-nh*$_1$*m-*, given the deletion of laryngeal in GAv. *ąnman-* 'soul, breath' vs. laryngeal 'vocalization' in Gk. ἄνεμος, Lat. *animus*, OIr. *anaimm*, etc.[34]

c. Reconstructed for structural or etymological reasons.
The last, and least certain, type of reconstructed consonant cluster is that which is reconstructed purely for paradigmatic or etymological reasons. This type may be defined as follows:

All languages show a particular word as having a consonant sequence Y(Z). However, the existence of a related form, either etymological or paradigmatic, contains at least one additional consonant, X. The presence of this consonant in this related form suggests its presence in the original form, *XY(Z).

For example, Hitt. *išpant-* 'night' is related to Ved. *kṣáp-, kṣapā́* 'night', Av. *xšap-* 'darkness' and Gk. ψέφος 'darkness' (IEW 649). This connection presumes that Hitt. *išpant-* was at some point ****kʷspent-*** 'night'. Our only evidence for this cluster is its etymological connection. However, a case could be made for it being a legal PIE onset, given this cluster's structural similarity with the onset **pst-*, as found in PIE **pster-* 'sneeze' and **psten-* 'breast, nipple'. Similarly, Gk. βδέω 'fart', which is related to Lat. *pēdō* 'fart' (< **pezd-*), Russ. *bzdětъ*[35] 'fart quietly' and Lith. *bìzdas* 'anus',[36] suggests an original PIE cluster ****bzd-***. However, since no language directly or indirectly attests the cluster *bzd-*,[37] it is not inconceivable that the onset **bzd-* was already simplified to **bd-* at a point within PIE. Again, independent evidence of the existence of its voiceless counterpart **pst-* renders it plausible that **bzd-* was a legal cluster in PIE.

34 See NIL 307 for discussion, with references.

35 < PSlav. **pьzd-*.

36 < **pizd-*.

37 Seeing as the outcome of PIE **pst-* in Baltic is *sp-* (Lith. *spenỹs*, OPruss. *spenis*), one might expect the outcome of PIE **bzd-* to have been similar (Proto-Baltic **zb-*?). It is imaginable, of course, that PIE **bzd-* > **bizd-* in Proto-Baltic-Slavic, thereby making this sequence indirectly attested.

> On the other hand, the PIE word for 'comb', **pek̂-ten-* (Lat. *pecten*), a derivative of **pek̂-* 'comb' (Gk. πέκς, Lith. *pešù* 'pluck, pull at the hair'), is frequently reconstructed as beginning with a tripartite onset **pk̂t-*: PIE **pk̂ten-* > Gk. κτείς, κτενός 'comb'.[38] However, this reconstruction is highly unlikely for two reasons. First, if **pk̂t-* had been a legal PIE onset, it would be the only onset of the shape *PPP- reconstructable. Second, the cluster **pk̂t-* is not directly or indirectly attested in any IE language: there exists no attested ***pten-*, ***pk̂en-* or ***pək̂ten-* in another language alongside Gk. κτεν-.

Let us now summarize the discussion thus far. Directly attested sounds and sound sequences (type 1) are indisputable, and it would be inadvisable to dismiss indirectly attested ones (type 2) as well. However, due to the frequently subjective and uncertain status of those of type 3, we should reconstruct those sound sequences only if they are extremely similar in shape to those of type 1 and 2, which I have labelled type 3a.[39] We may now rank these types in order of plausibility, from most plausible to least: **Type 1** (**tréi̯es*) >> **Type 2** (**h₂ner-*) >> **Type 3a** (**kʷspent-*) >> **Type 3b** (**pk̂ten-*). For a complete list of reconstructed word-initial and word-final consonant clusters, I refer the reader to Appendix B.

1.2.3 *Phonological Processes*

So far we have examined the surface and underlying levels in PIE and defined the inventories of each. But we also need to be aware of those (morpho-)phonological rules reconstructable for the proto-language that produce the allophonic variation discussed above. While numerous, it may be useful for the reader to have a complete list of the processes assumed here. Note that for each instance one may reconstruct an underlying form (before any phonological rules are applied), possible intermediate form(s) within the derivation, and a surface form which was uttered by PIE speakers. Rules are organized according to the natural class of the segment(s) affected.

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38 Mayrhofer 1986:117. The derivation of Pashto *ẓ̌manj* 'comb' from **fšančī* (Morgenstierne 1929:199) is not assured; see Charpentier (1929:197) for an alternative explanation.

39 By 'extremely similar', I mean that all features are identical save one minor difference, such as a difference in voicing and in place. For example, I find the reconstruction of **kʷspent-* 'night' and **bzd-* 'fart softly' as fairly plausible, as there exists only one difference in place and voicing with the reconstructable onset **pst-*. However, we must tread carefully here, as the onset *ˣmzd-*, which differs in one feature with **bzd-* ([-nasal] → [+nasal]) is clearly impossible.

1.2.3.1 Rules Targeting Vowels

(5) Vowel Contraction

The long mid vowels **ē* and **ō* may be derived through the contraction of adjacent vowels to resolve hiatus: */V_1/ + */V_2/ → *[$\bar{V}_1$]. It appears that the quality of the first vowel is preferred over that of the second: **-ōs* 'anim. o-stem nom. pl.' ← */-o-es/ and **-ēti* '3rd sg. them. subj.' ← */-e-eti/. Onsetless syllables were highly marked in PIE (Mayrhofer 1986:123–4[108]), and thus it is likely that vowel contraction resolved hiatus to avoid such marked sequences.

(6) The **kʷetu̯óres* Rule (Rix 1985)

For those working within the paradigmatic approach (see 1.3 below), at least one phonological rule of accent retraction needs to be reconstructed for PIE: */-é C_0 o-/ → *[-e C_0 ó-] / # C_0 __ C_0 V (C_0) #. As Rix (ibid.) discusses, this rule accounts for why expected PIE *ˣkʷétu̯ores*, *ˣsu̯ésores*, and *ˣh₂áu̯sosm̥* surface as **kʷetu̯óres* 'four (nom.pl.)' (Ved. *catvā́raḥ*), **su̯esóres* 'sisters (nom.pl.)' (Ved. *svasā́raḥ*), and **h₂au̯sósm̥* 'dawn (acc.sg.)' (Ved. *uṣā́sam*), respectively.

(7) Monosyllabic Lengthening (Kapovič 2006)

As will be discussed at length in chapter 3, it is likely that a minimal-word requirement was imposed in PIE, demanding that any stress-bearing (i.e., lexical) word contain at least two morae (McCarthy and Prince 1986). This requirement lengthened prosodically short monosyllabic words: V → Vː / # (C_0) __ (C) #. While there are indeed exceptions to this rule (cf. PIE **só* 'this', not *ˣsṓ*) which may be explained by the loss of this rule as a productive process within the daughter languages (see Sandell & Byrd, in preparation for further discussion), Kapovič 2006 argues that the short/long vowel alternations reconstructible for pairs such as **nu* : **nū* 'now' (Gk. νυ: Skt. *nū́*), **ne* : **nē* (OCS *ne* : Lat. *nē*) 'not', and **tu* : *tū* 'you (sg.)' (Latv. *tu* : OE *þū*) may be explained in this way, with lengthening occurring in stressed variants.

1.2.3.2 Rules Targeting Resonants

(8) Resonant Syllabification (Schindler 1977b)

In certain phonological environments (which will be discussed in further detail in chapter 3 and elsewhere) underlying non-syllabic liquids (*/r, l/), nasals (*/m, n/), and glides (*/i̯, u̯/) were realized as syllabic in

PIE. By 'syllabic' I simply mean that these resonants were parsed as the syllable peak in the nucleus. Syllabic liquids and nasals will be marked by the traditional mark of syllabification in IE studies, a circle under the consonant (*r̥, *l̥, *m̥, *n̥), while syllabic glides (*/i̯, u̯/) will be written as their respective high vowel (*i, *u).

(9) The Asno Law (Schmidt 1895)
The nasal sequence */-mn-/ simplified in word-medial position to a single nasal after long vowels, diphthongs, and sequences of short vowel plus consonant (i.e., tautosyllabic */-mn-/). There are two outcomes to this simplification, depending on placement of accent:
a. */n/ → ∅ / $_{\sigma}$[m __ V́-
b. */m/ → ∅ / $_{\sigma}$[__ n V-.

It is for this reason that */m/ is lost in */h_2éḱmnes/ → *h_2áḱnes 'anvil (gen.sg.)' (Skt. *áśnaḥ*, Av. *asnō*), but */n/ in */g^{whe}/ormnós/ → *g^{whe}/ormós 'warm' (Lat. *formus*, Skt. *gharmá-*, Arm. *ǰerm*, and Gk. θερμός). Note that the sequence */-mn-/ was maintained after short vowels, as here the sequence in question was heterosyllabic: Gk. πρύμνος 'prominent', Hitt. *šaramna-* 'fore'. Nasal loss also occurred in **tosi̯o* 'this (gen.sg.)' (← */tosmi̯o-/) and related forms, though it is unclear exactly how these two processes were connected, if at all.[40]

(10) Stang's Law (Mayrhofer 1986: 163–4)
Word-final sequences consisting of */u̯/, */h_2/, or */m/ + */m/ defied the expected syllabification rules (see 2.4) and were instead simplified via deletion of the initial segment of the cluster, with compensatory lengthening (CL) of the preceding vowel; */di̯éu̯m/ → **di̯ḗm* (Skt. *dyā́m*, Ζήν), */-ah_2m/→ **-ām* (Skt. **-ām*), */dom-m/ → **dṓm* 'house (acc.sg.)' (Arm. *tun*).

(11) Szemerényi's Law (Szemerényi 1962)
Another rule, which was no longer productive in late PIE, deleted word-final fricatives (specifically */s/ and */h_2/) in the sequence *VRF]$_{\omega}$, with CL: */p$h_2$térs/ → **p(əh_2)tḗr* 'father (nom.sg.)' (Gk. πατήρ). As discussed in Sandell & Byrd, in preparation, it is likely that this process more broadly affected any syllable-final sequence ending in a consonant

40 This rule is discussed in the context of Tocharian in Hackstein 2005:178ff.; for Anatolian, see Eichner 2013 and Oettinger 2014:56.

plus fricative (*VCF]$_\sigma$), thereby accounting for the long vocalism in forms such as **u̯ṓkʷs* 'voice (nom.sg.)' (← **u̯ṓgʷ* < */u̯ókʷs/) and loss of laryngeal in securely reconstructable etyma such as **u̯erdʰh₁o-* 'word' (← */u̯erh₁dʰh₁o-/).

(12) Post *[ō] /n/-Deletion (Mayrhofer 1986:159)
In word-final position PIE */n/ was lost, though only after *[ō]; cf. */k̂u̯ṓn/ → *[k̂u̯ṓ] 'dog (nom.sg.)' (Ved. *ś(u)vā́*, OIr. *cú*). Gk. κύων has restored the **-n* by analogy to other forms in the paradigm.

(13) Schwebeablaut (Anttila 1969)
Literally 'hovering vowel alternation', Schwebeablaut occurs when a resonant metathesizes from coda to onset position within a root (or vice versa): */CeRC-/ → **CReC-* or */CReC-/ → **CeRC-*. For a classic example note the alternation between **h₂au̯g-* 'grow, become strong' (Skt. *ójīyas-*, Lat. *augeō*, Goth. *aukan*) and **h₂u̯eks-* (Ved. *vakṣáyati*, Gk. ἀϝέξω, Eng. *wax*). It will be claimed in chapter 5 that instances of Schwebeablaut such as **h₂au̯g-* ~ **h₂u̯eks-* are driven by the avoidance of superheavy (or overlong) syllables.

(14) Sievers' Law (Schindler 1977b, Barber 2013)
A process of high vowel epenthesis altered word-medial sequences of consonant plus glide, when following either a long vowel or a short vowel plus consonant: [+sonorant, -syllabic, +high] → [+syllabic] / VXC __ V, where X = V, C. The best examples come from Sanskrit and Gothic; cf. */mert-i̯o-/ → **mertii̯o-* 'mortal' (> Ved. *mártiya-*) and */k̂erdʰ-i̯o-/ → **k̂erdʰii̯o-* (> Goth. *hairdeis* 'herdsman'). Sievers' Law will be the focus of chapter 5.

(15) Lindeman's Law (Lindeman 1965)
The epenthesis of *any* syllabic resonant (not only high vowels) may optionally occur in certain monosyllabic words with complex onsets of the shape consonant plus resonant: ∅ → *[R̥₁] / # C __ R₁ V (C₀) #. There are quite a few secure examples: */du̯óh₁/ → **duu̯óh₁* 'two' (Skt. *dvā* beside Lat. *duō*, Gk. δύω), */di̯ḗu̯s/ → **dii̯ḗu̯s* 'sky' (Gk. Ζεύς, Ved. *d(i)yáuḥ*), */krṓn/ → *kr̥rṓ 'piece of meat' (Lat. *carō*), */slei̯-/ → *sl̥lei̯- (Lat. *salīva*), */dʰĝʰmṓn/ → **ĝʰm̥mṓ* 'earthling' (Lat. *homō*), and */gʷnéh₂/ → **gʷn̥néh₂* (Boeotian Gk. βανά). This law is typically connected with Sievers' Law (Schindler 1977a), though we will discover in chapter 5 that this equation is unlikely to be true.

1.2.3.3 Rules Targeting Obstruents

(16) Laryngeal Feature Assimilation (Mayrhofer 1986:110)[41]
In PIE, laryngeal features (voicing and aspiration) were licensed (and therefore contrastive) before only vowels, resonants, and perhaps laryngeals. If an underlying voiced or voiced aspirate obstruent precedes another obstruent, it assimilates its laryngeal features to the following consonant. Examples include: */ni-sd-ós/ 'nest' → PIE **nizdós* (Skt. *nīḍá-*, Lat. *nīdus*, Eng. *nest*); */neg^{w}-/ 'become dark' (LIV 449) + */-t-/ + */-s/ → **nék^{w}ts* 'evening (gen.sg.)'; */nig^{w}-/ 'wash' + */-tó-/ → **nik^{w}tó-* > Skt. *niktá-* 'washed', Gk. ἄ-νιπτος 'unwashed'; */u̯eĝ^{h}-/ + */-s-/ → **u̯ek̂s-* (Skt. *vakṣ-*, Cyp. *éwekse* 'brought', Lat. *vēxī* 'I carried').[42]

(17) Final Voicing (Meillet-Vendryes 1968:146ff., Melchert 1994:85)
In PIE, all final stops were realized as voiced in word-final position after a sonorant, as they are in Hittite and Old Latin.[43] Though at first glance typologically bizarre, such a process is not entirely unheard of cross-linguistically: see Yu 2004 for synchronic and diachronic discussion of the same phenomenon in Lezgian, a Nakh-Daghestanian language. Examples include PIE */b^{h}eret/ → *[b^{h}ered] 'carried (3sg. impfct)' and PIE */ad/ → *[ad] 'at'.

(18) The Double Dental Rule (Mayrhofer 1986:110–11; Hill 2003:3–7)
In PIE, when two adjacent dental stops immediately preceded a vowel, an *[s] was inserted between the two: ∅ → [s] / T __ T V. Cf. */u̯id-tó-/ 'seen, known' → **u̯itsto-* (> Germ. *ge-wiss* 'certain', Gk. ἄ-ϊστος 'unknown', etc.); */h$_1$ĕ̄d-ti/ 'eats' → **h$_1$ĕ̄tsti* (> Hitt. *ēzzazzi* /ētstsi/, Welsh *ys*, etc.)

(19) The *métron* Rule (Saussure 1885:246ff.; Mayrhofer 1986:111)
In PIE, when two adjacent dental stops were followed by a resonant, one dental was deleted with no compensatory lengthening: */T/ → ∅ / V T __ R V or V __ T R V. The attested evidence presents a conflicting picture of which dental was lost and whether voicing assimilation preceded

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41 While technically obstruents, laryngeal-specific rules will be treated in isolation in section 1.2.3.4 below.

42 Thus, I will not assume that Bartholomae's Law applied within PIE, though its status will not affect any of the matters discussed here.

43 As argued in Sandell & Byrd, in preparation, it is likely that this rule targeted word-final fricatives as well.

or followed the loss of dental. For example, PGmc. **setlo-*,[44] Lat. *sella* and Gaul. *sedlon*, all require that **-t-* of the suffix was lost with the preceding stop having undergone no voicing assimilation: PIE */sed-tlo-/ 'instrument of sitting' > **sedlo-*.[45] On the other hand, Gk. μέτρον 'measure' (< PIE **métro-* < PIE */méd-tro-/ 'instrument of measuring'),[46] Skt. *átra-* 'nourishment' (< */$h_1$ed-tro-/) and PGmc. **χerϑra-* 'entrails, heart' (< */k̂erd-tro-/)[47] imply the opposite.

(20) Geminate */ss/ Simplification (Mayrhofer 1986:120–1)
In PIE, when two /s/ were adjacent and immediately preceded a vowel, one /s/ was deleted with no compensatory lengthening: */s/ → ∅ / V __ sV.[48] Examples include: */$h_1$és-si/ 'you are' → **$h_1$ési* (Skt. *ási*, Gk. εἶ, etc.), */$h_2$us-s-és/ 'dawn (gen.sg.)' → (Skt. *uṣás*), */$h_2$us-s-ih_1/ 'ear (nom. du.)' → **$h_2$usih_1* (Av. *uši*).[49] Degemination occurred word-finally as well, possibly with CL: */$h_2$éu̯soss/ 'dawn (nom.sg.)' → **$h_2$áu̯sōs* (Gk. ἠώς, Ved. *uṣā́s*).[50]

(21) Schwa Secundum (Mayrhofer 1986:175–7)
Schwa was inserted in the word-initial sequence stop + stop + resonant (where R ≠ */i̯/; cf. **ĝʰ(z)dʰi̯és* 'yesterday'): *∅ → ə / # (s) P __ P R. Excellent examples include */kʷtu̯or-/ → **kʷətu̯or-* 'four' (Lat. *quattuor*, Aeol. Gk. πίσυρες), */ptneh_2-/ 'spread out' → **pətnah_2-* (Lat. *pandō*, Osc. **patensíns** 'aperirent', Gk. πίτνημι), and */sk̂dnh_2-/ → **sk̂ədn̥h_2-* (TB *katnaṃ*, TA *knāṣ*, and Gk. σκίδναμαι).[51]

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44 Goth. *sitls* 'bench', OE *setl*, OHG *sezzal*.

45 Olsen 1988: 13. Skt. *sattra-* 'sacrifice with 12 or more pressing days in the Soma cult' and Av. *hastra-* 'a gathering where the sacrifice hymns were recited' (< **sed-tló-*) must be considered as secondary formations. As an anonymous reviewer reminds me, one cannot with absolute certainty rule out a **-lo-* formation in our reconstruction of PIE **sedlo-*.

46 If not from */méh_1-tro-/ with loss of **h_1* by the 'Weather Rule'; see Peters 1999, Neri 2011.

47 Feist 1939:235; Olsen 1988:21. Cf. Goth. *hairþram* 'entrails, heart', OHG *herdar* 'entrails', OE *hreþer* 'breast, stomach, heart'; cf. Lith. *kartóklys* 'omasum'.

48 Mayrhofer 1986:120–1. A similar reduction also occurred in certain Greek dialects; cf. PIE */pod-sú/ 'feet (dat.pl.)' → **potsú* > Proto-Gk. **possú* → Attic Gk. ποσί, not ˣπουσί or ˣπωσί.

49 Nussbaum 1986:132. Cf. OCS *uxo* (nom.sg.), *ušese* (gen.sg.) < **$h_2$us-es-* (IEW 785).

50 While it is conceivable that PIE **$h_2$áu̯sōs* derived from a collective plural */$h_2$éu̯s-os-h_2/ (as suggested by an anonymous reviewer), it is more likely an instance of */ss/ simplification, given that **$h_2$áu̯sōs* is restructable as an animate noun.

51 Vine 1999.

(22) Thorn Clusters (Schindler 1977a)
The segment known as thorn (*/þ/) in earlier literature was actually not a fricative at all, but rather a complex consonant cluster of underlying dental plus dorsal. There are two rules pertinent to thorn clusters.

a. Thorn Cluster Reduction
Thorn clusters were simplified when preceding a syllabic nasal: */T/ → ∅ / # __ K N̥-. This reduction makes good phonological sense, as nasals are not as sonorous as vowels (or syllabic liquids) and therefore would be less likely to be able to license multiple obstruents in an onset. The classic example is found within the paradigm of the word for 'earth': nom.sg. **dʰ(e)ĝʰōm* (Hitt. *tekan*, Gk. χθών), oblique **dʰəĝʰm-* (Hitt. *taknaš*), with schwa secundum in the sequence #/PPR-/, and oblique **ĝʰm̥m-* (Lat. *humus*, Gk. χαμαί), a Lindeman variant, with deletion in the sequence #[PPR̥-]. For an additional example, cf. **k̂m̥tóm* '100', from */dk̂mtóm/, a derivative of **dék̂m̥* '10'.

b. Thorn Cluster Epenthesis
It appears that *[s] was epenthesized in the tautosyllabic sequence dental stop plus dorsal stop. As noted above, according to some scholars this is not an instance of epenthesis, rather affrication (*[t͡s]; thus *$[\text{h}_2\text{ar}]_\sigma$ $[\widehat{\text{ts}}\text{kos}]_\sigma$), though I prefer to parse **$h_2$artskos* as *$[\text{h}_2\text{art}]_\sigma[\text{skos}]_\sigma$ (whence OIr. *art*, Ved. *ŕ̥kṣas* 'bear', with later analogical replacement of the initial syllable in the latter from).

(23) The *boukólos* Rule (Weiss 1995)
Segments with the features [+round, +high, -consonantal] (*[u, u̯]) triggered the derounding of an immediately adjacent labiovelar in PIE: */Kʷ/ → [-round] / u __. The most secure examples may be seen in the compound */gʷou̯kʷólos/ → **gʷou̯kólos* (OIr. *búachaill*, Gk. βουκόλος) and the syntagm */(ne) $\text{h}_2$ói̯u̯ kʷid/ → **(ne) $h_2$ói̯u kid* '(not) on your life' (Gk. οὐ[κί], Arm. *očʼ* 'not').[52]

(24) Post Rhotic d-Deletion
There is at least one reconstructable example of the loss of */d/ after */r/ with CL of the preceding vowel, as seen in */k̂érd/ 'heart' → **k̂ḗr* (Gk. κῆρ, Hitt. *ker*). It is unclear if this deletion was lexically restricted or should be

52 Cowgill 1960. See however, Clackson (2005:155–6), who views *očʼ* as an inner-Armenian innovation deriving ultimately from the pronoun *o-* plus *čʼ*, originally meaning 'no one'.

considered to be symptomatic of a broader phonological process, such as Szemerényi's Law.

1.2.3.4 Rules Targeting Laryngeals

(25) Laryngeal Coloring (Mayrhofer 1986:132, 142)
If *h_2* or *h_3* stood adjacent to tautomorphemic **e*, that **e* was colored to **a* and **o*, respectively. Thus, */$h_2$ek̂ros/ → *$h_2$ak̂ros* 'sharp' (Gk. ἄκρος, OIr. *ér* 'high, nobel', OLith. *aš̌ras* 'sharp') 'at the top, end, edge';[53] */deh_3-/ 'give' → **doh_3*- (Gk. δίδωσι 'gives', Lat. *dōnum* 'gift').[54]

(26) Laryngeal Metathesis (Mayrhofer 1986:174–5)
The sequence */#CHU-/ regularly metathesized to *[#CUH-] in PIE. For example, the zero-grade of the well-attested root 'drink', **peh$_3$i̯*- is realized as **pih$_3$-tó*-, with metathesis from original **ph$_3$i-tó*-. This metathesis is assured by the consistently long vowel found throughout the IE languages: Skt. *pītá*- 'having (been) drunk', OCS *pitъ* 'drank' (< **pih$_3$-tó*-) and Att. *pĩtʰi* 'drink!' (< **pih$_3$-dʰi*). This rule will be further discussed in section 3.3.2.

(27) Lex Schmidt-Hackstein (Schmidt 1973, Hackstein 2002)
In word-medial position, a laryngeal was lost in second position of a sequence of four consonants: */h_x/ → ∅ / C __ C C. Cf. */dʰu̯g$h_2$trés/ → **dʰuktrés* 'daughter (gen.sg.)' > NPers. *duxtar*-, Arm. *dster*. This rule will be discussed extensively in chapter 3.

(28) Pinault's Law (Pinault 1982)
In word-medial position, a laryngeal was lost following a consonant and preceding **i̯*: */h_x/ → ∅ / C __ i̯-. Unquestionably the best example may be seen in */sokʷh_2-i̯o-/ → **sokʷi̯o*- 'friend' > Lat. *socius*, cf. Skt. *sakhi-/-āy*- 'friendship', Gk. *ἄοσσος (base of *ἀοσσέω 'I help'), PGmc. **sagjaz* 'friend' (OE *secg*). As we shall see in chapter 6, it is likely that Pinault's Law only targeted */h_2/ and */h_3/.

53 NIL 288.

54 Mayrhofer 1986:101.

(29) The Saussure Effect (Saussure 1905, Nussbaum 1997)[55]

In PIE, a laryngeal was lost adjacent to a tautosyllabic resonant plus */o/: $^*/\mathrm{h}_x/ \rightarrow \varnothing / \left\{\begin{matrix} \$ \_\_ R\ o \\ o\ R \_\_ \$ \end{matrix}\right\}$. Excellent examples include */solh₂-u̯o-/ → **solu̯o-* 'all' (Skt. *sarva-*, Gk. ὅλος, Lat. *sollus*) and */h₃moi̯ĝʰó-/ → **moi̯ĝʰó-* 'urinater' (Gk. μοιχός 'adulteror'; for underlying laryngeal, cf. Gk. ὀμείχω, Lat. *meiō*, Ved. *méhati* 'urinate'). Pronk 2011 and van Beek 2011 have argued against the SE as a PIE process, claiming it to have been a phonetically impossible rule, though both Weiss 2012 and Byrd 2013 have independently suggested that the interaction of the low and back features of */o/ and $^*/\mathrm{h}_x/$ triggered deletion.

(30) The Weather Rule (Peters 1999:447, Neri 2011)

In word-medial position, a laryngeal was lost before the sequence stop plus resonant plus vowel: $^*h_x \rightarrow \varnothing / \_\_$ TRV. Cf. PIE */u̯eh$_1$d$^{\mathrm{h}}$rom/ → **u̯edʰrom* 'weather'> OCS *vedro*, Eng. *weather*.

(31) Dybo's Law (Zair 2006)

In the western Indo-European languages, it appears that a laryngeal was lost before an accented syllable beginning in a resonant: $^*/\mathrm{h}_x/ \rightarrow \varnothing$ / V __ RV́. Cf. */u̯i̯h$_1$-ró-/ → **u̯iró-* 'hero, man' > Lat. *vir*, OIr. *fer*, Goth. *wair* but **u̯ih$_1$ró-* > Ved. *vīrá-*, Lith. *výras*. It is unlikely that this process existed within PIE.

(32) Kuiper's Law (Weiss 2009:115)

In absolute utterance-final position (i.e., right before a pause), laryngeals were lost in word-final position without CL: $^*h_x \rightarrow \varnothing$ / V __ # (in pausa). Cf. Gk. νύμφα (voc.sg.) < **-ah$_2$* (ˣνύμφη), Ved. *indrā-varuṇa* < **-aH* (ˣ*indrā-varuṇā*).

(33) The *neognós* Rule (Beekes 1969:242ff., Schrijver 1991:328–30, Mayrhofer 2005:99–101, Weiss 2009:113)

In certain compounds and reduplicated formations, a laryngeal was lost in the zero-grade of */CVRH/ roots; cf. */neu̯o-ĝnh$_1$-o-/ → **neu̯oĝno-* 'newborn' (ˣneu̯oĝn̥h$_1$o-) > Gk. νεογνός; cf. Lat. *prīvignus* 'stepson'. Steer (2012), basing himself on Fritz 1996, identifies this process as the simplification of a word-medial onset sequence $^*{}_\sigma$[RH-: *[ne]$_\sigma$[u̯oĝ]$_\sigma$[nh$_1$o-]σ → *[ne]$_\sigma$[u̯oĝ]$_\sigma$[no-]$_\sigma$. While ingenious, I find his analysis questionable,

55 See also Rasmussen 1989:175ff. and Hackstein 1995:25–7.

as there is no good reason for *RH to have ever been parsed as a tautosyllabic onset in the first place.

(34) Laryngeal 'Vocalization'[56]
A few more words must be said regarding the concept of laryngeal 'vocalization', or the pronunciation of a laryngeal when occurring between two consonants. As alluded to in section 1.2.1.2 above, the precise meaning of 'vocalization' is by no means universally agreed upon, with scholars falling into one of two camps:

a. Direct Vocalization: */$d^h h_1$tó-/ → *[$d^h \mathring{h}_1$]$_\sigma$[tó-]$_\sigma$ 'placed'
b. Vowel Epenthesis: */$d^h h_1$tó-/ → *[d^həh_1]$_\sigma$[tó-]$_\sigma$ 'placed'

The first hypothesis, which claims that interconsonantal laryngeals were directly syllabified as the syllable nucleus, is certainly a reasonable one, given the many parallels in Salishan and Caucasian languages and the fact that the PIE resonants behave in a similar fashion (cf. */tntós/ → *[tn̥tós] 'stretched'). However, many Indo-Europeanists prefer to view laryngeal 'vocalization' as vowel epenthesis on account of certain cases of stop aspiration by *h_2 within Indo-Iranian; one need only cite the pair */p$h_2$tr-/ > *pitár-* (with unaspirated /p/) and */d^hug$h_2$ter-/ > *duhitár-* (with /h/ from earlier *-ǰʰ-). This latter approach is the most common one, taken most notably by Mayrhofer (1986:138).

> In virtuellen ersten Silben entstand ein überkurzer Sproßvokal vor dem Laryngal ($_e$H), der indoiranisch zu /i/ führte, ohne vorangehende Verschlußlaute zu aspirieren ... In virtuellen Mittelsilben stand der Sproßvokal hinter dem Laryngal (H_e), woraus sich Behauchung und Vokalisierung im Vedischen und Prasun (*duhitár-*), nur Behauchung in Teilen des Iranischen (altavest. *dugədar-*), nur Vokalisierung in einem Teil der restlichen Sprachen ..., schießlich Schwund ... in den übrigen Sprachen ... ergab.

Thus, it is typically assumed that there was epenthesis of a reduced vowel adjacent to the laryngeal consonant, with the schwa being preposed before the laryngeal in initial syllables (PIE */p$h_2$trés/ 'father (gen.sg.)' → **pə$h_2$trés* > Lat. *patris*) but postposed elsewhere (PIE *d^hug$h_2$tér-* 'daughter' > PInd. **d^hug^{h}Hətár-* > **d^hug^{h}ətár-* > **d^huǰ^{h}itár-* > Ved.

56 The following is an abridged and slightly modified version of Byrd, forthcoming c.

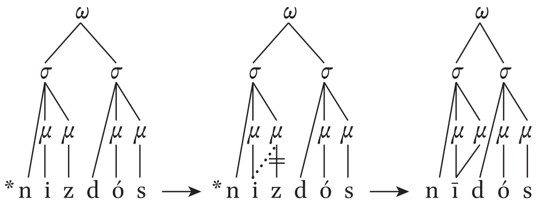
duhitár-; PIE *$*$méĝh$_2$* > PIIr. *$*$máj́^{h}Hə* > Ved. *máhi*).[57] However, recall the rules of consonant cluster reconstruction set forth in section 1.2.2 above. In all instances of purported laryngeal vocalization in absolute word-initial, word-medial, and word-final position, we are provided with indirect evidence of consonant clusters, given that some languages show laryngeal vocalization and others laryngeal deletion: *$*h_2$ner-* 'man' (Skt. *nara-* ~ Gk. ἀνήρ), *$*d^h$ugh$_2$ter-* 'daughter' (Lith. *duktė̃* ~ Gk. θυγάτηρ), *$*$meĝh$_2$* 'great' (Hitt. *mēk* ~ Gk. μέγα). And since the only reconstructable instances of laryngeal vocalization are to be found in word-initial interconsonantal sequences (such as */ph$_2$trés/ 'father (gen.sg.)'), then it must have been the case that schwa was only *preposed* in PIE, and all instances of postposed schwa occurred at a later date.

But a problem arises upon closer inspection. Why are forms with pre-laryngeal vowel epenthesis such as PIE *[pəh$_2$tér-] 'father'—with an "überkurzer Sproßvokal" that we may identify as *[ə]—invariably found in the daughter languages with a short vowel in the initial syllable, and not a long one? That is to say, if a vowel had been epenthesized before a laryngeal in */ph$_2$tr-/, then why does it produce *patris*, Skt. *pitúḥ* and not Lat. ^{x}*pātris*, Skt ^{x}*pītúḥ*? At first glance, such lack of compensatory lengthening (CL) appears to pose a problem for the vowel epenthesis hypothesis, arguing in favor of direct laryngeal vocalization. However, such a lack of CL in this configuration has well-grounded theoretical and phonetic motivations, with parallels across many languages and language families.

Compensatory lengthening (CL) may be defined as "the lengthening of a segment triggered by the deletion or shortening of a nearby segment" (Hayes 1989:260). While there are a number of types of CL (see Kavitskaya 2002), it most commonly occurs in the following scenario: a post-vocalic consonant is lost in the tautosyllabic sequence $VC(C_0)]_\sigma$, and upon deletion, the preceding vowel is lengthened: $VC(C_0)]_\sigma \rightarrow \bar{V}(C_0)]_\sigma$. Such a process is illustrated in the following well-known example: PIE /nisdós/ → *$[niz]_\sigma[dós]_\sigma$ >Lat. *nīdus*, Skt. *nīḍáḥ* 'nest'. Within the phonological literature (see Hayes 1989), CL is typically defined in terms of mora reassignment, with a mora (μ) defined as a unit of syllabic weight (Hayes 1989:254). Thus, after the loss of coda **z* in the change from PIE **nizdós* 'nest' to Lat. *nīdus*, the mora that was originally associated with **z* became linked to the preceding vowel, thereby creating a long vowel.

57 Cf. Mayrhofer 1986:138: For a plausible alternative to schwa epenthesis in Proto-Indic, see Kobayashi 2004:132–4.

(35) PIE **nizdos* 'nest' > Lat. *nīdus*



Of course, such a process requires the deleted consonant in question to have been moraic. But languages may in fact differ as to which types of segments can carry a mora in the coda: in Malayalam coda consonants never carry a mora, in Lithuanian only sonorants carry a mora, while in Latin all consonants carry a mora in the coda (Gordon 2006). If one were to posit that PIE had been a language like Malayalam or Lithuanian where obstruents were not moraic in coda position (cf. Cooper 2012), then compensatory lenthening in the sequence *-əh$_x$]$_\sigma$ would not be expected, as laryngeals would not have carried weight.

But this is unlikely for a variety of reasons. To begin with, the quantitative poetic meters of most ancient IE languages (Latin, Greek, Sanskrit, etc.) suggest that all consonants, not just resonants, were assigned a mora in coda position. Second, as we will learn in chapter 5, a grounded conception of Sievers' Law requires obstruents to have been moraic in PIE, as Sievers' Law was motivated by the avoidance of a superheavy syllable. And lastly and most crucially, there are a number of likely cases of obstruent consonant deletion reconstructable for PIE that exhibit compensatory lengthening.

(36) PIE Obstruent Deletion with CL
- a. Stang's Law:[58] */-eh$_2$m/ → *[-ām] > Skt. *sen-ām*, Gk. τῑμ-ήν, Lat. *puell-am*
- b. Szemerényi's Law:[59] */u̯ókʷ-s/ → *[u̯ṓgʷ] ⤳ *[u̯ṓkʷs] 'voice' > Av. *vāxš*, Lat. *vōx*
- c. Word-Final Degemination:[60] */h$_2$eu̯s-os-s/ → *[h$_2$usṓs] 'dawn (nom.sg.)' > Skt. *uṣā́s*

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58 Mayrhofer 1986:164.

59 Following the "broad" conception of Szemernyi's Law; see Sandell & Byrd, in preparation.

60 Szemerényi 1970:109. The lengthened vowel in the suffix of **h$_2$áu̯sōs* is often taken to be analogical to forms such as **dʰéĝʰōm* 'earth (nom.sg.)', but given that such simplifications may handle difficult-to-explain long vocalisms (such as */nás-s/ → *[nā́s] 'nose (nom.sg.)' and */u̯ís-s/ → *[u̯ī́s] 'poison (nom.sg.)'.), I believe this to be an unnecessary assumption.

d. Medial Cluster Simplification:[61] */té-tk̂-ti̯/ → *[tḗk̂ti] 'fashions' > Skt. *tā́ṣṭi*

e. Late/Post PIE Laryngeal Deletion:[62] *[dʰé$h_1$mn̥] > Gk. (ανά)-θημα 'offering'

I recognize that many of the processes listed above are not universally recognized, and it is not my intention to sway the reader one way or another on these matters—I simply refer the reader to the references cited. Fortunately, for our purposes processes (26a) and (26e) will suffice: it is clear that laryngeals were moraic in coda position within PIE and afterwards. And since a laryngeal would have carried a mora in the sequence *-ə$h_x]_\sigma$, CL is indeed expected.

Nevertheless, there are certain laryngeal loss rules reconstructable for PIE that exhibit no CL. Kuiper's Law (32), which deletes post-vocalic laryngeals in absolute utterance-final position (in pausa), Lex Schmidt-Hackstein (27), which deletes a word-medial laryngeal in the second position of four consonants, and the Weather Rule (30), whereby a word-medial laryngeal is lost before the sequence stop plus resonant plus vowel, all lead to no CL. But none of these cases provides an exact parallel to the sequence *-ə$h_x]_\sigma$: the sequence *-ə$h_x]_\sigma$ is never found in absolute utterance-final position, is not located in the sequence CH.CC, and does not obligatorily precede the sequence stop plus resonant. Of course, a form like *[pə$h_2$trés] 'father (gen.sg.)' may be collapsed into the Weather Rule, but other instances of schwa primum may not: */dʰ$h_1$só-/ → *[dʰə$h_1$só-] 'divine' > Gk. θεός, HLuv. *tasan-za* 'votive stele'. The precise reason for no CL continues to elude us.

Cross-linguistically, one also observes that CL tends not to apply in unstressed syllables: observe the loss of /ɹ/ in non-rhotic dialects within the name 'Herbert' → [həːbət], not ˣ[həːbəːt] or ˣ[həbəːt]. While it is likely that stress is somehow connected to our present problem, it cannot explain it entirely, since unstressed sequences of *-V$h_x]_\sigma$ produce CL after laryngeal loss.

(37) Compensatory Lengthening in Unstressed Syllables

a. *[gʷi$h_3]_\sigma$[u̯ó-$]_\sigma$ 'alive' > Ved. *jīvá-*, Lat. *vīvus*, etc.

b. *[bʰé$]_\sigma$[ro$h_2]_\sigma$ 'I carry' > Lat. *ferō*, Gk. φέρω, etc.

c. *[dʰu$h_2]_\sigma$[mó-$]_\sigma$ 'smoke' > Ved. *dhūmá-*, Lat. *fūmus*, etc.

61 Rix apud Harðarson 1993: 29 n. 12; cf. Kortlandt 2004. For a recent rebuttal of the existence of "Narten roots", see Melchert, forthcoming.

62 Fortson 2010:63.

To sum up, it seems exceedingly likely that laryngeals were moraic in coda position, and so laryngeal loss in the sequence *-ə$h_x]_\sigma$ should trigger CL. Since other phonological processes cannot be utilized to explain the problem at hand, we are led to conclude that there was something "special" about *[ə] that led to short vocalisms in the IE languages.

Indeed, this appears to be true. For cross-linguistically, there are four basic factors that determine the length of a vowel in a word: (1) vowel quality, (2) stress, (3) the number of syllables in a word, and (4) whether the vowel is found in an open or closed syllable. In all four of these regards, PIE *[ə] in the sequence *-ə$h_x]_\sigma$ comes out short:

a. The vowel [ə] is typically the shortest vowel of a vowel system,[63] if a language possesses a [ə] phoneme or allophone;
b. *[ə] is nearly always unstressed in PIE; aside from barytone vocatives of the type **pə́h₂ter* 'o father' (Gk. πάτερ), there are no securely reconstructable cases of accented vocalized laryngeal;
c. *[ə] is always found in the initial syllable of polysyllabic words (such as *[d^hə$h_1]_\sigma$[tós]$_\sigma$ 'placed'); and
d. *[ə] is always found in a closed syllable *[pə$h_2]_\sigma$[trés]$_\sigma$ 'father (gen.sg.)', *[d^hə$\hat{g}^h]_\sigma$[més]$_\sigma$ 'earth (gen.sg.)'.

Put together, these facts argue strongly in favor that PIE *[ə] was an extremely short vowel.

Such brevity holds ramifications for the PIE phonology. As Gordon (2006:45) notes, in many of the world's languages vowels must have some minimal duration in order to receive a mora. Mayrhofer was therefore on the right track in his assumption of an "überkurzer Sproßvokal"—PIE *[ə] was just too short to receive a mora. The assumption that *[ə] was a weightless vowel would directly explain the lack of CL in the sequence in the PIE sequence *-ə$h_x]_\sigma$, as weightless vowels are frequently invisible to phonological processes, including CL (Gordon 2006). One such example may be found in Sliammon [ɬáʔamɪn], a Central Coast Salish language spoken in British Columbia (Blake 2000), in which a short vowel is monomoraic, a long vowel or sequence of vowel plus consonant bimoraic, and [ə] non-moraic, consisting of a bare nucleus not associated with any mora. In Sliammon one of the functions that epenthetic schwa serves is to satisfy certain syllable structure constraints (such as

63 Cf. Flemming (2007): "The medial schwa vowels [in English (AMB)] ... average 64 ms ... By comparison, tense vowels can be as long as 300 ms in citation forms ... and are on the order of 150 ms in fluent speech".

*ComplexOnset); similarly, as we will later see in chapter 3, the purpose of PIE *[ə] was to fix unsyllabifiable sequences in addition to satisfying other highly ranked markedness constraints.[64] As evidenced by CL, coda consonants in Sliammon are moraic (Blake 2000:106ff.).

(38) Sliammon Compensatory Lengthening
   a. gaʔt'ᶿap → [gáːt'ᶿʌpʰ] 'drive, steer'
   b. tiʔta → [tíːtʌ] 'that one (gen.)'
   c. tih → [tíː] 'big'
   d. sə́ʔp'iqʷànθas → [sáʔp'ɛqʷàːθʌs] 'he hit me on the head'

Examples of consonant deletion following [ə] are quite rare in Sliammon, due to a lack of CL in unstressed syllables (Blake 2000:109) and a constraint blocking stressed [ə] in open syllables (Blake 2000:231). However, in sequences of [ə] + glide, we do find fusion of the two segments into a short vowel, which necessitates that [ə] be weightless (Blake 1992:37, 86).

(39) Sliammon Schwa Diphthong Monophthongization
   a. /ə + y/ → [i] : /səy-səy-say'/ → [sísisəy'] 'they're afraid'
   b. /ə + w/ → [u] : /təw-towmay'ə/ → [tútuumày'ə] 'west wind'

Kager (1990:248) describes a similar situation for Dutch, where (as in Sliammon) short vowels are monomoraic, long vowels and the sequence vowel plus consonant are bimoraic, and /ə/ is non-moraic. As expected, /ə/ is never lengthened via CL if a coda consonant is deleted (Booij 1995:139–40), unlike short vowels (cf. Booij 1995:148).

(40) Deletion of Coda /n/ in Dutch

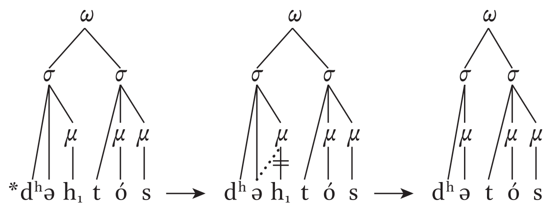
   a. open /opən/ 'open' → [opə]
   b. kuikentje /kœykən-tjə/ 'chicklet' → [kœykətjə]
   c. on-weer 'thunderstorm' /ɔn-ʋer/ → [ɔ̃ːʋer]
   d. on-zeker 'uncertain' /ɔn-zekər/ → [ɔ̃ːzekər]

As in Sliammon and Dutch, I propose that the PIE vowel system contained three types of syllable nuclei at the surface: monomoraic (*[i, e, a, o, u]), bimoraic

64 An anonymous reviewer reminds me that [ə] holds the same function in both classical and modern Armenian; cf. Vaux 1998:87–9.

(*[ī, ē, ā, ō, ū]), and non-moraic (*[ə]).[65] We may now return to the etymon cited above, */$\mathrm{d^hh_1}$tós/ 'placed', whose original moraic structure was *[*$\mathrm{d^hah_{1\mu}}$tó$_{\mu}$s$_{\mu}$] in PIE. At whatever point laryngeal loss occurred within the sequence *-əh$_x$]$_\sigma$ (be it within late PIE or in the IE daughter languages), the mora once linked to the laryngeal became associated with the preceding weightless vowel *[ə], resulting in a true, monomoraic vowel, *-ə$_\mu$. It is in this way that CL—or the transfer of a mora from one segment to another—does in fact occur.

(41) PIE *d^{h}əh$_1$tós* 'placed' > *d^{h}ə$_\mu$tós*



Monomoraic *[ə$_\mu$] later merges with other monomoraic vowels within the prehistory of each IE language family: Gk. ε, α, ο, IIr. *i*, elsewhere *a*. But what about schwa secundum, by which I mean *[ə] that was not immediately followed by a laryngeal in PIE? In all languages but one, this weightless *[ə] merged together with the inherited monomoraic schwa: Lat. *a* (*quattuor* 'four' < **kʷətu̯ṓr*), Hitt. *a* (*taknaš* 'earth (gen.sg.)' < **dʰəĝʰmés*), Toch. *a* (B *katnaṃ*, A *knāṣ* 'strew' < **kədnah$_2$-*). But in Greek, which is famously conservative in its vocalisms, a distinction is maintained. Monomoraic *[ə$_\mu$] merges with one of three non-high monomoraic vowels (ε, α, ο), while weightless *[ə] merges with /i/, one of the shortest vowels in its phonemic inventory, continuing its extremely brief pronunciation from PIE. This /i/ (< *[ə]) was likely maintained as the default epenthetic vowel in Proto-Greek, utilized in later inner-Greek formations such as ῥίζα 'root' (< **u̯ríd̯i̯ā*) and ἰπνός 'oven' (< **sipnós*).[66]

To conclude, we will follow the communis opinio in assuming that the process of PIE laryngeal vocalization involved the epenthesis of a non-moraic reduced vowel to facilitate the pronunciation of a laryngeal in a word-initial consonant cluster. Its "überkurze" pronunciation accounts for an apparent lack of CL in words such as Lat. *patris*, and allows us to view schwa primum

65 Though I have chosen to work within a framework that assumes moras, my hypothesis is entirely compatible with the ideas of Kavitskaya (2002), who proposes that compensatory lengthening directly results from the phonologization of vowel length upon segment deletion.

66 Vine 1999.

(laryngeal vocalization) and schwa secundum as identical phonological processes within PIE. As we will learn in chapter 3, the epenthesis of *[ə] was syllabically motivated.

1.3 Indo-European Accent and Ablaut

Scholars generally agree that PIE was a language with mobile pitch accent, continued to a greater or lesser extent by Vedic Sanskrit, Ancient Greek (both described by ancient grammarians), Proto-Germanic,[67] and Balto-Slavic.[68] The utilization of pitch-accent entails two basic properties of a language's accentual system (Hayes 2009: 292–3). First, pitch is phonemic, and therefore contrasts in pitch may result in minimal pairs: cf. the famous **tómh₁os* 'a cutting' (Gk. τόμος 'a cut, slice') vs. **tomh₁ós* 'sharp' (Gk. τόμος 'id.'). Second, only one syllable containing an ictus, or the word's accentual peak (Kiparsky, forthcoming), may surface per prosodic word; thus **bʰéreti* 'carries', not *ˣbʰéréti*. It is likely that a syllable receiving the ictus was phonetically prominent and carried a high pitch in PIE, very similar to the accentual properties of modern Swedish and Japanese. I follow Kiparsky (ibid.) in using the term 'accent' to refer to the underlying or derived accentual properties of a morpheme; the ictus occurs when an accented syllable is pronounced as such. Thus, there are two accents within the underlying form */k̂u̯ón-és/ 'dog (gen.sg.)', but only one ictus in the surface form *[k̂únes] 'dog (gen.sg.)' (Ved. *śúnaḥ*), realized solely in the first morpheme.

It is often the case that the placement of the ictus will shift between different members of a PIE word's paradigm, depending on the location of the underlying vowels which surface. To put it another way, whenever the vowels */e, o, ē, ō, a/ surface within a word, it is typically the case that the ictus falls upon them. It is in this way that accent is intimately connected with ablaut in PIE. Also known as vowel gradation or apophony, ablaut may be defined as the grammatical alternation of vowels in timbre (type) and length in PIE. The most basic series involved the interchange of **e*, **o*, and *∅, called *e*-(or full-) grade, *o*-grade, and ∅-grade, respectively, with the former two grades complemented by lengthened-grades, **ē* and **ō*. Each of these five grades may be reconstructed for different forms of the root **ped-* 'foot':[69]

67 Ringe 2006.

68 Illič-Svityč 1963 (1979).

69 Recall that adjacent obstruents will undergo laryngeal feature assimilation, with feature values spreading from the final obstruent. Thus, */pd-/ → **bd-*.

e-grade: **ped-* (PIE **péts* 'foot (gen.sg.)' > Lat. *ped-* 'foot')
o-grade: **pod-* (PIE **pódm̥* 'foot (acc.sg.)' > Gk. ποδ- 'foot')
∅-grade: **bd-* (PIE **bd-* 'foot (in compounds)' > Av. *fra-bd-əm* 'forefoot')
ē-grade: **pēd-* (PIE **pḗd(-su)* 'foot (loc.)' > OIr. *ís* 'beneath')
ō-grade: **pōd-* (PIE **pṓts* 'foot (nom.sg.)' > Goth. *fotus* 'foot')

Presumably, ablaut came into existence at an early stage of PIE through various phonological processes (cf. Kümmel 2012: 306ff.), most of which were lost as productive rules in late PIE. However, considering that a sizeable number of morphemes still alternate between full vocalism (**e*, **o*) and zero, it would be sensible to assume that late PIE had maintained a morphophonological rule of vowel syncope that targeted most (but not all) underlying vowels which do not surface in a stressed syllable. Consider the following forms:

a. */h$_1$és-ti̯/ → **h$_1$ésti* 'is' (Ved. *ásti* 'is')
b. */h$_1$és-énti̯/ → **h$_1$sénti* 'they are' (Ved. *sánti* 'they are')
c. */stḗu̯-énti̯/ → **stéu̯-n̥ti* (Ved. *stávati* 'they praise')

The reader will note two curious alternations between full-grade and zero-grade in the surface forms of the words cited above. First, though both **h$_1$ésti* 'is' and **h$_1$sénti* 'they are' start off with the same underlying root */h$_1$és-/ 'be', the root surfaces in different ways depending on the ending added. When combined with */-ti̯/ '(3rd sg primary ending)', an ending underlyingly in the zero grade,[70] the vocalism of the root surfaced, together with the ictus: **h$_1$ésti* 'is'. But when combined with */-énti̯/ '(3rd pl. primary)', the vocalism of the root is lost, as the underlying vocalism only surfaces in the first syllable of the ending, once again coinciding with the ictus. Note similar alternations between full grade and zero grade for the suffix */-énti̯/ '(3rd pl. primary)' in **h$_1$sénti* 'they are' and **stéu̯-n̥ti* as well.[71] Instead of assuming four underlying forms: */h$_1$és-/ 'be', */h$_1$s-/ 'be', */-énti̯/ '(3rd pl. primary)', */-nti̯/ '(3rd pl. primary)',[72]

70 Reconstructed as */-ti̯/ because this ending always surfaces in the zero-grade, hence the speakers would have internalized it as such.

71 As a Narten present, */stḗu̯-/ 'praise' is reconstructed with underlying lengthened *ē*-grade, which shortens to full grade in the weak forms.

72 Under the compositional approach (cf. Kiparsky, forthcoming), one would posit the following morphemes: */h$_1$es-/ 'be' (unaccented, resulting in a mobile paradigm), */stḗu̯-/ 'praise' (accented, resulting in a static paradigm), */-ti̯/ '(3rd sg primary ending)' (preaccenting), and */-énti̯/ '(3rd pl. primary)' (accented).

one may simply assume two (*/h$_1$és-/, */-énti̯/), with a single phonological rule of syncope deriving a full-grade morpheme to zero-grade. This is the most economical solution.

(42) Vowel Syncope (Preliminary)
$\breve{V} \rightarrow \varnothing$ / in certain morphological categories.
Short vowels were deleted in certain morphological categories in PIE.

However, the formulation proposed in (32) is unsatisfyingly vague. As it is currently formulated the indescript environment “in certain morphological categories” renders the rule’s intended phonological nature far from clear, lending it the appearance of a strictly morphological process, with no phonological triggers whatsoever. To make matters even worse, such a formulation cannot provide a straightforward explanation for why syncope occurred in certain cases (see above), yet did not in others, most puzzlingly in light syllables lacking the ictus; cf. */b^{h}ér-e-ti̯/ → *b^héreti* ‘carries’ (Gk. φέρει) and */h$_2$eu̯s-os-m/ → **h$_2$au̯sósm̥* ‘dawn (acc.sg.)’ (Gk. ἠόα, Ved. *uṣā́sam*).[73]

Over the course of the past century, scholars have posited a number of accent and ablaut patterns for the PIE athematic verb and noun. The most widely accepted view is that of the Erlangen School (Schindler 1972a, 1972b), also known as the paradigmatic approach (Kiparsky 2010), which proposes a finite set of paradigms for both lexical categories, in which accent and ablaut alternate within the root, stem, and affix of the strong and weak forms. For instance, four athematic[74] categories are typically reconstructed for the noun: acrostatic, proterokinetic, hysterokinetic, and amphikinetic. Each is defined according to which morpheme receives a vowel (vs. zero-grade), and in all cases but one (the suffix of the strong stem of the amphikinetic class) coincides with the ictus.

73 To top it off, as both Kiparsky (ibid.) and Keydana (2012) rightly point out, a rule that invokes the placement of ictus as the trigger of syncope cannot account for (and in fact, explicitly predicts against) a number of securely reconstructable instances of syllabic sonorants receiving the ictus; cf. */u̯ĺk^{w}os/ → **u̯ĺ̥k^{w}os* ‘wolf (nom.sg.)’, */kú̯rnos/ → **kúrnos* ‘foal, bastard (nom.sg.)’, and */septḿ/ → **septḿ̥* ‘seven’, among others. This problem will be directly addressed in chapter 4.

74 The terms ‘athematic’ and ‘thematic’ refer to the presence of the thematic vowel **e/o*, which is placed in between the stem and ending in certain words. For instance, the verb **h$_1$ésti* ‘is’ is an athematic verb since the ending *-*ti* is directly added to the root **h$_1$es-*, while **b^{h}éreti* ‘carries’ is a thematic verb, with an *-*e-* inserted between the root **b^{h}er-* and ending. By and large thematic formations do not exhibit paradigmatic ablaut.

(43) PIE Athematic Nominal Classes

	Acrostatic			Proterokinetic			Hysterokinetic			Amphikinetic		
Strong	ó	∅	∅	é	∅	∅	∅	é	∅	é	o	∅
Weak	é	∅	∅	∅	é	∅	∅	∅	é	∅	∅	é

Each type is classified according to the shape of the root, derivational suffix, and inflectional ending, in that order. For instance, PIE **u̯ódr̥* 'water' is reconstructed as an acrostatic noun, with *o*-grade in the root (**u̯ód-*), ∅-grade in the suffix (**r̥*) and ending (*∅) in the strong stems, and with *e*-grade in the root (**u̯éd-*), ∅-grade in the suffix (**-n-*) and ending in the weak stems; thus, **u̯ódr̥* (nom./acc.sg.) ~ **u̯édn̥s* (gen.sg.).[75]

However, due to a number of mismatches between the data attested in the daughter languages and the accent/ablaut classes reconstructed for PIE (see Kiparsky, forthcoming), as well as the inability to connect the paradigmatic approach with the extensive work done in theoretical linguistics, a number of scholars in recent times have questioned the views of the Erlangen School, favoring instead a "compositional" approach (Kiparsky 2010, forthcoming, Keydana 2012, Kim 2013). For the time being the compositional approach appears to have the upper hand, as it is more in line with modern morphophonological theory (and therefore more typologically plausible), explains seemingly unrelated phonological and morphological phenomena, and is falsifiable. For this reason I lean towards this latter approach, though the reader should note that the theories hypothesized within this monograph are compatible with both frameworks.

I will not dwell on all of the proposed features of the compositional approach here and will only focus on those aspects relevant to the rule of vowel syncope reconstructable for PIE.[76] Following Kiparsky, let us examine two nouns of nearly identical composition, which clearly underwent vowel syncope in certain members of the paradigm yet surface with the ictus on different syllables: */p$h_2$ter-/ 'father' and */b^{h}re$h_2$ter-/ 'brother'. Both are athematic nouns whose stems end in **-ter* (or perhaps **-$h_2$ter*, see Pinault 2006), with syncope

75 Generally speaking, the strong stem is found in the nominative, accusative, and vocative singular, the nominative plural, and the nominative, accusative, and vocative dual, the weak stem elsewhere.

76 For an extensive overview, see Kiparsky forthcoming.

occurring in the weak cases of the paradigm; cf. Skt. *pitár-am, pitrā́, pitṛ́ṣu* beside *bhrā́tar-am, bhrā́tr-ā, bhrā́tṛ-ṣu*. According to Kiparsky, the reason for the difference in placement of the ictus is that 'father' is underlyingly an unaccented root (*/ph$_2$ter-/) while 'brother' is underlyingly an accented one (*/b^{h}réh$_2$ter-/).[77] But if */ph$_2$ter-/ 'father' is underlyingly unaccented throughout its stem, how does the accent end up on the suffix in PIE **pəh$_2$térm̥*, **pəh$_2$tr̥su* (Skt. *pitár-am, pitṛ́ṣu*)? For this Kiparsky assumes a rule that assigns an accent to the final syllable of a polysyllabic stem (root + (optional) derivational suffix): */ph$_2$ter-m/ → *[pəh$_2$tér-m̥], */ph$_2$ter-sú/ → *[pəh$_2$tér-sú].

(44) Oxytone Rule
$\sigma \rightarrow \acute{\sigma}$ / $[\ldots\sigma]_{Stem}$ Infl
A final accent is assigned to all inflected polysyllabic stems.

At this point, vowel syncope occurs, targeting underlying unaccented AND accented short mid vowels that preceded:[78] *[pəh$_2$tér-sú] → *[pəh$_2$tŕ̥-sú], *[pəh$_2$tér-éh$_1$] → *[pəh$_2$tr-éh$_1$].[79] For Kiparsky vowel syncope is a non-cyclic process, meaning that multiple vowels are not triggered for deletion by the same accented morpheme: cf. Skt. /kar-tar-ā́/ → *kartrā́* 'by the creator', not ^{x}*kr̥trā́*.

(45) Vowel Syncope (Final)
/e, o/ → ∅ / __ Ḿ.
Short mid vowels are deleted before accented morphemes in PIE.

Finally, recall that in pitch-accent languages only one ictus may surface within a prosodic word, and so if we are to assume that multiple accents can be underlying or derived within a word's derivation, there must have been a rule in PIE that eliminated all accents but one—as well as a rule that inserted an accent

77 Though it may seem strange to some readers to assume that 'father' was underlyingly unaccented and 'brother' was underlyingly accented, such a situation is paralleled in numerous languages around the world, such as in certain dialects of Basque and Tokyo Japanese (Gussenhoven 2004).

78 As Kiparsky (ibid.) points out, pretonic syncope also occurs synchronically in Welsh. A substantial amount of scholarship assumes synchronic rules of syncope; see Kiparsky (ibid.).

79 Note the accentuation of **-tér-* by the OXYTONE RULE. The compositional approach concurs with our conclusion in section 34 above that laryngeal vocalization must have occurred in word initial *#Ch$_x$C- sequences—otherwise the sequence would have been monosyllabic, and therefore the OXYTONE RULE would not have targeted this form.

if there were no accents underlying or derived in the course of a word's derivation. Both functions are encapsulated by Kiparsky's BAP. Thus, *[pəh$_2$tŕ̥-sú] → *pəh$_2$tŕ̥su* (Skt. *pitŕ̥su*).

(46) Basic Accentuation Principle (BAP):
  a. The leftmost accented syllable of a domain retains the accent, all other accents are deleted.
  b. If there is no accented syllable in the word at the end of the derivation, place the ictus on the leftmost syllable.

Let us now examine these three processes together within the derivation of 'father' and 'brother' in the accusative singular, instrumental singular, and locative plural.[80]

(47) Accent & Ablaut Derivations: PIE 'father' and 'brother'

	***/ph$_2$ter-/**		
Inflection	pəh$_2$ter-m̥	pəh$_2$ter-éh$_1$	pəh$_2$ter-sú
Oxytone	pəh$_2$tér-m̥	pəh$_2$tér-éh$_1$	pəh$_2$tér-sú
∅-grade	—	pəh$_2$tr-éh$_1$	pəh$_2$tŕ̥-sú
BAP	—	—	pəh$_2$tŕ̥-su
(Sanskrit	*pitár-am*	*pitrā́*	*pitŕ̥su*)
	***/b^{h}réh$_2$ter-/**		
Inflection	b^{h}ráh$_2$ter-m̥	b^{h}ráh$_2$ter-éh$_1$	b^{h}ráh$_2$ter-sú
Oxytone	b^{h}ráh$_2$tér-m̥	b^{h}ráh$_2$tér-éh$_1$	b^{h}ráh$_2$tér-sú
∅-grade	—	b^{h}ráh$_2$tr-éh$_1$	b^{h}ráh$_2$tŕ̥-sú
BAP	b^{h}ráh$_2$ter-m̥	b^{h}ráh$_2$tr-eh$_1$	b^{h}ráh$_2$ter-sú
(Sanskrit	*bhrā́tar-am*	*bhrā́tr-ā*	*bhrā́tr̥-ṣu*)

80 Note that other phonological processes are assumed to occur at or to have occurred before the level of inflection, including syllabification, schwa epenthesis, and laryngeal coloring.

Once again, the process to focus on here is a reconstructable synchronic rule of ∅-grade: */$\mathrm{ph_2}$ter-é$\mathrm{h_1}$/ → *$pəh_2tréh_1$*, */$\mathrm{ph_2}$ter-sú/ → *$pəh_2$t*ŕ̥su*, */$\mathrm{b^h}$ré$\mathrm{h_2}$ter-é$\mathrm{h_1}$/ → *$b^hráh_2treh_1$*, */$\mathrm{b^h}$ré$\mathrm{h_2}$ter-sú/ → *$b^hráh_2$tr̥su*. This rule will take center stage in our analysis of exceptional resonant plus resonant syllabifications reconstructable for PIE in chapter 4.

CHAPTER 2

Phonological Theory & Past Views of the Indo-European Syllable

In the previous chapter we observed that PIE, like all languages, possessed a synchronic grammar, one which contained a finite number of phonemes and phonological rules.[1] This is the larger picture in which we will view each of our reconstructions and proposals within this monograph, ensuring that each abides by the system set forth in chapter 1. Thus, if we reconstruct a form with two adjacent obstruents, according to rule (16) those obstruents must agree in voicing and aspiration: *-pt- not ^{X}-$b^{h}t$-. If we reconstruct a word-initial sequence of two stops followed by a resonant (that is not *i̯), according to rule (21) that sequence must always exhibit epenthesis of schwa secundum in derived forms: *PəPR- not ^{X}PPR-. In short, throughout this work we will approach the analysis of late PIE from a synchronic standpoint, though always being mindful of diachronic residues and the possibility of multiple temporal layers. Within our synchronic analyses we will also continually strive to view PIE as a "real" language. While it is rarely the case that scholars treat PIE literally as an algebra problem, it is certainly true that not all scholarship in IE studies is mindful of (or even considers it important to be mindful of) this basic assumption. If all of the world's languages possess a certain property (such as syllables), then we should assume said property to exist in PIE, unless there is extraordinarily strong evidence to the contrary. On the other hand, if all of the world's languages lack a certain property (such as the ability to front single constituents within a coordinated structure),[2] then we should assume said property did not exist in PIE, unless there is extraordinarily strong evidence to the contrary. Our approach to the reconstruction of syllabification in PIE will therefore follow the well-accepted Uniformitarian Principle (Labov 1994:21).

1 See Byrd, forthcoming b for discussion of the structured approach to the reconstruction of sounds adopted here.

2 This would constitute a violation of the COORDINATE STRUCTURE CONSTRAINT. Thus, in the Eng. sentence "I spoke with John and Leroy." We may front the direct object to produce "John and Leroy, I spoke with", but *"John, I spoke with and Leroy" is strictly forbidden.

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(48) The Ramifications of the Uniformitarian Principle
Proposed sounds and sound sequences must follow absolute linguistic universals and should obey strong linguistic tendencies unless there is compelling evidence of the contrary.

2.1 Phonological Frameworks

The synchronic analyses presented in this book will alternate between rule-based generative phonology and the most widely used constraint-based phonological framework, Optimality Theory. The former framework (see Kenstowicz & Kisseberth 1979) will likely be familiar to most present-day scholars of Indo-European linguistics. Here underlying, phonological forms (denoted by //) transform into surface, phonetic forms (denoted by [] or italics) by undergoing one or more phonological processes within the derivation: /X/ → [Y] / A _ B. Indo-European scholars will perhaps be less familiar with Optimality Theory (OT). OT proposes that grammars arise from the interaction of conflicting constraints (Prince & Smolensky 1993) and formalizes the concept of 'conspiracies', or the triggering of one or more phonological rules by the avoidance of a single phonological structure.[3]

There are two basic types of constraints within OT: faithfulness constraints and markedness constraints. Faithfulness constraints require that the surface form (the output) be identical to the underlying form (the input) in some fashion. Markedness constraints place requirements on the structural well-formedness of the output. The interaction of these two types of constraints results in the winning candidate, or the most 'optimal' form. For example, let us assume two constraints as interacting within the grammars of German and English:[4]

(49) Sample Constraints
   a. *FinalVoice: No surface form may contain a final voiced obstruent. Assign one * for each instance.
   b. Ident(Voice): Corresponding input and output segments have identical values for the feature [voice]. Assign one * for every change.

3 Kisseberth 1970. For an introduction to Optimality Theory, see Kager 1999 and McCarthy 2008.

4 Note that within standard OT (Prince & Smolensky 1993) constraints are argued to be universal: all of the world's languages contain the same basic set of constraints (Zsiga 2013:310).

The first constraint, *FinalVoice, is a markedness constraint that blocks voiced obstruents from occurring in absolute word-final position in the surface form. The second constraint, Ident(Voice), is a faithfulness constraint, which requires that the voicing of the surface form be identical (faithful) to the underlying form.

The ranking of these two constraints differs in German and English. In German, it is more important to avoid word-final voiced obstruents in the output than it is to be faithful to the voicing of the input, hence the ranking *FinalVoice » Ident(Voice). On the other hand, in English it is more important to be faithful to the voicing of the input than it is to avoid word-final voiced obstruents, hence the ranking Ident(Voice) » *FinalVoice. This is illustrated in derivations of the word for 'hand' in German and English. Note that ☞ indicates a winning candidate, * a constraint violation, and ! follows a constraint violation that rules out a particular candidate as the most optimal.

(50) German and English 'hand'.

a. German:

/hand/	*FinalVoice	Ident(Voice)
a. [hand]	*!	
b. ☞ [hant]		*

b. English:

/hænd/	Ident(Voice)	*FinalVoice
a. ☞ [hænd]		*
b. [hænt]	*!	

2.1.1 *Relevance to IE Phonology*

Let us now apply the OT framework to a fairly well understood phenomenon in PIE, the avoidance of geminates.[5] This avoidance is reflected by a number of phonological processes either reconstructed for PIE or attested in one of the most archaic IE languages, Sanskrit. The advantage of utilizing an Optimality Theoretical framework in our reconstructions of PIE is that it provides us with tools that allow us to go beyond merely describing a process, by connecting specific phonological phenomena with the underlying tendencies of the PIE

5 Cf. Meillet 1903 (1934):131, Kent 1953:26, Mayrhofer 1986:110–2 & 120, Szemerényi 1996:109–10, Kobayashi 2004:38. For typological comparison see Itô 1988:139ff.

phonology as a whole. The reader will note that the majority of processes presented below are discussed in further detail in chapter 1.

a. ∅ → [s] / T_TV.[6]
In PIE, when two adjacent dental stops immediately preceded a vowel, an *[s] was inserted between the two. Cf. **u̯id-tó-* 'seen, known' → **u̯itsto-* (> Germ. *ge-wiss* 'certain', Gk. ἄ-ϊστος 'unknown', etc.); **h_1ĕ̄d-ti* 'eats' → **h_1ĕ̄tsti* (> Hitt. *ēzzazzi* /ētstsi/, Welsh *ys*, etc.)

b. *T → ∅ / VT_RV or V_TRV.[7]
In PIE, when two adjacent dental stops were followed by a sonorant, one dental was deleted with no compensatory lengthening. Cf. Gk. μέτρον 'measure' (< PIE **métro-* < PIE **méd-tro-* 'instrument of measuring').

c. *VR_1 → [V̄] / _R_1#.
In PIE, when two identical sonorants were adjacent at the end of a word, one sonorant was deleted with compensatory lengthening of the immediately preceding vowel. Cf. PIE **dṓm* 'house (acc.sg.)' < **dóm-m* (Gk. δῶ 'id.' < **dōm*), **dʰéĝʰōm* 'earth (acc.sg.)' < **dʰéĝʰom-m* (Schindler 1977b:31).

d. *R_1 → ∅ / V_R_1V.
In PIE, when two identical sonorants were adjacent and immediately preceded a vowel, one sonorant was deleted with no compensatory lengthening. Cf. **ném-mn̥* 'gift' > **ném-n̥* > OIr. *neim* 'poison' (Rasmussen 1999:647) and perhaps **stomh$_1$mn̥* > **stommn̥* > **stómn̥* > Gk. στόμα 'mouth' (Melchert (2007/2008) [2010]).

e. *Vs → [V̄] / _s#. (possibly)
In PIE, when two /s/ were adjacent at the end of a word, one /s/ was deleted with compensatory lengthening of the immediately preceding vowel. Cf. **h$_2$áu̯s-os-s* 'dawn (nom.sg.)' > **h$_2$áu̯sōs*, and perhaps also **mus-s* > **mūs* 'mouse (nom.sg.)' and **nas-s* > **nās* 'nose (nom.sg.)' (Szemerényi 1996:117; cf. IEW 755).

f. *s → ∅ /V_sV.[8]
In PIE, when two /s/ were adjacent and immediately preceded a vowel, one /s/ was deleted with no compensatory lengthening.[9] Cf. **h$_1$és-si* 'you are' > **h$_1$ési* (Skt. *ási*, Gk. εἶ, etc.).

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6 The "double dental rule". Mayrhofer 1986:110–11; Hill 2003:3–7.

7 The "*métron* rule". Saussure 1885:246ff.; Schindler apud Mayrhofer 1986:111.

8 Mayrhofer 1986:120–1.

9 Note that in each case of word-medial geminate simplification, no compensatory lengthening occurs.

g. Skt. /b/ → [d] / _b^h.
In Sanskrit, when a root-final labial stop preceded the instrumental plural case ending *-bhis*, that stop is realized as a dental. For instance, *ap-* 'water' + *-bhis* (instr.pl.) → *abbhis* → *adbhis*.

h. Skt. /s/ → [t] / _ + *-s-* (in certain morphological categories).
In Sanskrit, when a root-final /s/ preceded the /s/ suffix of the future and aorist, the /s/ of the root became a [t]. For example, *vas-* 'dress oneself' + *-sya-* (future) → *vat-sya-; vas-* 'id.' + *-s-* (aorist) → *a-vā́t-s-* (Narten 1964:239–240).[10]

Although each of the rules above differs in process, each is identical in its goal—to eliminate a sequence consisting of two of the same segment. We may hypothesize that an undominated constraint within the PIE grammar is the driving force behind each of the rules given: the OCP, or the avoidance of adjacent identical segments (McCarthy 1986).

(51) The Obligatory Contour Principle (OCP)
Two identical segments may not be adjacent to each other.[11]

The power of reconstructing the OCP for PIE is that this constraint allows us to explain each of the rules above as well as predict that heteromorphemic words such as **seh$_1$-h$_1$e*, **sek-kos* or **ser-ros* cannot occur in PIE, even though we currently have no evidence to prove this directly.

Cross-linguistically, it is very common for the OCP to be highly ranked in a language's grammar. For example, the OCP blocks geminate sequences in English, except across certain prosodic boundaries, such as in compounds like *penknife* [pɛn:aɪf] and heteromorphemic formations such as *solely* [sowl:i]. In PIE, we find the opposite situation. Whereas geminates were blocked across morpheme boundaries, tautomorphemic geminates were permitted in PIE:

10 Although processes (7) and (8) are not attested elsewhere in IE, the ban of heteromorphemic geminates is assured as a PIE phenomenon. Did PIE speakers utter forms, which were direct ancestors of the attested Skt. forms (**h$_2$adb^{h}is* 'waters (instr.pl)', **(e)u̯ḗtsm̥* 'I got dressed') or was there another repair strategy at work: **s*-epenthesis (**h$_2$abzb^{h}is*); deletion (**(e)u̯ḗsm̥*)?

11 More precisely formulated as: "At the melodic level, adjacent identical elements are prohibited" (McCarthy 1986:208).

**atta* 'daddy',[12] **kakka* 'poo-poo',[13] **akka* 'momma'[14] and **anna* 'momma'.[15] Meillet (1934:132) suggests that these cases of gemination show "valeur expressive", a feature he convincingly argues to be a pan-IE phenomenon.[16]

A number of scholars, beginning with Saussure (1885),[17] have contended that the avoidance of geminates in forms such as **u̯id-tó-* 'known', *méd-tro-* 'measurement' and **h₁és-si* 'you are' should be attributed to the fact that in PIE postvocalic consonants were pronounced ambisyllabically. Under this assumption, there actually was no deletion in words such as **méd-tro-*; rather, all words of the shape */VC_1C_2V/ were pronounced as *[$VC_1.C_1C_2V$]. The sequence **méttrom* was the same in pronunciation as **métrom*: both were realized as *[met.trom] with an ambisyllabic */t/.

This theory, however, creates more problems than it solves. First, it does not explain why we find deletion of a dental stop in words of the shape VTTRV (the *métron* rule) but not in the double dental rule, where there is **s*-epenthesis. Second, while the assumption of ambisyllabic consonants in PIE might explain the simplification of geminates in the *métron* rule, **h₁éssi* 'you are' and **némmn̥* 'gift', it does not demonstrate why there is geminate avoidance in other environments, such as the simplification of word-final geminates in **dómm* 'house (acc.sg.)' and **h₂áusoss* 'dawn (nom.sg.)'. Lastly, should we follow Saussure in assuming that postvocalic consonants were ambisyllabic in PIE, then underlying sequences of the shape *VC_1V and *VC_1C_1V would have been phonetically equal. Just as words of the shape */$VC_1C_1C_2V$/ must be reconstructed as *[VC_1C_2V] (*métro-, h₁etro-*), so should words of the shape */VC_1C_1V/ be reconstructed as *[VC_1V]. This is clearly false, since there was a distinction between monomorphemic words containing geminates, such as the well-attested **atta*

12 Gk. ἄττα, Lat. *atta* ("both used as respectful forms of address for old men" [Ringe 2006:71]), Goth. *atta* 'daddy', Hitt. *attaš* 'father'.

13 Gk. κακκάω, MIr. *caccaim*, Russ. *kákatъ*.

14 Gk. Ἀκκώ, Lat. *Acca* (*Lārentia*), Skt. *akkā* 'momma'.

15 PAnat. **ánna* (Melchert 1994:147).

16 As Craig Melchert points out to me, given the considerable amount of evidence presented in this section for a highly ranked OCP constraint in PIE, should the connection of Lat. *immō* with Hitt. *imma*, CLuv. *imma* and HLuv. *ima* 'indeed' be true (PIE **immoh₂* vel sim.), the PIE form would have to have been synchronically monomorphemic or a shared innovation. See Kloekhorst 2008:384 and de Vaan 2008:300 for recent discussion, with references.

17 Followed by Meillet 1934:129–30 and Hermann 1923:351ff. Schindler (apud Mayrhofer 1986:111–2) attributed loss of dental in **méd-tro-* to the typologically bizarre syllabification $[\text{mett}]_\sigma[\text{ro}]_\sigma$, with subsequent simplification of tautosyllabic geminate (likewise Keydana 2004:171). See chapters 3 and 5 for arguments against such an analysis.

'daddy' (not *ˣata*), and those words with a single intervocalic consonant, such as **éti* 'still'[18] and **ápo* 'away'.[19]

However, assuming a high-ranking OCP constraint within the PIE grammar that targets only heteromorphemic geminates presents no such problems. Moreover, we are now provided with the motivation for each instance of geminate avoidance above. In the OT derivation of each of these forms, we will need to assume three additional faithfulness constraints: MAX-T, DEP-[s], and MAX-C, as defined in (42) below.

(52) OCP Constraints
   a. MAX-T: Every dental stop in the input has a correspondent in the output. Assign one * for each instance of deletion.
   b. DEP-[s]: Every **s* in the output has a correspondent in the input. Assign one * for each instance of epenthesis.
   c. MAX-C: Every consonant in the input has a correspondent in the output. Assign one * for each instance of deletion.

The relative ranking of each constraint within the PIE grammar will determine which output form is most optimal. In each instance we of course find that the most optimal form avoids a geminate sequence. This is due to the undominated ranking of the OCP constraint. Each underlying form shows simplification of a geminate sequence, except in the case of the 'double dental rule', where words of the shape *VTTV undergo **s*-epenthesis. For this reason, we will need the constraint ranking MAX-T » DEP-[s] » MAX-C. The ranking MAX-T » DEP-[s] ensures that dental stops (T) are preserved, though with necessary **s*-epenthesis in the output form to avoid violation of the undominated OCP constraint. In cases where there are underlying geminates that are not dental stops, the ranking DEP-[s] » MAX-C is required, which results in simplification of the geminate sequence instead of **s*-epenthesis. It is for this reason that the candidate **némn̥*, and not *ˣnémsmn̥*, is chosen.[20] In short, in order for all of the correct forms to be chosen in the derivation, we require the constraint ranking to be: OCP » MAX-T » DEP-[s] » MAX-C.

18 Ved. *áti*, Gk. ἔτι, Lat. *et*, etc. (IEW 344).

19 Ved. *ápa*, Gk. ἄπο, Lat. *ab*, etc. (IEW 53).

20 A similar analysis holds true for PIE **dṓm* 'house (acc.sg)' as well.

(53) The OCP

			OCP	MAX-T	DEP-[s]	MAX-C
a.		u̯ittó-	*!			
b.		u̯itó-		*!		*
c.	☞	u̯itstó-			*	
d.		dómm	*!			
e.	☞	dṓm				
f.		némmn̥	*!			
g.		némsmn̥			*!	
h.	☞	némn̥				*
i.		h$_2$áu̯soss	*!			
j.	☞	h$_2$áu̯sōs				*
k.		h$_1$éssi	*!			
l.	☞	h$_1$ési				*

2.1.2 *Indo-European Conspiracies*

The assumption of a high-ranking OCP constraint within the PIE grammar explains why change is required in reconstructable (underlying) heteromorphemic geminate sequences and also predicts the ban of other, unattested geminate sequences. In our study of IE syllabification, our goals will be similar, with our reconstructions aiming to explain the phonological process in question as well as to provide predictions for other phonological phenomena in PIE.

2.2 Theoretical Assumptions of the Syllable

Let us now turn to the main focus of the book: the analysis of syllabification. Broadly speaking, a syllable may be defined as an abstract mental construct through which speech segments are organized. Though it has been difficult to identify any acoustic or articulatory correlates in what speakers and linguists tend to think of as syllables, it has been claimed that many (but not all) syllables are accompanied by a chest pulse ("an individual burst of action by the expiratory muscles").[21] However, a number of phoneticians, beginning with Ladefoged 1967, have argued this account to be incorrect. In the absence of such a theory, no good acoustic or articulatory definition of the syllable exists, a fact which leads Ladefoged and Maddieson (1990:94) to suggest that perhaps

21 Devine & Stephens 1994:9–10, to which I refer the reader for discussion, with references.

the syllable should be viewed strictly as a phonological unit. In fact, almost all of the evidence cited in favor of the syllable as a true constituent is phonological in nature, found in cases where phonological rules and constraints may be more succinctly expressed through the assumption of an underlying syllable structure than without one. Blevins (1995:207) cites four such cases.

First, the syllable may function as a domain for phonological rules and constraints, a domain which is "larger than the segment, smaller than the word, and contains exactly one sonority peak." For example in Classical Latin, stress is assigned based on the number of syllables in a word and the weight of the penult: to the first syllable if the word is monosyllabic or disyllabic; to the penultimate syllable if the word is trisyllabic or longer and the penult is heavy; and to the antepenultimate syllable in trisyllabic words or longer if the penult is light.[22] In Cairene Arabic we find that emphasis (pharyngealization) may spread only tautosyllabically, and a consonant may lose its emphasis if it is resyllabified within another syllable. For example, there is emphasis spread within both the first and second syllables of *ṣ̌ạṇṭịṭ* 'purse' (underlying /šạntịt/), though the final *-t* loses its emphasis in *ṣ̌ạṇṭịt-i* 'my purse' and *ṣ̌ạṇṭịt is-sitt* 'purse of the lady', when it is realized as the onset of the following syllable. Since emphasis will spread only to segments within the same syllable, the final *-t* of *ṣ̌ạṇṭịṭ* 'purse' will only be realized as emphatic if cosyllabified with the preceding /ị/: /šạntịt/ → [ṣ̌ạṇ]$_\sigma$[ṭịṭ]$_\sigma$ but /šạntịt-i/ → [ṣ̌ạṇ]$_\sigma$[ṭị]$_\sigma$[ti]$_\sigma$.[23]

Second, certain phonological rules and constraints may target the edges of syllables (margins). One such example frequently cited is the process of aspiration; for example, in English, aspiration targets syllable-initial voiceless stops (Kahn 1980:73).[24]

Third, there are cases where the syllables themselves are targets of morphological rules and language games. One common morphological process that targets syllables is reduplication, a process which we will discuss in greater detail in section 3.3.8. As for language games, or ludlings, there are quite a few in English. The most well-known game is Pig Latin, where—depending on

22 Weiss 2009:110.

23 Kenstowicz & Kisseberth 1979:260.

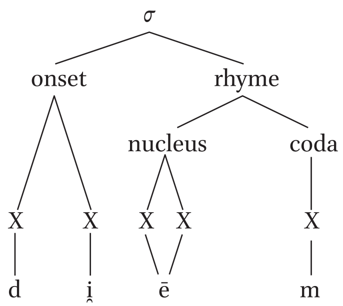
24 One might claim that laryngeal feature neutralization (voicing and aspiration; see 1.2.3) was a process in PIE that targeted syllable codas, as reflected in */nig^{w}tós/ → *[nik^w]$_\sigma$[tós]$_\sigma$ 'washed' and the generalization of voiced stops in word-final position (*/b^{h}eret/ → *[b^{h}e]$_\sigma$[red]$_\sigma$). However, this could not have been the case, since words such as **h_2aĝros* 'field (nom.sg.)' and **$h_2$ak̂ros* 'sharp (masc.nom.sg.)' were both syllabified as VC.CV (*[h_2aĝ]$_\sigma$[ros]$_\sigma$ and *[$h_2$ak̂]$_\sigma$[ros]$_\sigma$, respectively). If laryngeal neutralization had targeted all obstruents in coda-position, then *[h_2aĝ]$_\sigma$[ros]$_\sigma$ would have been automatically realized as *[$h_2$ak̂]$_\sigma$[ros]$_\sigma$.

which 'dialect' of Pig Latin one speaks—the speaker will either fully or partially transpose a word-initial onset to the end of a word, adding *-ay: sleep* → *eep-slay* or *leep-say; strict* → *ict-stray*, etc.[25] Another such game is [IZ] infixation, made popular by West Coast Gangsta Rap, in which [IZ] is inserted in between the onset and rhyme: *sleep* → *slizzeep* (^{X}*sizzleep*); *strict* → *strizzict* (^{X}*stizzrict*, ^{X}*sizztrict*).

Lastly, native speakers have clear intuitions regarding syllables within their language. This fact is reflected by the very existence of syllabaries as writing systems in many of the world's languages, such as Hittite, and the use of syllable counting and syllable weight in poetic meter, as seen in many of the oldest IE languages.[26]

In order to parse the syllable structure of any human language, we must first identify two factors: 1) what can occupy the syllable nucleus and 2) what can occupy the syllable margins. The syllable-initial margin is more commonly known as the onset and the syllable-final margin as the coda.[27] If the onset and coda are occupied by more than one consonant, then they are known as complex onsets and codas, respectively. To cite an example from PIE, in the word **di̯ḗm* 'sky (acc.sg.)', we may reconstruct a word-initial complex onset and word-final simplex coda.

(54) Syllable-internal Structure (PIE **di̯ḗm* 'sky (acc.sg.)')[28]



As represented in the diagram above, scholars typically observe a strict, hierarchical nature for the syllable, whereby the syllable node dominates the onset

25 See Barlow 2001 for a recent discussion.

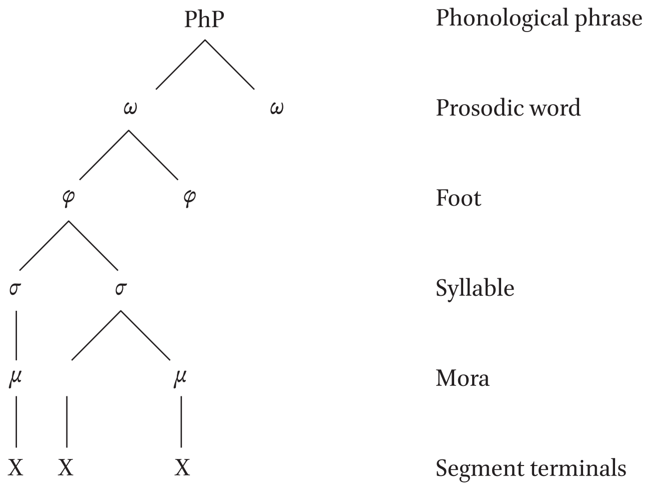
26 Cf. Meillet 1923.

27 Blevins 1995:212ff.

28 Cf. Blevins 1995:213.

and rhyme, the latter of which dominates the nucleus and coda in turn.[29] These structures are embedded within an even larger prosodic hierarchy, where syllables are organized into feet (φ), feet organized into prosodic words (ω), and prosodic words into phonological phrases (PhP).[30]

(55) Universal Prosodic Hierarchy



This hierarchy[31] will be especially important in our discussion of extrasyllabicity in the following chapters, where we will see that segments within certain PIE edge consonant clusters may be syllabified at a prosodic level higher than the syllable (most likely at the ω level).

One of the more striking features of the syllable is that it is nearly universally organized according to the sonority of the segments within. Sonority, which may be defined as "[the] loudness relative to other sounds produced with the same input energy (i.e., with the same length, stress, pitch, velocity of

29 See Bosch 2011 for an excellent overview of syllable-internal structure.

30 Nespor and Vogel 1986. There are two other categories located above the PhP in the hierarchy, the intonational phrase (IP) and the utterance (U). Given the nature of reconstruction, I am skeptical of our ability to say anything interesting about these two categories; the remaining five, however, are well within our reach and each will be relevant at some point in our analysis of the IE syllable.

31 Cf. Blevins 1995:210.

airflow, muscular tension, etc.)",[32] is a central concept in the study of syllabification, as the more sonorous a segment is the more likely it is to function as a syllable peak, as known as the nucleus. Therefore in order for us to be able to identify individual syllables in PIE we must be able to identify syllable peaks, the most sonorous segments within the syllable.[33]

Though sonority scales tend to differ slightly from language to language, certain hierarchies may be viewed as strong tendencies, if not universals. For example, we find voiced segments to be more sonorous than voiceless ones, vowels to be more sonorous than consonants and sonorants to be more sonorous than obstruents. This has led many to assume a universal sonority hierarchy, such as in Blevins 1995:211: low vowels > mid vowels > high vowels > glides > liquids > nasals > voiced fricatives > voiceless fricatives > voiced stops > voiceless stops. Here I will follow Kobayashi (2004:23) and Keydana (2011) in assuming a similar, but more broadly stated hierarchy to have been present in PIE.[34]

(56) PIE Sonority Hierarchy
E > U̯ > L > N > F > P

As early as Sievers 1881, scholars have noted that cross-linguistically, sonority tends to decrease within a syllable when moving away from the syllable nucleus, a phenomenon typically referred to as the SONORITY SEQUENCING PRINCIPLE.[35]

(57) Sonority Sequencing Principle (SSP)
Between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted.[36]

To take some examples from PIE, a word such as **séms* 'one (masc.nom.sg.)' does not show an SSP violation, since the onset **s* rises in sonority to the syllable

32 Blevins 1995:207.

33 Already recognized by scholars in the late 19th century; see, for example, Whitney 1874:291ff.

34 E = *ā̆, *ē̆, *ō̆. Kobayashi (2004:23) suggests that the reason the rightmost sonorant within a sequence of two adjacent unsyllabified sonorants is syllabified is due to a preference for onset maximization, not because glides, liquids and nasals were of equal sonority. This proposal will be investigated in depth in chapter 4.

35 Note that in this monograph I will consider both sonority rises (**ste-*, **-ets*) and sonority plateaus (**pte-*, **-ept*) to be violations of the SSP.

36 Clements 1990:284ff. Cf. Keydana 2004:164ff., 2011.

peak (the nucleus **é*) and then decreases in sonority into the coda (N > F). On the other hand, words such as PIE **stəh$_2$tós* 'having stood (masc.nom.sg.)' and **méĝh$_2$* 'great (nt.nom./acc.sg.)' each illustrate one SSP violation. In **stəh$_2$tós*, there is an SSP violation in the onset, since **s* is of higher sonority than the following **t* (F > P); in **méĝh$_2$* there is also one SSP violation, this time in the coda, since laryngeals were of higher sonority than stops (F > P).

One last point to make regarding the syllable pertains to phonotactics. As Kobayashi 2004:17 rightly points out, "[U]nderstanding the synchronic restrictions on the syllable, i.e. figuring out what kind of syllable is well-formed or ill-formed for the speakers of a language in question, is a prerequisite for describing alternation patterns of segmental duration." By identifying what constituted a possible syllable within various stages of Sanskrit, Kobayashi has been able not only to parse word-medial syllable divisions but also to pinpoint what were possible nuclei and consonant clusters, thereby giving us a more precise knowledge of Sanskrit phonotactics as a whole. In this book I will apply Kobayashi's methodologies to my study of PIE, a methodology which I believe can give us a better understanding of its phonotactics.[37]

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37 The theoretical assumptions of the syllable in this monograph will follow those views of Blevins 1995, unless noted otherwise, and are therefore representive of the traditional view of the topic. The literature devoted to the study of syllables is sizeable and contentious, and the existence of syllables unquestionably remains one of the most hotly debated topics in phonetics and phonology today. It therefore lies beyond the scope of this work to examine the problem of the Indo-European syllable from all possible theories pertaining to syllabification (for an excellent overview, see Goldsmith 2009). However, a few words should be said about the most widely accepted rival of Syllable Theory, Licensing by Cue (Steriade 1997, 1999, Côté 2000).

In recent times a number of phonologists (following Steriade 1999) have rejected the syllable as a phonological unit. Such a dismissal is not new, as mainstream Generative Theory rejected the existence of syllables in its early period, until an onslaught of work in the 1970s proved it unwise (see Pulgram 1970, Vennemann 1972, Hooper 1976, and Kahn 1980). There are five basic arguments put forth by the Steriadian school against the existence of syllables (taken from Vaux 2003, to whom I refer the reader for lengthy discussion, with references). First, as there exist no clear phonetic correlates to syllables, one wonders how the language learner is able to acquire these structures for their target language. Second, speakers often have unclear or conflicting intuitions on syllable count and syllable division, the famous example being Eng. 'lemon' ([lɛ.mn̩] vs. [lɛm.n̩] vs. [lɛm.mn̩]), which suggests that there are in fact no rules to derive syllable structure within the grammar (Steriade 1999). Third, a number of phoneticians have noted that while cross-linguistically the domain of phonetic coarticulation is C_0V (a sequence sometimes believed to correspond to the syllable), this division does not always correspond to the phonological notion of syllables, which typically break up intervocalic consonant

2.3 The Decomposition Theorem

In Section 2.1.1, I demonstrated that the assumption of ranked constraints in our analysis of the PIE phonology has immediate ramifications for our understanding of the PIE grammar, both in the explanation and connection of currently understood phonological processes as well as in the prediction of what

sequences. Fourth, the rules of syllabification in any given language are in nearly all cases predictable, and when they are not, different syllabifications naturally fall from word (or at the very least morpheme) division, thus rendering syllables unnecessary; cf. *sue Ted* versus *suit Ed*. And lastly, phonological processes traditionally interpreted in terms of syllabic conditioning (such as laryngeal neutralization in syllable codas) are explained by Steriade as being phonetic in nature, involving release cues, coarticulation, etc., leading us to the conclusion that not only are syllables unnecessary, but also that they insufficiently account for the phonological processes in question. While many of her arguments are difficult to ignore (especially points two and five), the theory is not entirely without its problems.

For instance, within a lengthy analysis of certain morphophonological facts within various Modern Armenian dialects, Vaux (2003:99) demonstrates that a substantial problem to the LbC theory lies in its inability "to account for morphological rules that are sensitive to syllable structure …", being unable to explain why the genitive singular of *i*-final nouns in Modern Western Armenian is in /-u/ for monosyllables but /-voj/ for polysyllables, and the plural suffix for monosyllables is in /-eɾ/ but for polysyllables /-neɾ/. Moreover, there are certain phonological processes that are neatly accounted for through the assumptions of syllables, but make no sense under the LbC approach; see Gerfen 2001 for a compelling example from Andalusian Spanish. But perhaps the most compelling phonetic evidence in favor of syllables comes from recent analyses of the language-specific articulation of word-initial CCV sequences (I am indebted to Jessica DeLisi for bringing these matters to my attention). There are some languages (such as English) that treat such sequences as complex onsets ($_{\sigma}$[CCV-, wherein "the articulatory gestures associated with each consonant in word initial CCV sequences have been shown to exhibit a similar coordinative relation to the vowel, which corresponds to complex gestural organization" (Tilsen et al. 2012:56), a property known as the c-center effect. In languages such as English that permit complex onset clusters, "relative to a singleton C, the timing of the prevocalic C gesture in a CC cluster is shifted closer to the following vowel, and the timing of the initial C gesture is shifted earlier relative to the vowel." (Tilsen et al.) However, there are are other languages (such as Moroccan Arabic [Shaw et al. 2009] and Tashlhiyt Berber [Hermes et al. 2011]) that treat such sequences as containing a singleton onset (C$_{\sigma}$[CV-), whereby the "gestural organization of word-initial prevocalic consonantal sequences" demonstrates that "only the rightmost consonant [is] coordinated with the following vowel". In other words, the different articulations of CCV sequences in Moroccan Arabic and Tashlhiyt Berber vs. English directly coincide with a different phonological treatment. It would be difficult to explain such facts within the LbC framework.

was a possible word shape in the proto-language. For example, reconstructing a highly ranked OCP constraint for PIE explains not only the 'double dental rule' and the simplification of geminate */s/ in word-medial position, it also predicts that no word in PIE could contain a geminate sequence across a morpheme boundary, regardless of segment. Even though we have no direct evidence for a ban on words like **sel+los* or **tah*$_2$*+h*$_2$*os*,[38] we can infer their prohibition through the existence of a large number of phonological rules in PIE, which were certainly driven by a highly ranked OCP constraint.

Just as the reconstruction of a high-ranking OCP constraint in the PIE grammar provides us with both explanatory and predictive power, so should an optimal theory of PIE syllabification be able to explain (parse) the syllable structure of known PIE words and predict which sequences may be syllabified. As we have seen in section 2.2, syllabification plays an integral role in every phonological system of the world. Though we clearly understand what could function as a possible syllable nucleus in PIE (cf. 2.4 below), we currently have no way of broadly gauging what constituted a possible onset or coda in PIE. In order to accurately predict how many and what kinds of consonants were allowed in multipartite onsets and codas in PIE—and more generally how the process of syllabification worked in PIE—we must develop a systematic methodology. It should first and foremost observe universal (or near-universal) characteristics of the syllable as set forth above, since Proto-Indo-European was at one point in time a living human language and behaved as such. This methodology should also be non-circular. We should not devise a theory of syllabification based solely on one's explanation of certain phonological rules, as many have done in the past.

Fortunately, such a methodology exists within the phonological literature and has been known for some time. Typically it is assumed through Syllable Theory that "words … [are] built up out of smaller phonological units, either syllables or, in more recent work, feet (which are, in turn, composed of syllables). After all, a rough account of possible sequences of sounds in words can often be formulated by saying that a phonotactically admissible word is one that can be analyzed as a sequence of phonotactically admissible syllables.

38 This raises the question: what *did* speakers do when an underlying heteromorphemic geminate **h*$_2$*h*$_2$ occurred in PIE, such as is reconstructed in **mólh*$_2$*h*$_2$*a* 'I grinded' (Jasanoff 2003:89)? If one follows Jasanoff 1988:73ff. in assuming that PIE **-óh*$_x$*h*$_x$*e#* > **-ṓh*$_x$*u#*, then it appears that there was a general simplification of (at least heteromorphemic) medial sequences **-Vh*$_x$*h*$_x$*V-* in PIE. Unlike those other instances of geminate simplification discussed in section 2.1.1 above, the simplification of **-Vh*$_x$*h*$_x$*V-* was accompanied by compensatory lengthening.

On this view, there should be perfect agreement between what consonant sequences can occur word-initially and syllable-initially, just as there should be perfect agreement between what consonant sequences can occur word-finally and syllable-finally." (Goldsmith 2009) This notion, that words are just sequences of syllables strung together, provides us with a window of opportunity. Given that there are two basic types of syllable margins—those which coincide with a word boundary, and those which do not—we may utilize the former to understand the latter, as the former are more easily identifiable (in PIE) than the latter. This inference of medial syllabification based on possible edge clusters in a language is called the DECOMPOSITION THEOREM (DT).

(58) Decomposition Theorem (DT)[39]
All medial clusters should be decomposable into a sequence composed of an occurring word-final cluster and an occurring word-initial cluster.

Thus, understanding word-edge phonotactics should allow us to predict what were possible word-medial codas and onsets in PIE, and from there, word-medial syllabification. Earlier instantiations of the DT may be found in Vennemann (1972; 1985), who splits up the DT into two syllable-preference laws, the LAW OF INITIALS and the LAW OF FINALS. For other similar proposals, see Pulgram 1970:97, Kahn 1980:57–8 and Steriade 1999:223ff., among others.

To illustrate the function of the DT, consider the following words in English:[40]

(59)	a.	a.ro.ma	b.	pen.tath.lon
		ma.tron		e.nig.ma
		di.sci.pline		Ed.na
		a.gen.da		at.las

The reader will note that certain consonant sequences are maximized within an onset and certain ones are not. The sequences /tr/ and /pl/ are of the former type (proved by the aspiration assignment and in the case of /pl/, stress assignment), while /nd/, /nt/, /thl/, /gm/, /dn/, and /tl/ are of the latter (again, proved by various phonological processes). But why are these latter sequences articulated as heterosyllabic? There are a variety of reasons: onset /nd/ and /nt/ both violate the SSP, and English does not allow tautosyllabic alveolar + /l/, nor any

39 Hammond 1999:68–69.

40 Taken from Giegerich 1999:237. Syllabifications may be proved by consonant release, stress assignment, and speaker intuition.

stop plus nasal. But these facts hold true in word-initial position as well. In fact, there is no word-medial onset or coda within English that does not also occur at word's edge. This phenomenon occurs in the vast majority of the world's languages and appears to hold true for PIE as well, with very minor exceptions. For instance, the reconstruction of the word *b^hes.trah$_2$* (Skt. *bhas.trā-* 'tube, bottle'), a derivative of the PIE root *b^hes-* 'blow',[41] predicts *-s]$_\sigma$ and *$_\sigma$[tr- to have been licit word-edge margins in PIE, a prediction confirmed by *tréi̯es* 'three (nom.pl.)' (Skt. *tráyaḥ*, Gk. τρεῖς, Eng. *three*, etc.). But the sequence *-s.tr-* is by no means an isolated example. Others include (but are not limited to):

(60)

	Medial Cluster	Coda	Onset
a.	*h$_1$és.ti 'is'	*h$_2$áĝ.ros 'field'	*tód 'that'
b.	*su̯ek̂.stos 'sixth'	*h$_3$réĝ 'o king!'	*stáh$_2$t 'stood up'
c.	*(t)per.sn V- 'heel'	*pəh$_2$tḗr 'father'	*snáh$_2$ti 'bathes'
d.	*h$_1$et.sk̂é/ó- 'eat (iter.)'	*tód 'that'	*sk̂inéh$_x$ti 'shines'
e.	*d^hug.h$_2$tḗr 'daughter'	*eĝ 'out(side)'	*h$_2$tugi̯étor 'terrifies'

Taking laryngeal feature assimilation into account (voicing assimilation and word-final voicing), it does appear that PIE more or less obeys the DT quite faithfully. Indeed, following certain key insights of Steriade (1999), we will see in this section that the DT is motivated by the universal tendency for speakers to construct medial syllable structure based largely (but crucially not solely) on a speaker's knowledge of a language's word-edge phonotactics.

2.3.1 *Exceptions to the Decomposition Theorem*

As it is currently formulated in (48), the DT cannot be universally true for medial consonant clusters in all of the world's languages, as there are situations that arise where restrictions on word-medial sequences are stricter or looser than those at word's edge. In order for the DT to be a viable tool in our study of PIE medial consonant sequences, we must address and explain all of these exceptions and then alter our model accordingly. It is crucial that the DT work for all of the world's languages; if it does not, how can we be certain that PIE was not an exceptional language in this regard? The remainder of this section will be organized as follows. First, we will examine situations where the DT

41 IEW 146. Cf. Skt. *bábhasti* 'blows', Gk. ψύω 'I blow'.

(as given in (48) above) is violated, discussing when these exceptions are likely relevant for PIE. We will then turn to an earlier study by Steriade (1999), which deals with the interaction of word-edge phonotactics and syllable structure. This will lead to a revision of the DT such that we may state it as a typological universal, thereby allowing us to securely reconstruct PIE syllabification.

2.3.1.1 Sequential Constraints

While it is true that every well-formed word consists of well-formed syllables, it is not true that any combination of well-formed syllables may create a well-formed word, since certain combinations of syllables are ruled out by sequential markedness constraints. These are constraints that apply in a linear fashion, such that if a sequence XY is blocked in one position it is blocked everywhere else, regardless of its location in the syllable. We have already seen one such constraint reconstructable for PIE, the OCP. Given the existence of words such as **bʰered* 'he carried (impfct.)' and **didoh₃mi* 'I give (pres.)', the DT would predict a sequence such as **edde* to occur, but we know this sequence never surfaced in PIE (see section 2.1.1). Another example of a sequential phonological constraint reconstructable for PIE is **Kʷu̯/*u̯Kʷ*, the so-called *bou̯kólos* rule, which was first proposed by Saussure 1889:161–2 (MSL, 6, 1889, 161–2) and has been established by Weiss (1995). From an analysis of the PIE words **suhₓnéu̯*[42] 'son (loc.sg.)' and **kʷís*[43] 'who? (nom.sg.)', the DT would predict the sequence **-u̯kʷ-* in the word **gʷou̯kʷólos* to be a perfectly acceptable consonant cluster, but a linear constraint delabializes **-kʷ-* after a preceding **-u̯-*, resulting in **gʷou̯kólos* 'cowherd' (> Gk. βουκόλος, OIr. *búachaill*). Thus we find that the presence of these two sequential constraints, the OCP and **Kʷu̯/*u̯Kʷ*, results in overgeneration within a DT-based analysis, since medial sequences which are otherwise predicted are in fact blocked.

As Pierrehumbert (1994:168) points out, standard syllable-based phonological theory—just as our formulation of the DT in (48) above—predicts that "in the absence of additional provisos, any concatenation of a well-formed [word-final (AMB)] coda and a well-formed [word-initial (AMB)] onset is predicted to be possible medially in a word." However, this is not the case for modern English, as Pierrehumbert demonstrates in her study of its inventory of medial clusters consisting of three or more consonants. English has a particularly rich array of consonant clusters at word's edge, with 147 different consonantal sequences in word-final position and 129 in word-initial position. Should it be possible for any combination of an existing word-final coda and word-initial onset to create a possible word-medial consonant cluster, we would expect

42 Ved. *sūnáu*.

43 Hitt. *kuiš*, Lat. *quis*, etc.

18,963 possible medial sequences in English! In reality, however, only 675 distinct clusters of three or more consonants are found word-medially in English, and only fifty clusters are found morpheme-internally (ibid.).

Looking at this problem from a stochastic point of view,[44] Pierrehumbert discovers that the combination of a low-frequency word-final coda and a low-frequency word-initial onset results in a non-occurring or low-frequency word-medial consonant cluster. Conversely, the combination of a high-frequency word-final coda and a high-frequency word-initial onset produces 200 likely medial sequences, from which almost all of the actually attested fifty morpheme-internal sequences may be taken. To rule out the 150 likely, but non-occurring word-medial sequences, Pierrehumbert invokes various sequential markedness constraints in her analysis of English, such as the OCP, which rules out geminates (**vekkro*) and more loosely clusters such as **-lCl-* (**velclo*), a constraint that requires agreement in labiality within nasal-stop sequences (**vemkro*) and the ban of velar obstruents before labials (**vekpro*). In short, one may gauge the likelihood of the occurrence of monomorphemic word-medial clusters in a language by discovering what are the most common edge sequences attested in a language and by determining relevant sequential constraints that may rule out concatenations of those sequences. Of course, since there exists no corpus of PIE texts it is impossible to do a statistical phonotactic analysis of PIE words as Pierrehumbert has done for English. However, her findings confirm our discussion of PIE above: word-medial sequences otherwise predicted by the existence of edge clusters may be ruled out by sequential markedness constraints.[45]

2.3.1.2 Consonant Licensing

Cross-linguistically it is common for languages to require a certain consonant or category of consonants to be followed by another consonant in order to be syllabified. For example, it is obvious that the DT is not able to account for the medial sequence in Gk. λέκτρον 'bed'. Like all stops in Greek, the coda *-k#* is not legal word-finally[46] and the onset *#ktr-* is not legal word-initially. Following Steriade (1982:223ff.), the coda consonant /k/ is allowed to stand in *léktron*

44 By which I mean "that [which] follows some random probability distribution or pattern, so that its behaviour may be analysed statistically but not predicted precisely" (Oxford English Dictionary on-line).

45 Moreover, since disyllabic morphemes were very rare in PIE (cf. **atta* 'daddy' and complex suffixes such as **-is-th$_2$o-*, **-e-ro-*, etc.), one wonders if we should focus on the 675 attested heteromorphemic consonant clusters in English instead for a better comparison with PIE.

46 This phonotactic generalization of course does not apply to the preposition *ék* 'out' or *ouk* 'not', since both are proclitics and thus must always be followed by another word.

since it is licensed by the following segment; in other words, /k/ can only exist in a coda if it is followed by and linked with another consonant.[47] In a similar fashion, in Italian and Japanese, obstruent codas are licensed only when they form the first part of a geminate sequence (cf. Ital. *struz.zo* 'ostrich', Jap. *gakkō* 'school') and are strictly banned word-finally (Itô 1988:17ff.).

In Greek consonant licensing is accompanied by complete laryngeal feature assimilation (voicing and aspiration); in Italian, it is accompanied by laryngeal feature and place assimilation. Examples include Gk. /klep/ 'steal' → [kleb] in *klebdēn* 'stealthily', Gk. /strep^h/ 'turn' → [strep] in *strépsomai* 'I will turn' and Ital. /leg(g)/ 'read' → [let] in the past participle *letto* 'read'. We have seen in section 1.2.3 that PIE coda obstruents were also required to assimilate completely to the following obstruent with respect to laryngeal features (but not place); cf. */skab^h/ 'shave' (cf. Eng. *shave*) + **-s-* (aor.) > **skaps-* > Gk. ἔσκαψα 'dug up' and **h$_1$leng^{wh}-t-* > **h$_1$lenk^w-t-* > Germ. **le(n)h^{w}t(a)* 'light' (> Eng. *light*). However, PIE obstruents do not have to be linked to a following consonant in order to be licensed in the coda, which may be inferred from the existence of obstruent-final words such as **úd* 'up; on high', **ég(s)* 'out(side)', **úb(s)* 'up', **u̯ih$_1$roms* 'men (acc.pl.)',[48] **b^{h}erond* 'they carried (impfct.)', **u̯ḗk̂st* 'carried' and **b^{h}eronts* 'carrying'.[49]

2.3.1.3 Lexical and Morphological Gaps

Edge consonant sequences can sometimes be more restricted than medial ones. For instance, even though the sequence *-mpt-* occurs word-medially in Lat. *ēmptus* 'the act of purchasing', a DT analysis of Latin predicts that this word should not exist, since *mp#* and *#pt* are illegal edge codas and onsets, respectively.[50] This is the opposite of the situation discussed above in section 2.3.1.1, where a linear constraint may override the predictions of the DT, thus resulting in overgeneration, since **g^{w}ou̯k^{w}ólos* was predicted to occur but does not. Here in the case of *ēmptus*, the DT results in undergeneration, since no word-edge cluster is attested that would predict the syllabification of a sequence *-mpt-* in Latin.

47 Likewise the /k/ of *ónuks* 'fingernail' is segmentally linked to the following /s/ (Steriade 1982:223ff.).

48 In early PIE **Vms* > **V̄m* by Szemerényi's Law: **d^{h}ég^{h}ōm* < **d^{h}ég^{h}oms* (cf. *ph$_2$tḗr* < *ph$_2$térs* (Szemerényi 1970:109)9; in later PIE, the sequence **-Vms* was restored (see section 3.3.5).

49 An additional example may be found in Keydana 2004:186–9, who argues **-nts* not to have been licit coda in IE, which was sometimes realized as **-ns*, other times **-nt*.

50 Hermann 1923:360.

We may view this undergeneration by the DT in one of two ways. First, in the case of *ēmptus*, the epenthesis of a stop [p] is required for the transition from /m/ to /t/ in the output: *em-* 'buy' + *-tus* > *ēm*[*p*]*tus*.[51] For this reason, perhaps we should view the underlying syllable structure of the medial sequence as *m$t*, which speakers would have constructed based on the already existing edge sequences in the language (cf. *hominem* 'man (acc.sg.)', *tū* 'you (nom.sg.)'). Since there is no word-final ***-mt$* and no word-initial ^{X}*$mt-* in Latin, the syllabification could only have been *-m$t-*. Should this hypothesis be true, the DT would predict medial syllabification based on underlying structures, not surface ones. However, the [p] in question must have been syllabified somewhere within *ēmptus*; otherwise, speakers of Latin would not have been able to pronounce it.[52] Thus, should we follow a formulation of the DT that applies at the phonemic level, we would lack the means of predicting not only which syllable [p] should be parsed with, but also its pronunciation as well! Consequently, it seems prudent not to formulate the DT to apply at the phonemic level, since our goal is to predict the syllabification of all consonants in the analysis of a language, which of course also includes consonants that are epenthetic.

A more serious exception lies in Lat. *sculptor*. As with *ēmptus* above, there exists no word-final *-lp* coda, though this particular [p] may in no way be claimed as epenthetic, since the root in question is *sculp-*. For this reason, undergeneration produced by the DT may be better attributed to a gap within the morphology or lexicon. In Latin, as is the case in almost all ancient IE languages and in PIE itself, the vast majority of words must end in some kind of overt morphology, and there exist no morphological endings of the shapes *-mp* or *-lp*. In fact, the inventory of word-final suffixes in IE by and large consists of a single consonant (**-s, *-m, *-H*, etc.), and if there is a consonant cluster in either a single suffix or through a concatenation of morphemes, the last consonant is invariably a coronal obstruent (**-nt* '3rd pl.', **-ms* 'acc.pl.', **-s-t* 'aor. 3rd sg.', etc.) or laryngeal (**meĝ*h_2 'great', **-me*(*s*)*d*^{h}*h*$_2$ '1st pl. M/P').[53] That said, though word-final codas of the shapes *-mp* and *-lp* do not exist in Latin, a coda consisting of a resonant + coronal stop does exist in word-final position in the sequences *-nt* (*sunt* 'they are'), *-rt* (*fert* 'he carries') and *-lt* (*vult* 'he wants'). The undergeneration produced by the DT may therefore be attributed to a gap in the Latin lexicon and grammar. Similarly, it would be hard to deny the existence of words such as **i̯eu̯ktrom* 'instrument of binding, yoking' (Skt. *yoktra-* 'cord') and **denk̂tro-* 'instrument of biting' (Skt. *dáṁṣṭra-* 'tusk') in PIE,

51 See Weiss 2009:173.

52 See section 3.3.1 below for discussion of the undominated constraint PARSE.

53 Hitt. *-wašta*, Ved. *-mahi*, Gk. -μεσθα.

even though there are no reconstructable word-final clusters of the shapes _*-u̯k-u̯g_ or _*-nk̂/-nĝ_.[54] These facts suggest that the DT should not be so strictly formulated as it is in (48), and that perhaps a more successful formulation of the DT should not require specific sequences to occur word-finally in order for them to occur word-medially. This possibility will be discussed in more detail in section 2.3.2 below.

2.3.1.4 Morpheme Structure Constraints

Furthermore, there are often language-specific restrictions upon the possible shapes of words within a particular morphological category, which are called morpheme structure constraints (MSCs).[55] Adherents of (monostratal) OT explicitly reject the existence of MSCs because they run counter to the assumptions of Richness of the Base (Kager 1999:19–20),[56] and have also been rejected in the past due to their frequent redundancy with respect to existing phonological rules. Nevertheless, a brief mention of MSCs has been included here, due to their relevance for the reconstruction of PIE. As first seen by Meillet (1934:173ff.), there were three root shapes that are strikingly absent: roots of the shape _*TeD_^{h}_-_, _*DeD-_, and _*D_^{h}_eT-_, where _*T_ = any voiceless stop, _*D_ = any voiced stop and _*D_^{h} = any voiced aspirated stop.[57] The DT would predict that the syllable _*ded_ would be legal anywhere in PIE (cf. _*b_^{h}_ered_ 'he carried', _*didoh_$_3$_mi_ 'I give'), though no root of this shape is reconstructable. Just as we saw above in the case of sequential constraints, the existence of MSCs leads to instances of overgeneration by the DT, predicting phonological sequences that do not occur in the language.

2.3.1.5 Extrasyllabicity

Lastly, it is typologically very common for a language's word-edge clusters to allow more complex sequences than the onsets and codas in medial position, a phenomenon called extrasyllabicity or edge effects. A cursory glance at an English word such as *texts* [teksts] proves this to be the case—there is no

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54 One conceivable situation in which such word-final sequences could have arisen is in the suffixless 2nd sg. root imperative, as seen in Lat. *ī* 'go! (2nd sg.)' (< _*h_$_1$_ei̯_). However, the word equation Gk. ἴθι = Skt. *ihí* makes it likely that the original PIE form was _*h_$_1$_id_^{h}_í_, which for our purposes means that the 2nd sg. root imperative did not contribute to the inventory of consonant sequences at word's edge. Cf. Fortson 2010:105.

55 Cf. Halle 1959:56ff.

56 The basic idea that *any* input is possible for an OT derivation (Prince & Smolensky 1993). See Zsiga 2013:304–29 for an excellent overview of OT, with helpful examples.

57 See Mayrhofer 1986:95[19], Szemerényi 1990:90ff. and Fortson 2010:78.

word in English with a word-medial coda of the shape -ksts$]_\sigma$. Similar facts will become apparent in our discussion of PIE extrasyllabicity in Chapter 3, where we will examine the laryngeal loss rule CH.CC > C.CC (Lex Schmidt-Hackstein) in depth.

2.3.1.6 Review of Exceptions to the Decomposition Theorem

So, to review, it appears that there are two main problems with the strict formulation of the Decomposition Theorem as given in (48). First, it overgenerates, or predicts non-existent sequences, in at least three cases: 1) instances of sequential constraints such as the OCP, 2) the occurrence of Morpheme Structure Constraints and 3) the existence of extrasyllabic consonants at word's edge. All three are reconstructable for PIE, the third of which will be discussed in great detail in the following chapter. Second, this strict formulation of the DT undergenerates, or fails to predict existing sequences, in at least two instances: non-existent clusters at word's edge due to 1) consonant licensing and 2) gaps within the lexicon and morphology. The first appears not to be relevant for PIE, since the same basic consonant clusters that occur word-medially may occur word-finally in PIE. However, there are accidental consonant cluster gaps in the lexicon that give us a deficient view in predicting medial consonant sequences. In short, in order to be able to predict a well-formed word in PIE, we must be fully aware that it is simply not the case that there is a one-to-one correspondence between word-edge clusters and word-medial clusters. In order to adopt the DT as a successful metric of syllabification, we must be able to explain all five of these exceptions and incorporate them into our model.

2.3.2 *Establishing the Decomposition Theorem as a Linguistic Universal*

This section will elucidate the typological universality of a broader, less restricted version of the Decomposition Theorem, which will be able to accommodate four of the five exceptions given in section 2.3.1. Universality, of course, is crucial in our study, as it allows us to reconstruct PIE syllabification in a reliable and credible fashion. To do so, we must establish a psychological connection between word-edge phonotactics and the process of medial syllabification. Consequently, it will become clear that the DT is not some ungrounded analytical tool devised for the study of medial syllabification; rather, it is a heuristic guideline innate to all humans for the purpose of dividing medial sequences into two distinct syllables, as Steriade (1999) proposes.

In the introduction of this seminal work, Steriade discusses the correlation between phonotactics, stress and intuitions of syllable division, which has been viewed by many to be strong evidence in favor of the assumption of the syllable as a unit of hierarchical structure. To give an example, Steriade (ibid.) compares Spanish and (Cairene) Arabic, where three distinct facts appear to be motivated by a unitary phonological phenomenon.[58] In Spanish, words can begin with clusters consisting of stop + liquid (PR), such as *tres* 'three', but in Arabic they cannot. Similarly, post-consonantal PR is allowed in Spanish (*semblanza* 'sketch'), but in Arabic, it is not. In Spanish, clusters of the shape PR do not count as heavy for stress assignment (*fúnebre* 'sad', not ^{x}*funébre*; contrast *solémne* 'solemn', not ^{x}*sólemne*), while those in Arabic do (*tanábla* 'extremely lazy (pl.)'). Lastly, the native intuitions of syllabic division for word-medial sequences of the shape VPRV are V.PRV by speakers of Spanish (*o.tros* 'others') but are VP.RV by speakers of Arabic (*zak.ru* 'they studied').[59]

These differences in Spanish and Arabic with respect to phonotactics, stress assignment, and speaker intuition have in the past been interpreted to be the result of a single phonological fact: Spanish allows complex onsets of the shape PR, but Arabic does not.[60] This has been seen by many to justify the assumption of the syllable as a phonological unit. However, for Steriade (ibid.) this assumption is unnecessary: "Arabic lacks all word-initial clusters whereas Spanish allows TR [= PR (AMB)] clusters word-initially. Word finally Arabic permits a broad range of C's, whereas native Spanish words end in sonorants or [s] only, not in stops. The syllable intuitions can be deduced entirely from the word edge differences: Spanish favors V.TRV over VT.RV parses because (a) word final stops are missing in the native lexicon and (b) TR initials are possible. Arabic on the other hand rejects V.TRV in favor of VT.RV because (a) TR initials (and all CC initials) are impossible and (b) VT finals are not ruled out."

Steriade's explanation, of course, looks very much like the Decomposition Theorem. There is a key difference, however. Steriade does not in fact believe that syllable boundaries really exist word-medially; rather, she believes that speakers, when asked to perform the task of syllable division, infer syllable boundaries word-medially based on possible sequences at word's edge. Steriade calls this inference the Word-based Syllables (WBS) hypothesis, which she explains as follows: "Speakers rely on inference when they attempt to locate syllable boundaries in a multi-vowelled string, and one guideline in this process is that the segmental composition of word and syllable edges must be similar." Though for our purposes I will not reject the phonological assumption of syllables altogether as Steriade has done, I will follow her insight into how speakers

58 Data taken from Harris (1983) and Broselow (1976), respectively.

59 Ibid.

60 Ibid.

may choose to parse syllables word-medially. I contend that medial syllabification (and all phonological processes that derive therefrom) relies heavily upon a speaker's knowledge of possible sequences at word's edge in a language, but is not completely dependent upon it. Unlike the earlier formulation of the DT (48), which requires that medial consonant clusters be decomposable into an occurring word-final coda and word-initial onset, I propose that speakers infer the medial syllabification based on what is possible at word's edge.

Much of the evidence that Steriade (1999) presents in favor of her WBS hypothesis comes from instances of variability of syllable divisions,[61] which she claims to arise when both phonotactic and syllabic preferences are in conflict with one another in a single parse. The word *lemon*, for example, exhibits variation in syllabification among speakers of English when surveyed. On the one hand, the parsing of a VCV sequence as V.CV is preferred, which would produce [lɛ.mn̥], while on the other hand open syllables with a lax vowel are strictly prohibited, which would produce [lɛm.n̥]. This conflict is made clear through the variation of syllabification among speakers surveyed (Derwing 1992): 51% of those polled syllabified lemon as [lɛm.n̥], 37% as [lɛ.mn̥] and 12% preferred the parse [lɛm.mn̥] with ambisyllabic *m*. Contrast this variation with the syllabification of the word *demon* among those same speakers surveyed; there was an 82% consensus for the parse [di.mn̥]. The difference here, of course, is that the initial syllable has a tense vowel, which is permissible in word-final position (e.g. Eng. *see*), whereas there is no word like [lɛ][62] in English.[63]

61 Cf. Treiman & Danis 1988.

62 An exception lies in the very recent and very popular internet interjection 'meh' [mɛ] "[an] expression of apathy or indifference" (American Heritage Dictionary).

63 Similarly, in an analysis of syllabification and syllabically-driven phonological processes in Italian, McCrary (2004) assumes the perceptually driven phonotactic constraint LEX-C / IN V_ OR _V/L ("In the native lexicon, a consonant may only occur if it is after a vowel or followed by a vowel or liquid.") to explain instances of speaker variation of syllabification of Italian words such as *pasta* ($[\text{pas}]_\sigma[\text{ta}]_\sigma$). Without the assumption of the LEX-C constraint, the WBS hypothesis would predict that the abundance of native words with initial onsets of the shape *st-*, as in *stare* 'stand' and the absence of native words ending in *-s* should always lead to the parse *pa.sta*. Those speakers with the ranking LEX-C » W-S(I) chose the parse *pas.ta*, whereas *pa.sta* was chosen if a word-to-syllable identity was deemed to be more important (W-S(I) » LEX-C). Another example may be seen in Polish, where a minority of Polish speakers surveyed by Dubiel (1994) parsed the words *karta* and *pokorny* as [ka.rta] and [po.ko.rny], respectively, despite the resulting SSP violation (see section 47). English speakers, on the other hand, unanimously reject such parses (Steriade 1999).

Further and more striking evidence comes from Arrernte,[64] where all words begin with a vowel and end in at least one consonant. Steriade's WBS hypothesis correctly predicts the Arrernte syllable to be invariably of the shape $VC(C_0)$, whereas standard syllable-based phonological theory cannot (cf. Prince & Smolensky 1993). The unusual syllable structure of Arrernte $VC(C_0)$ is confirmed through phonological processes such as reduplication tests, in which we see the reduplicant is clearly of the shape VC_0: *unt-em* 'is running' + *ep*-RED → *untepunt-em* 'keeps running', *atw-em* 'is hitting' + *ep*-RED → *atwepatw-em* 'keeps hitting'. Similar facts become apparent through language games such as 'Rabbit Talk', which moves the leftmost syllable to the end of the word (*itirem* 'thinking' → *iremit*, not ^{x}*tiremi*).[65]

Translating her findings into an OT framework, Steriade (1999:226) tentatively proposes two word-to-syllable identity constraints.

(61) Word-to-syllable identity conditions.
W-S(I): For any I, a syllable-initial segment, there is a word such that its initial segment is identical to I.
W-S(F): For any F, a syllable-final segment, there is a word such that its final segment is identical to F.

Should we follow Steriade's hypothesis, medial syllabification will crucially depend on the ranking of the word-to-syllable identity conditions W-S(I) and W-S(F) vis-à-vis the other constraints within a language's phonology.

2.3.3 *Fine-tuning the Decomposition Theorem*

Keeping the previous section in mind, let us now revisit the Decomposition Theorem, which was first formulated in (48) above. In section 2.3.1 we saw a number of exceptions to this formulation, leading us to the conclusion that the presence of particular consonants and consonant sequences at word's edge cannot be the sole factor in determining what may or may not be syllabified in word medial position. Rather, as Pierrehumbert (1997) convincingly shows, it is only one of many.

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64 A language spoken in central Australia of the Pama-Nyungan family. See Breen & Pensalfini (1999).

65 As briefly mentioned earlier in this chapter, English has a similar language game called Pig Latin, which moves a word-initial onset to the end of the word (in part or in whole), followed by the diphthong *-ay* (*Pig Latin* → *Igpay Atinlay, dissertation* → *issertationday*, etc.).

Our revised, and more successful formulation of the DT must therefore be much less stringent than (48) and will follow Steriade's crucial insight that speakers base medial syllabification on, and are not necessarily constrained by, the existence of similar, or identical, codas and onsets at word's edge. The DT should not require medial clusters to directly mirror edge sequences, such that a heterosyllabic cluster AB$CD requires AB to be an occurring word-final coda and CD to be an occurring word-initial onset. Rather, a heterosyllabic cluster ABCD is likeliest to be parsed as AB$CD if AB and CD (or sequences similar to AB and CD) occur at word's edge as a legal coda and onset, respectively, and if BCD and ABCD do not occur as legal onsets.

(62) Decomposition Theorem (revised)
Medial consonant clusters are decomposable into a sequence consisting of a coda plus onset, whose syllable division is produced by the interaction of a speaker's knowledge of consonant sequences at word's edge and syllable markedness constraints.

If speakers do construct syllable boundaries through inference of edge sequences as formulated in (52), it follows that we as non-speakers can also construct medial syllable boundaries in a similar fashion. It is in this way that I justify the use of the DT as a tool in the reconstruction of Proto-Indo-European syllabification.

Let us now put the newly formulated DT to the test, seeing how it measures up with the exceptions given in 2.3.1 above. First, sequential constraints and morpheme structure constraints may apply without fail, since the DT does not directly control what may or may not occur in word-medial position. In the case of 'cowherd' in 2.3.1.1, the candidate **gʷou̯kʷólos* never even surfaces due to a violation of the undominated sequential markedness constraint **Kʷu̯/*u̯Kʷ*. However, the DT does determine how a candidate that does not violate **Kʷu̯/*u̯Kʷ* will be syllabified. We know that **gʷou̯kólos* could not have been syllabified as **gʷo.u̯kó.los* because of a W-S(I) violation,[66] since **u̯k-* does not occur as a word-initial onset in PIE, and it could not have been syllabified as **gʷou̯k.ólos* because of a violation of the markedness constraint ONSET. This leaves us with the most optimal candidate **gʷou̯.kólos*, which satisfies both word-to-syllable identity constraints and the constraint ONSET.[67] Note that I do not assume a violation of W-S(F) in candidate (c) *[gʷou̯k]$_\sigma$[ó]$_\sigma$[los]$_\sigma$,

66 As well as an SSP violation; see sections 2.2 and 3.3.3.

67 The constraint rankings assumed below are preliminary and are given on a case-by-case basis. In (53), I have ranked ONSET » W-S(I), based on (55) below.

given the similarity[68] of the coda *-*u̯k* with the reconstructable word-final coda *-*u̯d* (PIE **ĝʰeu̯d* 'poured (3rd sg. impfct.)'; cf. Skt. *ajuhot* 'sacrificed (3rd sg. impfct.)').[69]

(63) PIE **gʷou̯kólos* → *[gʷou̯]$_\sigma$[kó]$_\sigma$[los]$_\sigma$

	*/gʷou̯kʷólos/	⋆Kʷu̯/⋆u̯Kʷ	ONSET	W-S(I)	W-S(F)
a.	*[gʷou̯]$_\sigma$[kʷó]$_\sigma$[los]$_\sigma$	*!			
b.	*[gʷo]$_\sigma$[u̯kó]$_\sigma$[los]$_\sigma$			*!	
c.	*[gʷou̯k]$_\sigma$[ó]$_\sigma$[los]$_\sigma$		*!		
d. ☞	*[gʷou̯]$_\sigma$[kó]$_\sigma$[los]$_\sigma$				

Turning to the problem of undergeneration, we now understand that medial syllabification may be based on similar, though not identical consonant sequences at word's wedge. For this reason, instances of lexical and morphological gaps are quite straightforward. Words such as Lat. *sculptor, ēmptus* are likeliest to be parsed as [sculp]$_\sigma$[tor]$_\sigma$, [ēmp]$_\sigma$[tus]$_\sigma$ because RP sequences occur word-finally (see 2.3.1.3) but PP sequences of the type $*pt*- are non-existent in the native Latin lexicon. In the case of Greek *léktron*, the winning candidate is [lék]$_\sigma$[tron]$_\sigma$, and not [lékt]$_\sigma$[ron]$_\sigma$ or [lé]$_\sigma$[ktron]$_\sigma$. All three candidates violate one or more word-to-syllable identity constraints. However, the most optimal form, [lék]$_\sigma$[tron], is chosen because it violates the fewest number of markedness, faithfulness and word-to-syllable identity constraints.[70]

(64) Greek *léktron* → [lék]$_\sigma$[tron]$_\sigma$

	/léktron/	LICENSE	W-S(I)	W-S(F)
a.	[lé]$_\sigma$[ktron]$_\sigma$	*!	*	
b.	[lékt]$_\sigma$[ron]$_\sigma$	*!		*
c. ☞	[lék]$_\sigma$[tron]$_\sigma$			*

68 How does one gauge 'similarity'? At this time, I have no good answer, which I acknowledge poses a major problem for my hypothesis. Though it is beyond the scope of this book to give an accurate metric on how one defines 'similarity', I refer the reader to Bailey & Hahn 2001 for a survey of numerous approaches.

69 LIV 179.

70 For this tableau I have posited an ad hoc, Greek-specific constraint LICENSE: 'Consonants must be properly licensed.'

It has also been noted that word-initial **r-* was blocked in Greek, Hittite and likely PIE, despite the fact that syllable-initial **r-* is almost certainly assured. Through our knowledge of Greek meter, we know that the first syllable of Greek *ára* was light and therefore was syllabified as $[\text{á}]_\sigma[\text{ra}]_\sigma$. Similarly, we may assume that PIE **h₂n̥rés* 'man (gen.sg.)' was syllabified as *$[\text{h}_2\text{n̥}]_\sigma[\text{rés}]_\sigma$, despite the *W-S(I) violation.[71] Both syllabify as such in order to satisfy the more highly ranking constraint, ONSET.

(65) Greek *ára*, PIE **h₂n̥rés*

/ára, *h₂n̥rés/			ONSET	W-S(I)
a.		$[\text{ár}]_\sigma[\text{a}]_\sigma$	*!	
b.	☞	$[\text{á}]_\sigma[\text{ra}]_\sigma$		*
c.		$[\text{h}_2\text{n̥r}]_\sigma[\text{és}]_\sigma$	*!	
d.	☞	$[\text{h}_2\text{n̥}]_\sigma[\text{rés}]_\sigma$		*

There is one remaining exception discussed in 2.5 that cannot be handled by the present formulation of the DT: extrasyllabicity. It is for this reason that the majority of scholars assume extrasyllabicity (a.k.a. edge effects, syllable appendices, etc.) as an additional theoretical mechanism in the study of syllabification. For example, Pierrehumbert (1997) was required to assume final extrasyllabic consonants in her analysis of medial consonant clusters in English, positing that any coronal obstruent in word-final position that does not follow a vowel, offglide or nasal is extrasyllabic. For instance, the /t/ in *weft* is extrasyllabic, whereas the /d/ in *mad* is not (Pierrehumbert 1997:172). This is confirmed by a lack of medial codas of the shape -ft$]_\sigma$ (^{X}*weft.kry*) and by the existence of medial codas of the shape -d$]_\sigma$ (*vod.ka*) in English. In the next chapter, we will see that it is also necessary to reconstruct extrasyllabicity in both word-initial and word-final position in Proto-Indo-European. This assumption will allow us to explain certain phonological rules of vowel epenthesis and consonant deletion in the PIE grammar.

2.4 Earlier Views of the Indo-European Syllable

As we have seen in the previous sections, syllabification may play a significant role in a language's phonology. In this section we will revisit the most notable

71 One wonders, though, if the syllabification of such forms fluctuated among speakers of Ancient Greek and PIE, if questioned, as was seen in the example of Eng. *lemon* above.

treatments of Indo-European syllabification in past scholarship, addressing which views to maintain, which to abandon, and which to improve upon.

The first comprehensive comparative treatment of IE syllabification was published nearly a hundred years ago by Eduard Hermann (1923). The bulk of this book is devoted to a survey of the synchronic evidence for syllable structure in all of the major IE branches but Anatolian (Albanian, Armenian, Balto-Slavic, Celtic, Greek, Indo-Iranian, Italic, Germanic and Tocharian), concluding with a brief discussion of Hermann's views of PIE syllabification. However, the scope of his investigation of PIE syllabification was fairly narrow, focusing solely on the problem of syllable division. Undoubtedly his most significant finding is showing that every sequence of the shape *VCCV in PIE was syllabified as *$[\mathrm{VC}]_\sigma[\mathrm{CV}]_\sigma$, even those where *CCV formed a legal syllable onset: PIE *$[\mathrm{put}]_\sigma[\mathrm{los}]_\sigma$ 'son' (not $^{\mathrm{X}}[\mathrm{pu}]_\sigma[\mathrm{tlos}]_\sigma$), *$[\mathrm{h_1es}]_\sigma[\mathrm{ti}]_\sigma$ 'is' (not $^{\mathrm{X}}[\mathrm{h_1e}]_\sigma[\mathrm{sti}]_\sigma$), *$[\mathrm{h_2\mathring{r}t}]_\sigma[\mathrm{kos}]_\sigma$ 'bear' (not $^{\mathrm{X}}[\mathrm{h_2\mathring{r}}]_\sigma[\mathrm{tkos}]_\sigma$). Hermann (1923:351) backs up his hypothesis with a considerable amount of evidence from Greek, Italic, Celtic, Germanic and Indo-Iranian, and points to a tendency for closed syllables to become open within the history of the majority of the Indo-European languages.

Many of Hermann's findings regarding PIE syllable division are upheld most recently in an important contribution by Keydana (2004), who gives one of the first up-to-date analyses of PIE phonology done within an OT framework. In this paper Keydana assumes the following syllable divisions in PIE:[72]

a. *VCCV → *$[\mathrm{VC}]_\sigma[\mathrm{CV}]_\sigma$
PIE **u̯itto-* 'known' → *$[\mathrm{u̯it}]_\sigma[\mathrm{to}]_\sigma$ → *$[\mathrm{u̯it}]_\sigma[\mathrm{sto}]_\sigma$
b. *VCRV → *$[\mathrm{VC}]_\sigma[\mathrm{RV}]_\sigma$
Gk. μέτρο- 'measure' → $[\mathrm{mét}]_\sigma[\mathrm{ro}]_\sigma$
c. *VCCRV → *$[\mathrm{VCC}]_\sigma[\mathrm{RV}]_\sigma$
Skt. *matsya-* 'fish' → $[\mathrm{mats}]_\sigma[\mathrm{ya}]_\sigma$; PIE **méttro-* → *$[\mathrm{mett}]_\sigma[\mathrm{ro}]_\sigma$ → *$[\mathrm{met}]_\sigma[\mathrm{ro}]_\sigma$

According to Keydana, these syllable divisions may be generated through the interaction of the following constraints:

72 See Keydana 2004:171ff. for discussion of *V{R,V}CCV sequences.

(66) Keydana's Syllabification Constraints

a. ⋆COMPLEXONSET: Onsets may not contain more than one consonant in the output. Assign one * for each instance.

b. NOCODA: No syllable may have any consonants in the coda. Assign one * for each instance.

c. ⋆COMPLEXCODA: Codas may not contain more than one consonant in the output. Assign one * for each instance.

In order to arrive at the syllable divisions he reconstructs for PIE, he assumes the following constraint ranking: ⋆COMPLEXONSET » NOCODA » ⋆COMPLEXCODA.

(67) PIE Syllabification (Keydana 2004)

/VCCV/, /VCRV/, /VCCRV/			⋆COMPONS	NOCODA	⋆COMPCODA
a.		V.CCV, V.CRV, VC.CRV	*!		
b.	☞	VC.CV, VC.RV, VCC.RV		*	(*)

Though Keydana's analysis nicely explains Hermann's reconstructions within an OT framework, it unfortunately encounters a number of exceptions. For instance, the parade example of PIE syllabification, */k̑u̯nbʰi̯s/ 'dogs (instr.pl.)', which is syllabified as *[k̑u̯n̥]$_\sigma$[bʰis]$_\sigma$ (> Skt. *śvabhis*) fails his rankings.[73]

(68) PIE */k̑u̯nbʰi̯s/ (Keydana 2004)

*/k̑u̯nbʰi̯s/			⋆COMPONS	NOCODA	⋆COMPCODA
a.	☹	*[k̑u̯n̥]$_\sigma$[bʰis]$_\sigma$	*!		
b.	☞	*[k̑un]$_\sigma$[bʰis]$_\sigma$		*	

One may avoid these results by following Keydana's own suggestion (2008) that there was a general tendency within PIE for coronal codas to be avoided in PIE, formalized through the reconstruction of a constraint ⋆R/C 'Coronal sonorants

73 The ☹ indicates a candidate that doesn't win, but should.

are blocked in coda position'.[74] While the ranking ⋆R/C » ⋆ComplexOnset will certainly produce the expected form *[k̂u̯n̥]$_\sigma$[bʰis]$_\sigma$, it still leaves instances such as **srutós* 'flowed',[75] **k̂litós* 'leaned'[76] and **k̂lutós* 'heard; famous'[77] unexplained. If simple codas were preferred over complex onsets (as given in Keydana's ranking ⋆ComplexOnset » NoCoda » ⋆ComplexCoda), then these forms should have been realized as ˣ*s̥r̥u̯tós*, ˣ*k̂l̥i̯tós*, and ˣ*k̂l̥u̯tós*, respectively.

Cluster division, of course, is not the only aspect of syllabification, nor is it the only one that has been investigated by scholars thus far. For example, we have known for quite some time what may act as a possible syllable nucleus in PIE—low vowels (**ĕ̄, *ŏ̄, *ă̄*), glides/high vowels (**ĭ̄, *ŭ̄*), liquids (**r̥, *l̥*) and nasals (**m̥, *n̥*). We are fairly certain that fricatives and stops never behaved as sonority peaks,[78] unlike, for example, in Imdlawn Tashlhiyt Berber.[79] This is grounded in the fact that no IE language suggests a reconstruction with a syllabic obstruent, as there are no words of the shape *CO̥C inherited in any IE language. For instance, there is no suggestion that the initial sequence of **psten-* 'breast' was syllabified as ˣ[ps̥]$_\sigma$[ten]$_\sigma$, the medial sequence of **s(u̯)ek̂sto-* 'sixth' as ˣ[s(u̯)e]$_\sigma$[k̂s̥]$_\sigma$[to]$_\sigma$ or the final sequence of **u̯ék̂st* 'carried' as ˣ[u̯ék̂]$_\sigma$[st̥]$_\sigma$. All evidence suggests that these sequences were bona fide consonant clusters.[80]

An important advance in our understanding of PIE syllabification was made by Meillet (1934:134–6), who first discussed the direction in which the rules of syllabification operate in PIE. In his *Introduction*, Meillet gives four distinct rules of the syllabification of sonorants in PIE, each based on the segments' surrounding environments:[81]

74 For further discussion, see section 4.1.1.

75 Ved. *srutá-*, Gk. ῥυτός, Lith. *srutà* and Latv. *strauts* (IEW 1003).

76 Ved. *śritá-*, Av. *srita-*, Gk. κλιτός (IEW 601).

77 Ved. *śrutá-*, Gk. κλυτός, Lat. *inclutus*, OIr. *cloth* (IEW 605).

78 The possibility of direct laryngeal vocalization aside.

79 See Dell & Elmedlawi 1985.

80 On the typological naturalness of the PIE syllabic sonorants, see most recently Cooper 2013.

81 Meillet gives a fifth 'rule' of syllabification (or lack thereof): "A l'initiale: il n'y a pas de règle générale" ("Word initially, there is no general rule."). I will address his observation later on in this section.

a. First: “If a sequence of two sonorants follows a vowel or is in the first syllable of a word : the first is consonantal, the second syllabic.”[82]
Examples
   a. PIE */sru̯-tó-s/ ‘flowed (masc.nom.sg.)’ → **srutós* > Skt. **srutáḥ*, Gk. ῥυτός
   b. PIE */k̂u̯n-bʰi̯s/ ‘dog (instr.pl)’ → **k̂u̯n̥bʰis* > Skt. *śvábhiḥ*
   c. PIE */gʷʰrn-su̯/ ‘mind (loc.pl)’ → **gʷʰr̥n-sú* → Gk. φρασί ‘mind; heart; diaphragm (dat.pl.)’ (IEW 496)
   d. */kʷetu̯r-to-s/ ‘fourth (masc.nom.sg.)’ → **kʷetu̯r̥tos* > OCS *četvrъtъ*
b. Second: “If a sequence of two sonorants follows a single consonant and precedes a vowel: the first is syllabic, the second consonantal.”[83]
Examples
   a. PIE */k̂u̯nés/ ‘dog (gen.sg.)’ → **k̂unés* > Skt. *śúnaḥ*, Gk. κυνός
   b. PIE */kʷetu̯r-es/ ‘four (nom.pl.)’ → **kʷetures* > Lith. *keturì* (cf. Skt. *catúraḥ* ‘four (acc.pl.)’)
   c. PIE */di̯u̯és/ ‘sky, sky god (gen.sg.)’ → **diu̯és* > Skt. *diváḥ*, Gk. Διός
   d. PIE */ĝʰi̯més/ ‘winter (gen.sg.)’ → **ĝʰimés* > Av. *zimō*, Gk. -χιμος, Skt. *himáḥ*
c. Third: “If a sequence of two sonorants follows a vowel and precedes either a consonant or the end of the word: the first is consonantal, the second syllabic.”[84]
Examples
   a. PIE */néu̯n/ ‘nine’ → **néu̯n̥* > Skt. *náva*, Lat. *novem*, Gk. ἐννέα;
   b. PIE */neu̯nti̯-/ → **neu̯n̥ti-* > Skt. *navatí-*, Av. *navaiti-* ‘ninety’.[85]
d. Fourth: “If a sequence of two sonorants stands between two vowels: the first forms the second half of a diphthong, the second is consonantal.”[86]
Examples
   a. PIE */oi̯u̯os/ ‘one’ → **oi̯u̯os* > Av. *aiva*, Cyp. *oiwos* ‘only’ (cf. OLat. *oinos*, Goth. *ains*, etc.)
   b. PIE */de/oru̯V-/ ‘oak (tree)’ → **deru̯V-* > Lith. *dervà*, OCS *drěvo*, Gaul. *derwen* ‘oak’, Gk. δουρός ‘tree; stick (gen.sg.)’ (< **doru̯ós*)

82 “Entre deux consonnes après syllable brève ou dans la syllabe initiale du mot: la première sonante est consonne, la seconde voyelle.”

83 “Entre consonne précédée de syllabe brève et voyelle: la première sonante est voyelle, la seconde consonne.”

84 “Après voyelle, devant consonne ou à la fin du mot: la première sonante est consonne, la seconde voyelle.”

85 IEW 318.

86 “Entre deux voyelles: la première sonante est second élément de diphtongue et l’autre est consonne.”

Schindler (1977a:56) recognized a broader pattern within Meillet's rules of PIE syllabification and very elegantly collapsed all four observations into one phonological rule. He understood that in PIE, if given two adjacent sonorants that are potential syllable nuclei, the rightmost was always chosen, if it was not adjacent to a 'true' vowel (**e, *a, *o*, etc.). Schindler formulated his rule as follows:

(69) Rule of PIE Syllabification (Schindler 1977a)

$$\begin{bmatrix} +son \\ -syll \end{bmatrix} \rightarrow [+syll] \,/\, \begin{Bmatrix} \text{-}syll, \\ \# \end{Bmatrix} \_ \begin{Bmatrix} \text{-}syll, \\ \# \end{Bmatrix}$$

(iterative from right to left)

Since publication, Schindler's 'right-to-left' formulation has been widely accepted by nearly all scholars to date and has become the standard view of PIE syllabification.

However, Schindler himself (1977a:56–7) recognized there to be five instances where this rule does not correctly predict the syllabification reconstructable for PIE.

(70) Exceptions to (59)

a. *#R̯R̯- ↛ *#R̥R̯-.
Roots of the shape *#R̯R̯-, such as **u̯i̯-*, **u̯l-*, and **mn-* are never realized as *#R̥R̯-, i.e. **ui̯V-*, **ulV-*, **m̥n-*, respectively. Examples include **u̯i̯eth$_2$-* (^{X}*ui̯eth$_2$-*) > Ved. *vyathate* 'rolls', **u̯reg-* (^{X}*ureg-*) > Ved. *vrá-jant-* 'going', and **mneh$_2$-* (^{X}*m̥neh$_2$-*) > Gk. ἔμνησα 'remembered'.

b. **-Cmn-* ↛ **-Cm̥n-*
Word-medial post-consonantal */mn/ is often reduced to *$_\sigma$[m- or *$_\sigma$[n- by the Asno Gesetz (Schmidt 1895).[87] Thus, PIE **ĝ^{h}ei̯mno-* 'winter', ultimately a derivative of *n*-stem **ĝ^{h}ei̯mn̥* (Hitt. *giman*, Gk. χεῖμα),[88] → *[ĝ^{h}ei̯]$_\sigma$[mno]$_\sigma$ → *[ĝ^{h}ei̯]$_\sigma$[mo]$_\sigma$ > Lith. *žiemìnis*,[89] not expected ^{X}[ĝ^{h}e][i̯m̥]$_\sigma$[no]$_\sigma$. We see a similar reduction in the oblique of **h$_2$ak̂mō* 'stone'; for instance, */h$_2$ek̂mnés/ 'stone (gen. sg.)' → *[h$_2$ak̂]$_\sigma$[mnés]$_\sigma$ → *[h$_2$ak̂]$_\sigma$[nés]$_\sigma$ > Skt. *aśnaḥ*, not expected ^{X}[h$_2$a]$_\sigma$[k̂m̥]$_\sigma$[nés]$_\sigma$.

87 See rule (9) for further discussion. Intervocalic *-*mn*- (presumably syllabified as *-m]$_\sigma$[n-) remained: cf. Skt. *nimná-* 'valley' (**nimno-*), Gk. πρύμνος 'prominent' (**promno-*), Hitt. *šaramna-* 'fore' (**sromno-*), Lat. *antemna* 'ship yard' (**h$_2$antimnah$_2$*), etc.

88 Itself a derivative of a root noun **ĝ^{h}ei̯m-* (Lat. *hiems*). See NIL 165–6.

89 With the secondary suffix *-*ino*-; cf. Gk. χειμερινός.

c. *CR$_1$R$_2$V ↛ *CR̥$_1$R$_2$V
There are rare instances where the sequence *CR$_1$R$_2$V is syllabified as [CR$_1$R̥$_2$]$_\sigma$[V]$_\sigma$ (thereby creating hiatus), if /CR$_1$R$_2$C/ → [CR$_1$R̥$_2$]$_\sigma$[C-]$_\sigma$ occurs elsewhere within same paradigm. Schindler (ibid.) cites two examples: PIE _*triōm_ 'three (gen.pl.)', which should have syllabified as ^{X}_tr̥i̯ōm_ if (according to Schindler) it had not been for _*tri-b^{h}is_ 'three (dat.pl.)', and Skt. _-v(i)yās_, not ^{X}_-uyās_, with _-vī_ (< _*-u̯ih$_2$_) as its nominative. It is striking that the Paradebeispiel of RR syllabification, */k̂u̯n-/ 'dog', does not follow this pattern: */k̂u̯n-és/ (*CR$_1$R$_2$V) → _*k̂unés_ (*CR̥$_1$R$_2$V) beside */k̂u̯n-b^{h}is/ (*CR$_1$R$_2$CV) → _*k̂u̯n̥-b^{h}is_ (*CR$_1$R̥$_2$CV).

d. *-R-m(s) ↛ *-R̥m(s)
In a much more widespread fashion, accusatives to sonorant final athematic nouns of the type _*-im, *-um(s), *-r̥m(s)_ are never syllabified as _*-i̯m̥, *-u̯m̥(s), *-rm̥(s)_, respectively. Thus, */ménti̯m/ 'mind (acc.sg.)' → *[mén]$_\sigma$[tim]$_\sigma$ (^{X}_ménti̯m̥_),*/s(e)uh$_x$num(s)/ 'son(s) (acc.)' → *[s(e)uh$_x$]$_\sigma$ [num(s)]$_\sigma$ (^{X}_s(e)uh$_x$nu̯m̥(s)_), and */pəh$_2$tr̥ms/ 'fathers (acc.)' → [*pəh$_2$]$_\sigma$[tr̥ms]$_\sigma$ (^{X}_pəh$_2$trm̥s_).

e. *CR-n-C- ↛ *CRn̥C-
The last—and undoubtedly most vexing—exception is the nasal-infixed present. While the strong stem poses no problem at all (thus a root of the shape */CeRC-/ + */ne-/ → *[CR̥]$_\sigma$[neC]$_\sigma$, the weak stem is particularly problematic: */Cr-n-C-/ → *[Cr̥n]$_\sigma$[C-. The classic example is PIE */i̯u̯ngénti/ 'they yoke' → *[i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$ (^{X}[i]$_\sigma$[u̯n̥]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$), continued by Lat. _iungunt_ 'they join', etc.[90]

While one may perhaps explain the exceptional syllabifications found in (60c) to analogy with other members of the paradigm, four exceptions still remain.

A more recent advance in our understanding of PIE syllabification is found in Kobayashi (2004:22), who correctly recognizes that the expression "right to left" in Schindler's formulation leads to overgeneration of nucleus placement. He suggests the following: "[i]f we can code the principle of minimizing the syllable coda in the procedure of nucleus placement itself, the use of such a directional expression will become unnecessary." Kobayashi's suggestion of coda minimization may be phrased in an opposite fashion: onset maximization.

90 As we will see in chapter 4, the usual explanation of "syllabification by analogy" in the case of the nasal-infixed presents is unlikely to be true.

(71) Onset Maximization (OM)
Syllabify as many consonants as possible within the onset.

This principle is neatly expressed through three constraints that Kobayashi assumes in the PIE grammar, HNUC, ALIGNNUC and ONSET.[91]

(72) Kobayashi's Syllabification Constraints[92]

a. HNUC: When there is more than one segment which can become the nucleus of a syllable, the nucleus is assigned to the one with the highest sonority. In the case of PIE */k̂u̯nb^{h}is/ inst.pl. 'dog,' this constraint requires *u̯ to be the nucleus (> ^{X}k̂unb^{h}is); when, on the other hand, *n becomes the nucleus (> *k̂u̯n̥b^{h}is), it is counted as a violation of this constraint.

b. ALIGNNUC: ALIGN(Nucleus, R, σ, R): Align the right edge of a syllable nucleus with the right edge of a syllable, i.e. minimize codas.

c. ONSET: A segment to the left of a syllable nucleus is an onset; in other words, diereses are not allowed. The candidate *k̂u.n̥.b^{h}is (> ^{X}śuabhis), in which both the adjoining sonorants become the nuclei of two separate syllables to better satisfy ALIGNNUC, is ruled out by the constraint.

In order to produce the desired syllabification of the parade example */k̂u̯nb^{h}i̯s/ as *[k̂u̯n̥]$_\sigma$[b^{h}is]$_\sigma$, Kobayashi ranks these three constraints as follows: ONSET » ALIGNNUC » HNUC.

(73) PIE *k̂u̯nb^{h}i̯s → *[k̂u̯n̥]$_\sigma$[b^{h}is]$_\sigma$

*/k̂u̯nb^{h}i̯s/			ONSET	ALIGNNUC	HNUC
a.		*[k̂un]$_\sigma$[b^{h}is]$_\sigma$		*!	
b.	☞	*[k̂u̯n̥]$_\sigma$[b^{h}is]$_\sigma$			*
c.		*[k̂u]$_\sigma$[n̥]$_\sigma$[b^{h}is]$_\sigma$	*!		

91 Frazier 2006:21 also assumes the principle of OM for PIE, through reconstruction of a high-ranking constraint NOCODA instead of ALIGNNUC. For our purposes, they are equivalent.

92 Taken from Kobayashi 2004:23.

The advantage that Kobayashi's analysis has over previous analyses is that it explains two of the exceptions given in (60), complex *#RR- onsets such as **u̯i̯eh$_1$t* 'turned' (a) and medial onsets of the shape **mn-* (b).[93]

(74) PIE **u̯i̯eh$_1$t* → *[u̯i̯eh$_1$t]$_\sigma$

*/u̯i̯eh$_1$t/			Onset	AlignNuc	Hnuc
a.		*[u]$_\sigma$[i̯eh$_1$t]$_\sigma$	*!		
b.	☞	*[u̯i̯eh$_1$t]$_\sigma$			

Because Kobayashi's Onset Maximization principle produces the same results as Schindler's 'right to left' formulation given in (59) and also provides a straightforward explanation for exceptions (60a) and (60b) above, it is clearly an improved hypothesis of PIE syllabification.

However, as convincingly demonstrated by Cooper (2012), Kobayashi's theory fails on other grounds. For starters, the widely-accepted assumption that VCCV sequences in PIE were syllabified as VC.CV (Hermann 1923) cannot be generated with these constraints and constraint ranking, and thus must be denied for PIE within his framework (cf. Byrd 2010b:38).

(75)

*/VCCV/			Onset	AlignNuc	Hnuc
a.	☹	*[VC]$_\sigma$[CV]$_\sigma$		*!	
b.	☞	*[V]$_\sigma$[CCV]$_\sigma$			

But more seriously, Cooper (2012:59) shows that Kobayashi's constraint ranking Onset » AlignNuc » Hnuc cannot generate the expected syllabification of forms such as */péru̯r/ as *[pér.u̯r̥] (Gk. πεῖραρ 'end; rope'), predicting instead ^{X}[pé.rur].[94]

(76)

*/péru̯r/			Onset	AlignNuc	Hnuc
a.	☹	*[pér]$_\sigma$[u̯r̥]$_\sigma$		*	*!
b.	☞	*[pé]$_\sigma$[rur]$_\sigma$		*	

93 Though syllabifications of the type *$h_2$ak̂mnés* 'stone (gen.sg.)' → *[h$_2$ak̂]$_\sigma$[mnés]$_\sigma$, with subsequent deletion to *[h$_2$ak̂]$_\sigma$[nés]$_\sigma$ (likely a postlexical rule; see section 5.3.1), are not generated by the constraints given in Kobayashi's analysis, we may safely view this type of syllabification as an instance of Onset Maximization.

94 Keydana's 2004 framework fails in this regard as well (Cooper, ibid.). The form *[pér.u̯r̥] will not be discussed beyond this point, though has a very straightforward explanation within our proposed framework. *[pér.u̯r̥] was syllabified as such in order to align morpheme boundaries with syllable boundaries; see ch. 5 and ch. 7 for further.

For this reason, in a meticulous cross-linguistic survey of nearly all possible analyses, Cooper argues in favor of positing an ALIGN constraint for PIE, one which aligns morae—not syllables—to the left edge of the prosodic word (Cooper 2012:88).[95]

(77) ALIGN-L(μ, PrWd): Align morae to the left edge of the prosodic word.

(78)

*/k̂u̯nbʰis/			DEP-V	ONSET	ALIGN-L
a.	☞	*[k̂u̯n̥]$_\sigma$[bʰis]$_\sigma$			11
b.		*[k̂un]$_\sigma$[bʰis]$_\sigma$			12!
c.		*[k̂u]$_\sigma$[n̥]$_\sigma$[bʰis]$_\sigma$		*!	12
d.		*[k̂u̯Vn]$_\sigma$[bʰis]$_\sigma$	*!		16

This formulation, however, still predicts onsets to be maximized in certain cases in word-medial position, such as */dru̯bʰ-i̯e-/ → ˣ[dru]$_\sigma$[bʰi̯e-]$_\sigma$, vs. expected *[drubʰ]$_\sigma$[i̯e-]$_\sigma$ (Gk. θρύπτω 'break'). For this reason Cooper proposes that complex onsets were largely only permitted in word-initial position in PIE and disfavored elsewhere, following Zoll (1998) in assuming that languages may only permit marked sequences in certain positions of the word.

(79) COINCIDE(complex onset, initial syllable): A complex onset belongs to an initial syllable.
  i. ∀x(x is a complex onset) → ∃y(y=initial syllable ^ COINCIDE (x,y))
  ii. Assess one mark for each value of x for which (i) is false

With the constraint ranking COINCIDE » ALIGN-L, Cooper is able to generate the correct results for both *[k̂u̯n̥]$_\sigma$[bʰis]$_\sigma$ (since here the complex onset is word-initial) and *[drubʰ]$_\sigma$[i̯e-]$_\sigma$:[96]

(80)

*/dʰru̯bʰ-i̯e-/			COINCIDE	DEP-V	ONSET	ALIGN-L
a.	☞	*[dʰrubʰ]$_\sigma$[i̯e-]$_\sigma$				10
b.		*[dʰru]$_\sigma$[bʰi̯e-]$_\sigma$	*!			7

However, there are two significant downsides to Cooper's analysis. First, both constraints suggested for PIE are to some extent ad hoc, as they are proposed by Cooper for his own analysis of PIE syllabification; one would prefer

95 The numbers written within the column ALIGN-L indicate the number of constraint violations.

96 The tableau given in 70 is an abridged version of the one given at Cooper 2012:393.

the constraints used in any phonological analysis of PIE to have widespread parallels within the languages of the world. Second, and more seriously, the evidence for such constraints is restricted to the proposed system of syllabification itself—there appear to be no other phonological processes that lend credence to his proposal. One would like to see some other reason to justify the hypothesis that morae were indeed aligned with the left edge of the prosodic word or that complex onsets were marked in word-medial position.[97] But these objections aside, Cooper's framework is a marked improvement over all previous analyses and therefore will be assumed as the starting hypothesis in our analysis of the Indo-European syllable which follows.

We have now surveyed a number of past views of IE syllabification, and it should be clear to all that the topic at hand is a complex one, with many questions remaining unanswered. Nevertheless, there remain scholars, especially within the "Leiden School", whose practice is not to indicate the syllabification (or more specifically, nucleus placement) of reconstructed PIE forms, arguing it to be "superfluous".[98] However, given the existence of the aforementioned exceptions to our understanding of Indo-European syllabification as well as reconstructable instances of apparent lexicalized syllabifications (cf. PIE **kur-*, not expected ^{X}*ku̯r̥-*, as continued by Hitt. *kūrkaš* 'foal' and Gk. κύρνος 'bastard'),[99] it is evident that the process of IE syllabification is NOT as straightforward as these scholars would lead us to believe. As Kobayashi (2004:21)[5] rightly points out, "Proto-Indo-European forms are not just a string of mechanically reconstructed symbols but are subject to phonological restrictions and well-formedness conditions, just like forms in ancient and modern languages." His insight into the problem is correct: PIE was a human language, and as such its speakers organized their speech sounds into syllables. Let us now see exactly how they did so.

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97 Pace Cooper 2012:392, it is far from clear that the *neognós* rule simplified a medial complex onset of the shape */Rh_x-/. Even if it did, word-initial */#Rh_x-/ could only have surfaced as *[R̥h_x- in PIE as there are no reconstructable #**Rh_x*- sequences, leading us to the conclusion that the sequence in question was equally marked no matter the position within the word.

98 Beekes 1995:125.

99 Melchert 1994:132. See chapter 4 for further discussion.

The Indo-European Syllable

Preliminaries

The Proposal

PART 2

The Proposal

CHAPTER 3

The Maximum Syllable Template

In the previous chapter, we established a universal means of predicting medial syllabification called the Decomposition Theorem (DT), but we were unable to account for the existence of extrasyllabic consonants in our model. This chapter will first begin with a discussion of the process of extrasyllabicity and will establish it as a feature within the PIE phonology, providing typological parallels when relevant. We will then proceed to examine particular phonological rules that occur in word-medial position, which I will claim were motivated by violations of syllable structure. These rules will allow us to formulate a PIE Maximum Syllable Template, which I postulate is the driving force behind at least six phonological processes: the *métron* rule, Lex Schmidt-Hackstein, the loss of **t* in PIIr. **$h_x$ok̂th$_x$tí-* 'eighty', schwa primum, schwa secundum, and sonorant syllabification.[1]

3.1 Past Uses of the Decomposition Theorem in Indo-European Studies

The DT has been used before in various studies of Indo-European phonology, though never by that particular name. Both Juret (1913) and Wolff (1921) implied DT-like explanations for various phonological changes within the prehistories of Latin and Germanic, respectively. In his 1923 treatment of IE syllabification, Hermann argued against both scholars, demonstrating that the use of the DT in their analyses leads to false conclusions. Against Juret, Hermann (1923:214–216) pointed out that if *Ses.tius* reflected *Seks.tius* one would expect the same simplification of **ks* in *rēx* and *coniux*. Against Wolff, Hermann (1923:271–272) pointed out that if the cluster *VχsCV* was simplified to *VsCV* in German because *s* closed the syllable, the same treatment would also be expected in *sechs*. In both instances, Hermann comes to the conclusion that the reason for simplification is that the clusters themselves were bad, regardless of syllable structure. This leads him to conclude that in an analysis of PIE syllabification (1923:360): "Scrutinizing the beginnings and ends of words doesn't work [in determining

1 The following is a revised and expanded version of Byrd 2012.

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the syllabification of] multipartite consonant groups in the middle of the word."[2]

Where Hermann is incorrect, however, is his assumption that word-edge onsets and codas have a status equal to those in word-medial position. As we saw earlier in section 2.3.1.5, it is possible for a language to permit consonant clusters in a word-initial onset or a word-final coda, but not allow those same clusters in the middle of a word. Word edges are known to license special syllable structures, and certain consonants or consonant sequences may not be incorporated into the onset or the coda of the syllable in question. When these segments occur in medial position they cannot be syllabified, and so they are either deleted through STRAY ERASURE or supported through STRAY EPENTHESIS (Itô 1988).

These segments are called extrasyllabic.[3] Extrasyllabic segments must be: **consonants**—vowels cannot be extrasyllabic—and **at word's edge**—segments must be peripheral (Hdouch 2008:69).[4] As discussed by Bagemihl (1991:625): "… segments must belong to syllables, syllables to metrical feet, and metrical feet to phonological words or phrases. The only way that a segment can avoid being syllabified is through extraprosodicity [for our purposes, extrasyllabicity (AMB)], which is only available at the edges of well-defined domains (usually words). If a segment is not licensed through either syllabification or extraprosodicity, it is subject to one of two operations: the language may undergo a process of STRAY EPENTHESIS, in which case a degenerate syllable is assigned to the stray consonant (this syllable will ultimately receive a vocalic nucleus through default rules). Otherwise, unsyllabified segments are subject to the process of STRAY ERASURE …, which deletes all unlicensed material from the

2 "Das Schielen nach dem Wortanfang und Wortende nützt also bei den mehrteiligen Konsonantengruppen des Wortinnern nichts."

3 See Vaux and Wolfe 2009 for the most recent defense of extrasyllabicity.

4 Lunden (2006) suggests that word-final extrasyllabicity is ultimately due to word-, phrase- and utterance-final lengthening, whose purpose is to make the boundaries of prosodic categories easier to perceive. This phenomenon is found in all of the world's languages, including sign language, as well as in music. Lunden demonstrates that if a shorter and a longer duration are increased by the same amount, listeners will perceive the increase to the shorter duration as the greater one. Thus, in non-final position a coda consonant will create length that distinguishes itself from a CV syllable, but in final position the increase in duration is not sufficient to metrically distinguish it from the syllable shape CV. In short, Lunden demonstrates that the reason certain languages allow super-heavy syllables only in absolute word-final position is that they are perceived as heavy syllables, providing a perceptual reason for the existence of extrasyllabic consonants in word-final position.

representation."[5] Thus we may be able to explain certain instances of medial consonant deletion in PIE as the result of STRAY ERASURE, when the segment is not licensed through syllabification or extrasyllabicity.

Examples like these abound in the phonological literature within languages both Indo-European and non.[6] A well-known example comes from Modern Icelandic, as discussed by Vennemann (1972:11). Here there is a rule in which a *t* is deleted in between an *s* and another consonant, except when the consonant is *r*. Thus, /t/ is lost in /sɪstkɪn/ → [sískjɪn] 'siblings', but not in /vestra/ → [vɛ́stra] 'in the west'. As Vennemann notes, the DT predicts that *-str-* may be syllabified as *s.tr* in word-medial position, as *s#* and *#tr-* are both legal margins in Icelandic. On the other hand, it predicts that *stk* cannot be syllabified either as *st.k* or as *s.tk*, since neither *st#* nor *#tk* is a legal syllable margin in Modern Icelandic.[7] The consonant /t/ cannot be syllabified and is therefore deleted via STRAY ERASURE. On the other hand, in Negev Bedouin Arabic (McCarthy 1994:213–4) there is a prohibition against syllable-final gutturals preceded by *a*: CaGCVC → CaGaCVC (where C = any consonant and G = any guttural). One finds *ašrab* 'I drink' alongside *aħalam* (/aħlam/) 'I dream' and *tašrab* 'you drink' beside *taħalam* (/taħlam/) 'you dream'. Epenthesis does not occur after word-final or stem-final gutturals: *rawwaħ/rawwaħna* 'he/we went home'. Word- and stem-finally, the guttural is tolerated via extrasyllabicity, but word-medially the guttural must be licensed to a syllable, and it is for this reason that STRAY EPENTHESIS occurs. Thus we see that the process of syllabification plays a central role in determining legal sequences in a language, and if the sequence proves to be illegal, either deletion or epenthesis may take place.

Just as in Icelandic and Negev Bedouin Arabic, certain unsyllabifiable consonants within certain sequences were allowed to be extrasyllabic at word's edge in PIE. However, if unsyllabifiable consonants occurred in a context where they could not be realized as extrasyllabic (namely in word-medial position), the illicit sequence in question was repaired. As we shall see, a PIE speaker could repair the sequence in question in one of three ways: resonant vocalization, STRAY EPENTHESIS, or STRAY ERASURE.

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5 For a perceptual account of edge effects and processes of STRAY ERASURE and STRAY EPENTHESIS, see Côté 2000:267ff.

6 Scholars have proposed a number of stray processes to occur in the attested IE languages: Hittite (Kavitskaya 2001), Sanskrit (Steriade 1988, Kobayashi 2004), Greek (Steriade 1982, Zukoff, forthcoming), late Latin (Itô 1986), German (Wiese 1996), Polish (Rubach 1997), to name a few.

7 Note that in word-final *-st* clusters (e.g. *breytast* 'gets dressed'), the /t/ is 'extrasyllabic' and therefore does not constitute an actual coda *st#*.

3.2 A First Look at Stray Erasure: Lex Schmidt-Hackstein

Let us begin with processes of Stray Erasure, examining first the PIE laryngeal loss rule CHCC > CCC, focusing in particular on Hackstein's 2002 formulation (Lex Schmidt-Hackstein). The starting point to this discussion is the PIE word for 'daughter'. It is widely agreed that there are two variants of the word for 'daughter' reconstructable for PIE: one with a laryngeal, **dʰugh₂ter-*, and one without, **dʰukter-*.[8] The former is continued in numerous languages (Skt. *duhitár-*, GAv. *dugᵊdar-*, Gk. θυγάτερ-, TA *ckācar*, TB *tkācer*), where we find the expected outcome of an interconsonantal **h₂*, namely a vocalic reflex (Skt. *i*, Gk. α and Toch. *ā*)[9] or deletion (Av. *dugᵊdar-*). The latter form, **dʰukter-*, is only unambiguously continued by Iranian **duxϑrī-* (OPers. **duhçī-*) and **duxtar-* (NPers. *duxtar*),[10] Gaul. *duxtir*,[11] Goth. *dáuhtar*[12] and possibly Osc. **fuutreí** 'girl (dat.sg.)',[13] Arm. *dstr*[14] and HLuv. *t(u)watra/i-*, Lyc.

8 */dʰugter/; */g/ is devoiced via laryngeal feature neutralization, as discussed in section 1.2.3.

9 Mayrhofer 1986:136ff.

10 On April 17, 2009 at the Sound of Indo-European conference in Copenhagen, Denmark, Agnes Korn kindly suggested to me that *duxt(a)r-* should rather be viewed as a reflex of YAv. *duγδ(a)r-* by a process of fricative devoicing, as is seen in GAv. *aogᵊdā* 'speak (3rd sg. act. impfct.)' > **aoγδa* > YAv. *aoxta*. This is a possibility only if fricative devoicing may be demonstrated to have existed in all Iranian languages that attest to **duxt(a)r-*. However, according to Hoffmann-Forssman 2004:95, the replacement of expected **aoγδa* (< *aogᵊdā*) with *aoxta* is not phonological, but rather strictly analogical (cf. YAv. *saēta*, *staota* 'praised' with -ta; Hoffmann-Forssman 2004:204). Note that YAv. shows not *duxt(a)r-*, but rather *duγδ(a)r-* (< *dugᵊdar-*), with expected fricativization of obstruent cluster. If *aoxta* were the result of a phonological rule of fricative devoicing, why does this not also occur in 'daughter'?

11 If Zair 2012 is correct in postulating that laryngeals were regularly lost in the environment VC_T{V/#} in Proto-Celtic, Gaul. *duxtir* would not provide conclusive evidence of CHCC > CCC in Celtic.

12 Ringe 2006:138.

13 < PItal. **fuχtrei̯* (de Vaan 2008:253). The normal outcome of a cluster *-kt- is -ht- in Oscan, not -t- with compensatory lengthening. For discussion of this form with references see Untermann 2000:306–7 and de Vaan 2008:253.

14 According to Hamp 1970, Clackson 1994:166–7, Olsen 1999:148,768, Martirosyan 2010:244–5, and Martin Macak (p.c., 5/2013), this deletion must be traced back to PIE. CHCC > CCC may be assumed if one follows Muller 1984 and Beekes 1988:77, who propose that the normal development of medial laryngeals in Armenian is loss before a single consonant, vocalization before a cluster.

kbatra- 'daughter',[15] since Slav. **dъšti*,[16] and Lith. *duktė̃*[17] may be derived from either form.

3.2.1 *Evidence and Past Scholarship*

Gernot Schmidt (1973) was the first to examine these two variants in detail. The focal point of his discussion deals with sorting out the multiplicity of forms in the Iranian languages. While Sanskrit only shows one variant (*duhitár-*), there are three in Iranian (Schmidt 1973:38): **dugdar-* (GAv. *dugᵊdar-*), **duxϑrī* (Old Persian **duhçī-*, Modern Persian *došī-zah* 'young girl') and **duxtar-* (Modern Persion *duxtar*). Schmidt convincingly shows that the latter two forms must derive from a sequence **dʰukt(e)r-*, since Bartholomae's Law does not occur in these forms (Schmidt 1973:54). Bartholomae's Law, which is often called the 'Buddha rule'[18] and is to be reconstructed back at least as early as Proto-Indo-Iranian (PIIr.), involves the progressive transfer of laryngeal features (voicing and aspiration) from a voiced aspirate onto the following voiceless segment (Kobayashi 2004:115ff.): PIE **dʰugh₂ter-* > PIIr. **dʰugʰh₂tar-* > PIr. **dʰugʰdʰar-* > PIr. **dʰugdar-* > Av. *dugᵊdar-*.

To explain the two variants of 'daughter' reconstructed, Schmidt (1973) sets up the following linear phonological rule for PIE.

(81) CHCC > CCC (Schmidt)
$*H \rightarrow \varnothing$ / C_CC
A laryngeal is lost in the second position of a sequence of four consonants.

Deletion presumably occurred in the oblique stem, which contained the sequence *CHCC: */dʰugh₂trés/ 'daughter (gen.sg.)' → **dʰuktrés*.[19] The oblique

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15 Melchert 1994:69 assumes loss of **h₂* with later anaptyxis in the cluster **-gtr-*: **dʰugh₂tr-* > **dugtr-* > **dugₑtr-* > **dugatr-*. Kloekhorst 2008:902–4 assumes a highly archaic PIE *dʰu̯egh₂tr-* > *dʰu̯egtr-* > *dʰu̯atr-*, with expected **g* deletion in Luvian and Lycian. In both scenarios, CHCC > CCC, though it remains unclear to me why */g/ would have not been realized as **k* in this position in Anatolian, as we see elsewhere in IE.

16 Derksen 2008:129.

17 Ibid.

18 The form *buddha* derives from *budh-* 'be awake' + *-ta-*, a past (passive) participial suffix.

19 Peters (apud Mayrhofer 1981:436, 1986:138[172]) restricts Schmidt's laryngeal deletion rule to the sequence $*\mathrm{CHCCV}_{[+stress]}$:

(1) CHCC > CCC (Peters).
$*H \rightarrow \varnothing$ / $\mathrm{C\_CCV}_{[+stress]}$
A laryngeal is lost if it is in second position in a sequence of four consonants if the accent follows the cluster.

(or weak) stem differs from the strong stem in where the accent was located and which part of the stem had a vowel. For example, in the strong stem **dʰugh₂-tér-*, accented **é* was found in the suffix, while in the oblique stem the accent and vowel were located in the ending (**dʰug(h₂)-tr-és* 'daughter (gen.sg.)').[20]

Further instances of the CHCC > CCC rule may be seen in the following:[21]

a. Alternation between Skt. strong stem *janima* 'birth' < **ĝenh₁-mn̥* and oblique *janman-* < **ĝenh₁-mn-* ← */ĝenh₁-mn-/, to which may be compared Dor. Gk. γέννᾱ 'descent' < **ĝénh₁mnah₂*, Skt. *jantú-* 'person' (< oblique */ĝenh₁-tu̯-/).[22] Root in question: PIE ****ĝenh₁***- (IEW 373–5; LIV 163–5).
b. Lat. *verbum*, Hesych. ἔρθει · φθέγγεται 'speaks' from */u̯erh₁-dʰh₁-o-/; cf. Gk. ῥῆμα, TA *wram* 'thing'. Lith. *var̃das* 'name' is ambiguous, as laryngeal loss in */u̯orh₁-dʰh₁-o-/ may also be attributed to the Saussure-Hirt Effect (see Nussbaum 1997 and Yamazaki 2009, with references). Root in question: ****u̯erh₁***- (IEW 1162–3; LIV 689–90).
c. OIr. *fo·ceird* 'places', from */kerhₓ-dʰh₁-o-/; cf. Ved. *kiráti* 'spreads, pours out'. Root in question: PIE ****kerhₓ***- 'spread, pour out' (IEW 933–5; LIV 353–4).
d. Hitt. *paltsḫa-* 'pediment', from PIE */pl̥th₂-s-h₂-ó-/ (Melchert 1994:69) and TB *plätk-* 'step forward', from PIE /plth₂-sḱé/ó-/ 'stretch out' (via **pl̥tsḱé/ó-*); cf. Ved. *prathāná-* 'spreading out'. Root in question: PIE ****pleth₂***- (IEW 833; LIV 486–7).
e. PIE **ĝʰdʰi̯és* 'yesterday', from */ĝʰh₁-di̯-és/;[23] cf. Ved. *hyás*, Gk. (ἐ)χθές, Lat. *herī*, OIr. *in-dé*, Wel. *doe*, Alb. *dje*, PGmc. **gestra-* (Goth. *gistra-dagis*, OE *geostra*, etc.). Root in question: ****ĝʰ(o)h₁*** 'back, beyond' (IEW 416).
f. Perhaps Proto-Celtic **sexskā/i-* 'rushes, sedge' (Matasović 2009:331), from */sekh₁skV-/ (via **seksk-*). Cf. OIr. *seisc*, MWel. *hescenn*, MBret. *hesq*, etc. Root in question: PIE ****sekh₁***- 'cut' (IEW 895–6; LIV 524; Jasanoff 2003:80).

However, neither discussion provides any instances of laryngeal retention in the sequence V́CHCC-, and therefore I fail to see any benefit to such a modification of Schmidt's original rule.

20 For more details on these alternations see Fortson 2010:79ff.

21 Items a.-d., g., and i. have been taken from Hackstein 2002, to which I refer the reader for additional (and at times less certain) examples. See Zair 2012:162–8 for further possible examples, with discussion.

22 It seems unlikely that CHCC > CCC is reflected in Lat. *germen* 'seed' (*ˣgenimen*), though this possibility should not be ruled out entirely. See de 2008:Vaan 261 for discussion.

23 Proposed by Vine (2008:17). See Hackstein 2014, however, for a different view.

g. Ved. *mahnā́* 'size, power (instr.sg.)', perhaps from */meĝ$h_2$mnéh_1/, with later **m* deletion by the *asno* law (NIL 473).[24] Stem in question: PIE ***meĝh₂**-* (IEW 708ff.; NIL 468ff.).

h. MWel. *kyscaf* 'sleeps', from **kufské/ó- < *kupské/ó-* ← */kub$h_2$ské/ó-/ (Schumacher 2000:87[74]); cf. Lat. *-cumbō* 'lie down'. Root in question: PIE ***keu̯bh**$_2$-* (IEW 590; LIV 357–8).

i. Lastly, perhaps the most compelling evidence for the rule in question comes primarily (but not exclusively) from Tocharian, through the continuation of the sequence */-$d^h h_1$sk̂é/ó-/ in certain words.[25] Root in question: PIE ***d^heh_1**-* (IEW 235–9; LIV 136–8):
   a. TB *kätk-* 'arrange' < **k̂é tsk̂e/o-* ← */k̂é $d^h h_1$sk̂e/o-/; cf. **k̂e/*k̂o-* 'here' (IEW 609–10) in Arm. *s-a* 'this', Lat. *ce-do* 'gimme, hand it over', Eng. *he*, etc.
   b. TB *wätk^a-* 'decide, command' < **u̯i tsk̂e/o-* ← */u̯i $d^h h_1$-sk̂e/o-/; cf. Skt. *vidh-* 'allot, satisfy'.[26]
   c. Toch. *kātk-* 'be happy' < **ga(h_2) tsk̂é/ó-*← */gah_2 + $d^h h_1$-sk̂é/ó-/; cf. Gk. γηθέω and Lat. *gaudēre* (< **gáh_2 u̯i d^heh_1-*).
   d. Lat. *suēscō* 'am accustomed' < **su̯é tsk̂e/o-* ← */su̯é + $d^h h_1$-sk̂e/o-/; cf. Ved. *svadhā́* 'habitual state'.

Keydana (2004:172) has argued against the assumption of the CHCC > CCC rule on theoretical grounds, since, according to him, it would be impossible for both vowel epenthesis and consonant deletion to have occurred in such similar sequences in the same synchronic system using an OT framework (which, of course, we will also be using here). His scenario, however, may be disputed on at least two grounds. First, as argued in section 1.2.2, it is not assured that the laryngeals were 'vocalized' in the sequence *VCHCV in PIE—in fact, it is simplest to assume that those language (sub-)families that vocalized, did so independently, as did those languages which deleted laryngeals in this sequence.

However, even if we were to assume that laryngeal vocalization (or epenthesis) 'fixed' intervocalic consonant clusters of the shape *-CHC- in PIE, it would still be unproblematic to set up a phonological rule CHCC > CCC within an OT framework, provided that the CHCC > CCC rule occurred at a different

24 See (9).

25 Also from Hackstein 2002, who builds upon work done by Melchert 1977 and Jasanoff 1978:38.

26 Hackstein 2002:8 also entertains the possibility that TB *wätk^a-* derives from PIE **uth_2-sk̂é/ó-*, a *-sk̂é/ó-* formation to **u̯eth_2-* 'say' (LIV 694–5), seen in OLat. *votāre* 'prohibit', OIr. *as:pena* 'witnesses'.

point in time (or at a different point in the derivation) than did vowel epenthesis in the sequence *-CHC-. We could accept this on blind faith, since there's no particular reason to believe that both rules occurred at the same point in time. Or, should we accept that the vocalization of *H in intervocalic *CHC sequences is einzelsprachlich, the archaicness of the CHCC > CCC rule relative thereto may be established, since the CHCC > CCC rule can be shown to have occurred both in dialects that 'vocalize' laryngeals in intervocalic *CHC clusters as well as in those dialects that do not. For example, we find that CHCC > CCC occurs in Proto-Italic (_*fuχtrei̯_ < _*d^{h}ug(h$_2$)tréi̯_; cf. de Vaan 2008:253), a language which vocalizes *VCHCV to *VCaCV: Lat. _animus_ < PItal. _*anamos_ < PIE _*h$_2$anh$_1$mos_. On the other side, we find evidence of CHCC > CCC in Anatolian (cf. Hitt. _palzaḫḫa-_ 'pediment' < _*pl̥tsh$_2$ó-_ ← */pl̥th$_2$sh$_2$ó-/[27] 'broad area'; Melchert 1994:69), which does not vocalize laryngeals in the intervocalic sequence *CHC (Melchert 1994:65). The sequence *-Ch$_{1/3}$C- undergoes deletion, not epenthesis, in _*u̯orh$_1$ĝent-_ > _úarkant-_ 'fat',[28] _*h$_1$ómh$_1$sei̯_ > Hitt. _ānši_ 'he wipes'[29] and likely _*h$_2$arh$_3$sei̯_ > _*ḫarši_ 'he furrows',[30] and *-Ch$_2$C- either retains its laryngeal or deletes it, depending on the cluster in question; cf. _*b^{h}érh$_2$ti_ > _parḫzi_ 'chases' with retention in the sequence *-Rh$_2$C-,[31] but with deletion in *-Th$_2$C-: _*h$_2$u̯edh$_2$-i̯e/o-_ > Hitt. _ḫu̯etti(i)ya-_ 'pull, draw'.[32]

In order to accept Schmidt's CHCC > CCC rule for the protolanguage, we would therefore need to postulate that at the time the sequence *CHCC was disfavored, the relevant constraint ranking was DEP-V >> MAX-C;[33] in other words, it was more important for IE speakers not to epenthesize a vowel to fix the sequence *CHCC than it was to delete a consonant. At a later date, however, be it in late PIE or within the individual languages, this constraint ranking

27 This form is a 'transponat', one that likely never existed as such in PIE, but will be presented as a PIE form for expositional purposes.

28 Kloekhorst 2008:81.

29 Cf. Kloekhorst 2008:72.

30 Analogically replaced by _ḫaršzi_ according to Kloekhorst 2008:313. See also LIV 272–3, with references.

31 Kloekhorst 2008:634–5 reconstructs _*b^{h}érh$_{2/3}$ti_. Setting the ambiguity of the laryngeal aside, for our purposes the reader should simply note that Hittite illustrates undeniable cases of laryngeal retention and deletion with NO inherited vowel epenthesis.

32 Melchert 1994:65ff. A careful reader will note the violation of Pinault's Law here (see chapter 6).

33 Should one prefer to work with true 'vocalized' laryngeals (i.e. _*h̥$_x$_), one could substitute Dep-V with IDENT(σ) 'Do not alter the value of the feature [syllabic]. Assign one * for every instance in the output where this feature has been altered.' See section 5.3.4.

was reversed, which allowed for vowel epenthesis (vocalization) to occur in complex sequences containing laryngeals in word-medial position.[34]

$$\begin{gathered} {}^{\star}\text{CHCC} >> \textsc{Dep-V} >> \textsc{Max-C} >> {}^{\star}\text{VCHCV} \\ (*[\text{d}^\text{h}\text{uk}]_\sigma[\text{trés}]_\sigma,\ *[\text{d}^\text{h}\text{ug}]_\sigma[\text{h}_2\text{tḗr}]_\sigma) \\ \downarrow \\ {}^{\star}\text{CHCC},\ {}^{\star}\text{VCHCV} >> \textsc{Max-C} >> \textsc{Dep-V} \\ (*[\text{d}^\text{h}\text{ug}]_\sigma[\text{h}_2\text{ə}]_\sigma[\text{trés}]_\sigma,^{35}\ *[\text{d}^\text{h}\text{ug}]_\sigma[\text{h}_2\text{ə}]_\sigma[\text{tḗr}]_\sigma) \end{gathered}$$

If, as I have suggested above, laryngeal vocalization did not occur in the PIE sequence *VCHCV, then only those languages which show vocalization, and not deletion, necessarily reversed the inherited PIE constraint ranking Dep-V >> Max-C; language groups such as Balto-Slavic and Iranian retain the older configuration.[36]

3.2.2 *Counterexamples*

Despite the many attractive examples of laryngeal loss in the environment CHCC, there are numerous counterexamples that contradict both Schmidt's (and Peters') CHCC > CCC rule, presented in (72) and (73), respectively (Hackstein 2002:10–11).[37] The counterexamples in (73) will be discussed in section 3.3.5 below.

34 The constraints *CHCC and *VCHCV stand for 'The sequence *CHCC is prohibited in the output.' and 'The sequence *VCHCV is prohibited in the output.', respectively.

35 Cf. Skt. *duhitúr*, Gk. θυγατρός. Of course, if a language continues the more archaic oblique form with laryngeal deletion, the form would remain as *[d^huk]$_\sigma$[trés]$_\sigma$.

36 As we will see in chapter 5, there is reason to believe that in PIE Dep-V >> Max-C at the stem level of the grammar, but this constraint ranking was reversed at the postlexical level. It is therefore conceivable that the rule *∅→ *[ə] / VCh$_x$_CV originated as a postlexical process in PIE, which was only continued by certain languages. This would entail that the CHCC > CCC rule and the vocalization rule could actually have existed within the same time frame, though at different lexical levels, thereby bringing the number of possible scenarios under which the CHCC > CCC rule may have existed in the PIE grammar to three.

37 Hackstein provides two additional examples, Toch. *nāsk-* 'spin, yarn' and Toch. *nāsk-* 'bathe, wash', which he proposes are derived from *$snh_1s\hat{k}\acute{e}/\acute{o}$-, with a secondarily introduced consonant cluster CCHCC-. I have omitted both of these forms from my study, since neither form was syllabified as **snHsk̂é/ó-* (vs. **sn̥Hsk̂é/ó-*) in PIE and therefore did not possess a quadripartite consonant cluster CHCC, the structural description for Schmidt's laryngeal loss rule, as given in (71).

(82) Counterexamples to CHCC > CCC: Word-Initial Position

a. *_d^{h}əh$_1$s-nó-_ > *_fasno-_ > Lat. _fānum_ ‘temple’; cf. Skt. _dhiṣṇ̣ya-_ ‘pious; mindful’

b. *_pəh$_2$-sk̂é/ó-_ > TB _pāsk-_ ‘protect, observe, retain’

c. *_dah$_2$-su̯é_ → *_dəh$_2$-su̯é_ > Skt. _dīṣva_ ‘dole out!’

d. *_stəh$_2$-mn-ó-_ > OIr. _taman_ ‘treetrunk’,[38] Gk. σταμνός ‘big drinking mug’, TB _stām_ ‘tree’, pl. _stāna_

e. *_dəh$_1$-mn-ó-_ > Gk. δέμνια ‘bed, repository’, Ion. κρήδεμνον ‘headband’

f. *_dəh$_3$ĝ^{h}mó-_ ‘askew’ > Gk. δοχμός, Skt. _jihmá-_ ‘id.’[39]

g. *_pəh$_2$trés_ ‘father (gen.sg.)’ > Lat. _patris_, Skt. _pitúr_, etc.

(83) Counterexamples to CHCC > CCC: Word-Internal Position

a. *_k̂erh$_2$srom_ > Lat. _cerebrum_ ‘brain’

b. *_temh$_x$srah$_2$_ > Skt. _tamisrā_, Lat. _tenebrae_ ‘darkness’[40]

c. *_ĝenh$_1$trih$_2$_ > Lat. _genitrix_, Ved. _jánitrī-_ ‘bearer, mother’

d. *_ĝenh$_1$d^{h}lo-_ > Gk. γένεθλον ‘relative’

e. *_h$_2$arh$_3$trom_ > Gk. ἄροτρον, OIr. _arathar_,[41] Arm. _arawr_ ‘plow’[42]

f. *_(h$_x$)i̯enh$_2$trih$_2$-_ > Lat. _ianitrīcēs_ ‘brothers’ wives’[43]

g. *_terh$_1$trom_ ‘auger’ > Gk. τέρετρον, OIr. _tarathar_[44]

If CHCC > CCC is strictly a linear rule as per Schmidt, we would expect laryngeal loss in each of the examples in (72) and (73) above. While some of the examples may be explained by analogy, such as Skt. _dīṣva_[45] or Lat. _fānum_,[46] it would be difficult to account for vowel epenthesis in an example such as

38 For a different etymology, cf. Joseph 1982:36ff.

39 <*_ž́iž́^{h}má-_ < PInd. *_diž́^{h}má-_. See Beekes 1969:183, EWAia I:591 and IEW 181, with references.

40 Cf. OHG _dinstar_ ‘dark’, Lith. _tim̃sras_ ‘dark red’, with expected (likely inner-dialectal) deletion (IEW 1064).

41 Cf. OWel. _arater_, Wel. _aradr_, OCorn. _aradar_, MBret. _arazr_, Bret. _arar_ ‘plow’.

42 Lat. _arātrum_ may or may not belong here, as this form could be a remodeling of an inherited *_aratrom_ or simply derive from the verb _arāre_ ‘to plow’ (Weiss 2009:283). It is impossible to tell.

43 Cf. Gk. εἰνατέρες, Arm. _nēr_, Ved. _yātar-_, etc. See NIL 204–7 and Kölligen 2012 for discussion.

44 Also Wel. _taradr_, Corn. _tardar_, MBret. _tarazr_ (Joseph 1982:41–2). Cf. Lat. _terebrā_ ‘auger’ < *_terh$_1$srah$_2$_ (Schrijver 1991:210).

45 That is to say, PIE *_dh$_2$su̯-_ > *_tsu̯-_ (with voicing assimilation) → *_d(ə)h$_2$su̯-_, by analogy with such forms as *_dah$_2$t_ ‘(s)he shared (aor.)’ (> Skt. _áva adāt_ ‘(s)he divided’; LIV 103–4).

46 One could conceivably argue for the following scenario: _d^{h}h$_1$sno-_ > *_tsno-_ → *_d^h(ə)h$_1$sno-_, with reinsertion of laryngeal from the full-grade stem *_d^{h}eh$_1$s-_, as continued by Osc.-Umb.

**dəh₃ĝʰmo-* 'askew' through a non-phonological process, since there is no other evidence for a root **doh₃ĝ-* attested in IE.

3.2.3 *Hackstein's Syllable-Based Treatment of CHCC > CCC*

Hackstein (2002) noted that all of the exceptions in (72) are easily explained if one assumes a syllable boundary in Schmidt's laryngeal loss rule, as given in (74).

(84) CH.CC > C.CC (Hackstein)
*H → ∅ / C_$CC
A post-consonantal laryngeal is lost at a syllable boundary before two consonants.

Hackstein's reformulation nicely handles all of the counterexamples given in (72). In words such as **dʰəh₁snó-* and **pəh₂trés*, **hₓ* did not immediately precede a syllable boundary since it was a member of an underlyingly tautosyllabic quadripartite consonant cluster.

Hackstein, however, does not discuss the conditions for syllabification in PIE or how one determines the location of the syllable boundary in the sequence *CHCC. Moreover, why does laryngeal deletion only occur at a syllable boundary, whereas elsewhere we find vowel epenthesis (vocalization)? And lastly, and in my opinion most crucially, does the rule CH.CC > C.CC result from something inherently "bad" about the sequence CH.CC or is it the product of a more general phonological tendency within the PIE grammar?

3.3 Deducing Indo-European Syllabification

Although Hackstein was unable to demonstrate that the PIE medial sequence *CHCC was syllabified as *CH.CC in a conclusive manner, it is clear that laryngeal deletion in the sequence *CHCC *is* better explained if a syllable boundary is introduced. Fortunately the Decomposition Theorem provides us with a way to identify syllable boundaries in a non-circular manner. If **h₂* was a consonant and surfaced as [-syllabic] (cf. Mayrhofer 1986:121ff.) in the medial sequence *CHCC, */dʰugh₂trés/ 'daughter (gen.sg.)' must have been divided into two syllables, since there were only two possible syllable nuclei within the word. We

fíísnú 'temple (nom.sg.)' (< **dʰeh₁s-*; cf. Lat. *fēriae*, Osc. **fíísíaís** 'holiday'); Untermann 2000:281–3.

may immediately rule out *gh_2tr- and *h_2tr- as onsets of the second syllable, as they are not onsets reconstructable for PIE. *tr- and *r- were acceptable onsets in PIE (cf. *tréyes* 'three (nom.pl.)', *$h_2\mathring{n}.r\acute{e}s$ 'man (gen.sg.)'),[47] though it is debatable whether *r- appears word-initially.[48] Therefore, the most natural syllable division would have occurred after *-gh_2 and before *tr-, since the onset of the second syllable would have been maximized and the syllable boundary would also coincide with the morpheme boundary (if not *d^hug-h_2tr-).[49] It is thus likely that the oblique stem of 'daughter' was syllabified as *$d^hugh_2.tr$-, just as Hackstein proposed. A similar coda is reconstructable (through indirect attestation) in *$m\acute{e}\hat{g}h_2$ 'great' (Gk. μέγα, Skt. *máhi*, Hitt. *mēg*), where we find either vowel epenthesis (*$m\acute{e}\hat{g}h_2ə$ in Gk., Skt.) or laryngeal deletion (**mēg* in Hitt.) in the daughter languages.

On the other hand, examples of *CHCC in (72) above undergo vowel epenthesis (vocalization): Lat. *fānum* 'temple' < **fasnom* < *$d^həh_1sn\acute{o}$- ← */d^hh_1snó-/. There is good reason for this. If deletion, and not epenthesis, had taken place in order to fix this 'bad' cluster *CHCC, the result would have been **tsnó-*, which would not have been a legal word, as this sequence in word-initial position is not reconstructable for PIE. Similarly, the reason deletion does not occur in the oblique stem of 'father' is because if *#ph_2tr- had reduced to **#ptr-*, it would have resulted in the sequence *#PPR-.[50] This was the classic environment for the epenthesis of schwa secundum, a process of vowel epenthesis well-attested in many IE languages; cf. */mĝnó-/ → **məĝnó-* > Lat. *magnus* 'great', */$d^h\hat{g}^h$més/ → *$d^hə\hat{g}^hm\acute{e}s$ > Hitt. *taknaš* 'earth (gen.sg.)',[51] */k^wtu̯ōr/ → *$k^wətu̯\bar{o}r$ > Lat. *quattuor* 'four' and */ptneh_2-/ → *$pət$-na-h_2- > Gk. πίτνημι, Lat. *pandō* (< **patnō*) 'fly' (Mayrhofer 1986:118). We may therefore say that epenthesis occurs in the sequence *CHC(C)- if deletion would have resulted in a bad cluster.

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47 *$h_2\mathring{n}r\acute{e}s$ (and not $^x h_2 nr\acute{e}s$) should be reconstructed as the original syllabification for two reasons. First, no daughter language indicates that *#h_xnr- was a legal onset in PIE. Second, the less complex onset *#nr- is also not reconstructable for PIE, a prerequisite for a more complex *#h_xnr-, following the Substring Generalization, which states that "all substrings of a well-formed onset or coda should themselves be well-formed"; see Hammond 1999:54, following Greenberg 1978:250. Gk. ἀνδρός 'man (gen.sg.)' therefore should be reconstructed as *$h_2\mathring{n}.r\acute{o}s$ (← *$h_2\mathring{n}.r\acute{e}s$).

48 Weiss 2009:38.

49 Cf. Pinault 2005 [2006].

50 Where R = */m, *n, *l, *r, *u̯/. Cf. Mayrhofer 1986:175–7.

51 Schindler 1977b:31.

(85) Conditions for PIE Laryngeal Cluster Repair:
Delete a laryngeal in a bad cluster if the result would produce a legal consonant sequence; otherwise, insert a schwa.

Likewise the onsets ^{X}*psḱ-*, ^{X}*tsu̯-*, ^{X}*stmn-* are not reconstructable for PIE, providing an explanation for epenthesis in */ph$_2$-sḱé/ó-/, */dh$_2$-su̯é/, and */sth$_2$-mn-ó-/. On the other hand, **ĝ^{h}d^{h}i̯-* was a legal word-initial onset in PIE (we know this since it's reconstructable), and so in the form */ĝ^{h}h$_1$d^{h}i̯és/ 'yesterday', deletion of the laryngeal was permitted to occur (following Vine 2008).

3.3.1 *Proto-Indo-European 'Father'*

It has been claimed by Schmidt (1973) that laryngeal deletion occurred in the oblique stem of 'father', */ph$_2$tr-/, to produce **ptr-*, which is reflected by the Avestan oblique stem *fəδr-* 'father'.[52] However, as Insler (1971:573[2]) and Beekes (1988:86–7) contend, the Avestan form is more likely to have been produced by analogy with the strong stem *ptar-*. This is confirmed by rule (75) above, which allows for the sequence **pt-* to have originated only in the strong stem, where there had been an underlying sequence */ph$_2$tV-/. The original, non-analogically affected paradigm for 'father' was therefore: strong stem **ptér-*; weak stem **pəh$_2$tŕ-*.

The cluster */#CHC-/ had two possible fates in PIE: *#CC- or *#CəHC-. The former, *#CC, is the expected regular outcome of the phonological rule given in (75), if the resulting cluster was legal: **ph$_2$tér-* → **ptér-* > Av. (*p*)*tar-*.[53]

52 Schmidt also posits laryngeal deletion in PIE 'father's brother': **ph$_2$tru̯i̯o-* > **ptru̯i̯o-*. He proposes that **ptru̯i̯o-* is continued by YAv. *tūriia-* 'father's brother' and Proto-Slavic **stru̯i̯o-* 'id.', while Skt. *pitr̥vyà-*, Lat. *patruus*, OHG *fatureo* all go back to secondary **ph$_2$tru̯i̯o-*/**ph$_2$tr̥u̯i̯o-*, with **h$_2$* analogically restored into the root. Kortlandt (1982) has been severely (and, in my opinion, convincingly) critical of the derivation of Slavic **str-* from **ptr-*, thus making the Avestan form the only possible evidence for a cluster **ptr-* (< **ph$_2$tr-*) in 'father's brother'. Note, however, that there is no trace of **p* in YAv. *tūriia-* 'father's brother'; this suggests that the form should be derived directly from *(*p*)*tr̥u̯i̯o-* (cf. Hoffmann & Forssman 2004:94), with the expected simplification of a bipartite obstruent onset before a syllabic resonant (**#PPR̥* > **#PR̥*; see Schindler 1977b:31f.). Perhaps **h$_2$* was deleted by rule (75), producing a legal onset **pt-*, which was subsequentally reduced by the rule **#TTR̥* > **#TR̥*: **ph$_2$tr̥u̯i̯o-* > **ptr̥u̯i̯o-* > **tr̥u̯i̯o-* > *tūriia-* (cf. Mayrhofer 1986:138[172]). I am indebted to Marek Majer for references and helpful discussion on the Slavic material.

53 Av. (*p*)*tar-* 'father' shows the only instance of laryngeal deletion in a word-initial *#CHC- sequence in Iranian (Hoffmann & Forssman 2004:81–2), which perhaps may be considered a sign of its antiquity. Contrast GAv. *sīšā* 'show! teach!' (~ Ved. *śiṣánt-* 'instructing') < **#ḱh$_x$s-* (LIV 318–9).

We know the onset _*pt-_ to have been legal in PIE through the reconstruction of words such as _*ptero-_ ‘wing’ (Gk. πτερόν ‘wing’, Arm. _t’ert’_ ‘leaf, foliage’). The latter outcome, *#CəHC-, arose in two ways, either by sound law or by analogy. If the deletion of *H in *#CHC- resulted in an illegal cluster, then schwa epenthesis occurs as the expected regular outcome of (75): _*d^hh_1só-_ ‘possessing the divine’ → PIE _*d^hə$h_1$só-_, not ^{X}_tsó-_. The cluster _*ts-_ was an exceedingly rare, perhaps impossible onset (to my knowledge, the only possible example of such an onset is _*tsel-_ ‘steal’; see Kroonen & Lubotsky 2009) and it is for this reason that laryngeal deletion was blocked. PIE _*d^hə$h_1$só-_ produces Gk. θεός ‘god’ as well as Proto-Anatolian _*dasó-_ ‘votive offering’, continued by HLuv. _tasan-za_ ‘votive stele’, Lyc. _ϑϑẽ_ ‘altar’ and Lyd. _taśẽṽ_ ‘votive object’ (Melchert 1997:49–50; Watkins 2008:139–40.).[54] These particular Anatolian forms assure vowel epenthesis in this sequence as a PIE process, since as Melchert (1994:65) argues, _*h_1_

54 In Byrd 2011, I propose that the Hittite words for ‘dream’ (_tesḫa-/zasḫ(a)i-_) ultimately derive from the PIE root/stem _*d^heh_1s-_ ‘divine, divinity’, formed to an earlier _o_-stem _*d^hh_1s-h_2-ó-_ ‘(possessing) the divine; divination (of the night)’. The original oxytone _i_-stem noun, _zasḫ(a)i-_ (phonetically _tsḫí-_; Rieken apud Hoffner & Melchert 2008:47), illustrates the deletion of *h_1 in the sequence *CHCC. Of course, as we have seen, laryngeals were lost in the sequence *CHCC only if the resulting outcome had been a legal cluster in PIE. The question, then, is whether _*Th_1sh_2í-_ would have produced a legal sequence _*tsh_2í-_ in PIE (thence Hitt. _tsḫi-_), or, to avoid an illicit onset, would rather have undergone schwa insertion (_*Təh_1sh_2í-_).

The answer to this is by no means straightforward, as one finds conflicting forms in the attested IE languages. For example, both Hitt. _zikke-/zaske-_ /_tske-_/ ‘put (iter.)’ and Toch. _tāskmāṃ_ ‘similar to’ (Hackstein 1995:189) are derived from _*d^hh_1sḱé/ó-_, the former with laryngeal deletion and the latter epenthesis. Nevertheless, following the well-established Substring Generalization (Greenberg 1978:250), if _*tsḱ-_ and _*tsh_2-_ had been legal onsets in PIE, we would expect _*ts-_, _*sḱ-_, and _*sh_2-_ to have been legal onsets as well. The latter two can be established as onsets (cf. _*sḱeh_x(i̯)-_ ‘shine’ and _*s$h_2$au̯-_ ‘rain’), but it is difficult to do so for _*ts-_. If _*ts-_ had not been an onset present in PIE, we would predict that _*tsḱ-_ and _*tsh_2-_ were not legal PIE onsets, either. If this had been the case, */Th_1sh_2í-/ was most likely realized as *[Təh_1sh_2í-]. Of course, a PIE form with schwa epenthesis does not account for either Hitt. _zikke-/zaske-_ or _zasḫ(a)i-_. But _zasḫ(a)i-_ is not a form reconstructable back to PIE—it is only attested in Hittite—and so we must assume that rules within a proto-Hittite grammar produced _zasḫ(a)i-_, not rules within PIE. Note that while _*ts-_ was perhaps not a legal onset in PIE, it was in Hittite, as an affricate /t͡s/. This, I believe, provided Hittite speakers with the option of deleting *H in a sequence *THsC, be it one inherited (though morphologically renewed) as in the case of _*d^hh_1sh_2é/ó-_ ‘put (iterative)’ or one newly formed within the prehistory of Hittite, _*Th_1sh_2í-_ ‘dream’.

On the other hand, if Melchert (2003) is correct in following Merlingen 1957:51 in the assumption that thorn clusters, phonemically _*TK-_, should undergo a process of affrication or s-epenthesis (_*TK_ > _*TsK_) as continued by CLuv. _īnzagan=za_ ‘inhumations’ < _*en_ invariably disappears without a trace in Anatolian. Secondly, *#CəHC arises when the laryngeal was reinserted into the cluster via analogy: */p$h_2$ter-/ → **ptér-* ⇝ **pə$h_2$tér-* > Gk. πατέρ-. Crucially, when a laryngeal was restored analogically it was also accompanied by schwa epenthesis—otherwise it could not have been syllabified.

In short, the onset cluster *#CHC- was not tolerated in any fashion in PIE and had to be 'fixed', either through a rule of laryngeal deletion or through a rule of schwa epenthesis.[55] These conditions, as they apply to the oblique forms of our two familial words in question, **d^{h}ug$h_2$trés* 'daughter (gen.sg.)' and **p$h_2$trés* 'father (gen.sg.)', may be formulated through the following constraints:

(86) Constraints for Laryngeal Cluster Conditions
- a. PARSE: Syllabify all segments. Assign a * for every violation.
- b. *CHCC: The sequence *CHCC is prohibited in the output. Assign a * for every violation.
- c. *$_\sigma$[PPR: The sequence two stops + sonorant (**r, *l, *m, *n, *u̯*) is prohibited in the onset of the output. Assign a * for every violation.
- d. DEP-V: Every vowel in the output has a correspondent in the input. Assign a * for each instance.
- e. MAX-C: Every consonant in the input has a correspondent in the output. Assign a * for each instance.
- f. INTACT: Do not delete the root in its entirety. Assign a * for every violation.

The first constraint, PARSE, demands that every segment be syllabified in the output. The next two, *CHCC and *$_\sigma$[PPR, are PIE-specific markedness constraints, which require that the sequences CHCC and $_\sigma$[PPR be avoided in the output. DEP-V and MAX-C are faithfulness constraints, which require that no vowel be epenthesized and no consonant be deleted, respectively. Because we find laryngeal deletion in */d^{h}ug$h_2$trés/ and not epenthesis, the constraint

d^{h}z(^{h})ĝ^{h}ōm, then it is conceivable that PIE **d^hh_1sḱé/ó-* did simplify to **tské/ó-*, which was inherited by Hittite but morphologically renewed in Tocharian.

55 If Melchert (1994:175) is correct in deriving Hitt. *išḫunawar* 'sinew' from PIE **s$h_2$nóh_1u̯r̥* (with a tripartite onset), perhaps the ban of *#CHC should be more narrowly viewed as a ban of *#PHC (vel sim.). Kloekhorst (2008:395–6), however, denies the existence of any such form meaning 'sinew' and contests that *išḫunau-* only means 'upper arm'. Following Weitenberg 1984:224–5, he reconstructs **sh_2u-neu-*, originally 'throwing arm', which would therefore provide no evidence for a PIE tripartite onset **sh_2n-*. For now I will leave this question open for future investigation.

ranking must be Dep-V >> Max-C. Lastly, the constraint Intact, though ad hoc for my analysis, very understandably requires that the root be 'intact' in the winning candidate in some fashion, with there being at least one phonological segment of the root remaining in the output.[56]

(87) PIE */d^{h}ugh$_2$trés/ → [d^{h}uk]$_\sigma$[trés]$_\sigma$

	/d^{h}ugh$_2$ + trés/	Parse	⋆CHCC	Dep-V	Max-C
a.	[d^{h}ugh$_2$]$_\sigma$ [trés]$_\sigma$		*!		
b.	[d^{h}ug]$_\sigma$h$_2$[trés]$_\sigma$	*!			
c.	[d^{h}u]$_\sigma$[gəh$_2$]$_\sigma$[trés]$_\sigma$			*!	
d. ☞	[d^{h}uk]$_\sigma$[trés]$_\sigma$				*

In (77) we see that candidate (a) fails, since it violates the undominated constraint ⋆CHCC. Candidate (b) is not the most optimal, since the *h_2 is not syllabified in the output and all word-medial consonants must be syllabified. Lastly, candidate (d) triumphs over (c), since it was better for PIE speakers to delete a consonant than it was for them to insert a vowel.

(88) PIE */ph$_2$trés/ → [pəh$_2$]$_\sigma$[trés]$_\sigma$

	/ph$_2$ + trés/	Intact	⋆CHCC	⋆$_\sigma$[PPR]	Dep-V	Max-C
a.	[ph$_2$trés]$_\sigma$		*!			
b.	[ptrés]$_\sigma$			*!		*
c.	[trés]$_\sigma$	*!				**
d.	[pə]$_\sigma$[trés]$_\sigma$				*	*!
e. ☞	[pəh$_2$]$_\sigma$[trés]$_\sigma$				*	

In the derivation of */ph$_2$trés/, the most optimal form shows one instance of vowel epenthesis with no consonant deletion. The difference between the derivation of */ph$_2$trés/ in (78) and that of */d^{h}ugh$_2$trés/ in (77) is that consonant deletion does not improve the output in (78) in any way. If *h_2 were deleted, then the resulting [ptrés]$_\sigma$ would violate the undominated constraint *$_\sigma$[PPR (the sequence which prompts schwa secundum). If both *p and *h_2 were deleted, then the output form violates the undominated constraint Intact, which requires that the underlying root be continued in the output form

56 Cf. RealizeMorph 'A morpheme must have some phonological exponent in the output', proposed by Walker 2000.

through at least one segment.[57] This results in the choice of the most optimal candidate, *$[\text{pəh}_2]_\sigma[\text{trés}]_\sigma$, with vowel epenthesis (vocalization).

3.3.2 *Why does *#CHC- simplify to *#CC-?*

It's worth digressing to investigate why, in response to the ban of an onset *#CHC- in PIE, *#CHC- should simplify to *#CC- (with loss of *H) and never to *#CH- (with loss of final *C) or *#HC- (with loss of initial *C). One could simply suppose that laryngeals were marked consonants in PIE and more prone to deletion than other consonants, but it is conceivable that the reduction of *#CHC- to *#CC- may be attributed to a general markedness (but not necessarily complete avoidance) of the PIE clusters *#CH- and *#HC- themselves.

Roots of the shape *#CH- are very poorly attested in PIE. The LIV lists seven: five of the shape *P + *H; two of the shape **s* + *H. The evidence for the onset **#sH-* (at least, **#sh*$_2$-) in PIE is fairly strong; though the two verbal roots given by the LIV, **sh*$_2$*ai̯-* 'bind' (544) and **sh*$_2$*au̯-* 'pour, rain' (555) do not conclusively point back to PIE **sh*$_2$-, the root equation of Hitt. (*i*)*šḫamai-* 'song' and Skt. *sā́man-* 'song' (< **sh*$_2$*om-*) assures that the onset **sh*$_2$- was a possible one in PIE.[58]

Roots of the shape *P + *H are much less securely reconstructable.[59] The first given in the LIV, **k*$^{(w)}$*h*$_2$*ad-* 'crush', is only attested in IIr., continued by Ved. *khā́dati* 'chews', YAv. *vī-xaδa* 'smash apart!', Khot. *khad-* 'wound' and Bal. *khāδ-* 'eat' (LIV 359–60). Since this root is restricted to the IIr. branch, aspiration does not necessarily have to be derived from an initial cluster **k* + **h*$_2$, and may only be reconstructed with any certainty as PIIr. **k*^{h}*ad-*. The next root, **k*$^{(w)}$*h*$_2$*aĝ-* 'consume', is found solely in Iranian (Khot. *khāś-* 'drink', Parth. *x'z-* 'devour') and Arm. *xacanem* 'I bite' (LIV 360). However, as Klingenschmitt 1982:210 discusses, it is conceivable that the Arm. form is an Iranian loanword (cf. Parth. *x'z-*), and therefore we would only need to reconstruct a PIr. root **k*^{h}*aȷ́-*, though as Martirosyan (2010:324) points out, "one [would need to] assume a very old borrowing with consonant shift **ȷ̌* > *c*, cf. the well-known case of *partēz* 'garden'."

The root **kh*$_2$*ai̯d-* 'hit', is only attested in Italic (*caedō* 'I strike') and perhaps in Alb. *qeth* 'cuts; shears (hair)'.[60] If the LIV is correct in separating Skt.

57 Note, too, that there is no onset of the shape *#HPR- reconstructable for PIE (aside from **h*$_3$*b*^{h}*ruh*$_x$- 'brow', of which I'm highly skeptical), which presumably is why ^{X}*h*$_2$*trés* does not surface as the winning candidate.

58 Kloekhorst 2008:395.

59 For a more extensive study, see Elbourne 2000.

60 See LIV 360 for references. Orel 1998:359 reconstructs **kaitsa*, which he connects with Skt. *keśa-* 'hair', Lith. *káisti* 'scrape, shave'.

khidáti 'rips' from these roots, neither the Latin nor Albanian form requires the sequence **kh₂*- and may just as easily go back to an original **kaid*- (with *a*-vocalism). Next, the LIV cites the root **th₂au̯s*- 'be quiet'; cf. Hitt. *tuḫussiyezzi*, CLuv. *taḫušii̯a*- 'keep silent/quiet' (< **th₂us-i̯é*-). Melchert (AHP 108–9) and Kloekhorst (hesitantly in 2008:894–5) assume an inherited **th₂*- onset, with later anaptyxis specific to each Anatolian language: PIE **th₂u*- > Hitt. *tuḫu*-, CLuv. *taḫu*-. Oettinger (1979:326) reconstructs **tuh₂s*- as the protoform, with expected metathesis (see below) of the laryngeal and high vowel dating back to PIE (PIE **th₂u*- > PIE **tuh₂*- > Hitt. **tuḫ*-), comparing Skt. *tūṣṇī́m* 'quietly'.[61] Lastly, probably the most widely attested root that points back to an initial *PH- onset is **(z)gʷʰh₂al*- 'make a mistake', which is continued by Ved. (AB) *skhalate* 'makes a mistake', Arm. *sxalem* 'I make a mistake', Gk. σφάλλω 'trip up, overthrow', σφάλλομαι 'be mistaken' and, without initial *s*-mobile, Lat. *fallō* (LIV 543). Perhaps, however, this root's reconstructable voiceless aspirate may be attributed to Siebs' Law ($*s + D^h \rightarrow *sT^h$) and not to the cluster *PH.[62]

The strength of each instance of reconstructed initial *#PH- onset varies significantly case-by-case, with roots like **k⁽ʷ⁾h₂ad*- (which occurs solely in Indo-Iranian), which in no way need to be derived from PIE vs. the well-attested root **(s)gʷʰh₂al*-, which most certainly does. Of course, the main reason a laryngeal is reconstructed in most of these roots is the presence of aspiration in Indo-Iranian, Greek and Armenian (*x* < **kʰ*), though, as Jasanoff 2008:156[4] points out, when reconstructing any of these roots the onset stop + laryngeal is "simply the LIV notational substitute for "classical" (and likewise unsatisfactory) [voiceless aspirate] (AMB)". I myself am not presenting this evidence in order to argue on behalf of the reconstruction of voiceless aspirates.[63] I am merely arguing that the scarcity of *#PH- initial roots indicates that onsets of this shape were disfavored in PIE.[64]

This markedness of the onset *#CH-, as Brent Vine reminds me, may also be reflected in a securely reconstructable phonological process in PIE: the

61 GAv. *tušnā*, OPruss. *tusnan* 'still'; MIr. tó, *tuae* 'silent', Wel. *taw* 'silence'; see Schumacher 2000:179.

62 Lat. *fallō* may go back to **gʷʰal*- (cf. *-fendō* < Cf. **gʷʰen*-; Weiss 2009:79). For another possible etymon with voiceless aspirate derived from Siebs' Law, cf. Ved. *sphuráti* 'jerk, kick', Av. *sparaiti* 'push, tread', OE. *spurnan* 'spurn' vs. Ved. *bhuráti* 'jerk, quiver, move rapidly' (Southern 1999:43). See Siebs 1904, Collinge 1985:155–8, Southern 1999:49ff.

63 Note that advocates of this view would also have to explain the paucity of initial voiceless aspirates! I find it more plausible that PIE speakers would avoid a complex onset *P + *H over a singleton voiceless aspirated stop.

64 Word-medially, it is likely that *$PH was present in PIE in the second person singular perfect suffix **-th₂a* and mediopassive suffix **-th₂or/i̯*.

metathesis of the sequence *#CHU- to *#CUH-.[65] This sequence (*#CHU-) is regularly generated in the zero-grade to "long diphthong roots".[66] For example, the zero-grade of the well-attested root 'drink', **peh_3i̯-* is realized as **pih_3-tó-*, with metathesis from original **ph_3i-tó-*. This metathesis is assured by the consistent long vowel found throughout the IE languages: Skt. *pītá-* 'having (been) drunk', OCS *pitъ* 'drank' (< **pih_3-tó-*) and Att. πῖθι 'drink!' (< **pih_3-d^hi*). On the other hand, when *#PPU- sequences are created within the grammar, no such metathesis takes place: **d^hg^{wh}(e)i̯-* 'perish' + *-tó* → **$d^h(z^h)g^{wh}$itó* (Gk. ἔφθιτο '(s)he perished') NOT ^{X}*d^hik^wtó* (Gk. ^{X}ἔφθιπτο).[67] If, as seems reasonable, metathesis in *#CHU- sequences was driven by an avoidance of *#CH-sequence, then this would demand a constraint ranking *#CH >> LINEARITY (= 'Don't metathesize'):

(89) **ph_3itós* → **pih_3tós*

/ph_3itós/			*#CH	LINEARITY
a.		ph_3itós	*!	
b.	☞	pih_3tós		*

Now, if *#CH and *#CC were equally marked within the PIE grammar, then our constraint ranking would be *#CH, *#CC >> LINEARITY, thereby requiring metathesis to occur in the sequence *#CCU-:

(90) **d^hg^{wh}itó* → ^{X}*d^hik^wtó*

/d^hg^{wh}itó/			*#CC	LINEARITY
a.	☹	$d^h(z^h)g^{wh}$itó	*!	
b.	☞	d^hik^wtó		!

Naturally, metathesis did not occur. We may therefore conclude that the constraint ranking in PIE was *#CH- >> LINEARITY >> *#CC-, and thus the sequence *#CH- was more marked than *#CC-.

On the other hand, word-initial sequences of the shape *#HC- are much more robustly attested. Well-established roots of the shape *#HT- include **$h_1$ger-* 'wake up' (Gk. ἐγείρω, Ved. *jāgā́ra*; LIV 245–6), **$h_2\hat{k}$eu̯s-* 'hear'

65 Mayrhofer 1986:174–5, first seen by Winter 1965:192.

66 Roots of the shape **Ceh$_x$U̯-*. Cf. Mayrhofer 1986:174–5.

67 *g^{wh} → *k^w by assimilation of laryngeal features with the following *-t-.

(Gk. ἀκούω, Goth. *hausjan*),[68] **h₂seu̯s-* 'become dry' (Gk. αὖος 'dry', Ved. *śuṣyati* 'will dry'; LIV 285) and **h₂teu̯g-* 'terrify' (Hitt. *ḫatukzi* 'terrifies', Gk. ἀτυζόμενος 'terrified').[69] Even more common are roots of the shape *#HR-: cf. **h₁leu̯dʰ-* 'climb; grow' (Gk. ἤλυθον 'I came', Goth. *liudan* 'grow'; LIV 248–9), **h₁nek̂-* 'take' (Gk. ἐνεγκεῖν 'bring', OCS *nošǫ* 'I carry'; LIV 250–1), **h₂leg-* 'attend to, worry' (Gk. ἀλέγω 'worry about', Lat. *-legō*; LIV 276–7), **h₃reĝ-* 'reach out' (Gk. ὀρέγω, Lat. *regō*; LIV 304–5).

If the sequence *#HC- was so common in PIE, then how could one claim that *#HC- was more marked than *#CC-? At this point, I find no evidence in favor of such an assumption. The total number of roots of the shape *#PP in PIE is vanishingly small—perhaps almost as small as *#PH- roots. Aside from the root/stem **pter-* 'wing', **ptah₂k-* 'duck, crouch'[70] and **pk̂u-*, the ∅-grade of **pek̂u-* 'livestock',[71] the most common type of root with an onset *#TT- contains so-called 'thorn' clusters, such as **t(s)k̂ei̯-* 'inhabit' (Ved. *kṣéti* 'dwells'; LIV 643–4); **t(s)ken-* 'strike, wound' (Gk. κτείνω 'kill'; LIV 645–6) and **dʰ(zʰ)gʷʰei̯-* 'be destroyed' (Gk. ἔφθιται 'has perished'; LIV 150–1).[72]

In conclusion, with no evidence of a markedness scale *$HP- >> *$PP- visible in our reconstruction of PIE, perhaps it would be better to assume simply that the laryngeals *themselves* were marked in PIE (relative to other consonants), a proposal perhaps corroborated by a sizeable number of laryngeal deletion rules reconstructable for PIE.[73] This markedness may be illustrated using two faithfulness constraints, MAX-C and MAX-H.[74]

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68 Likely from **h₂k̂h₂ou̯s-* 'be sharp-eared', a denominative verb composed of the root **h₂ak̂-* 'sharp' + *h₂áus-* 'ear' (Ringe 2008:28). Even if this clever etymology were true, it does not prove that an onset **h₂k̂h₂-* was permissible in PIE—for all we know **h₂k̂h₂ou̯s-* > **h₂k̂ou̯s-* upon compound formation. See IEW 587–8.

69 LIV 286. The LIV also cites **h₃pus-* 'copulate; marry', which Watkins 1982 (followed by Zeilfelder 1997) has proposed as the source of Gk. ὀπυΐω 'wed; have sex with' and Hitt. *ḫapuša-* 'reed, shaft, penis'. Kloekhorst 2008:299 argues that due to problems of vocalism and semantics, Hitt. *hāpūša-* 'shaft (of an arrow, reed), shin-bone', cannot be connected with the Greek form.

70 Gk. πτήσσω 'I duck', Arm. *t'ak'eaw* 'concealed (oneself)', Lat. *taceō* 'am silent', OHG *dagēn* 'be silent' (LIV 495).

71 > YAv. *fšu-*, Ved. *kṣu-* (Hoffmann & Forssman 2004:105) and perhaps Gk. κύ-κλωψ 'Cyclops' (< 'cattle thief').

72 See Schindler 1977b.

73 See section 1.2.3.4. Note that this does not imply that EVERY instance of laryngeal deletion should be motivated by the constraint ranking Max-C >> Max-H. For instance, we will later see that loss of *H in CHCC > CCC in word-medial position is to be attributed to a violation of PIE syllable markedness constraints.

74 Kie Zuraw has pointed out to me that it is typologically common for languages to preserve the first consonant of a word-initial cluster, if simplified. However, the reduction of the

(91) PIE Consonantal Faithfulness Constraints
  a. MAX-C: Every non-laryngeal consonant in the input has a correspondent in the output. Assign a * for each instance.
  b. MAX-H: Every laryngeal consonant in the input has a correspondent in the output. Assign a * for each instance.

(92) PIE *ph_2*tḗr* → *[ptḗr]$_\sigma$

	/ph_2trés/	INTACT	*CHC	DEP-V	MAX-C	MAX-H
a.	[ph_2tḗr]$_\sigma$		*!			
b.	[h_2tḗr]$_\sigma$				*!	
c. ☞	[ptḗr]$_\sigma$					*
d.	[tḗr]$_\sigma$	*!			*	*
e.	[pəh_2]$_\sigma$[tḗr]$_\sigma$			*!		

3.3.3 *Extrasyllabic Consonants in Coda Position*

Let us now return to Lex Schmidt-Hackstein, in which laryngeal deletion occurred within the word-medial sequence CH.CC. Utilizing the DT, we established in section 3.3 above that the medial sequence *CHCC could only have been syllabified as Hackstein proposed. This syllabification was deduced through the analysis of words such **méĝ*h_2 'great' and **tréi̯es* 'three'. But while **-ĝ*h_2*#* in **méĝ*h_2 was undoubtedly pronounced as a bipartite cluster in PIE,[75] such pronunciation does not necessarily entail that this sequence was *syllabified* as a bipartite cluster within the same syllable. It is entirely possible that given the unusual sonority sequencing in the sequence **-ĝ*h_2*#*, ***h_2 was extrasyllabic at a word's edge and allowed to remain. However, in medial position extrasyllabicity is not allowed and therefore ***h_2 would not be syllabifiable in the sequence **-g*h_2, resulting in deletion via STRAY ERASURE: *[d^hug]$_\sigma$$h_2$[trés]$_\sigma$ → *[d^huk]$_\sigma$[trés]$_\sigma$. Thus, it is conceivable that laryngeal loss occurred in the sequence CH.CC because the sequence did not consist of a legal coda plus a legal onset.

But not all laryngeals were extrasyllabic in word-final position. Since we find compensatory lengthening (CL) in the sequences *-VH# (**-a*h_2 > Skt. *-ā*,

sequence *#P_1P_2R̥ → *#P_2R̥ as seen in PIE **$d^h\hat{g}^h$m̥-* → **$\hat{g}^h$m̥-* (Gk. χαμαί 'on the ground') perhaps speaks against such an explanation in this case.

75 This is an example of an indirectly attested cluster, since Hittite *mēg* shows laryngeal deletion whereas inner IE shows vowel epenthesis (Inner IE **mégh*$_2$*ə* > Skt. *máhi*, Gk. μέγα). See section 1.2.2 for explicit discussion of this methodology.

Gk. -ᾱ, etc.)[76] and *-RH# (pre-PIE *u̯édorh$_2$ 'waters' > PIE *u̯édōr),[77] it is unlikely that *H in these two sequences was extrasyllabic. Consonants that are licensed by a syllable carry moras, while extrasyllabic segments do not.[78] Since the deletion of an extrasyllabic segment would not have produced CL, *H in the sequences *VH# and *RH# was not extrasyllabic. Thus, *H was only extrasyllabic in the position *VPH#, where there was a violation of the Sonority Sequencing Principle.

(93) Sonority Sequencing Principle (SSP)
Between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted.[79]

We may infer that the SSP violation in the coda *PH$ is the reason for the extrasyllabicity of *H, and therefore any segment that violates the SSP in this position should be extrasyllabic. Typologically this makes good sense, as many languages that prohibit SSP violations word-internally allow them at word's edge (Steriade 1982:92, Hdouch 2008:72). French *arbre* /aʁbʁ / is allowed but there exists no word ^{X}/aʁbʁ.po/.[80] In Russian, we find words such as *mgla* 'mist' and *rubl'* 'ruble', but words such as **glub.mgla* and **rubl'.to* are strictly prohibited.

(94) Rule of Coda Extrasyllabicity in PIE
Any SSP violation from a consonant in the coda renders that consonant extrasyllabic.

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76 CL here, of course, cannot be reconstructed for PIE, since there is no indication the sequence *-VH$ became *V̄ in the proto-language. Nevertheless, the fact that laryngeal deletion in the sequence *-VH$ invariably results in CL in the daughter languages makes it highly likely that laryngeals were syllabified (i.e., not extrasyllabic) in this position in PIE.

77 Hitt. *úidār*, Gk. ὕδωρ. See Szemerényi 1970:155 & 159 and Nussbaum 1986:129ff.

78 In Attic Greek, when an unsyllabifiable (i.e. extrasyllabic) coda consonant is lost via STRAY ERASURE, it never results in compensatory lengthening: /galakt/ 'milk' → [gala] (not ^{X}[galā]); /RED-komid-k-a/ 'I have eaten' → [kekomika] (not ^{X}[kekomīka]). See Steriade 1982:227. For a view of compensatory lengthening that is not mora-based see Kavitskaya 2002.

79 See section 2.2. Note once again that I consider both sonority rises (**ste-, *-ets*) and sonority plateaus (**pte-, *-ept*) to be violations of the SSP.

80 French *arbre* in fact has three pronunciations, depending on dialect (Hdouch, ibid.): /aʁbʁ/ (with extrasyllabic C pronounced), French /aʁb/ (deletion), and French *arbre* /aʁbʁə/ (epenthesis). This precisely parallels the Hittite outcome of PIE *meĝh$_2$ (extrasyllabic C pronounced) as *mēg* (deletion) and the inner-IE outcome as *megh$_2$ə (epenthesis).

3.3.4 *Revisions to CHCC > CCC*

Our rule of coda extrasyllabicity allows us to account for the exceptions presented in (73), which are given again in (86) below. If *H were extrasyllabic only in the word-final sequence *PH# and the loss of a laryngeal occurs in the sequence CH.CC because *H could not be syllabified, then we should expect a more specific environment for laryngeal deletion; namely, *PH.CC > *P.CC.[81]

(95) PH.CC > P.CC
*H → ∅ / P_$CC
A post-consonantal laryngeal is lost at a syllable boundary before two consonants if its sonority value is of greater or equal value than that of the preceding consonant.

This revision perfectly handles the previously unexplained exceptions found in section 3.2.2 above:

(96) Counterexamples to CHCC > CCC: Word-Internal Position
a. **ḱerh$_2$srom* > Lat. *cerebrum* 'brain'
b. **temh$_x$srah$_2$* > Skt. *tamisrā*, Lat. *tenebrae* 'darkness'
c. **ĝenh$_1$trih$_2$* > Lat. *genitrix*, Ved. *jánitrī-* 'bearer, mother'
d. **ĝenh$_1$d^{h}lo-* > Gk. γένεθον 'relative'
e. **h$_2$arh$_3$trom* > Gk. ἄροτρον, OIr. *arathar*, Arm. *arawr* 'plow'
f. *(*h$_x$*)*i̯enh$_2$trih$_2$-* > Lat. *ianitrīcēs* 'brothers' wives'
g. **térh$_1$trom* 'auger' > Gk. τέρετρον, OIr. *tarathar*

It would be difficult to explain away by analogy a number of the counterexamples in (86), such as **ḱerh$_2$.srom*, **temh$_1$.sreh$_2$* and *(*h$_x$*)*i̯enh$_2$.trih$_2$*; this fact, combined with the threefold attestation of the highly archaic **h$_2$arh$_3$.trom*, makes it very likely that the sequence RH.CC did not undergo a regular rule of laryngeal loss in late PIE.

3.3.5 **RF$*

If the laryngeal loss rule only applied to sequences of the shape *PH.CC, how does one explain the loss of laryngeal in *janman-* and γέννᾱ (< **ĝénh$_1$mnV-*) discussed above? And if these instances of deletion are true, how may we account for them within the same synchronic grammar as cases of laryngeal retention, such as in **ĝénh$_1$.trih$_2$-* (Skt. *jánitrī-*, Lat. *genetrix*)? At the surface, it certainly

81 This analysis holds should we assume that the laryngeals were of equal or higher sonority as stops (as discussed in section 2.2), since both scenarios result in an SSP violation in the coda.

appears that there were two different treatments of the sequence *RH.CC in the proto-language: speakers either deleted a laryngeal, whereby losing a mora, or dealt with the disfavored cluster *RHCC, retaining the moraic structure created within the derivation.

It is curious that when laryngeal deletion did occur in the sequence *RH.CC, no compensatory lengthening (CL) is triggered on the preceding vowel: **ĝénh*$_1$*mnV-* > *janman-*. Given that the laryngeal was not extrasyllabic and therefore carried a mora, we would perhaps expect to find the form ^{X}*jānman-* attested in Sanskrit, with CL targeting the preceding nucleus as it does in word-final position (**u̯édorh*$_2$ > **u̯édōr*) . Earlier in my 2010 dissertation I explained the absence of medial CL to the (P)IE tendency to avoid superheavy syllables (syllables consisting of more than two morae) in medial position, resulting in the loss of a mora,[82] and attributed this variation to a reranking of constraints in late PIE:[83]

(97) Constraints for *RH$ Analysis
  a. *RH$: The output may not have the sequence sonorant + laryngeal immediately preceding a syllable boundary. Assign one * for each violation.
  b. Max-H: Every laryngeal consonant in the input has a correspondent in the output. Assign one * for every loss.
  c. *Superheavy: No medial syllable may consist of three or more morae. Assign one * for each violation.
  d. Max-μ: Every mora in the input has a correspondent in the output. Assign one * for every loss.

I argued that the vacillation of two of these constraints in the PIE grammar gave us the source of the conflicting set of data attested in the IE languages, a vacillation, which, as we will see, would have to be attributed to a reranking within late PIE. The grammar in which laryngeal deletion occurred had the constraint ranking *RH$ >> Max-H, with the form ^{X}[ĝēn]$_\sigma$[trih$_2$]$_\sigma$ being eliminated from selection due to the underlying tendency within the grammar to avoid superheavy syllables, represented by the constraint ranking *Superheavy >> Max-μ.

82 As we will discuss in greater detail in Chapter 5, this tendency also underlies certain cases of Schwebeablaut, Osthoff's Law, the replacement of certain *e*-grade oblique stems with ∅-grade forms, as well as Sievers' Law.

83 Within OT diachronic change is typically explained as the reranking of phonological constraints (Archangeli 1997:31).

(98) Variant One: /ĝenh$_1$trih$_2$/ → [ĝen]$_σ$[trih$_2$]$_σ$

/ĝenh$_1$trih$_2$/			*RH$	Max-H	*Superheavy	Max-μ
a.		[ĝenh$_1$]$_σ$[trih$_2$]$_σ$	*!		*	
b.	☞	[ĝen]$_σ$[trih$_2$]$_σ$			*	*
c.		[ĝēn]$_σ$[trih$_2$]$_σ$			*	

But a later generation of speakers would slightly alter the PIE grammar, one which would produce forms such as *[ĝenh$_1$]$_σ$[trih$_2$]$_σ$, signaling that the constraint ranking at this time had become Max-H >> *RH$.

(99) Variant Two: /ĝenh$_1$trih$_2$/ → [ĝenh$_1$]$_σ$[trih$_2$]$_σ$

/ĝenh$_1$trih$_2$/			Max-H	*RH$	*Superheavy	Max-μ
a.	☞	[ĝenh$_1$]$_σ$[trih$_2$]$_σ$		*	*	
b.		[ĝen]$_σ$[trih$_2$]$_σ$	*!			*
c.		[ĝēn]$_σ$[trih$_2$]$_σ$	*!		*	

While such an account may successfully explain instances of medial laryngeal loss with no CL in */RHCC/ sequences, it runs into a serious roadblock. We are forced to assume that the constraint *Superheavy applies only to medial syllables, thereby restricting compensatory lengthening to final syllables: */u̯édorh$_2$/ > *[u̯édōr]. Otherwise, if *Superheavy had applied to all syllables, we would expect */u̯édorh$_2$/ > [^{X}u̯édor].

(100) /u̯édorh$_2$/ → [u̯é]$_σ$[dōr]$_σ$

/u̯édorh$_2$/			*RH$	Max-H	*Superheavy	Max-μ
a.		[u̯é]$_σ$[dorh$_2$]$_σ$	*!		*	
b.	☹	[u̯é]$_σ$[dōr]$_σ$		*	*!	
c.	☞	[u̯é]$_σ$[dor]$_σ$		*		*

But as Sandell & Byrd, in preparation discuss, the restriction of the constraint *Superheavy to medial syllables is ultimately an unnecessary assumption. The problem here lies not with the constraint *Superheavy (which certainly applied to all syllables throughout the word); rather, the problem lies in my past expectation that CL should even have occurred in the medial sequence */VRH/ upon loss of a laryngeal. For as argued by Sandell & Byrd, CL would not occur according to the Well-Formedness Condition,[84] which states that

84 Goldsmith 1979, Nespor and Vogel 1986.

moras cannot "leap over" an intervening mora to attach to a segment.[85] We will not dwell on this problem any further, and I refer the reader to Sandell & Byrd, ibid. for further discussion.[86] In short, we need not worry about the candidate $*[\hat{g}\bar{e}n]_\sigma[trih_2]_\sigma$ (as I did in my previous analysis) and may continue by assuming that the more archaic $*[\hat{g}en]_\sigma$[C- (with laryngeal loss) had been replaced by $*[\hat{g}enh_1]_\sigma$[C- (with laryngeal preservation) at some point in the PIE grammar, driven the promotion of MAX-H over ⋆RH$.

As alluded to previously, laryngeals were also deleted in word-final *RH sequences in PIE, a phenomenon first recognized by Szemerényi (1979:155, 159) and discussed in further detail by Nussbaum 1986:129ff. and Jasanoff 1989:137. In fact, there also seems to have been variation in the treatment of word-final syllables of this shape, just as was the case in word-medial *RH$ sequences. One could cite the Skt. form *nā́māni* 'names (nom./acc.)' as evidence of variation, though the lengthened vowel of the suffix (*-ān-*) undoubtedly derives from **-onh*$_2$ by Szemerényi's Law, with the **-h*$_2$ (or its later outcome) being analogically reintroduced from other neuter paradigms such as vowel-final and obstruent final stems, where the **-h*$_2$ had not been lost. More compelling evidence of the non-application of Szemerényi's Law in PIE may be cited in the archaic forms Skt. *jáni-*, YAv. *jaini-*, Arm. *kin*, TA *śaṃ*, TB *śana* from **gʷénh*$_2$ 'woman'[87] and Hitt. *kit-kar* 'at the head', which derives either from *kēd* + **k̂érh*$_2$ 'head (loc.sg.)' or *kēd* + **k̂arḫ* (< **k̂r̥h*$_2$) 'id.'.[88]

Given the existence of variation within sequences of the shape *-VRH$ in both medial and final position, it is conceivable that both rules were driven by the same phonological phenomenon. Just as there were root variants **ĝen-* (Skt. *janman-*), **ĝenh*$_1$*-* (Skt. *jánitrī-*) in medial position in PIE so were there variants **gʷēn* (OIr. *bé*), **gʷénh*$_2$ (Skt. *jáni-*) in final position. The forms without a laryngeal are the more opaque and therefore the more archaic, which entails that the constraint ranking ⋆RH$ >> MAX-H was older than the ranking MAX-H

85 "Association lines do not cross" (Goldsmith, ibid.).

86 Given our rule of coda extrasyllabicity (84) above, it would be impossible to assume that all word-final consonants were extrasyllabic, though it is possible—indeed likely—that a consonant in absolute word-final position was extrametrical in PIE. Cf. Watson 2002:92: "In contrast to extrametrical consonants, which link directly with the syllable node of the peripheral syllable, the extrasyllabic consonant falls into ... a degenerate syllable".

87 See NIL 177–85 for discussion and references for each form. Contrast OIr. *bé* < **gʷen* < **gʷēn* < **gʷénh*$_2$, which according to Jasanoff 1989:140, provides evidence for an earlier, laryngeal-less form produced by Szemerényi's Law.

88 Nussbaum 1986:96–99. Whether from PIE **k̂érh*$_2$ or much later **k̂arḫ*, Szemerényi's Law ceased to exist at some point within the prehistory of Hittite.

>> *RH$ in PIE. Like the neuter nominative/accusative plural endings in *-V̄R, the laryngeal-less *CERH roots should be viewed as archaims and were likely to have already been lexicalized at a late stage of PIE.

Of course, as is well known, Szemerényi's Law is also found in the environment */-VRs#/, with loss of *s and subsequent compensatory lengthening (→ *V̄R#).[89] Should one assume that the laryngeals were all fricatives in manner (see section 1.2.1.2 for discussion), then both processes in question may be collapsed as targeting the word-final sequence *-VRF#.

(101) Szemerényi's Law
PIE *VRF → V̄R / _#
In a word-final sequence of vowel + sonorant + fricative (*/s, h_1, h_2, h_3/), the fricative is lost with subsequent compensatory lengthening on the preceding vowel.

Just as in sequences of the shape *-VRH#, Szemerényi's Law ceased to be productive in those of the shape *-VRs# —forms such as **u̯ih₁roms*[90] 'men' (not ^{X}*u̯ih₁rōm*), **sals*[91] 'salt' (not ^{X}*sāl*) and **séms*[92] 'one (masc.nom.sg.)' (not ^{X}*sḗs*) are frequently reconstructable. Those instances where Szemerényi's Law did apply, such as PIE **p(əh₂)tḗr* (← */ph₂térs/), **dʰéĝʰōm* (← */dʰéĝʰoms/), and the third plural perfect ending **-ēr* (← */-ers/),[93] had all been morphologized, and the long vowel produced was no longer synchronically viewed as the outcome of a process of **s*-loss.

If Szemerényi's Law did apply within sequences of the shape *-VRH# and *-VRs#, and if codas of the shape *RH$]_\sigma$ were also avoided word-medially, then we would also expect there to have been instances of deletion in sequences of the shape *RsCC, as there were in those of the shape *RHCC. Unfortunately I have not yet found any such examples of **s* deletion in PIE. However, it is curious to note that an examination of the forms listed in the IEW, LIV and NIL reveals a number of roots of the shape **-Rs*, such as **dʰers-* 'take courage',[94] **ĝeu̯s-* 'taste'[95] and **(s)kers-* 'cut',[96] though only a fraction attest derivatives

89 Szemerényi 1970:109.

90 Goth. *wairans*.

91 Gk. ἅλς, Lat. *sāl*.

92 Gk. εἷς, not ^{X}ἧς.

93 Seen in Lat. *-ēr-e* and likely Hitt. *-er, -ir* (Jasanoff 2003:32).

94 IEW 259; LIV 147; NIL 120–2. Ved. *dhr̥ṣṇóti* 'is courageous', Goth. *ga-dars* 'dares'.

95 IEW 399–400; LIV 166–7. Ved. *juṣāṇá-* 'taking pleasure', Goth. *kausjan* 'taste; meet'.

96 IEW 945; LIV 355–6. Hitt. *karašzi* 'cuts, fails', TB *śarsa*, TA *śärs-* 'knew'.

with the sequence RsCC. Moreover, in almost every instance the attested RsCC sequence is secondary. Lith. *žiezdrà* 'gravel; grain', *žiẽz(g)dros* 'gravel' to the root **ĝei̯s-* 'gravel' (IEW 356), PSlav. **męzdra* continued by RCS *męzdrica* 'egg shell' and Russ. *mjazdra* 'the flesh-side of the hide' to **mēms-* 'meat' (IEW 725), and OPruss. *tiēnstwei* 'excite' from **tens-* 'thin out' (IEW 1069) are all formations which cannot be reconstructed back to PIE. In fact, I have found only one reconstructable sequence of the shape *RsCC: *(h_1)oi̯s-tro-/-trah$_2$, continued by Gk. οἶστρος 'rage', Lith. *aistrà* 'vehement passion' and Lith. *aistrùs* 'passionate', formed to the root *$h_1$eis-, as seen in Lat. *īra* 'anger' (Plautus *eira*).[97]

It is unclear whether the paucity of reconstructable sequences of the shape *RsCC is of any significance, though it would be explained nicely by a general avoidance of the shape *RF$. If I am correct that Szemerényi's Law applied also in word-medial position, then we may tentatively reformulate the rule as follows:

(102) Szemerényi's Law (Revised).

$$\text{PIE *VRF} \rightarrow \begin{cases} \bar{\text{V}}\text{R} / \_\# \\ \text{VR} / \_\$\text{C}_0 \end{cases}$$

A fricative is deleted in a coda sequence of the shape vowel + sonorant + fricative (*/s, h_1, h_2, h_3/), with compensatory lengthening on the preceding vowel if lost word-finally.

This rule was no longer productive in late PIE, which explains the variation found in the attested IE languages.[98]

I recognize that readers may find my analysis curious: why piece apart a perfectly good rule such as Lex Schmidt-Hackstein into two separate processes? There are two very good reasons. First, doing so allows us to explain the phonetic/phonological motivation behind each process. It is typologically common for SSP violations to be avoided in word-medial position, and as Sandell & Byrd argue (ibid.), it is typologically common for a fricative to be deleted in coda position as proposed in my new interpretation of SzL. But more crucially for those skeptics, connecting those archaic instances of RH.CC > R.CC with SzL provides us with a straightforward way to account for the fact that this process had clearly become moribund in late PIE, as evidenced by the numerous reconstructable exceptions to LSH such as *ĝenh$_1$trih$_2$ 'bearer,

97 IEW 299ff.; Olsen 1988:16.

98 In fact, it is likely that the original version of SZEMERÉNYI'S LAW targeted all post-consonantal coda fricatives. See Sandell & Byrd, in preparation.

mother'.[99] On the other hand, there are *no* reconstructable exceptions to the rule PH.CC > P.CC.

3.3.6 *Extrasyllabicity Test #1: Monosyllabic Lengthening*

Returning now to the more general problem of reconstructing word-final extrasyllabicity in PIE, it is helpful that there exists an independent, non-circular method to test for coda extrasyllabicity in languages where monosyllabic lengthening is a synchronic phonological process (Itô 1988:123). This phonological process is employed by languages to make light monosyllables heavy, in order to satisfy a minimal word requirement that demands that a lexical item consist of at least two morae.[100]

(103) Minimal Word Requirement
Any word bearing stress must consist of at least two morae.

For example, in Old Irish, vowels found in monosyllables are lengthened if the word bears stress. Thurneysen (1946:32) lists *sé* besides *sessed* 'sixth', *mé* 'I' besides the emphasizing particle *messe*, *gé* 'pray (3 sg. subj.)' besides *gessam* (1 pl. subj.), *tó* 'yes' and *trú* 'doomed person (nom.sg.)' beside *troch* (gen.sg.). However, in unstressed monosyllables (enclitics and proclitics) the vowel is never lengthened, as we see in the unstressed clitic *de* 'from him, it' (not ^{X}*dé*). Whether the lengthened vowel in the monosyllable is historically or synchronically derived is irrelevant; *synchronically* there are no stressed monosyllables in Old Irish that consist of a single mora.

As for extrasyllabic coda consonants, if a word of the shape #CV# lengthens to #C$\bar{V}$# and #CVX# also lengthens to #C$\bar{V}$X# by a process of monosyllabic lengthening, we may assume that X is extrasyllabic. For example, in Ponapean, a Micronesian language spoken primarily on the island of Pohnpei and the Caroline Islands, one finds vowel lengthening in certain monosyllabic nouns ending in a consonant (Rehg & Sohl 1981:117; McCarthy apud Itô 1988:123ff.)[101]

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99 Pace Zair 2012:167, just as archaic forms of the shape *-*V̄R* must be reconstructed for PIE in word-final position beside *-*VRF*, so must we posit the absence of a laryngeal in PIE **ĝen*(*m*)*n*- (Dor. Gk. γέννᾱ, Skt. *janman*-) beside **ĝenh*$_1$*trih*$_2$ (Lat. *genitrix*, Skt. *jánitrī*-). The Gk. form γένεθλον 'relative' must be a later formation, created either in late PIE or proto-Greek.

100 See McCarthy & Prince 1986:6–7 for discussion, with references.

101 Vowel-final roots are inherently long in Ponapean (e.g. /ntā/ 'blood'), which ironically have shortened within the history of the language: /ntā/ 'blood' > [nta], through a more general process of apocope (Rehg & Sohl 1981:89).

(104) Ponapean Monosyllabic Noun Lengthening
a. /pik/ → [piik] ‘sand’ (vs. inflected *pik-en* ‘sand of’)
b. /pet/ → [peet] ‘bed’ (< Eng. *bed*)
but
c. /keep/ → [keep] ‘yam’, not ^{X}[keeep]
d. /kent/ → [kent] ‘urine’, not ^{X}[keent]

In Ponapean, a monosyllabic noun of the shape CVC behaves as if it is light, or consisting of only one mora, while a noun of the shape CVVC and CVCC behaves as if it is heavy. McCarthy argues that by assuming the final consonant of nouns to be extrasyllabic, the forms presented in (94) may be syllabically parsed as $[\text{pi}]_\sigma$k, $[\text{pe}]_\sigma$t, $[\text{kee}]_\sigma$p, $[\text{ken}]_\sigma$t, etc. This is why the process of monosyllabic lengthening, or the lengthening of a vowel to satisfy the minimum word requirement, occurs only in monosyllabic nouns of the shape CVC.

As early as Hirt (1921–37:II/227), it has been suggested that a process of monosyllabic lengthening existed in PIE, in order to account for long and short variants of some very common Indo-European words.[102] Sihler (1995:38) proposes that this lengthening occurred only when PIE monosyllables were stressed (cf. Old Irish above). If a minimal word requirement was present in the proto-language, a restriction of vowel lengthening to stressed monosyllables is to be expected, since lexical items always require accentuation, while grammatical items such as clitics do not.[103] Kapović (2006:151[442]) argues that Sihler's explanation of monosyllabic lengthening is impossible, since there is lengthening of the 1st pl. pronominal clitic **nōs* ‘us’ found in Latin *nōs* and Slavic *na-*, which should never have occurred, since, having been a clitic, it was always unaccented. Kapović's argument, however, is not fatal to Sihler's suggestion, since as we will see, both instances of lengthening in Latin and Slavic may be viewed as secondary within the individual prehistories of each language.

Kapović (2006) presents an excellent overview of the problem of monosyllabic lengthening and convincingly argues for the reconstruction of this phonological process for PIE. The most solid examples are presented in (95) below and are primarily taken from Kapović (2006:147ff.). Examples (vi)–(ix) of set (a) and (iv) of set (b) have been graciously suggested to me by Brent Vine.

102 Darin Arrick (p.c.) has informed me of a similarly unexplained alternation of long and short vowels within monosyllabic lexemes in Mutsun, a Utian language once spoken in Northern California.

103 Cf. Blevins & Wedel 2009:158.

(105) Possible examples of lengthened monosyllables in PIE.

a. In open syllables.

   i. ***me*** 'me (acc.)' (Gk. ἐμέ, OIr. *mé*, Goth. *mi-k*) vs. ***mē*** (Skt. *mā*, Av. *mā*, Lat. *mē-d*, Gaulish *mi*, Welsh *mi*)[104]

   ii. ***nu*** 'now' (Skt. *nú*, Gk. νῦ, Lat. *nu-nc*, OIr. *nu*, *no*, Latv. *nu*) vs. ***nū*** (Skt. *nū́*, Av. *nū*, Gk. νῦν, OCS *ny-ně*, Lith. *nū-naĩ*)[105]

   iii. ***tu*** 'you' (Gk. σύ, Latv. *tu*, OE *þu*, OIr. *tu-ssu*, Hitt. *tu-k*) vs. ***tū*** (Lat. *tū*, Hom.Gk. τῡ́νη, Av. *tū*, OCS *ty*, OE *þū*)[106]

   iv. ***ne*** 'not' (Skt. *ná*, OCS *ne*, Lat. *ne-que*, Goth. *ni-h*) vs. ***nē*** (Lat. *nē*, OIr. *ní*, OCS *ně*-)[107]

   v. ***t(u̯)e*** 'you (acc.)' (Gk. σέ, τέ) vs. ***t(u̯)ē*** (Skt. *tvā́*, Av. *ϑβā*, Lat. *tē-d*)[108]

   vi. ***bʰe*** 'emphasizing particle' (East Lith. *bè*), ***bʰo*** (Goth. *ba*, OCS *bo*) vs. ***bʰē*** (perhaps GAv., YAv. *bā*),[109] ***bʰō*** (Pol. *ba*)[110]

   vii. ***de*** 'directional particle' (Lat. *quan-de*, *in-de*), ***do*** (OCS *do*) vs. ***dē*** (OIr. *dí*, Gk. δή, Lat. *dē*), ***dō*** (Lat. *dōnec*, OIr. *do, du*, PGmc. **tō*)[111]

   viii. ***ku*** 'interrogative particle' (Skt. *kútaḥ*, Av. *kuϑa*) vs. ***kū*** (Skt. *kū́*, Av. *kū*)[112]

   ix. ***u̯e*** 'disjunctive particle' (Lat. *-ve*, Skt. *i-vá*) vs. ***u̯ē*** (Skt. *vā*, Av. *vā*, Gk. ἦ-(*F*)ε, ἤ)[113]

b. In syllables with one coda consonant.

   i. ***ud*** 'on high' (Skt. *úd*) vs. ***ūd*** (Gmc. **ūt* > Goth. *ut* [ūt], Eng. *out*, Germ. *aus*)[114]

   ii. ***u̯os*** 'y'all' (Skt. *vas*, YAv. *vō*, GAv. *və̄*) vs. ***u̯ōs*** (Lat. *vōs*, OCS *va*)[115]

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104 IEW 702.

105 IEW 770.

106 IEW 1097.

107 IEW 756–8.

108 IEW 1097.

109 Note that Dunkel 2014:121 posits that *bā* derived from **bʰé-h₁*; if true, this would not constitute an instance of monosyllabic lengthening.

110 IEW 113; Dunkel 2014:116ff.

111 IEW 181ff.; de Vaan 2008:162; Dunkel 2014:148ff.

112 IEW 647ff.; Dunkel 2014:436ff.

113 IEW 75; Dunkel 2014:839ff.

114 IEW 1103–4.

115 IEW 514.

iii. ***nos*** 'us' (Skt. *nas*, Hitt. *-naš*, YAv. *nō*, GAv. *nə̄*, Alb. *na*, Gk. *νόσφιν* 'apart (from)') vs. ***nōs*** (Lat. *nōs*, OCS *na*)[116]
iv. ***ub*** (Lat. *s-ub*) vs. ***ūb*** (OHG *ūf*, OCS *vy-sokъ*)[117]

Other purported examples of monosyllabic lengthening in PIE include **mūs* 'mouse', which has traditionally been connected to **mus-* 'steal' ('mouse' < 'the thief') and **i̯ūs* 'y'all' (Av. *yūš*, Skt. *yūyám*, Lith. *jū́s* and OCS *vy*), from an earlier **i̯us*. However, the root 'steal' clearly is to be reconstructed as **mush$_x$-*,[118] in order to account for seṭ-forms such as *moṣīs* 'steal (2nd sg. injunctive)'. Therefore, the root 'steal' does not give us any particular reason to assume monosyllabic lengthening in **mus* 'mouse' versus a straightforward development of **u* plus laryngeal (**muh$_x$s*).[119] In addition, the pronoun **i̯ūs* has no attested short variant, and as Kapović himself admits (2006:148[431]), may just as easily derive from PIE **i̯uh$_x$s*.

If monosyllabic lengthening did exist as a synchronic phonological process within PIE, our rule of coda extrasyllabicity should show precisely where it occurred. We have seen that in PIE, extrasyllabic consonants were only present in codas when they violated the SSP. Thus, in order for a consonant to be extrasyllabic, another consonant would necessarily precede it, and therefore any word-final syllable with extrasyllabic consonant(s) would ALWAYS be heavy. So, if our rule of coda extrasyllabicity (84) is correctly formulated, monosyllabic lengthening should only be found in words of the shape CV, which would explain the long variants of **me* 'me', **nu* 'now', **tu* 'thou', **ne* 'not', **t(u̯)e* 'thee', **bʰe*/**bʰo* 'emphasizing particle', **de*/**do* 'to', **ku* 'interrogative stem', and **u̯e* 'or'.

But in (95b) above, there are four possible examples of monosyllabic lengthening in words ending in a single final consonant. Note, however, that all of the long variants occur in Western Indo-European (sub-)branches: Italic, Slavic and Germanic. In Latin, monosyllables of the shape /CVs/ always have a long vowel (cf. *ās* 'as, a type of coin', *pēs* 'foot', *vīs* 'strength', *ōs* 'mouth', *mūs* 'mouse', etc.),[120] and therefore the forms *nōs* and *vōs* provide no evidence for the original vowel length in PIE, as any monosyllable of the shape /CVs/ would automatically have been realized as [CV̄s] in Latin. In Slavic, coda consonants were

116 IEW 758.
117 IEW 1106–7; Derksen 2008:535.
118 Cf. LIV 445.
119 If 'steal' and 'mouse' are to be connected, a possible explanation may be found in Olsen 1999:130–1, with references to previous literature.
120 Brennan 2006. For a detailed discussion of word minimality in Latin, see Mester 1994:19ff.

completely eliminated by the Law of Open Syllables (Carlton 1990:100), and so it is conceivable (though ad hoc) that in a prehistoric Slavic grammar, either the loss of **-s* (via an intermediate stage **-h*) had resulted in compensatory lengthening in this particular form: **nos* > **noh* > **nō* > *na*, or **s*, at some point along path to zero, had become extrasyllabic, at which time monosyllabic lengthening had taken place: $*[\text{nos}]_\sigma > *[\text{no}]_\sigma\text{s} > *[\text{nō}]_\sigma\text{s} > [\text{na}]_\sigma$.[121] Neither are particularly compelling scenarios since, to my knowledge, there are no parallel examples.[122] Perhaps, however, an ad hoc explanation may be maintained since we are dealing with a high-frequency word, a type which tends to undergo unusual phonological developments.[123] Though I currently do not have an explanation for the vowel lengthening found in the Germanic forms **ūt* 'out' and **ūp* 'up',[124] the reader should note that monosyllabic lengthening did not occur in PGmc. **hʷát* 'what' (< PIE **kʷód*; not PGmc.^{X}*hʷṓt*) or **át* 'at' (< PIE **ád*; not PGmc. ^{X}*ṓt*), two words of similar shape (Ringe 2006:98).[125] In short, the restriction of MSL to monosyllables of the shape $*\#C_0V\#$ agrees with the proposed environment of word-final extrasyllabicity.

3.3.7 *Extrasyllabic Consonants in Onset Position*

As in PIE word-final codas, multiple violations of the SSP were allowed in PIE word-initial onsets. Bipartite onsets include **stah$_2$-* 'stand', **u̯reh$_1$-* 'find', **h$_2$teu̯g-* 'terrify', and tripartite onsets include **psten-* 'breast', **streu̯-* 'strew', **h$_2$ster-* 'star',[126] **h$_1$sti-* 'existence'. The key difference between medial onsets and codas, however, lies in the fact that the SSP may be violated in bipartite

121 A similar derivation would also be assumed for PIE **ub*.

122 Moreover, as an anonymous reviewer reminds me, all of this may be beside the point, as *na* and *va* are the accusative dual forms of the first and second person pronouns, respectively, and do not mean 'we, us' and 'you (pl)' as in Latin.

123 In other words, high-frequency words are more likely to undergo lexical diffusion. Cf. Labov 1994:483.

124 Perhaps the presence of **u* in these protoforms—being inherently shorter and less sonorous than **a*—is a factor here?

125 These forms will be addressed further in Sandell & Byrd, in preparation. While we consider MSL to be a diagnostic of extrametricality (which subsumes extrasyllabicity), their conclusions do not significantly impact our analysis of the IE syllable.

126 Derived by Adams (1995) as an agent noun to the root **h$_2$ah$_1$s-* 'be hot' (LIV 257–8), followed by Pinault (2007). I remain agnostic on the etymology, but I will point out that the reduction of **h$_2$h$_1$ster-* to **h$_2$ster-* would be an unusual one for (late) PIE, since word-initial CHCC clusters tended to be fixed by schwa epenthesis (cf. 'father (gen.sg.)', etc.). Nevertheless, we would expect simplification in this case, given that deletion was preferred over epenthesis in PIE, should the resulting cluster be a legal one.

medial onsets, if the first segment of the cluster was a fricative: *d^hug.$h_2$ter-, *$h_1$et.sḱé/ó- 'eat (iterative)', *$h_2$uk.sto-[127] 'grown', *pn̥k.sti- 'fist',[128] *s(u̯)ek.sto- 'sixth'.[129] This suggests that an SSP violation was allowed in a PIE bipartite onset. Note that *d^hugh$_2$ter-, *$h_1$etsḱé/ó-, *$h_2$uksto-, etc. could not have been syllabified as *d^hugh$_2$.ter-, *$h_1$ets.ḱe/o-, *$h_2$uks.to-, because there would have been an SSP violation in the coda; see rule (84) above.

3.3.8 *Extrasyllabicity Test #2: Reduplication*

In section 3.3.6 we saw that monosyllabic lengthening provides us with an independent method of determining coda extrasyllabicity in languages that have a Minimal Word Requirement. Depending on one's theoretical view of reduplication, there may also exist an independent test of onset extrasyllabicity: the analysis of a language's reduplication patterns.[130] According to this particular theoretical view, if a certain consonant occurs in absolute root-initial position and participates normally in the reduplication process, we may say that that consonant is syllabifiable in that language. Conversely, if a particular root-initial consonant is not copied into the reduplicant then we may say that that consonant is extrasyllabic.

For example, Sanskrit roots with no extrasyllabic segments in the onset reduplicate the initial consonant (*prā-* 'fill' → *pi-pra-*) while those roots with extrasyllabic consonants in the onset reduplicate the second (*sthā-* 'stand' → *tí-ṣṭhati* 'stands' not **sí-ṣṭhati*).[131] As Steriade (ibid.) shows, only those roots with an SSP violation in the onset behave differently from the normal pattern of reduplication, since those violating consonants are extrasyllabic. In (Attic) Greek, reduplication is blocked for onsets with extrasyllabic consonants: the perfect of γνω 'know' is ἔ-γνωκα, not ^{X}γέ-γνωκα, since #γν- contains an extrasyllabic γ that blocks reduplication.[132] Thus, analyzing how reduplication worked

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127 Continued by Dardic, Pashai (dialectal) *ūṣ/ux* 'long' (Turner 1966:74, Nr. 1627). Sanskrit **uṣṭa-*, the expected reflex of **$h_2$uksto-*, has been replaced by *ukṣita-* (NIL 354–5).

128 OHG *fūst*, OE *fȳst*, OBulg. *pęstь* (IEW 839).

129 Lat. *sextus* (← **sektos* < **sekstos*), Gk. ἕκτος, Ved. *ṣaṣṭhá-*, Goth. *saihsta*, Lith. *šẽštas*, TB *ṣkaste* (Weiss 2009:293).

130 See Steriade 1982:312ff., Keydana 2006, Keydana 2011. An alternate view is given by Carlson 1997 (see also Morelli 1999, Cho & King 2003 and Vaux & Wolfe 2009) who points out that the choice of consonant in reduplicative templates is rather due to reduplicant-specific markedness constraints and therefore nothing may inferred about the underlying syllabic structure.

131 Steriade 1982:312ff., Kobayashi 2004:43, Keydana 2006:95–7.

132 Steriade (1982:221) argues that in Greek adjacent tautosyllabic consonants must be at least four intervals apart on the sonority scale (see top of p. 221). The reason γ is

in PIE may be able to tell us in a non-circular fashion whether there were extrasyllabic consonants in word-initial position and exactly which consonants could function as extrasyllabic. Fortunately for our study, reduplication is a common morphological process in Proto-Indo-European. It is found in many verbal categories (reduplicated presents, aorists, desideratives and perfects) and very rarely in nominal formations, in such forms as **kʷe-kʷlós* 'wheel' (Skt *cakrá-*, Gk. κύκλος, OE *hwēol*, etc.).

For the most part reduplication is a well-understood morphological process in PIE.[133] There are two reconstructable types of reduplication, partial and full, with the latter utilized only in intensive/iterative formations, such as Skt. *dár-darti* 'pry open' to *dar-* 'split' and Gk. πορ-φῡ́ρω 'swell, surge (of the sea)' to an earlier **pʰur-*.[134] All other morphological categories reduplicated partially. Some reduplicated with *e*-vocalism (perfect, aorist, certain presents, and nominal formations), while others showed *i*-vocalism (certain presents and desiderative).

Roots with a single consonant in the onset simply reduplicated that particular consonant, followed by a vowel: **gʷem-* 'come' → **gʷe-gʷóm-e* 'came' (> Skt. *jagā́ma*); **bʰer-* 'bear' → **bʰi-bʰérti* 'carries' (> Skt. *bibhárti*). Roots with two consonants in the onset reduplicated with the first: **drem-* 'run' → **de-drom-* (> Hom.Gk. ἀνα-δέδρομε 'towered'); **mnah$_2$-* 'remember' → **me-mnóh$_2$-/me-mn̥h$_2$-* (> Gk. μέμνημαι 'I remember'); **smei̯-* 'smile' → **se-sm(o)i̯-* (> Ved. *siṣmiyāṇa-* 'smiling'), **h$_2$neḱ-* 'reach' → **h$_2$a-h$_2$noḱ-* (> Skt. *ānáṃśa*, OIr. *-ánaic*), etc.[135] Based on these facts, the reduplication template for PIE may be reconstructed as *C$_1$V-C$_1$(C)V- for morphological categories with partial reduplication. Complications arise, however, in the reconstruction of reduplicants for roots whose onsets consisted of /s/ + stop and /H/ + stop, namely, those roots where the first consonant of a bipartite onset was a fricative and violated the SSP.[136]

Let us first address the reduplication template for roots of the shape *sP-. Here, the uncertainty for reconstruction lies in the many different types of reduplicants attested in the IE languages. As we saw, Sanskrit shows *PVsP-*

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extrasyllabic in the sequence #γν- is because there is only a sonority distance of three intervals in this cluster.

133 For excellent and thorough discussions of the process of reduplication in PIE, see Brugmann 1897–1916:20–41, Niepokuj 1997 and Keydana 2006.

134 Cf. Hitt *paraḫzi* 'chases' < **bʰerh$_2$-* 'move quickly'. See Schaefer 1994 for discussion of Vedic intensives; for Greek, see Tichy 1983.

135 Kümmel 2000:287.

136 See Keydana 2006.

(cf. *tí-ṣṭʰati* 'stands' to *stʰā-*) while its most closely related branch, Iranian, attests to *sVsP-* (Av. *hi-štaiti*, *vi-ša-starᵊ*, OPers. *a-hi-štatā*, all to *stā-* 'stand'), as does Celtic (cf. OIr. *se-scaind* 'jumped' < **se-skond-e*). In non-productive reduplicated *i*-presents in Greek, we find **sVsP-* (cf. ἵ-στημι),[137] while productive perfect formations block reduplication altogether (ἐ-στρατόωντο 'were on the battlefield', with simple prefixed ἐ-). In Latin, the highly archaic and non-productive reduplicated present *si-stō* (= Umbr. **se-stu**) attests to *sVsP-*, while later productive reduplicants to roots of the shape *sPV-* exhibit a curious process of reduplicative infixation: *stā-* 'stand' → *ste-t-*; *spond-* 'libate' → *spo-po-nd-*, etc.[138] In Gothic the reduplicative template is always *sPVsP-* (*stai-stald* to *stald-*, etc.),[139] while in Tocharian, we find three reduplicant shapes attested: in A, *sV-* (*spārtw*$^{(ā)}$- 'turn, behave, be' → *sā-spärtwu*), and in B, *PV-* (*spārtt*$^{(ā)}$- 'turn, behave, be' → *pa-sparttau*) and *sPV-* (*stäm*$^{(ā)}$- 'stand' → *śce-ścamoṣ*; *staukk*$^{(ā)}$- 'swell' → *sta-staukkauwa*).[140]

Many scholars[141] have viewed this disparity among reduplicants in the IE languages as proof that the reduplication template for roots of the shape **sP-* was **sPVsP-*, exactly as is attested in Gothic. The basic idea is that those languages whose reduplicants have a single consonant (**s* or **P*) have simplified the original, more complex reduplicant beginning in **sP-* through a process of dissimilation: PIE **sti-stah*$_2$*-ti* 'stands' > **si-stah*$_2$*-ti* or **ti-stah*$_2$*-ti*.[142] However, as early as Brugmann,[143] it has been recognized that since Lat. *sistō* and Gk. ἵστημι do not follow their respective synchronic pattern of reduplication, they must be archaisms derived from an older reduplicative template **sVsP-*. It is simplest to assume that both forms go back to a common archaism, and that the reduplication pattern found in Avestan and Old Irish continues the original state of affairs.

Those scholars who reconstruct a PIE **sti-stah*$_2$*-ti* 'stands' typically see confirmation in their reconstruction of the reduplicant to **h*$_1$*ger-* 'awaken', the only root of the shape *HP- with an attested reduplicated form (Kümmel

137 As well as the archaic ἕ-στηκα 'I stood'.

138 Fleischhacker 2002:5. See Keydana 2011 for an alternative analysis.

139 I follow Keydana 2006 and 2011, who assumes a subsegmental status of /s/ in /sP/ clusters in Gothic (suffricates), which easily accounts for the entire copy of the initial cluster of the root.

140 Forms taken from Malzahn 2009:964, 963, 959–60 and 990, respectively.

141 For instance, Szemerényi 1970:249 and LIV 590.

142 Keydana 2006:81 convincingly dispels this notion, demonstrating that dissimilation cannot produce the attested reduplicants as long as reduplication is still an active morphological process.

143 1897–1916:40–1.

2000:191–4). There are three attested reflexes of the perfect to **$h_1$ger-* 'awaken': Skt. *jāgā́ra* 'wakes, is awake', Av. *jaγāra* 'is awake' and Gk. ἐγρήγορε 'is awake' (LIV 245–6). The Avestan form must be secondary, having eliminated the lengthened grade in the reduplicant by analogy to other perfects. The Greek and Sanskrit forms, however, appear to derive from an original **$h_1$ge-$h_1$gor-e* 'woke up', with the [r] in the Greek reduplicant secondary by analogy to the aorist ἔγρετο (LIV 245).

However, as Keydana (2006:104–5) demonstrates, the Sanskrit form is more easily explained as deriving from **gēgor-* < **ge-Hgor-*, following the reduplication template **PVHP-*, analogous to the **PVsP-* reduplication template discussed above. Just as *PVsP-* replaced **sVsP-* as the reduplication template to roots of the shape *sP-* in the prehistory of Sanskrit,[144] so may we posit that **PVHP-* replaced an earlier template **HVHP-* to roots of the shape **HP-*. Similarly, Greek ἐγρήγορε may be viewed as a later formation, remade from original *ἥγορε (< **h_1e-$h_1$góre*) and re-marked as a reduplicated form through the process of Attic reduplication (cf. Rix 1992:204–5), as has occurred, for example, in the perfect of **$h_1$neḱ-* 'take': **h_1e-$h_1$noḱ-* > **ēnoḱ-*[145] ⤳ Att. ἐν-ήνοχα 'has carried' (LIV 250). Likewise, **h_1e-$h_1$góre* > **ēgore* ⤳ *ἐγ-ήγορε, with the -ρ- secondarily inserted into the reduplicant.[146]

Note also that if the reduplicant to **$h_1$ger-* 'awaken' had consisted of two consonants in the onset, it would be the sole example of such a reduplication type reconstructed for PIE, since, as we saw, roots of the shape **sP-* reduplicated with a simple **sV-*. This makes it increasingly likely that a single reduplication template existed in PIE: *C_1V-C_1(C)V-. In short, PIE reduplication proceeded in the same way for all bipartite onsets: **pleh₁-*'fill' → **pi-pleh₁-* (Gk. πίμπλημι 'fill'), **stah₂-* 'stand' → **si-stah₂-* (Lat. *sistō*, Gk. ἵστημι, etc.), **u̯reh₁ĝ-* 'break' → **u̯e-u̯roh₁ĝ-* (Gk. ἔρρωγε), **h₂neḱ-* 'reach' → **h₂a-h₂noḱ-* (> Skt. *ānáṃśa*, OIr. *-ánaic*), and **h₁ger-* 'awaken' → **h₁e-h₁gor-*.[147]

3.3.9 *The Rule of Onset Extrasyllabicity*

Reduplication tests indicate that because the reduplication pattern in PIE was the same for all roots with bipartite onsets, an SSP violation was allowed in the PIE onset, unlike in Sanskrit. This is corroborated by allowance of an SSP violation in word-medial onsets: **dʰug.h₂ter-*, **h₁et.sḱe/o-* 'eat (iterative)',

144 See Kobayashi 2004:43–4 for a succinct explanation on why the reduplicative template was changed from **sVsP-* to *PVsP-* in the prehistory of Sanskrit.

145 Cf. Skt. *ānáṃśa*, OIr. *-ánaic* < **h₂a-h₂noḱ-*.

146 For a convincing proposal of how Attic reduplication came to be, see Zukoff, forthcoming.

147 Cf. Keydana 2006:66–7 & 2011.

**s(u̯)ek.sto-* 'sixth'.[148] Curiously, none of the verbal roots with tripartite onsets have reduplicated forms; we cannot reconstruct **pipsterti* 'sneezes', **sestrou̯e* 'strewed' or the like.[149] If not simply by chance, it is likely these roots possessed an extrasyllabic segment that blocked reduplication, just as in Greek above. This, coupled with the fact that there is no reconstructable medial onset consisting of more than two consonants, allows us to postulate a rule of onset extrasyllabicity for PIE.

(106) Rule of Onset Extrasyllabicity in PIE
The maximal onset in PIE consisted of two consonants. Any consonant preceding this sequence is to be considered extrasyllabic.

The following bolded consonants were extrasyllabic: *****p****sten-*, *****s****treu̯-*, *****h₂****ster-*, *****kʷ****spent-*. Note that while **pst-* was a legal word-initial onset in PIE, **ptr-* was not (see 3.3 above). It appears that—with the sole exception **ĝʰdʰi̯és* 'yesterday' (Skt. *hyáḥ*, Gk. χθές)—in all legal tripartite onsets, either the first or second consonant was an **s*.[150] At this time I am unsure of this fact's

148 SSP violations in word-medial onsets are not allowed in many of those languages where the synchronic reduplication template for roots of the shape #sP- has diverged from that of the protolanguage due to onset extrasyllabicity: Lat. *steti*, Gk. ἐστρατόωτο, Skt. *tíṣṭhati*. Thus, *sP-* was licensed as an extrasyllabic onset at word's edge (*stāre, statós, sthitá-*) but blocked word-medially, reflected by the following cluster simplifications: *Sestius* from *Sekstius* (the *k* in *sextus* is analogical; Weiss 2009:375), Gk. -ιστος and Skt. *vittá-* from *u̯itstós* 'known' (for Sanskrit, cf. Kobayashi's (2004:38) PRINCIPLE OF COHESIVE CLOSURE: "In Indo-Aryan, the closure of two plosives in the same consonant cluster should not be interrupted by a continuant consonant").

149 Though reduplicated forms of **ksneu̯-* 'sharpen' are found in both Av. *kuxšnuuąna-* (to *xšnu-* 'agitate') and Skt. *cukṣṇāva* 'whet (3rd sg. perf.)', it is unclear whether this provides a direct example of reduplication in a tripartite onset for PIE, as **ksneu̯-* is attested as a verbal root only in Indo-Iranian. If it is necessary to reconstruct a **ke-ksnou̯-* 'sharpen (perfect)' back to PIE, then perhaps at least three consonants were allowed in the PIE onset, though the first (of three) could not violate the SSP. Thus, **ksneu̯-* → **ke-ksnou̯-* but **pster-* 'sneeze' could not form a perfect **pe-pstor-*.

150 Then again, maybe **ĝʰdʰi̯és* 'yesterday' was NOT an exception, if it was realized as *[ĝʰzdʰi̯és], with *s-epenthesis (as per Schindler 1972b; for a different view, see Melchert 2003:153). If this were the case then the syllable structure of 'yesterday' would be *ĝʰz[dʰi̯és]$_\sigma$ with two extrasyllabic consonants. For extensive discussion of this form with literature see Vine 2008.

significance: was the presence of **s* a requirement for extrasyllabicity or merely a coincidence?[151]

3.4 Review of PIE Extrasyllabicity

Our rules of coda and onset extrasyllabicity ((84) and (96) above) correctly predict 1) deletion in the coda because of SSP violation (*$[\mathrm{d^hug}]_\sigma \mathrm{h_2}[\mathrm{trés}]_\sigma \rightarrow$ *$[\mathrm{d^huk}]_\sigma[\mathrm{trés}]_\sigma$ 'daughter (gen.sg.)'), 2) retention in the onset despite SSP violation (*$[\mathrm{h_1ed}]_\sigma[\mathrm{s\hat{k}é/ó}]_\sigma$ > *$[\mathrm{h_1et}]_\sigma[\mathrm{s\hat{k}é/ó}]_\sigma$ 'eat (iterative)') and 3) deletion in the coda & retention in the onset (*$[\mathrm{Vd^h}]_\sigma \mathrm{h_1}[\mathrm{s\hat{k}é/ó}]_\sigma$ 'put (iterative)' > *$[\mathrm{Vt}]_\sigma[\mathrm{s\hat{k}é/ó}]_\sigma$).[152] The last example, **-Vd^hh₁sḱé/ó-* 'put (iterative)' > **Vtsḱé/ó-*, reinforces the fact that only two consonants were allowed in the onset. Although word-initially the onset *$*h_xst$-* was legal in *$*h_2ster$-* 'star' and *$*h_1sti$-* 'existence', word-medially it was not. Thus we have deletion of *$*h_1$* in *$*\text{-}Vd^hh_1s\hat{k}é/ó$-* for two reasons: 1) *$*h_1$* violated the SSP in the coda *$*\text{-}d^hh_1$* and 2) a maximum of two consonants was allowed in a PIE onset.

3.5 The Maximum Syllable Template

Through an examination of reconstructable consonant clusters in PIE, we find that the maximal medial consonant cluster in PIE consisted of four consonants. While **i̯éu̯ktro-* 'cord' (NIL 399) was a well-formed PIE word, those such as **i̯eu̯k.stro-*, **i̯eu̯rk.stro-* were impossible, indicating that the maximum syllable template in PIE was CCVCC.

(107) MAXIMUM SYLLABLE TEMPLATE (MST) in PIE: CCVCC
The maximum PIE syllable consists of two consonants in the onset and two consonants in the coda. The onset may violate the SSP; the coda may not.[153]

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151 Once again, note that I do not reconstruct **pkten-* 'comb' as a legal consonant cluster in PIE, since there is no direct or indirect evidence in favor of such a reconstruction. It is likely that Gk. κτείς, κτενός 'comb' continues PIE **kten-*, with loss of **p* according to rule (98) below.

152 See section 3.2.1 for examples, taken from Hackstein 2002.

153 There were therefore significantly fewer possible contrasts in PIE codas as compared to onsets. We may potentially explain this phenomenon by looking to two properties within

Any violation of the maximum PIE syllable template should result in STRAY ERASURE or STRAY EPENTHESIS, following a modified version of the laryngeal deletion rule given in (75) as proposed in chapter 2 above.

(108) Conditions for PIE Cluster Repair
If a PIE syllable violates the MST and the violating consonants cannot be realized as extrasyllabic or directly vocalized, delete a consonant if the result would produce a legal consonant sequence; otherwise, insert a schwa.

Ultimately (98) should allow us to collapse any syllable-driven phonological process of epenthesis and deletion in PIE. In addition to the process of STRAY ERASURE in the sequence *PH.CC and STRAY EPENTHESIS in the sequence *#CHC(C) (cf. *ph_2trés* and *d^hh_1só-* above), it is very likely that the epenthesis of schwa secundum also results from a MST violation. This would render schwa primum and schwa secundum the exact same phonological process: fixing a cluster that violates the MAXIMUM SYLLABLE TEMPLATE with an epenthetic vowel, a process we may simply call schwa indogermanicum.[154]

Moreover, we should expect STRAY ERASURE to eliminate any consonant that violates the SSP within a word-medial coda sequence. For an excellent example, see Rau's 2009 historical analysis of Ved. *aśītí-* 'eighty', which he straightforwardly reconstructs as **$h_x$ok̂(t)h_x-tí-*, an abstract *-ti-* formation to the PIE word for 'eight', **$h_x$ok̂toh$_x$*.[155] According to Rau, **$h_x$ok̂th$_x$-tí-* reduced to

PIE. First, there were roughly four times the number of onsets vs. codas at word's edge, and it is perhaps for this reason that a larger number of contrasts were possible for onsets in word-medial position (see Appendix B). Second, as discussed in (17) it is conceivable that word-final stops, being voiced by rule, were not released in coda position, and therefore multiple obstruents were not as perceptible compared to onset position. One will also note that fricative plus stop onset clusters (which constitute all of the certain instances of word-medial SSP violations in PIE) are extremely common cross-linguistically.

154 Note that in order to view these two rules of epenthesis as a unitary phonological process, we must envision two 'rounds' of schwa primum (laryngeal 'vocalization') to have occurred within the IE languages. The first occurred in PIE and was inherited by all IE languages: **ph_2trés* → **pə$h_2$trés* > Arm. *hawr*, OIr. *athar*; **d$h_1$só-* → **də$h_1$só-* > Gk. θεός, PAnat. **daso-*. The second occurred independently in particular IE languages. This is essentially why some IE languages continue laryngeals as vowels in certain environments (PIE **d^hug$h_2$ter-* > PGk. **d^hugh_2əter-* > Gk. θυγάτηρ; PIE **$h_2$stér-* > PGk. **h_2əstér-* > Gk. ἀστέρ-) while others do not (PIE **d^hug$h_2$ter-* > Lith. *duktê*; PIE **$h_2$str̥-* > Skt. *str̥bhis*). See item (34) in chapter 1 for further discussion.

155 See Rau 2009 for discussion, with references.

h_xoḱ$h_x$tí- in PIE or at a very early stage of Proto-Indo-Iranian via "dissimilation … in order to break up the difficult cluster **ḱth$_x$t-* which ensued."[156] As Rau correctly recognizes, this deletion must have been very early because PIE **ḱ* in **h_xoḱ(t)h_x-tí-* becomes Skt. *ś*, not *^{X}ṣ*, which is the expected development of PIE **ḱ* in the cluster **-ḱt-* (cf. Skt. *aṣṭāu* 'eight' < **h_xoḱtoh$_x$*). Of course, what made this cluster "difficult" was not the close proximity of two dental stops (cf. PIE **u̯it.sto-* 'known', PIE **mat.h$_2$tó-* 'torn off' > Skt. *mathitá-* 'shaken', etc.), but rather the violation of the SSP in the coda of the first syllable, rendering the violating consonant unsyllabifiable: *$[\mathrm{h_x o\hat{k}}]_\sigma \mathrm{t}[\mathrm{h_x tí\text{-}}]_\sigma$ > *$[\mathrm{h_x o\hat{k}}]_\sigma[\mathrm{h_x tí\text{-}}]_\sigma$.[157] Thus, we see that there was nothing inherently "bad" about the Indo-European laryngeals, phonemically or phonetically, that would result in their loss in the position *PH.CC. Rather, there was something inherently "bad" about the syllable structure—a violation of the SSP in the coda. I would contend that the reason there are more examples of PH.CC > P.CC than, say, PP.CC > P.CC is that there is a greater number of roots of the shape *-PH than of the shape *-PP.[158]

156 Under the present analysis, Gk. ὄγδο(ϝ)ος 'eighth' could not derive directly from PIE **h_xoḱth$_x$u̯os* (with quadripartite consonant cluster), but perhaps could from PIE **h_xoḱtəh$_x$u̯os* (with medial schwa epenthesis). See Beekes 2010:1044 for further discussion.

157 Another possible example of word-medial consonant deletion driven by a MST violation may be found in PIE **teḱslah$_2$* 'weapon' (IEW 1058), which is continued by ON *þexla* 'mattock', OHG *dehsa*(*la*) 'hatchet', Lat. *tēlum* 'spear, missile' (for an alternative etymology of Latin *tēlum*, see de Vaan 2008:609), RCS *tesla* 'axe'; OIr. *tál* 'axe', Ogam *TALA-GNI*. Joseph 1982:43, followed by Olsen 1988:16, has suggested that **teḱslah$_2$* is a **-tlo-* derivative to **tetḱ-* 'fashion', with the original meaning 'instrument of fashioning, tool, axe'. Given the number of ad hoc changes required for such a reconstruction and the fact that such medial clusters were exceedingly rare in PIE, I *very* tentatively propose the following derivation/prehistory of the reconstructable form **teḱslah$_2$*. First, we must recognize that the underlying form */tetḱtleh$_2$/ could not have produced the surface syllabification *$[\mathrm{tet\hat{k}}]_\sigma[\mathrm{tlah_2}]_\sigma$ as it violated the MST, and so we would perhaps expect */ḱ/ to be lost via stray erasure. However, this would have produced **tetstlah$_2$*, which also violated the MST (see below) and therefore would not have been chosen as the output, either. Moreover, since the sequence */tetḱtleh$_2$/ contained a thorn cluster, it should have undergone *[s]-epenthesis, leading us once again to an unsyllabifiable candidate $[\mathrm{tets\hat{k}}]_\sigma[\mathrm{tlah_2}]_\sigma$. We therefore see that the conditions for cluster simplification were necessary, though the path to the actual form is unclear. Precisely why metathesis occurred in **tetsḱtlah$_2$* en route to **teḱslah$_2$* is unknown, though presumably it was the best PIE speakers could do to satisfy the constraints MST and OCP.

158 The LIV lists only two verbal roots of the shape *-PP, both ending in thorn clusters: ****h$_2$ad^{h}g^h-*** 'push' (LIV 255; Gk. ἄχθομαι 'am oppressed', Hitt. *ḫatki* 'closes') and ****tetḱ-*** 'fashion, create' (IEW 1058–9; LIV 638–9. Gk. τέκτων 'craftsman', Ved. *tákṣan-* 'carpenter', Av. *tašan-* 'creator' < PIE **tétḱ-on-*). It lists seven of the shape tectal + *s: ****deḱs-*** 'be brave,

3.6 The *métron* Rule

If the above hypothesis successfully accounts for the data attested in IE, then the *métron* rule may be explained in a fashion more typologically natural than previously (Mayrhofer 1986:111; Hill 2003:23ff.): namely, as the result of a violation of the SSP in a medial coda. Saussure's and Schindler's syllabification of **médtrom* as **médt.rom* makes little sense typologically[159] and runs counter to what we presently know about PIE syllabification. Not only did PIE allow the sequence **tr* as an onset word-initially (**tréyes*) and word-medially (**dʰuk.trés*), it actively banned the SSP violation which would have occurred in the syllabification **médt.rom*.

As we have seen in section 2.1.1, all geminates were strictly banned across morpheme boundaries in PIE, and an illegal sequence *VTTV was fixed by *s*-insertion. This *s*-insertion (*VTTV > *VTsTV) was possible since one violation of the SSP was allowed in the onset: **u̯id-tó-* > **u̯it.stó-*. However, if an **s* were epenthesized into a sequence of the shape *VTTRV then there would have been an SSP violation in the coda, which was strictly banned: **méd.trom* ↛ ^{X}*méts.trom*. Resyllabification of ^{X}*méts.trom* to ^{X}*mét.strom* would not have been allowed because of the MST, *CCVCC: **méd.trom* ↛ ^{X}*mét.strom*.[160] However, the OCP constraint must always be obeyed in PIE across morpheme boundaries, which results in the deletion of the final root consonant: **méd.trom* → **mé.trom* (**mét.rom*?).[161] Thus we see that the strict ban of an SSP violation in PIE

to suit' (IEW 189; LIV 112. Ved. *dakṣáyanti* 'make suitable', Gk. δεξιτερός, Lat. *dexter* 'on the right', etc.), *****dek*$^{(w)}$*s***- 'indicate' (IEW 189; LIV 112. Only attested in IIr.; Av. *daxšta-* 'feature'), ****h*$_2$*leks***- 'protect' (IEW 32; LIV 278. Gk. ἀλέξω 'ward off', Ved. *rákṣati*), ****h*$_2$*u̯eks***- 'grow' (IEW 84–5. LIV 288–9. Eng. wax, Gk. αὔξομαι 'I grow', etc.), ****i̯ek*$^{(w)}$*s***- 'appear' (IEW 502; LIV 312. Only attested in IIr.; cf. Ved. **prá yakṣanta* 'they distinguish themselves', Yagh. *yaxš*- 'appear'), ****mi̯eḱs***- 'set oneself' (LIV 445. Only attested in IIr.; Ved. *mimyákṣa* 'belongs to') and ***(*h*$_1$)*reḱs***- 'harm' (LIV 505; cf. IEW 864. Gk. ἐρέχθω < **erekstʰō*, Ved. *rákṣas-* 'injury', Av. *rašah-* 'damage'). The nominal root ***(*h*$_2$)*aks***- 'axis, axle' (IEW 5; NIL 259–62), seen in Lat. *axis*, Ved. *ákṣa-* and Gmc. **ahslō* 'axle' (OE *eaxel*, OSax. *ahsla*, etc.), also belongs here. Crucially, I have found no evidence that any of the derivatives formed to these roots violated the MST.

159 See Jasanoff 2002:291 for a similar criticism of Mayrhofer's treatment of the Skt. imperatives *bodʰi* 'heed' and *yódʰi* 'fight'.

160 A glaring exception is PIE **u̯oi̯tsth*$_2$*a* 'you know' if we are to view this word as having a quintipartite consonant cluster (and not **u̯oi̯tstʰa* or the like). I am indebted to Jessica DeLisi for pointing this out to me.

161 If the /d/ of the root was lost, we would expect **mé.trom*; if the /t/ of the suffix was lost, we would expect **mét.rom* (see chapter 7 for discussion).

codas is the driving force behind the deletion of a dental in the *métron* rule. Consonant deletion of the root dental occurs to avoid the violation of two constraints: the OCP and the MST.[162]

(109) PIE **méd-trom* → $[\text{mé}]_\sigma[\text{trom}]_\sigma$

/méd-trom/		OCP	MST	Max-T	Dep-[s]
a.	$[\text{mét}]_\sigma[\text{trom}]_\sigma$	*!			
b.	$[\text{méts}]_\sigma[\text{trom}]_\sigma$		*!		*
c.	$[\text{mét}]_\sigma[\text{strom}]_\sigma$		*!		*
d. ☞	$[\text{mé}]_\sigma[\text{trom}]_\sigma$			*	
e.	$[\text{més}]_\sigma[\text{trom}]_\sigma$			*	*!

*[s] epenthesis is ultimately avoided in the output form, as candidate (e), $[\text{més}]_\sigma[\text{trom}]_\sigma$, violates two constraints (Max-T & Dep-[s]), whereas the winning candidate (d) only violates one.

Note that we must explicitly view *TT > *TsT as a rule of *s*-insertion and not as a rule of affrication of the first dental. This is because affrication would lead to a different syllabification of **u̯id-tó-* (**u̯it͡s.tó-*), producing the same coda as would be found if the metron rule did not occur (**mét͡s.tro-*). A similar process of /s/ epenthesis may be demonstrated to occur in the Limburg dialect of Dutch, where /s/ is inserted and subsequently palatalized to [ʃ] before the diminutive suffix *-kə* if the root ends in a velar consonant: *bok* 'book' → *bœkʃkə* 'little book'; *ɛk* 'corner' → *ɛkʃkə* 'little corner'.[163] Of course, the insertion of *[s] is not restricted to the double dental rule. There were alternations within PIE of the suffix *-men* ~ *-smen* (originally morphological, of course); cf. Attic παράδειγμα (< **dei̯k̂mn̥*) vs. Epidaurian παρδειχματων (< **dei̯k̂smn̥* [Stüber 1998:52]).[164] Moreover, if Merlingen (1957:51) is correct, thorn clusters also illustrate a process of **s*-epenthesis: **$h_2$artk̂os* → **$h_2$artsk̂os* 'bear' (Schindler 1977b:32–3); **$d^h\hat{g}^h\bar{o}m$* → **$d^hz(^h)\hat{g}^h\bar{o}m$* 'earth' (Melchert 2003). And lastly, one should not forget the enigmatic *s-mobile*: **pek̂-* ~ **spek̂-* 'see' (Southern 1999; Keydana 2011). It is unclear how many (if any) of these processes are connected to the double dental rule.

162 See section 2.1.1 for the motivation behind the constraint ranking, OCP >> Max-T >> Dep-[s].

163 Hinskens 1996:137–8. For perceptual motivation of s-insertion after a stop, see Côté 2000:49.

164 See Brugmann 1897–1916 II/1:242–3 for further discussion.

3.7 Couching the Analysis in Optimality Theory

We have now reached a point in our discussion in which we may couch the findings of this chapter within OT. Recall from our previous discussions the following constraints:

(110) Previous Constraints
- a. INTACT: Do not delete the root in its entirety. Assign one * for each violation.
- b. PARSE: Syllabify all segments. Assign one * for each segment that remains unsyllabified in the output form.
- c. *CHCC: The sequence *CHCC is prohibited in the output. Assign one * for every violation.
- d. $*_\sigma$[PPR: The sequence two stops + sonorant (**r, *l, *m, *n, *u̯*) is prohibited in the onset of the output. Assign a * for every violation.
- e. DEP-V: Every vowel in the output has a correspondent in the input. Assign one * for each instance of epenthesis.
- f. MAX-C: Every non-laryngeal consonant in the input has a correspondent in the output. Assign one * for each instance of consonant deletion.
- g. *PEAK/R: Resonants may not occupy the syllable nucleus. Assign one * for each instance of resonant syllabification.

We now know, however, that the processes driven by the previously assumed constraints *CHCC and $*_\sigma$[PPR were motivated by a more general phonotactic constraint, the MAXIMUM SYLLABLE TEMPLATE.

(111) MST: Syllables must be syllabified according to the MAXIMUM SYLLABLE TEMPLATE. Assign one * for each segment that violates the MST.

We may therefore abandon both constraints in favor of the MST. The reader should note that I recognize the MST was in actuality a *bundle* of constraints, which at the very least included *SUPER-COMPLEX ("No syllable margin may contain more than two consonants."; cf. Chen 2008), SSP-CODA ("The SONORITY SEQUENCING PRINCIPLE may not be violated in coda position."), and possibly others.[165] The use of MST here is for representational simplicity, with all undominated syllabic markedness constraints being collapsed into the MST.

165 For future work, it may be prudent to modify *SUPER-COMPLEX even further (should the analysis demand such a fine-grained approach) and perhaps to recognize a family of

(112) PIE */d^hugh$_2$trés/ → *[d^huk]$_\sigma$[trés]$_\sigma$

*/d^hugh$_2$trés/	Parse	MST	Dep-V	Max-C
a. *[d^hugh$_2$]$_\sigma$[trés]$_\sigma$		*!		
b. *[d^hug]$_\sigma$h$_2$[trés]$_\sigma$	*!			
c. *[d^hu]$_\sigma$[gəh$_2$]$_\sigma$[trés]$_\sigma$			*!	
d. ☞ *[d^huk]$_\sigma$[trés]$_\sigma$				*

A problem arises, however, in the derivations of words which surface with licit extrasyllabic segments, such as **h$_2$stḗr* 'star (nom.sg.)'. Segments which should surface as extrasyllabic are deleted under our current constraint ranking Parse >> Max-C.

(113)

*/h$_2$stḗr/	Parse	MST	Dep-V	Max-C
a. *[h$_2$stḗr]$_\sigma$		*!		
b. ☹ *h$_2$[stḗr]$_\sigma$	*!			
c. *[h$_2$əs]$_\sigma$[tḗr]$_\sigma$			*!	
d. ☞ *[stḗr]$_\sigma$				*

We will therefore assume another type of constraint within the grammar, one that allows for extrasyllabic segments to surface in the output form. Following Sherer 1994 (though slightly modified for our present purposes), we may assume the constraint *Appendix, which simply states that "Extrasyllabic consonants may not surface in the output form." Since extrasyllabic segments did in fact surface in PIE and are not deleted through Stray Erasure, we must posit the constraint ranking Max-C >> Parse, *Appendix.

(114) PIE */h$_2$stḗr/ → *h$_2$[stḗr]$_\sigma$

*/h$_2$stḗr/	MST	Max-C	Parse	*Appendix
a. *[h$_2$stḗr]$_\sigma$	*!			
b. ☞ *h$_2$[stḗr]$_\sigma$			*	*
c. *[stḗr]$_\sigma$		*!		

SSP constraints (such as SSP-Coda, SSP-Onset, SSP-Onset(FP)), given that fricative + stop onsets are the only securely reconstructable clusters in medial position that violated the SSP.

However, as it is currently formulated, the constraint ranking MAX-C >> PARSE, *APPENDIX is overly powerful, since it now predicts that all unsyllabifiable segments surface in the output form as extrasyllabic.

(115)

		*/d^hugh_2trés/	MST	MAX-C	PARSE	*APPENDIX
a.		*[$d^hugh_2]_\sigma$[trés]$_\sigma$	*!			
b.	☞	*[$d^hug]_\sigma h_2$[trés]$_\sigma$			*	*
c.	☹	*[$d^huk]_\sigma$[trés]$_\sigma$		*!		

We therefore need to recognize a family of *APPENDIX constraints, which will allow us to separate those licit instances of extrasyllabicity from the illicit ones. In a similar fashion, Barlow (1999) assumes two ADJUNCT constraints (which are more or less equivalent to *APPENDIX) in her analysis of an English-speaking child with a phonological disorder: the specific constraint ADJUNCT-/S/ ("Only /s/ is licensed by the adjunct position.") and the universal ADJUNCT constraint ("Adjuncts are prohibited").[166] The constraint ranking ADJUNCT-/s/ >> MAX >> ADJUNCT permits extrasyllabic *s* to surface in the output form but prohibits other types of extrasyllabic segments. For PIE, we may also identify two types of *APPENDIX constraints. The first, more specific *APPENDIX constraint was undominated within the constraint ranking and prohibits all illicit extrasyllabic segments from surfacing. The second must continue to fall within the previously assumed constraint ranking MAX-C >> PARSE, *APPENDIX, which allows the correct extrasyllabic segments to surface. These include single, non-resonant consonants adjacent to or being */s/ in absolute word-initial position, as well as coronal and laryngeal segments in word-final position.

(116) Appendix Constraints

a. *BADAPPENDIX (*BADAPP): Illicit extrasyllabic segments, such as extrasyllabic medial segments and extrasyllabic resonants, may not surface in the output form. Assign one * for every extrasyllabic consonant.

b. *APPENDIX (*APP): Extrasyllabic consonants may not surface in the output form. Assign one * for every extrasyllabic consonant.

166 Cf. Hammond 1999.

As with the constraint MST, the reader should note that the constraint ⋆BadAppendix represents a constraint bundle and is posited as a single constraint for reasons of representational simplicity.[167]

(117) PIE */d^hugh$_2$trés/ → *[d^huk]$_\sigma$[trés]$_\sigma$

		*/d^hugh$_2$trés/	⋆BadApp	MST	Max-C	Parse	⋆App
a.		*[d^hugh$_2$]$_\sigma$[trés]$_\sigma$		*!			
b.		*[d^hug]$_\sigma$h$_2$[trés]$_\sigma$	*!			*	*
c.	☞	*[d^huk]$_\sigma$[trés]$_\sigma$			*		

Given processes of schwa epenthesis in word-initial clusters, ⋆BadAppendix must outrank Dep-V.

(118) PIE **ph$_2$trés* → [pəh$_2$]$_\sigma$[trés]$_\sigma$

		/ph$_2$ + trés/	⋆BadApp	MST	Dep-V	Max-C	Parse
a.		*[ph$_2$trés]$_\sigma$		*!*			
b.		*[ptrés]$_\sigma$		*!			*
c.		*ph$_2$[trés]$_\sigma$	*!*				**
d.		*h$_2$[trés]$_\sigma$	*!			*	*
e.	☞	*[pəh$_2$]$_\sigma$[trés]$_\sigma$			*		

And lastly, ⋆BadAppendix must also outrank ⋆Peak/R, accounting for resonant syllabification in word-initial position.[168]

167 Again, it would perhaps behoove future researchers to analyze the effects of ⋆BadAppendix through more specific constraints.

168 One may avoid resonant appendices in a different (perhaps better) way, by assuming that the general constraint ⋆Appendix >>⋆Peak/R, eliminating the need for a constraint ⋆Appendix(Resonant) or the like, which currently is encoded in ⋆BadAppendix. Nevertheless, one will of course need other undominated ⋆Appendix constraints, which will rule out forms such as ^{X}p[k̂ten-] 'comb' and ^{X}p[h$_2$ter-] 'father'.

(119) PIE */tntós/ → *[tn̥]$_{\sigma}$[tós]$_{\sigma}$

*/tntós/			*BadApp	MST	Dep-V	*Peak/R	Parse
a.		*[tntós]$_{\sigma}$		*!*			
b.		*tn[tós]$_{\sigma}$	*!*				**
c.		*n[tós]$_{\sigma}$	*!				*
d.		*[tən]$_{\sigma}$[tós]$_{\sigma}$			*!		
e.	☞	*[tn̥]$_{\sigma}$[tós]$_{\sigma}$				*	

3.8 Exceptions to the MST?

As formulated, the MST explicitly banned PIE medial coda sequences where there was an SSP violation. Therefore if any such sequence is attested or reconstructable in an IE language, it cannot derive directly from PIE. For example, Lat. *extrā* 'outside' clearly violates the PIE MST, but we know the medial cluster /kstr/ in this word to be secondary, having arisen through a prehistorical process of syncope[169] from the sequence **eksterād*, with the /k/ being reintroduced into the word by analogy with the simplex preposition, *ex*.[170] Also a derivative of the PIE adposition **ek̂s/*eĝ^{h}z* (IEW 292–3), Gk. ἐχθρός 'outsider' at first glance appears to show a MST violation (< **ek̂stros*). However, this form is not likely to derive from PIE, and according to Beekes (2010:488–9), it may simply be a *-ro-* derivative of ἐχθός 'outside', a form that may be reconstructed as **ék̂stos*, with a perfectly licit syllable structure in PIE under the rules of PIE syllabification set forth above: *[ék̂]$_{\sigma}$[stos]$_{\sigma}$.

Other apparent MST violations need not be so. For instance, Lat. *lūstrum* '(ceremony of) purification' has long been reconstructed as **l(e/o)u̯k-s-tro-* 'illumination' (vel sim.),[171] a **-s-tro-* derivative[172] to **leu̯k-* 'light'; cf. Lat. *lūx*. However, de Vaan (2008:354–5) objects to this etymology, arguing that "there is no good evidence for 'enlightening' in the meaning of *lūstrum*". Instead he proposes two alternate etymologies for this word: 1) that it may be

169 See Nishimura 2008 for an excellent discussion of syncope in the Italic languages.

170 Meiser 1998:152. Likewise, the English word *extra* /ekstrə/ is an explicit violation of the PIE MST. Though the maximum medial syllable in English monomorphemic words is also of the shape CCVCC and SSP violations in medial codas are rare (cf. Hammond 1999:84), I find it highly unlikely for it in any way to be a (modified) continuation of the original PIE MST.

171 Walde & Hofmann 1982:839; IEW 688.

172 As for the origins of the suffix *-stro-* in Latin, Leumann (1977:313) deems it "nicht erklärt", though it certainly does not derive from PIE.

connected with *lavō* 'wash',[173] though there are no clear passages in Latin with the sense of 'washing' and 2) following Serbat (1975:312), *lūstrum* is originally from **luh$_x$-* 'set free'[174] + *-stro-*, as found in Gk. λύω 'loosen' and Lat. *luō* 'atone for; liberate', which de Vaan ultimately chooses as his preferred etymology. Note, however, that the assumption of the PIE MST does not necessarily rule out the reconstruction of *lūstrum* as **l(e/o)u̯k-s-tro-*; rather, it requires that at the time **l(e/o)u̯k-s-tro-* was formed, the PIE MST no longer synchronically functioned as the maximum syllable template at that point within the prehistory of Latin.[175]

There are a number of instances of a sequence PiCC attested within Sanskrit, which at first glance suggest an inherited sequence *-PH]$_\sigma$[CC-. For example, to the root **k̂neth$_2$-* 'pierce' (LIV 337) one finds Ved. *śnathiṣṭam* 'pierce (2nd du. aor.)' (virtual **k̂neth$_2$st-*); to **k̂reth$_2$-* 'slacken' (IEW 620; LIV 338), *śranthiṣyati* 'will slacken', *śra(n)thitvā* 'having slackened' (virtual **k̂reth$_2$-CC-*); to **ku̯ath$_2$-* 'froth, foam' (IEW 627–8; LIV 374), *kvathiṣyati* 'will boil' (virtual **ku̯ath$_2$si̯e/o-*); to **k$^{(w)}$Reph$_x$-* 'wail' (IEW 569; LIV 370), *akrapiṣṭa* 'wailed' (virtual **ek$^{(w)}$Reph$_x$sto*); and lastly to **g^{h}reb^{h}h$_2$-* 'grab', we find *agrabhīṣṭa* 'grabbed (3 sg. aor M/P)' (virtual **eg^{h}reb^{h}h$_2$sto*). However none of these examples argues decisively in favor of a reconstructed PIE sequence *PHCC, since they all may be instances where **h$_x$* (or just plain *i*) has been restored by analogy with other, phonologically regular *seṭ* forms in the paradigm. Thus beside *śnathiṣyati* we find *śnathitá-*; beside *agrabhiṣṭa* the forms *gr̥bhītá-* '(having been) seized' and *ágrabhīt* 'seized (3 sg. aor.)'; and certain forms, such as the form *akrapiṣṭa*, might even be secondarily *seṭ* (LIV 370).

In short, I have been unable to find any exceptions to the MST reconstructable for PIE, and any instance of what looks like *POCC (either *PHCC or *PPCC) may easily be viewed as secondary.[176]

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173 PIE **leu̯h$_3$-*. IEW 692; LIV 418.

174 IEW 681–2; LIV 417.

175 Olsen (1988:17) provides another potential violation of the MST in her reconstruction of Umbr. **perkslum, pesklu** 'prayer' as **perk̂s-tlo-*. However, Untermann (2000:540) derives these forms from **perk̂-sk̂-elo-*, formed in the same fashion as **tiçel** '(sakrale) Deklaration, nuncupatio' < **dik̂-elo-*, which would make this exception not probative.

176 The following roots of the shape *-PH (all taken from the LIV) have been examined in this study: ****b^{h}edh$_2$-*** 'dig' (IEW 113–4; LIV 66), ****b^{h}leu̯d^h$_2$-*** 'dissolve' (IEW 159; LIV 90), ****g$^{(w)}$renth$_2$-*** 'knot, tie' (IEW 386; LIV 191), ****g^{h}reb^h$_2$-*** 'grab' (IEW 455; LIV 201), ****h$_2$ak̂h$_3$-*** 'eat (up)' (IEW 18; LIV 261), ****h$_2$u̯edh$_x$-*** 'speak' (IEW 76–7, LIV 286), ****h$_3$u̯ath$_2$-*** 'wound' (IEW 1108; LIV 307), ****i̯eu̯ĝh$_x$-*** 'become restless' (IEW 512, LIV 315), ****k̂neth$_2$-*** 'pierce' (LIV 337), ****k̂reth$_2$-*** 'slacken' (IEW 620; LIV 338), ****keu̯bh$_2$-*** (IEW 590; LIV 357–8), ****k$^{(w)}$Reph$_x$-*** 'wail' (IEW 569; LIV 370), ****Kreph$_x$-*** 'crack' (IEW 569; LIV 370), ****ku̯ath$_2$-*** 'froth, foam' (IEW 627–8; LIV 374), ****k^{w}erph$_x$-*** 'turn' (IEW 631; LIV 392–3), ****lembh$_x$-*** 'droop, sag' (IEW 656–7; LIV 411),

3.9 Conclusions

In this chapter, we have seen that the LEX SCHMIDT-HACKSTEIN is more precisely formulated as PH.CC > P.CC and is driven by a strict ban of an SSP violation in medial codas, just as the *métron* rule and the loss of /t/ in PIE *h_x*o*ḱ*th*$_x$*tí* > Skt. *aśītí* 'eighty'. This ban is part of the MST constraint reconstructed for PIE, which was deduced through phonotactic analysis of edge clusters (the Decomposition Theorem) and the assumption of extrasyllabic consonants at word's edge.

Though it may seem strange at first to posit extrasyllabic consonants for PIE, common sense reminds us that while the consonant clusters in the words **u̯ḗḱst* 'he carried' and **$h_2$ster-* 'star' are reconstructable for PIE, there is no such word as **u̯eḱst.$h_2$ster*. In fact, this word looks decisively *un*-Indo-European. With the assumption of syllabically driven phonological rules, we may now see the PIE MST as the driving force in at least four major phonological processes in PIE: PH.CC > P.CC, the *métron* rule, schwa indogermanicum, and resonant syllabification. As we will see in part 3 of this book, the MST may also be utilized in the explanation of other phonological processes in PIE, though its effects will be much less direct.

As an aside, though this analysis assumes a phonological framework that employs extrasyllabic segments, it is conceivable that another framework would describe the phonological phenomena equally as well, or perhaps even better. For instance, Keydana (2011) proposes that PIE fricatives (**s*, **h_x*) were able to form semi-syllables, which were licensed in the onset of phonological words and restricted to one C-slot. Of course, if Keydana's framework (or anyone else's) proves to be more explanatory, our analysis should be modified accordingly. The key point to our discussion is that PIE medial consonant clusters may be accurately predicted by the assumption of a special status of certain consonants at word's edge and that certain phonological rules were triggered when violations of the MST occurred.

****meikh***$_2$- 'flash, shine' (IEW 712–3; LIV 429), ****mei̯th***$_2$- 'change (out), remove' (IEW 715; LIV 430), ****menth***$_2$- 'stir around' (IEW 732; LIV 438–9), ****meth***$_2$- 'rip off' (IEW 732, LIV 442–3), ****peth***$_1$- 'fall' (IEW 825–6; LIV 477–8), ****peth***$_2$- 'spread out' (IEW 824–5; LIV 478–9), ****peth***$_2$- 'fly' (IEW 825–6; LIV 479), ****pleth***$_2$- 'spread out' (IEW 833; LIV 486–7), ****preu̯th***$_2$- 'snort, foam' (IEW 810; LIV 494), ****rei̯ḱʷh***$_2$- 'scratch' (IEW 858; LIV 504), ****reu̯dh***$_x$- 'cry, wail' (IEW 867, LIV 508), ****sekh***$_x$- 'separate; cut; distinguish' (IEW 895–6; LIV 524), ****skebʰh***$_x$- 'support' (IEW 916; LIV 549), ****(s)kedh***$_2$- 'split apart, spread out' (IEW 918–9; LIV 550), ****stembʰh***$_x$- 'support, fight against' (IEW 1012–3; LIV 595), ****TerKh***$_2$- 'let, allow' (IEW 258: LIV 635), ****u̯edʰh***$_1$- 'push' (IEW 1115: LIV 660), ****u̯eth***$_2$- (LIV 694), ****u̯i̯eth***$_2$- 'waver, roll' (IEW 1178; LIV 696).

CHAPTER 4

Schindler's Exceptions and the Phonology-Morphology Interface

4.1 What We Know So Far

The analysis of reconstructable PIE edge sequences and the assumption of extrasyllabic consonants have enabled us to reconstruct a MAXIMUM SYLLABLE TEMPLATE (MST) for PIE. The MST is to be viewed as an undominated constraint bundle in the PIE grammar, which restricted possible phonotactic sequences at syllable's edge. Any sequence that violated the MST resulted in consonant deletion, vowel epenthesis, or sonorant syllabification, provided that the violating segments in question could not be realized as extrasyllabic. However, the reconstruction of the MST cannot explain all of the properties of the PIE syllable, for there still remain certain enigmatic sonorant plus sonorant sequences raised in chapter 2. As we learned there, Schindler's right-to-left syllabification rule is typically invoked to explain the syllabification of **R* + **R* sequences:

(120) Rule of PIE Syllabification (Schindler 1977a)

$$\begin{bmatrix} +son \\ -syll \end{bmatrix} \rightarrow [+syll] / \begin{Bmatrix} -syll, \\ \# \end{Bmatrix} \_\_ \begin{Bmatrix} -syll, \\ \# \end{Bmatrix}$$

(iterative from right to left)

In short, Schindler's rule predicts that if given two adjacent sonorants that are potential syllable nuclei in PIE, the rightmost one would always be chosen as the syllable nucleus, if it was not adjacent to a 'true' vowel (**e, *a, *o*, etc.).

His rule nicely handles the most common environments in which the sequence **R* + **R* occurs:

a. $\begin{Bmatrix} C \\ \# \end{Bmatrix}\mathrm{RRC} \rightarrow \begin{Bmatrix} C \\ \# \end{Bmatrix}\mathrm{R\mathring{R}C}$:

PIE */sru̯-tó-s/ 'flowed (masc.nom.sg.)' → **srutós* > Skt. **srutáḥ*, Gk. ῥυτός

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b. $\left\{\begin{matrix} C \\ \# \end{matrix}\right\}$ RRV → $\left\{\begin{matrix} C \\ \# \end{matrix}\right\}$ R̥RV:
PIE */k̂u̯nés/ ‘dog (gen.sg.)’ → **k̂unés* → Skt. *śúnaḥ*, Gk. κυνός

c. CRR# → CRR̥#:
PIE */néu̯n/ ‘nine’ → **néu̯n̥* > Skt. *náva*, Lat. *novem*, Gk. ἐννέ(*F*)α;

d. VRRV → VRRV:
PIE */oi̯u̯os/ ‘one’ → **oi̯u̯os* > Av. *aiva*, Cyp. *oiwos* ‘only’

However, Schindler’s rule is riddled with exceptions, for as we discovered in section 2.4 there are five instances where the syllabification reconstructable for PIE is not correctly predicted.

a. *#R̯R̯- ↛ *#R̥R̯-
Roots of the shape *#R̯R̯-, such as **u̯i̯-*, **u̯l-*, and **mn-* are never realized as *#R̥R̯-, i.e. **ui̯V-*, **ulV-*, **m̥n-*, respectively. Cf. **u̯i̯eth$_2$-* (ˣ*ui̯eth$_2$-*) > Ved. *vyathate* ‘rolls’.

b. **-Cmn-* ↛ **-Cm̥n-*
Word-medial post-consonantal */mn/ is often reduced to *$_\sigma$[m- or *$_\sigma$[n- by the Asno Gesetz (Schmidt 1895).[1] Thus, PIE **ĝ^{h}ei̯mno-* ‘winter’, ultimately a derivative of *n*-stem **ĝ^{h}ei̯mn̥* (Hitt. *giman*, Gk. χεῖμα) → *[ĝ^{h}ei̯]$_\sigma$[mno]$_\sigma$ → *[ĝ^{h}ei̯]$_\sigma$[mo]$_\sigma$ > Lith. *žiemi̇̀nis*,[2] not expected ˣ[ĝ^{h}e][i̯m̥]$_\sigma$[no]$_\sigma$.

c. *CR$_1$R$_2$V ↛ *CR̥$_1$R$_2$V
There are rare instances where the sequence *CR$_1$R$_2$V is syllabified as [CR$_1$R̥$_2$]$_\sigma$[V]$_\sigma$ (thereby creating hiatus), if /CR$_1$R$_2$C/ → [CR$_1$R̥$_2$]$_\sigma$[C-]$_\sigma$ occurs elsewhere within same paradigm. Cf. PIE **triōm* ‘three (gen.pl.)’, not ˣ*tr̥i̯ōm*. (due to **tri-b^{h}is* ‘three (dat.pl.)’) and *-v(i)yās*, not ˣ*-uyās* (with *-vī* (< **-u̯ih$_2$*) as its nominative).

d. *-R-m(s) ↛ *-R̥m(s)
Accusatives to sonorant final athematic nouns of the type **-im, *-um(s), *-r̥m(s)* are never syllabified as **-i̯m̥, *-u̯m̥(s), *-rm̥(s)*, respectively. Cf. */ménti̯m/ ‘mind (acc.sg.)’ → *[mén]$_\sigma$[tim]$_\sigma$ (ˣ*ménti̯m̥*), */s(e)uh$_x$num(s)/

1 See 9.
2 With the secondary suffix **-ino-*; cf. Gk. χειμερινός.

'son(s) (acc.)' → *[s(e)uh$_X$]$_\sigma$[num(s)]$_\sigma$ (^{X}*s(e)uh$_X$nu̯m̥(s)*), and */pəh$_2$trms/ 'fathers (acc.)' → [*pəh$_2$]$_\sigma$ [tr̥ms]$_\sigma$ (^{X}*pəh$_2$trm̥s*).

e. *CR-n-C- ↛ *CRn̥C-
Lastly, the weak stem of the nasal-infixed present syllabifies in an unexpected fashion: */Cr-n-C-/ → *[Cr̥n]$_\sigma$[C-. Cf. PIE */i̯u̯ngénti/ 'they yoke' → *[i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$ (> Lat. *iungunt* 'they join'), not ^{X}[i]$_\sigma$[u̯n̥]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$.

Previous scholarship has suggested a number of ways to handle these exceptions. For instance, Keydana (2004), followed by Cooper (2012), claims that the constraint ONSET was ranked high in the PIE grammar, resulting in the preference of **u̯i̯eth$_2$*- (> Ved. *vyathate* 'rolls') over ^{X}*u̯ieth$_2$*- (type a). Kobayashi (2004:23–4) proposes the constraint ranking HNUC[3] ≫ ALIGNNUC,[4] resulting in ONSET MAXIMIZATION (requiring PIE speakers to syllabify as many consonants as possible within the onset), which is able to explain roughly half of these exceptions. Thus, according to Kobayashi if a consonant cluster *could* be syllabified as an onset, it was. It is clear that **u̯i̯*- and **mn*- were licit onsets in PIE, as we may reconstruct the roots *[u̯i̯et]$_\sigma$[h$_2$- and *[mnah$_2$-]$_\sigma$. This means that those same onsets were syllabifiable in word-medial position as well, hence *-[u̯i̯ah$_2$s]$_\sigma$ and [*h$_2$ak̂]$_\sigma$[mnés]$_\sigma$ (with subsequent simplification to [*h$_2$ak̂]$_\sigma$[nés]$_\sigma$ by the Asno Gesetz). Lastly, Cooper has put forward a constraint ALIGN-L (μ, PRWD), which entails that all morae be aligned to the left edge of the prosodic word, which also results in a preference for complex onsets.

Each of these solutions, however, cannot explain three of the types of unexpected syllabifications listed above. One is minor and isolated: (c) the well-established form **triōm* 'of three'. The remaining two are systematic and well attested: (d) accusatives of the shape *-*R̥m(s)*, and (e) the nasal-infixed presents.

4.1.1 *Keydana 2008: ⋆R/C*

To explain the anomalous syllabifications in type (d), Keydana (2008) reconstructs an additional constraint ⋆R/C for PIE, which states that 'coronal

3 "When there is more than one segment which can become the nucleus of a syllable, the nucleus is assigned to the one with the highest sonority."

4 "ALIGN(Nucleus, R, σ, R): Align the right edge of a syllable nucleus with the right edge of a syllable, i.e. minimize syllable codas."

sonorants are blocked in coda position'.[5] Thus while a complex onset is preferred in (111):

(121) */ḱu̯nbʰi̯s/ 'with dogs'

*/ḱu̯nbʰi̯s/	⋆R/C	⋆CompOns	NoCoda	⋆CompCoda
a. *[ḱu̯n̥]$_\sigma$[bʰis]$_\sigma$		*	*	
b. ☞ *[ḱun]$_\sigma$[bʰis]$_\sigma$	*!		*	(*)

It is systematically avoided in (112), due to the high-ranking status of ⋆ComplexOnset:

(122) */ménti̯m/ 'mind'

*/ménti̯m/	⋆R/C	⋆CompOns	NoCoda	⋆CompCoda
a. *[mén]$_\sigma$[ti̯m̥]$_\sigma$	*	*!		
b. ☞ *[mén]$_\sigma$[tim]$_\sigma$	*		*	

Given Keydana's reconstructions, we would expect coronal sonorants to be avoided in coda position within the class of nasal-infix presents (type e) as well. But sadly, Keydana's framework (just as Schindler's rule) predicts the syllabification of **i̯u̯ngénti̯* as *[i]$_\sigma$[u̯n̥]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$ and not *[i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$.[6]

(123) */i̯u̯ngénti̯/ 'they yoke'

*/i̯u̯ngénti̯/	⋆R/C	⋆CompOns	NoCoda	⋆CompCoda
a. ☞ *[i]$_\sigma$ [u̯n̥]$_\sigma$ [gén]$_\sigma$ [ti]$_\sigma$	*		*	
b. ☹ *[i̯un]$_\sigma$ [gén]$_\sigma$ [ti]$_\sigma$	* *!		* *	

Faced with this difficulty Keydana is required to assume that the syllabification of nasal-infix presents must have been *lexicalized* in PIE: "[z]weitens ist CU*n*C dann lizenziert, wenn -*n*- Morphemstatus hat. So wird das präsensstammbil-

5 See section 2.4 for further discussion of Keydana's framework.

6 This, in fact, is not strictly true for this particular form given Keydana's views of the high-ranking nature of Onset; it is, however, true of all roots of the shape */O(R)eRC-/ that form nasal-infixed presents.

dende *n*-Infix immer nichtsilbisch realisiert: *sunve* (: *SAV*), *pinvate* (: *PAY*[1]) etc. Diese Besonderheit des -*n*- Infixes muß—da es allein betroffen ist—lexikalisch sein."[7] As we shall soon see, the assumption of lexicalized syllabification is quite problematic and should only be considered if all else fails. Nevertheless, as pointed out in section 2.4, it is clear that Keydana's hypothesis simply does not work, for it incorrectly predicts that the non-coronal sonorants **u̯* and **i̯* were not vocalized in the following cases:

(124) Exceptions to Keydana's ⋆R/C

*/sru̯tós/ 'flowed'	⋆R/C	⋆CompOns	NoCoda	⋆CompCoda
a. ☹ *[sru]$_\sigma$ [tós]$_\sigma$		*!	*	
b. ☞ *[sr̥u̯]$_\sigma$ [tós]$_\sigma$			**	
*/k̂li̯tós/ 'leaned'				
a. ☹ *[k̂li]$_\sigma$ [tós]$_\sigma$		*!	*	
b. ☞ *[k̂l̥i̯]$_\sigma$ [tós]$_\sigma$			* *	
*/k̂lu̯tós/ 'famous'				
a. ☹ *[k̂lu]$_\sigma$ [tós]$_\sigma$		*!	*	
b. ☞ *[k̂l̥u̯]$_\sigma$ [tós]$_\sigma$			* *	

4.1.2 *Cooper 2012: Adjusting the Sonority Hierarchy*

Perhaps a more promising approach is presented in Adam Cooper's recent dissertation (2012), who suggests that the correct explanation to the exceptions in (d) lies in revising the PIE phonological sonority hierarchy in which **m* was less sonorous than the other sonorants.[8]

(125) Cooper's Sonority Hierarchy
a, e, o ≫ i̯, u̯, r, l, n ≫ m ≫ O

7 2008. See also Kobayashi 2004:19.

8 Tsunoda 2008 argues that alveolar /n/ is more sonorous than /m/ and /ŋ/ in the Warrongo language (once spoken in northeast Australia), largely based on permitted medial consonant clusters and adherence to the Syllable Contact Law (SCL; Venneman & Murray 1983). It appears unlikely that the hierarchy that Tsunoda assumes reflects anything universal, given that /ɾ/ is also more sonorous than both /w/ and/j/ in Warrongo. One wonders if such a radical restructuring of the hierarchy is even necessary and if it would perhaps be more prudent simply to consider -*Vɾ wV*- sequences (cf. *ɟiɾ wi* 'namesake') as simple violations of the SCL.

Thus, for Cooper the consonant **m* remains non-syllabic in the accusative singular **mentim* ‘mind’ for the same reason that **d* remains non-syllabic in */i̯d/ → **id* ‘it’. Since both **m* and **d* are less sonorous than **i̯*, **i* is selected as the syllable nucleus. In short, “[t]he sonorant *m* is expected to be syllabic in all environments in which sonorants are uncontroversially so (e.g., between two consonants), but when it is rightmost in a string of sonorants, any of which could potentially be syllabic (e.g., again, between two consonants), it is consonantal” (Cooper 2012:200). Similarly Steriade (1988: 98), in her analysis of Sanskrit syllabification, points out that “only six among the twenty roots of the form *Cam*(*C*) show a zero-grade variant *Cm*(*C*) (surface *Ca*(*C*)) as against thirty-six roots with rhyme *n* out of the forty-eight roots of the form *Can*(*C*)”. Steriade ascribes these facts to the low sonority of Skt. *m*.

Cooper modifies his OT framework[9] through the creation of an additional ⋆PEAK/X constraint (⋆PEAK/*m*), ranking it higher than ALIGN-L to arrive at the desired syllabification. The complete constraint ranking is as follows: ⋆PK/OBSTRUENT ≫ DEP-IO ≫ ONSET ≫ ⋆PK/*m* >> ALIGN-L ≫ ⋆PK/*n* ≫ ⋆PK/LIQUID ≫ *PK/GLIDE.

(126)

*/Rm/	⋆PK/OBS	DEP-IO	⋆PK/*m*	ALIGN-L
a. ☞ **-R̥m*				*
b. **-Rm̥*			*!	

That ONSET ≫ ⋆PK/*m* is ensured through examples such as **lm̥b^{h}-e-* (> Ved. *rábhate* ‘takes’).

(127)

*/lmb^{h}-e-/	⋆PK/OBS	ONSET	⋆PK/*m*	ALIGN-L
a. ☞ **lm̥b^{h}e-*			*	*
b. **l̥mb^{h}e-*		*!		

And that the MST[10] >> ONSET is ensured through examples such as **m̥s-i̯e-* (> Gk. μαίομαι ‘seek for’),[11] a **-i̯é/ó-* present built to the root **mes-* ‘stretch out the arm’ (LIV 441).

9 See section 2.4.
10 Cooper’s Sonority-Sequencing.
11 With analogical μ- from the full grade (we expect Gk. αἴομαι).

(128)

*/ms-i̯e-/	MST	ONSET	★PK/*m*	ALIGN-L
a. ☞ **m̥s-i̯e-*		*	*	
b. **msi̯e-*	*!			

Cooper finds additional support for his theory in derivatives of the root **drem-* 'sleep', continued as a **-i̯é/ó-* present **dr̥m-i̯e-* in Latin *dormiō*, which as Cooper correctly points out, could not have been syllabified as **drm̥-i̯e-*, for we would expect Lat. *ˣdreniō* or the like (cf. Lat. *veniō* 'come' < **gʷm̥-i̯ō*).[12]

(129)

*/drm-i̯ō/	★PK/OBS	DEP-IO	★PK/*m*	ALIGN-L
a. ☞ **dr̥m-i̯ō*				*
b. **drm̥-i̯ō*			*!	* *

He also points to the lack of vowel shortening before **m* in the history of Greek via Osthoff's Law (cf. κρημνός 'cliff')[13] and the change of **l̥* to **Li* in Celtic before **m* and obstruents (cf. OIr. *cride* 'heart', *cruim* 'worm' from PIE **k̑r̥dii̯o-* and **kʷr̥mi-*, respectively), while elsewhere to **aL* (cf. *marb* < **mr̥u̯os*).[14] Each of these facts argues in favor of **m* being phonologically less sonorous than the other sonorants within Indo-European as a whole.

Cooper (2012:203)[15] sees additional evidence for his hypothesis in STANG'S LAW,[15] a phonological rule securely reconstructable for PIE in which a laryngeal or glide is lost with compensatory lengthening in the environment **V_m*, as seen in the accusative singular of 'cow', **gʷṓm* (Ved. *gā́m*), from an earlier

12 Note, however, Ved. *śrā́myati* 'becomes tired', from **k̑rm̥h₂-i̯é-* (LIV 338). Should one desire to explain this form in Cooper's framework, I suspect she could attribute the unexpected syllabification to the avoidance of a superheavy syllable: thus, *[k̑rm̥h₂]$_\sigma$ ≫ ˣ[k̑r̥mh₂]$_\sigma$. Within the framework proposed below, however, one may claim that */k̑remh₂i̯é/ → [k̑rm̥h₂][i̯é-], with a moraic **m* (→ **m̥*) been generated before syncope occurred in the derivation.

13 Though according to Collinge (1985:130), this is a "non-process" when any nasal (not just μ) is followed by another nasal (cf. Aeol. μῆννος 'month (gen.sg.)'). However, Rix (1992:56) cites PGk. **āmr-ii̯ā* Ion. μεσ-ἄμβρίη 'midday' with shortening by Osthoff's Law. According to Beekes 2010:934, Attic μεσ-ημβρία has "analogical η after ἦμαρ, ἡμέρα."

14 Schumacher 2004:125–6. Note, however, that the development of **l̥* to **Li* before O is not entirely regular—we sometimes find the reflex **aL*: **tr̥sto-* > OIr. *tart* 'thirst' (Thurneysen 1945:131).

15 See section 10.

**gʷou̯m*, and in the accusative singular of **-ah₂* stems, **-ām* (Ved. *-ām*), from an original **-ah₂m*. While it is tempting to view this process as some sort of metric to gauge the sonority of **m* with respect to other consonants, it is unclear how probative this metric would be. For while it is likely that the sequence **-Vu̯m* did fall in sonority as Cooper claims, the sequence **-Vh₂m* almost certainly did not; hence sonority could not have been the (sole) motivation for the simplification of these sequences, if they were in fact caused by the same phonological process.[16]

Cooper's adjustment of the PIE sonority hierarchy raises a further question: is there any evidence of differing sonority values among the other sonorants **i̯, *u̯, *r, *l, *n*? If so, this could possibly bring PIE more closely into line with the majority of the world's languages, which show the clear hierarchy: U̯ ≫ L ≫ N.[17] It turns out there is such evidence: as has long been known, there are securely reconstructable instances of metatheses of */u̯L/ to **Lu* in PIE.[18] According to Brugmann (ibid.) these metatheses occurred in between two consonants in word-medial position, though note that two of the examples target */u̯r/ in absolute word-final position as well.

a. **kʷ(e)tu̯r̥-* → **kʷ(e)tru-* 'four' > Av. *čaϑru-gaoša-* 'four-eared', Lat. *quadruplex* 'fourfold',[19] Gaul. *petru-* 'id.', Gk. τρυ-φάλεια 'helmet' (with simplification of **kʷtru-* already in PIE); contrast Lat. *quattuor*, Goth. *fidwor*, etc. Presumably **kʷ(e)tu̯r̥-* continued by Gk. τρά-πεζα, τέτρατος, Lith. *ketviȓtas*, and OCS *četvrŭtŭ* is analogical to the cardinal.

b. **ĝʰu̯r̥-* 'move in a crooked fashion' (LIV 182) → **ĝʰru* in Ved. *ví hruṇāti* 'makes to go astray'; contrast PIE **ĝʰu̯er-* > Ved. *hvárate* and various forms for 'beast': Gk. θήρ, Lat. *ferus* 'wild', OCS *zvěrĭ*.

16 Cooper also points out that an additional benefit to his hypothesis is that sequences of the shape **mR-* (e.g., **mnah₂-* 'remember') would not create a sonority plateau and hence would not violate the SSP. Even if this were true, we would still have to accept the presence of SSP violations in both word-initial and word-medial onsets, most commonly attested in roots of the shape **FO-* (e.g., **stah₂-* 'stand') and **u̯R-* (e.g., **u̯lei̯kʷ-* 'be wet'). Of course, these facts are unproblematic should the reader accept the MST as the guiding phonotactic principle for PIE.

17 Blevins 1995.

18 The majority of examples (and the most secure ones) involve the sequence **-u̯r-*. See Brugmann & Delbrück 1930:260–1, Meillet 1937:134, Mayrhofer 1986:162.

19 While seemingly sporadic, the change of **-t-* to *-d-* also is found in *quadrāgintā* '40', *quadrāre* 'to square', and *quadrāns* 'one fourth of an *as*' (Weiss 2009:369).

c. **tu̯r̥-* → **tru-* 'agitate' > Gk. ὀ-τρῡ́νω; contrast Ved. *tvárate* 'hurries', *turáṇas* 'in a hurry', OE *weran* 'mix', OHG *dweran* 'agitate'.

d. PIE **su̯eḱu̯rh₂-* → **su̯eḱruh₂-* 'mother-in-law' > Ved. *śváśrū́-*, OHG *swigar*, OCS *svekry*; contrast PIE **su̯éḱu̯ro-* → PIE **su̯éḱuro-* > Ved. *śváśura-*, Gk. ἑκυρός, Germ. *Schwäher* 'father-in-law'.

e. **h₁u̯l̥dʰ-* → **h₁ludʰ-* 'climb, grow' > Ved. *áruhat* 'climbed', Gk. ἤλυθον 'I came', OIr. *luid* 'went', etc. (LIV 248); contrast Ved. *várdhate* 'grows'.[20]

f. **u̯ĺ̥kʷos* → **lúkos* 'wolf' > Gk. λύκος, Lat. *lupus*; contrast Ved. *vŕ̥ka-*, etc. This metathesis, if real, was likely restricted to Greek and Italic, as **kʷ* does not lose its labiality adjacent to **u* via the *boukolos* rule (see 23).

g. **smóḱu̯r̥* → **smóḱru* 'beard' > Ved. *śmáśru*; contrast Arm. *mawrowkʿ* 'beard', Lith. *smãkras, smakrà* 'chin', Latv. *smak(a)rs* 'chin', and Hitt. *zama(n)kur* 'beard'.

h. **dráḱu̯r̥* → **dráḱru*[21] 'tear' > Gk. δάκρυ, Lat. *lacruma* (< Greek), Goth. *tagr*, etc; contrast Arm. *artawsr*, which may continue **-u̯r̥*.

If Cooper is correct in assuming that **U̯* was of the same sonority value as **L* in PIE, then there is no apparent reason for any such metatheses to have taken place. In fact, these metatheses only make sense if one assumes **U̯* to have been more sonorous than **L*, spurred by the speakers' desire to target the segment of highest sonority as the syllable nucleus. The data thus suggest that the sonority hierarchy should be modified even further, a point which we return to at the end of this chapter.

4.1.3 *Review*

To sum up, while Schindler's widely accepted right-to-left rule of syllabification accounts for the majority of cases of sonorant + sonorant syllabification in PIE, there are a substantial number of exceptions. Following Cooper 2011, we've seen that the assumption of certain highly ranked constraints (ONSET, ALIGN-L, and ★PK/*m*) account for each of the exceptions listed in types (a)–(d), apart from the isolated form *triōm* 'three (gen.pl.)', which will be addressed in chapter 7. However, despite these efforts the weak stem of the nasal-infix presents is handled poorly within all current frameworks of PIE syllabification. This class is simply anomalous.

20 Krisch 1996:24–5, following Schindler.

21 (Post?) PIE **daḱru-* "ist wahrscheinlich aus **dráḱru-* dissimiliert…" (IEW 179).

4.2 Nasal-infixed Presents: An Overview

The nasal-infix present is a verbal class which is continued to a greater or lesser extent by most IE languages.[22] It was a robust verbal type in PIE, formed to 248 roots, of which 168 are certain (LIV 17). While it is possible that in the beginning the nasal infix formed imperfective verbs conveying a certain type of Aktionsart,[23] it is clear that within late PIE its primary function was to create imperfective (present) stem formations to semantically perfective (aorist) roots (Clackson 2007:153). The majority of these roots formed root aorists—**i̯éu̯g-/*i̯ug-* 'joined' (Ved. *yójam*, GAv. *yaogət*), **bʰei̯d-/*bʰid-* 'split' (Ved. *abhet*, possibly Celt.Ib. *bietu*), and **ĝnoh$_3$- *ĝn̥h$_3$-* 'know' (Gk. ἔγνων, Arm. *caneaw*). We may therefore reasonably assume that the nasal-infixed present itself was synchronically derived from root aorists in late PIE.

The nasal infix takes two ablauting shapes, **-né-* and **-n-*, whose ablaut is continued only in Anatolian and Indo-Iranian. While the strong form **-né-* has posed no problem to any previous (or present) conception of PIE syllabification,[24] the weak form in **-n-* has been especially troublesome. Should we follow Schindler's right-to-left syllabification algorithm, Kobayashi's principle of ONSET MAXIMIZATION, or Cooper's ALIGN hypothesis, the infixation of a nasal into the aforementioned roots should produce the stems ^{X}*iu̯n̥g-*, ^{X}*bʰi̯n̥d-*, and **ĝnn̥h$_3$-*, respectively. However, this is not what we find: PIE */i̯u̯ngénti̯/ 'they yoke' → *[i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$[25] (not ^{X}[i]$_\sigma$[u̯n̥]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$), */bʰi̯ndénti̯/ 'they split' → *[bʰin]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$ (not ^{X}[bʰi̯n̥]$_\sigma$[dén]$_\sigma$ [ti]$_\sigma$),[26] and */ĝnnh$_3$énti̯/ 'they know' → *[ĝn̥n][h$_3$ón][ti] (not ^{X}[ĝnn̥][h$_3$ón][ti]).[27]

In the remainder of this chapter, we will entertain a number of possible solutions to the problem of the nasal-infixed presents. We will begin by refuting the "usual" solution, which proposes the syllabification of the nasal-infixed presents to have been driven by analogy. We will then proceed to examine multiple conceivable explanations: first, that syllabification was underlying in the nasal infix, second, that the unexpected syllabifications were motivated by the nasal-infixed present's morphological derivation, and third, that the

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22 See Fortson 2010:97 for a brief introduction.

23 Cf. Clackson 2007:153–4.

24 PIE **i̯u̯-né-g-ti, *bʰi̯-né-d-ti, ĝn-né-h$_3$-ti* → *[i̯u]$_\sigma$[nék]$_\sigma$[ti]$_\sigma$ '(s)he joins' (Ved. *yunákti*), *[bʰi]$_\sigma$[nét]$_\sigma$[sti]$_\sigma$ '(s)he splits' (Ved. *bhinátti*), and [ĝn̥]$_\sigma$[nóh$_3$]$_\sigma$[ti]$_\sigma$ '(s)he knows' (Ved. *jānā́ti*), respectively.

25 Ved. *yuñjánti*, YAv. *yuṇjiṇti*, Lat. *iungō*, Lith. *jùngiu*, etc.

26 Ved. *bhindánti*, Lat. *findō*, etc.

27 OIr. *ad-gnin*, Goth. *kunnan*, etc.

unexpected syllabifications came into being due to the placement of prosodic word boundaries. In the end, however, we will see that the most plausible solution—not only to syllabification of the nasal-infixed presents but to the syllabification of all **R* +**R* sequences—lies in the process of quantitative ablaut, whereby underlying vowels were syncopated under certain morphological conditions.

4.3 The Usual Solution: Syllabification by Analogy

Scholars often explain the anomalous class of nasal-infixed presents by analogy; cf. Fortson (2010:71): "(M)orphological analogy surely played a role, since the root that this form comes from is **i̯eug-* or **i̯ug-*, and **i̯ung-* is closer to the root in shape and sound than **iu̯n̥g-*." The root 'yoke' is perhaps not the best example to cite, due to the monstrous appearance of expected **iu̯n̥g-* on account of its onsetless triple sonorant sequence. Following Keydana 2004 and Cooper 2012, we may easily avoid this candidate by the higher-ranking nature of ONSET:

(130)

*/i̯u̯ng-/	★PK/OBS	ONSET	ALIGN-L	★PK/*n*
a. ☞ **i̯ung-*			* * *	
b. **iu̯n̥g-*		*!	* *	*

But the vast majority of other roots[28] that form nasal-presents are composed of a less exceptional shape, *Oe(R)C-, whose syllabification in the weak stem cannot be explained by ONSET. Cf. **bʰei̯d-* 'split':

(131)

*/bʰi̯nd-/	★PK/OBS	ONSET	ALIGN-L	★PK/*n*
a. ☹ **bʰind-*			* * *!	
b. ☞ **bʰi̯n̥d-*			* *	*

Should we invoke analogy to account for these anomalous syllabifications, we must first ask ourselves: what exactly do we mean by analogy? Typically analogy is defined as "a process where one form of a language becomes more like another form due to an indirect association that is mediated by some

28 There are in fact quite a few roots of the shape ReR(C)- which form nasal-infixed presents (**lei̯kʷ-* 'leave' (LIV 406–7), **meu̯k-* 'loosen, pull off' (LIV 443–4), *nei̯k-* 'rise' (LIV 451), etc.), but the list pales in comparison to roots not of that shape. See LIV 712–3.

higher-order generalization or pattern" (Blevins & Blevins 2009:4)[29] and usually targets forms within the same paradigm or word class. But as Jessica DeLisi points out to me,[30] if analogy had been the source of exceptional syllabifications within the weak stem of the nasal-infixed verbs, then why do we find a completely regular pattern with no exceptions? For it has long been noted that analogy is a process that occurs haphazardly, not systematically.[31] Should we not expect relics of the original syllabification pattern, such as a **bʰi̯n̥dénti* beside **i̯ungénti*? Of course, we do not: these syllabifications are completely systematic, suggesting that even if the source of their exceptional syllabifications had been analogical, they must have been grammaticalized at some point in time and therefore encoded within the synchronic syllabification algorithm of the language.

Syllabification is typically not a process susceptible to analogy. As Hayes (2008:251) points out: "In most languages, syllabification is predictable: starting out from the string of segments, one can predict the syllabification." In other words, syllabification is (nearly) universally a process derived solely by phonological rules. Should there exist an instance of analogical syllabification, presumably it would occur in a paradigm that contains multiple allomorphs, with the syllabification of one (or more) related form(s) in the paradigm influencing the syllabification of a separate form within said paradigm.

A lengthy search has yielded no other certain examples. Even the approach "Syllabification by Analogy" (SbA), a theory of data-driven syllabification proposed by Marchand et al. (2009), which "infer[s] 'new' syllabifications from an evidence base of already-syllabified words" proposes the creation of new syllables by analogy to existing ones in the language, where crucially the analogy is between the unknown word and other *known* words within the language, not between other words within the paradigm.[32] In short, just as */k̑u̯nko-/

29 Cf. Arlotto 1972:130.

30 April 2012, p.c.

31 Summed up nicely in Sturtevant's Paradox: "sound change is regular and causes irregularity; analogy is irregular and causes regularity" (Anttila 1989:94).

32 "When an unknown word is presented as an input to the system, so-called full pattern matching between the input letter string and database entries is performed, starting with the initial letter of the input string aligned with the end letter of the database entry. If common letters are found in matching positions in the two strings, their corresponding phonemes (according to the prior alignment) and information about their positions in the input string are used to build a pronunciation lattice, as detailed next. One of the two strings is then shifted relative to the other by one letter and the matching process continues, until the end letter of the input string aligns."

syllabifies as **k̑u̯n̥ko-* (Ved. *śvaka- 'wolf'*; NIL 436–40), so should */h_1u̯-n-k̑-enti/ syllabify as ^{X}*h_1u̯n̥k̑énti* (cf. Arm. *owsanim* 'learn', OIr. *to-ucci* 'understands', and Lith. *jùnkti* 'become accustomed', all ultimately derived from **$h_1$unk-*).[33]

But even if analogy could affect a language's syllabification patterns, a more serious problem arises when one considers the Indo-European phonological system as a whole. Why was the alternation of syllabicity in other **R* + **R* sequences seemingly permitted **everywhere** else within the proto-language, within and across paradigms? Striking examples include:

a. PIE **di̯eu̯-* 'shine': A classic example of glide / high-vowel alternation is found in this root, with all omorphs such as **di̯ḗu̯s* 'sky (nom.sg.)' (Gk. Ζεύς) ~ **di̯u-t-* 'shining' (Skt. *dyut-*) ~ **diu̯és* 'sky (gen.sg.)' (Gk. Διός) ~ **diu̯ots* 'day' (CLuv. *Tiwaz* 'sun god') ~ **dei̯u̯os* 'divine' (Lat. *dīuus*).

b. PIE **sah$_2$u̯l-* 'sun': The word for 'sun', typically reconstructed as a peculiar **-l/n-* heteroclite,[34] contains a consonantal **u̯* and syllabic **l̥* in **s(a)h$_2$u̯l̥* (Ved. *súvar*), with the situation reversed in the derivative **suh$_2$l-i̯o-* (Ved. *sū́rya-*), after laryngeal metathesis.[35]

c. PIE **si̯eu̯h$_X$-* 'sew': The expected zero-grade form **si̯uh$_X$-* is reconstructable for **si̯uh$_X$-i̯é-* (Oss. *xwyj-/xuj-* 'sew') and **si̯uh$_X$-tó-* (Ved. *syūtá-,* Lith. *siū́tas*, Lat. *sūtus*), though a possible instance of laryngeal metathesis, with subsequent syllabification of **i* (**si̯uh$_X$-* → **sih$_X$u̯-i̯e-*), may account for the vocalisms in Ved. *sī́vyati* and Goth. *siujan* 'sew'.[36]

These examples are by no means isolated. It appears that IE speakers simply had no problem tolerating fluctuations of syllabicity in their language. They did so to satisfy the phonological constraints and morphological conditions of their language. So what exactly makes the nasal-infixed presents so special in their syllabifications? Perhaps one could point to the very fact that this is the only infix in the proto-language, though such an argument runs the danger of ad hoc circularity.[37]As a matter of fact, in languages with widespread infixation

33 LIV 244–5.

34 Fortson 2010:123.

35 See section 3.3.2.

36 LIV 545.

37 Infixes syllabify strangely, hence the strange syllabification!

like Tagalog,[38] or even in a language like English where infixes are present at the extreme margins of the grammar,[39] infixes never behave strangely with respect to their syllabification patterns, at least no more so than other affixes. PIE was no exception.

4.4 Solution 1: Syllabification as Underlying

One possible solution to our problem would be to claim that the nasal of the nasal-infixed present **-n(e)-* was overtly marked as [-syllabic] in the lexicon, which would require that syllabification have been underlying for this particular morpheme. Perhaps one could claim more broadly that syllabic structure was lexically specified for *all* morphemes (or even just a subset of them) in PIE, just as one finds with other prosodic properties, such as stress in Russian[40] and tone in Chinese. Such a broad claim has been put forth by Vaux (2003) in the context of Modern Armenian, who contends that the selection of the correct plural suffix entails access to prosodic structure within the morphology itself, which for Vaux necessarily feeds phonology.[41] But there appears to be no reason to assume underlying syllabification for PIE, since in the vast majority of its grammar syllabification is clearly derived by phonological rules, as we have seen quite extensively in this and past works on the matter.

Moreover, there existed a subclass of verbs that formed nasal-infixed presents that renders the hypothesis of a lexicalized [-syllabic] */n/ even less likely: the class of disyllabic roots, or roots of the shape *CePh$_x$-.[42] In this class the nasal infix **-n-* occupies the nucleus of the second syllable in the weak stems,

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38 Klein 2005.

39 In English there are three marginal infixes: *-ɪz- infixation, fucking* infixation, and “Homeric” infixation (Yu 2007:12.) Examples include [hɪ]$_\sigma$[za͡ʊs]$_\sigma$ ‘hizzouse’, [ɪm]$_\sigma$[fʌ]$_\sigma$[kn̩]$_\sigma$[pʰɑ]$_\sigma$[sə]$_\sigma$[bl̩]$_\sigma$, and [sæk]$_\sigma$ [sə]$_\sigma$[mə]$_\sigma$[fo͡ʊn]$_\sigma$. Should infixation be exceptional with respect to syllabification, perhaps we would find [hɪz]$_\sigma$[a͡ʊs]$_\sigma$, [i]$_\sigma$[mfʌ]$_\sigma$[kn̩]$_\sigma$[pʰɑ]$_\sigma$[sə]$_\sigma$[bl̩]$_\sigma$, [sæk]$_\sigma$[sə]$_\sigma$[məf]$_\sigma$[oʊn]$_\sigma$ or the like, with illicit consonant clusters and vowel-initial syllables. This of course does not happen.

40 Minimal pairs abound: [zaˈmok] ‘lock’ beside [ˈzamok] ‘castle’, [uˈznaju] ‘I’ll learn it’ beside [uznaˈju] ‘I recognize it’, and [moloˈde͡ts] ‘attaboy!’ beside [ˈmolode͡ts] ‘fine young man’. A language which has phonological stress is French, which assigns stress automatically to the ultimate syllable of the word (if that does not contain ə). PIE was more akin to Russian than it is to French in this regard.

41 This assumption, however, is not universally held.

42 So-called because roots like **ma/eth$_2$-* ‘tear off’ become disyllabic **matʰi-* in Sanskrit, etc. More broadly we may say that every PIE root of the shape CVC$_1$C$_2$ was disyllabic, where C$_1$

such that */CePh$_x$/ + /n/ → *[Ce]$_\sigma$[Pn̥h$_x$]$_\sigma$.[43] For example, the widely attested root *g^hr̥$b^h h_2$- 'grab' formed a weak nasal-infixed stem *[g^hr̥]$_\sigma$[b^hn̥h_2]$_\sigma$, securely reconstructable through the archaic word equation Ved. *gr̥bhāyati* and YAv. *gəuruuaiieiti*, and related OPers. *agarbāya*.[44]

(132)

*/g^hrb^hnh_2i̯éti/	MST	Dep-V	Align-L	★Pk/*n*
a. ☞ *g^hr̥b^hn̥h_2i̯éti*			*…	*
b. *g^hr̥b^hnh_2i̯éti*	*!		*…	
c. *g^hr̥b^hnəh_2i̯éti*		*!	*…	

If the nasal of the nasal-infixed present *-*n*(*e*)- had been lexically specified in PIE as [-syllabic], it is likely that candidate (c. *g^hr̥b^hnəh_2i̯éti*) in (122) would have been chosen, given the common occurrence of schwa epenthesis to resolve MST violations. However, in this case the nasal infix behaves in exactly the same way as any other C + **n* + *h_x + C sequence in PIE (cf. *ĝn̥h_1-tó- 'born'), and so it is highly unlikely that the **n* of the nasal infix was lexically specified for syllabicity. Thus, when infixed, **n* is syllabified as *[n̥] in the output for two reasons: first, to avoid a MST violation (^{X}[g^hr̥b^hnh_2]$_\sigma$), and second, due to the constraint ranking Dep-V ≫ ★Peak-*n* (^{X}[g^hr̥b^h]$_\sigma$[nəh_2]$_\sigma$).

Nasal infix aside, it is widely believed that there existed at least one instance of lexicalized syllabification in PIE,[45] as argued by Forssman (1980): Hittite *kūrkaš* 'foal'. If inherited from PIE, Hitt. *kūrkaš* may derive from either *$k^{(u)}$ur-ko- or *$k^{(u)}$u̯r̥-ko-, as both *-*ur*- and *-*u̯r̥*- become *-*ūr*- in Proto-Anatolian; cf. Hitt. *ūrki*- 'track' (< PIE *u̯r̥ǵi-) and Luv. *pāḫūr* (< PIE *pah$_2$u̯r̥*).[46] However, as Forssman convincingly argues, the connection of Hitt. *kūrkaš* with Iranian **kurno*-(*ko*-) 'foal' (continued by Pahlavi *kwlk*ˈ /kurrag/ 'foal', Mod.Pers. *kurra*

was of an equal or less sonority than C_2, since C_2 could not be syllabified with the preceding segments of the root.

43 For morphological discussion, see Jasanoff 2003:123ff., following Saussure 1879:241ff.

44 Consequently, the weak stem of class IX verbs such as Ved. *gr̥bhnā́ti*, *gr̥bhnīté* (RV) must be viewed as secondary. The expected form is ^{X}*gr̥bhāté* (< [g^hr̥]$_\sigma$[b^hn̥h_2]$_\sigma$[tór]$_\sigma$).

45 Other examples of words which appear to go back to PIE *-*uR*- are not guaranteed. Melchert (1994:132) makes a connection between Hitt. *šurka*- 'root' and Lat. *surculus*, which Kloekhorst (2008:793) denies, suggesting a foreign origin given the existence of *i*-stem and *a*-stem forms. Within Indic the metathesis of *-*u̯R̥*- to *-*uR*- is much more widespread, with near minimal pairs such as *úraṇa*- 'lamb' beside *vraṇá*-, the former derived from *urā* 'lamb' (Mayrhofer 1986:161[268]). Cf. also *ulkā́*- 'meteor', with derivatives *ulkuṣī́*- 'id.', *ulkuṣī́-mant*- 'accompanied by fiery phenomena', forms which are perhaps connected to Ved. *várcas* 'brightness' and the Italic deity *Volcānus* (EWAia:231–2).

46 Melchert 1994:132.

'foal', Kurdish *kur̠* 'young boy, son', and Arm. *k' owrak* 'foal', an Iranian borrowing) and Gk. κύρνος 'bastard',[47] conclusively points back to a PIE **kur-no-, *kur-ko-*.[48] This, of course, is not the syllabification we should even *be able* to reconstruct, as we expect to find descendants of a PIE *ˣku̯r̥-* instead.[49]

(133)

*/ku̯r-Co-/	ALIGN-L	★PK/*n*	★PK/L	★PK/U̯
a. ☹ *kurCo-*	*...*!			*
b. ☞ *ku̯r̥Co-*	*...		*	

But do lexicalized syllabifications even occur in language (Vaux 2003 aside)? The most commonly cited example in the phonological literature is taken from modern Gaelic, where we find two peculiarities. First, it has been claimed that one finds hiatus in instances where, historically, two adjacent vowels were located in separate syllables; these contrast with diphthongs syllabified in the same syllable (Green 1997:157).[50]

47 According to Forssman (ibid.), Gk. κύρνος 'bastard' originally also meant 'foal'.

48 Forssman lists a number of other possible derivatives of PIE **kur-*, including: Ved. *kúla-* 'family', Av. *sukurəna-* 'hedgehog', OPers. *kuru-* (in PN Κῦρος), Gk. κούρος 'young boy' (cf. Myc. *ko-wo/korwos/*, Arc. Cor. *κόρϜα*, etc.; according to Beekes 2010:752–3, this form most likely derives from the root **k̑erh*$_3$- 'grow' [IEW 577, LIV 329]), OIce. *hornungr*, OE *hornung(-sunu)* 'bastard', Lith. *kùrtas*, Latv. *kurts* 'greyhound'. Guus Kroonen (p.c., 12/29/2013) kindly points out to me that Gmc. **hurnunga-* may or may not derive from PIE **kur-no-*, and could come from **k̑r̥n-n̥k̑-o-, *k̑urn-n̥k̑-o-* or **hwurnunga-* < **k̑u̯r̥n-n̥k̑-o-*, due to the change **hwu-* > **hu-* that obscures the vocalization of the initial syllable.

49 Norbert Oettinger (p.c., 3/13/2014) reminds me of another notable set of forms with problematic syllabification: Hitt. *karkid-ant-* 'horned' (< **kargid-* 'horn'), HLuv. *zurnid-* 'horn', perhaps Norwegian *hork* 'ruffe' (a fish with sharp spines on its front fin, Kroonen, p.c. 3/18/2014), Skt. *śr̥ṅ̊ga* 'horn', and Gk. κραγγών 'shrimp', the last two which seem to derive from PIE **k̑r̥go-*. Nussbaum (1986:3) invokes analogy to account for these syllabifications, though a phonological derivation would of course be preferred. If one follows the approach put forth in this book, this syllabification need not be analogical: both PIE */k̑rngo-/ and PIE */k̑erngó-/ → PIE **k̑r̥ngo-*.

50 For a similar contrast between two monophthongs in hiatus and homosyllabic diphthong, cf. the oft-cited English pair [ˈʔaɪ.da] 'Ida' and [ʔa.ˈi.da] 'Aïda'.

(134) Gaelic Hiatus[51]

	Historical monosyllables			Historical disyllables		
a.	piəɣ	<bia>	'food'	pi.əɣ	<beadh>	'let him be'
b.	Ruəɣ	<rua>	'red'	Ru.ə	<bhruach>	'promontory'
c.	tuən	<dán>	'poem'	tu.an	<duán>	'hook'

According to Green (citing Borgstrøm 1940 and Ternes 1973), the dialects differ on how these contrasts are manifested phonetically, if a contrast is maintained at all. In the Barra dialect, one finds a slight glottal 'catch' after the short vowel, in the dialect of Harris, the hiatus is resolved through the epenthesis of [h], in the dialect of Lewis, the contrast is completely tonal, and in the dialect of Applecross, Ross-shire, the contrast is durational, with the original monosyllables being "markedly longer than the original disyllables". But it is unclear if any Gaelic dialect actually make a contrast in syllabification as has been claimed.

The second, and (in my opinion) more serious, example of lexicalized syllabification in Gaelic pertains to instances of vowel epenthesis, a process which occurs between a sonorant and a following consonant unless that consonant is homorganic or an aspirated stop (Green, ibid.).

(135) Gaelic Epenthesis

	Underlying monosyllables		Underlying disyllables	
a.	aram /arm/	'army'	aran	'bread'
b.	s′aLak /s′aLk/	'hunt'	s′aLəg	'sight, spectacle'
c.	marav /marv/	'dead'	potəx	'old man'

For Borgstrøm (1937) there is an intriguing difference of the syllabification of these pairs in the Barra dialect. In the left column, the syllable break lies before the medial consonant (*a.ram, s′a.Lak, ma.rav*); in the right column it lies after medial consonant (*ar.an, s′aL.əγ, pot.əx*). Thus, it appears that in Barra we have instances of contrasting syllabification, which one may reasonably claim to be underlying—if the syllabifications were not underlying, how does one explain the contrasts? However, as Bosch & de Jong (1997) convincingly show,

51 R and L stand for 'fortis' /r/ and /l/, respectively.

these are differences in stress, not syllabification (*arám, s'aLák, maráv* vs. *áran, s'áLəg, pótəx*), and therefore they in no way validate the syllabifications which Borgstrøm proposes.[52]

Another purported instance of lexicalized syllabification comes from Imdlawn Tashlhiyt Berber (ITB), in which there is a set of morphemes that does not follow the normal syllabification rules as laid out by Dell and Elmedlaoui (1985). Syllabification always proceeds from left to right in ITB, ensuring that each syllable contains an onset. However, there is a subclass of morphemes, in which high vowels consistently do not vocalize as expected:[53]

(136)	a. *suy*	'let pass!'	*zwi*	'beat down!'
	b. *lur*	'give back!'	*lwr̥*	'run away!'
	c. *t-urti-t*	'garden', f.	*t-wr̥ta-t*	'type of feline', f.

Following the normal syllabification rules of ITB, *zwi* 'beat down!', *lwr̥* 'run away!', and *t-wr̥ta-t* 'kind of feline', f., should have been syllabified as **zuy* 'let pass!', **lur* 'give back!', and **turtat*, respectively. According to Elmedlaoui (ibid.) these exceptions must be viewed as lexicalized syllabifications, in which the language lexically specifies that the *w* of each root in question be non-syllabic at the surface.

But even if Elmedlaoui's analysis holds true—and even if other instances of lexicalized syllabification come to light—it is clear that such syllabifications are vanishingly rare cross-linguistically, if they do in fact exist at all. For this reason it would be preferable to devise an alternate explanation for the exceptional syllabifications seen in the nasal-infixed presents and PIE **kur-*, if we are able to do so.[54]

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52 Moreover, as Green (1997:159) argues, the reason that Borgstrøm hears the syllabification of the right column in such a way in the first place is due to the ambisyllabic pronunciation of medial consonants following a stressed short vowel. Green compares Borgstrøm's error of transcription to the frequent syllabification of words such as *happy* as *happ.y*, which many scholars (such as Kahn [1980]) have claimed to have an ambisyllabic *-pp-*.

53 Dell & Elmedlaoui 1985:114–5.

54 Readers may be reminded of the English pair *mistake* $[\text{mɪ}]_\sigma[\text{ˈsteɪk}]_\sigma$ 'error' and *mistake* $[\text{mɪs}]_\sigma[\text{t}^\text{h}\text{eɪk}]_\sigma$ 'accidentally take', which show clear contrasts in syllabification. This contrast is not underlying, however, and should rather be attributed to differences in prosodic word boundaries. See section 4.6 below.

4.5 Solution 2: Correspondence by Derivation

As is well known, one of the greatest difficulties for classic OT is the way in which it handles certain types of opacity (Idsardi 2000). By opacity, we simply mean the unexpected overapplication or underapplication of a phonological process in the surface form.[55] There are, however, two types of opacity that may be straightforwardly handled within OT. Consider the data in (127) and (128) below.

(137)	a. [pʰl̥iz]	'please'	c. [pʰl̥is]	'police'
	b. [pʰɹ̥e͡ɪd]	'prayed'	d. [pʰɹ̥e͡ɪd]	'parade'

(138)	a. [mʌ̃ŋkiz]	'monkeys'	c. [kʰæts]	'cats'
	b. [dɑgz]	'dogs'	d. [hɔɹsəz]	'horses'

These data from English illustrate classic examples of two very common types of opacity, **feeding** and **bleeding**. In the first set a sonorant always devoices immediately following a tautosyllabic voiceless stop, in cases where the sequence is underlying (a. /pliz/, b. /pɹe͡ɪd/) as well as derived in fast speech (c. /polis/, d. /pɑɹe͡ɪd/). In traditional SPE-type phonology, these facts are explained by synchronic rule ordering, with the processes of vowel reduction and ə deletion occurring *before* sonorant devoicing.

(139)

UR	/polis/
Stress Assign	[poˈlis]
V Reduction	[pəlis]
ə → ∅	[plis]
R → R̥	[pl̥is]
Other Rules	[pʰl̥is]
SR	[pʰl̥is]

55 Thus Kager (1999:373–4), following McCarthy's terminology: "We call a generalization *non-surface-apparent* if it takes effect at a level concealed at the surface. A set of forms undergo a process, although they fail to match its structural description at the surface.... A generalization is *non-surface-true* if it has cases of non-application at the surface that are controlled by a non-surface level. This is the logically opposite situation of the previous cases. A set of forms fail to undergo a process even though their surface forms match its structural description."

These facts may be easily derived in parallel (classic) OT through the constraint ranking AGREE(Voice), *ə ≫ MAX-V, IDENT(Voice). No intermediate level (i.e. ordering) is necessary.

(140)

/polis/	AGREE(Voice)	*ə	MAX-V	IDENT(Voice)
a. ☞ [ˈpʰl̥is]			*	*
b. [ˈpʰlis]	*!		*	
c. [pʰəˈlis]		*!		

The second set of data in (128) above contains the well-known allomorphs of the English plural morpheme /z/. In SPE-style phonology, it is clear that the processes of voicing assimilation and ə epenthesis do not occur simultaneously, as /z/ remains voiced in 'horses'. This, too, is explained by synchronic rule ordering. Devoicing must occur *after* schwa epenthesis: (/hɔɹsz/ → [hɔɹsəz], [hɔɹsəz] ↛ ˣ[hɔɹsəs]). Once again, no intermediate level is necessary for an OT analysis: schwa epenthesis occurs to satisfy the highly ranked constraint *SS (which bans two adjacent stridents), and the change of /z/ to [s] does not materialize because it is a redundant change in the output.

(141)

/hɔɹsz/	*SS	AGREE(Voice)	DEP-V	IDENT(Voice)
a. ☞ [hɔɹsəz]			*	
b. [hɔɹsəs]			*	*!
c. [hɔɹsz]	*!	*		
d. [hɔɹss]	*!			*

There are, however, numerous examples of opacity that cannot be explained in the classic OT framework, in languages both living and dead. These are typically instances of **counterfeeding**,[56] **counterbleeding**,[57] and a phenomenon known as **saltation**.[58] In the interest of space, we will only examine

56 "If rule A feeds rule B but they are applied in the order B precedes A, then these rules are said to be in counterfeeding order" (McCarthy 2007:107).

57 "If rule A bleeds rule B but they are applied in the order B precedes A, then these rules are said to be in counterbleeding order".

58 Instances where one sound is converted to another sound, "jumping over" a third sound in the phonemic inventory, as seen in the change of voiceless stops (but not voiced stops!) to voiced fricatives in Campidanian (Sardinian): /belːu piʃːi/ → [belːu βiʃːi] 'nice fish' but /sːu binu/ → [sːu bĩu] 'the wine'. See Hayes 2013 for further examples and discussion.

counterfeeding, which is likely the type of opacity creating our exceptional syllabifications.[59] Thus the rules of syllabification occur *too late* to produce the expected syllabifications, taking place after some other phonological process has affected the underlying form. But before we discuss the situation in PIE, let us first review a well-known example of counterfeeding from Levantine Arabic (Kiparsky 2000).

(142)	/fihim/	'understood'	/fihm/	'understanding'
	fíhim	'he understood'	fíhim	'understanding'
	fihím-na	'he understood us'	fíhm il-wálad	'the boy's understanding'
	fhím-na	'we understood'	fíhim-na	'our understanding'

Beginning with Brame 1974, scholars have pointed out two problems with the above data. First, [i] in an open syllable does not syncopate as expected in [fihím-na] 'he understood us'; cf. /fihím-na/ → [fhímna] 'we understood'. Second, the position of stress in [fíhim-na] 'our understanding' is unexplained, as stress regularly falls on heavy penults (Kiparsky, ibid.); cf. [fihímna] 'he understood us'. These facts cannot be dealt with in classic OT, in which both forms should be homophonous with [fhímna] 'we understood'.[60]

(143)

/fihim-na/	*-i$]_\sigma$	WSP	MAX-V
a. ☹ [fíhimna]		*!	
b. ☹ [fihímna]	*!		
c. ☞ [fhímna]			*

Of course one cannot overlook the fact that the words 'he understood' and 'understanding' are both [fíhim], with an accented, unsynpocated [í] in the first syllable. It is for this reason that syncope does not take place in [fihímna] 'he understood' and the vowel remains accented in [fíhimna] 'our understanding'. The correct synchronic solution must somehow acknowledge those facts.

Perhaps the most popular treatment of opacity within OT assumes Output-to-Output correspondence (OO-correspondence) constraints, also referred to as 'paradigm uniformity', 'uniform exponence', and 'base-identity' constraints.[61] The idea is that a certain member of a paradigm (the **base**) phonologically 'influences' other members of the same paradigm, thereby resulting in

59 If opacity is in fact relevant to the situation at hand!

60 WSP (Weight-to-Stress Principle): heavy syllables are stressed (Kager 1999:155).

61 This theory has a long and distinguished pedigree, see Kager 1999:257 for references.

unexpected surface forms. Crucially, the correspondence is between separate output forms.

(144) **Base** [fíhim] 'he understood' ⇔ **Derivative** [fihímna]
↑ ↑
Input /fihim/ **Input** /fihim-na/

Kager (1999:282) defines a 'base' as follows: (1) it is a free-standing output form (a word), and (2) it contains a *subset of the grammatical features* of the derived form. As [fíhim] 'he understood' satisfies both conditions, it acts as the base of the derived form [fihímna] 'he understood us'. No syncope occurs due to a high-ranking OO-correspondence constraint HeadMax-BA, which requires that vowels stressed in the base remain in the output form (Kager 1999:283).

(145)

Input: /fihim-na/ Base: [fíhim]	HeadMax-BA	*-i]$_\sigma$	Max-V
a. ☞ [fihímna]		*!	
b. [fhímna]	*		*

While the assumption of the constraint HeadMax-BA (albeit ad hoc) works well to explain the lack of syncope, the difference of stress placement between [fihímna] 'he understood us' and [fíhimna] 'our understanding' has not yet been addressed. Recognizing the underlying form of the latter as /fihm-na/, Kager proposes an additional constraint, HeadDep-IO, which requires that every vowel in the output's prosodic head have a correspondent in the input. But as Kiparsky (ibid.) points out, while this solution does successfully produce the correct stress placement, it is unsatisfactory for a number of reasons. First, HeadDep-IO cannot account for other unexpected stress assignments in Levantine Arabic (/katab-t/ → [katábit] 'I wrote', not ˣ[kátabit]), and second, it ignores the fact that epenthetic [i] is completely ignored by *all* phonological processes, such as the shortening of closed syllables (/šáaf-t/ → [šífit] 'I saw', ˣ[šáafit]), and the spread of "emphasis" across epenthetic [i], which is blocked by vowels otherwise (/rubaṭ-t/ → [rubaṭiṭ] 'I fastened', ˣ[rubaṭit]).

It is in this context that Kiparsky (ibid.) proposes "to abandon full parallelism in favor of stratified constraint systems", a framework known as Stratal Optimality Theory (Stratal OT) or LPM-OT.[62] Stratal OT is by-and-large an

62 See Kiparsky 2000 and more recently Bermúdez-Otero 2011 and Bermúdez-Otero, forthcoming.

OT adaptation of the earlier, rule-based Lexical Phonology and Morphology[63] and continues the well-established notion of the phonological cycle. As Collie (2007:13) explains: "In SPE, the cycle is a principle of phonological rule application ... In a morphologically or syntactically complex form, a sequence of rules will apply to the innermost phonological string that contains no internal morphosyntactic bracketing ([ ]). The innermost set of brackets will be deleted, and the phonological rules will then reapply, again to a string containing no internal brackets. This recursive application of rules continues until the outermost morphosyntactic constituent of the complex form is reached ... So, for a hypothetical string [X[Y]Z], rules would apply first to [Y], then a special rule would delete the brackets immediately on either side of Y, before the same rules applied to [XYZ]."

In Stratal OT "bracket erasure" occurs in the transition between each phonological level (stratum). Scholars typically posit three strata, arranged in the following order: STEM, WORD and POSTLEXICAL (or phrasal). Unlike classical OT, where there is one level of constraint rankings, constraints may have different rankings at each phonological level in Stratal OT.[64]

(146)

Input

↓

Stem Stratum: GEN*Stem* EVAL*Stem*

↓

Word Stratum: GEN*Word* EVAL*Word*

↓

Postlexical Stratum: GEN*Postlex* EVAL*Postlex*

↓

Output

63 For discussion with references, see Kaisse and Shaw 1985.

64 Kiparsky (2000) further explains: "LPM-OT's goal is to reduce cyclicity to I/O faithfulness, and opacity to inter-level constraint masking. Thus, if α is the constraint system of some domain (say, stems) and β the constraint system of a larger domain (word level or postlexical) then β's markedness constraints can render α opaque. These are the only sources of cyclic effects and opacity: there are no O/O constraints, no paradigm uniformity constraints, and no sympathy constraints. The intrinsic seriality of LPM-OT provides a handle on opaque and cyclic constraint interactions without retreating to the unconstrained ordering theory of pre-OT days. The insights of both OT and LPM can be retained—and new insights emerge from their combination which are not available under either of them on their own."

Let us now see how Stratal OT handles the problem of opacity in Levantine Arabic.[65] The first stratum in the grammar, the stem level, is where roots combine with subject affixes and is the first domain for stress assignment.

(147)	/fihim/	/fihim/	/fihm/
	fihím-na	fíhim	fíhm
	'we understood'	'he understood us'	'our understanding'

The object and possessive suffixes *-na* are then added at the word level, where syncope also takes place in *fhímna*. It does not occur in *fihímna* as the stress assigned to the initial syllable at the stem level protects *i* from being deleted, though stress is reassigned to the root once again following the WSP.

(148)	fhímna	fihím-na	fíhm-na
	'we understood'	'he understood us'	'our understanding'

Lastly, [i] epenthesis is a postlexical process, manifesting itself in order to make a triconsonantal sequence syllabifiable.

(149)	[fhímna]	[fihímna]	[fíhimna]
	'we understood'	'he understood us'	'our understanding'

Returning now to PIE, is it possible that the exceptional syllabification of the nasal-infixed presents reflects a set of opaque processes reconstructable for the proto-language, and if so, could we explain such opacity within OT, utilizing either the OO-correspondence or Stratal OT frameworks?[66] In section 4.2 we learned that the nasal-infixed present was almost certainly derived from the root aorist, whose original function was to form imperfective (present) verbs to perfective (aorist) stems. In other words, the aorist historically served as the *base* of the present formation. One then could argue that the vocalism of the base (the aorist) was extended to its derivative (the nasal-infixed present) through satisfaction of one (or many) OO-correspondence constraint(s).[67] In other words, the base [i̯u]$_\sigma$[gént]$_\sigma$ *controlled* the root vocalism of the derivative /i̯u̯ngénti̯/.

65 This account is taken from Kiparsky 2000.

66 We may of course utilize other frameworks, such as Harmonic Serialism (cf. Torres-Tamarit 2012).

67 Cf. Ved. *áyukta*, only attested in the mediopassive.

(150) **Base** [i̯u]$_\sigma$[gént]$_\sigma$ ⇔ **Derivative** [i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$

↑ ↑

Input /i̯u̯gént/ **Input**/i̯u̯ngénti̯/

Within a tableau we may express this with the constraint MAX(μ)-BA, which requires that every mora in the base have a correspondent in the derived form.[68]

(151)

Input: /i̯u̯ngénti̯/ Base: [i̯u̯$_\mu$gé$_\mu$n$_\mu$ti̯$_\mu$]	MAX(μ)-BA	ONSET	ALIGN-L	⋆PK/U
a. ☞ [i̯u$_\mu$n$_\mu$gé$_\mu$n$_\mu$ti$_\mu$]	*		…	*
b. [i$_\mu$u̯n̥$_\mu$gé$_\mu$n$_\mu$ti$_\mu$]	* *!	*	…	

However, this analysis runs into trouble when we consider Kager's definition of the base. While [i̯u]$_\sigma$[gént]$_\sigma$ is a free-standing output form, it does not contain a subset of the grammatical features of the derived form [i̯un]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$, as [i̯u]$_\sigma$[gént]$_\sigma$ conveys different tense / aspect. Even so, we are still faced with the question raised in section 4.3 above when we considered the possibility of syllabification by analogy.[69] Why was such an OO-correspondence constraint only relevant for the nasal-infixed presents but apparently not for other derivatives in PIE?

Let us now examine the problem within the Stratal OT framework, which will play a prominent role in our treatment of SIEVERS' LAW in the next chapter. In the following analysis I will assume the nasal-infix suffix to be added at the word level.[70] Though it remains unclear exactly why certain derivational suffixes would have been added at the stem level whereas others were added at the word level,[71] it is crucial to assume that the nasal infix entered the derivation at the latter in order to explain its 'exceptional' syllabification within the

68 Cf. Kager 1999:289.

69 In fact, Kiparsky 2000 labels phonological opacity and paradigmatic effects as "synchronic analogy"!

70 Note that while I have no independent evidence for these assumptions, I am not aware of any counter-argument that suggests otherwise.

71 While ad hoc for this particular analysis of PIE, the addition of suffixes at different points in the phonological derivation occurs in a multitude of languages, where the first member of the pair contains a 'level 1' suffix (added at the stem level), and the second member contains a 'level 2' suffix (added at the word level).

current framework. I'll also tentatively assume that the first cycle of syllabification at the stem level produces *[i̯u]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$ and *[bʰi]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$ for the stems 'they join' and 'they split', respectively.[72] For reasons of brevity we will only focus on the derivation of 'split'.

(152) Stem level

/bʰi̯dénti̯/	MST	PARSE	ONSET	ALIGN-L	★PK/U̯
a. ☞[bʰi]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$				…	* *
b. bʰi̯[dén]$_\sigma$[ti]$_\sigma$		*!*		…	*
c. [bʰi̯dén]$_\sigma$[ti]$_\sigma$	*!*			…	*

The morpheme *-*n*- is then infixed at the word level, where the faithfulness constraint MAXLINK-μ is ranked high in the grammar. This constraint, which will be discussed in further detail below, may be simply defined as 'Do not delink a mora (μ) from a segment associated with said mora in the input.'[73] This constraint will effectively keep the syllabification of the syllables *[bʰi]$_\sigma$ and *[i̯u]$_\sigma$ (of *[bʰi]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$ and *[i̯u]$_\sigma$[gén]$_\sigma$[ti]$_\sigma$, respectively) intact in the output of the word level.

(153) Word level

[bʰi]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$ + /-n/	MST	DEP-V	MAX-C	MAX LINK-μ	ALIGN-L	★PK/n̥	★PK/U
a. ☞[bʰin]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$					…		*
b. [bʰi̯n̥]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$				*!	…	*	
c. [bʰi]$_\sigma$[dén̥]$_\sigma$[ti]$_\sigma$			*!		…		*
d. [bʰi]$_\sigma$[nə]$_\sigma$ [dén]$_\sigma$[ti]$_\sigma$		*!			…		*
e. [bʰi]$_\sigma$[ndén]$_\sigma$[ti]$_\sigma$	*!				…		*

In this way we can motivate the actually occurring stem [bʰin]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$, with a nucleus *[i] and not *[n̥], as being driven by faithfulness to the moraic structure of an earlier stage of derivation (the stem level).

Turning now to the aforementioned class of disyllabic roots (see section 4.4 above), we arrive at the correct syllabification with no modification to our framework at all. As noted before the nasal infix is vocalized in order to avoid violations of the MST.

72 Kessler, n.d. has made a similar suggestion.

73 Morén 2001:27ff.

(154) Word level

[gʰr̥bʰ]$_σ$[h$_2$án]$_σ$[ti]$_σ$ + /n/	MST	DEP-V	MAX-C	MAX LINK-μ	*PK/n
a. ☞[gʰr̥]$_σ$[bʰn̥]$_σ$[h$_2$án]$_σ$[ti]$_σ$				*	*
b. [gʰr̥bʰ]$_σ$[nh$_2$án]$_σ$[ti]$_σ$	*!				
c. [gʰr̥bʰn]$_σ$[h$_2$án]$_σ$[ti]$_σ$	*!				
d. [gʰr̥bʰ]$_σ$[nə]$_σ$[h$_2$án]$_σ$[ti]$_σ$		*!			

Should all of this be true, it is conceivable that the assumption of a high-ranking MAXLINK-μ may also provide us with a mechanism to explain another exceptional type of PIE syllabification: the accusative singular and plural of acrostatic and proterokinetic **-i-*, **-u-* and **-r-* stems.[74] While we have seen that Cooper's account works quite nicely, we may approach these accusative forms in the same manner as we have done for the nasal-infix presents: assume that adherence to a high-ranking MAXLINK-μ is driving the violation of the expected maximization of onsets. At the stem level, the root is combined with the suffix, which are then syllabified.

(155) STEM LEVEL: **mén-* + **-ti-* → *[mén]$_σ$[ti]$_σ$ (cf. **méntis*)

At the word level, the form **méntim* 'mind (acc.sg.)' is chosen over ^{X}*méntḭm̥* because the latter violates MAXLINK-μ.

(156) Word Level: [men]$_σ$[ti]$_σ$ + *-m*

/[men]$_σ$[ti]$_σ$ + -m/	MST	MAXLINK-μ	ONSET	ALIGN-L
a. ☞ [men]$_σ$[tim]$_σ$				…*
b. [men]$_σ$[tḭm̥]$_σ$		*!		…
c. [men]$_σ$[ti]$_σ$[m̥]$_σ$			*!	…*

While the above solution does "work", it feels like a brute-force solution, arbitrarily assuming certain affixes as stem affixes and others as word affixes with no independent evidence suggesting otherwise. As with our explanation utilizing OO-correspondence constraints above, while the assumption of multiple

74 Schindler 1977a:57. See Fortson 2010:119ff. for discussion of the acrostatic and proterokinetic ablaut classes, with examples.

lexical strata creates the appearance of an intricate case of counterfeeding, deep down it still has the feel of synchronic analogy.

4.6 Solution 3: Invoking the pword (ω)

Perhaps the explanation that makes the most typological sense for our exceptional syllabifications lies in the reconstruction of prosodic word boundaries within PIE. To illustrate what I mean by this, let us begin by examining two pairs of words in English:[75]

(157)	*camp leader*	[kʰæ̃mp˺]$_\sigma$[liː]$_\sigma$[dɹ̩]$_\sigma$	*post-rio*	[pʰo͡ʊst˺]$_\sigma$[ɹi]$_\sigma$[jo͡ʊ]$_\sigma$
	employ	[ɛ̃m]$_\sigma$[pʰloɪ]$_\sigma$	*Postrio*	[pʰo͡ʊs]$_\sigma$[tʰɹi]$_\sigma$[jo͡ʊ]$_\sigma$

In each of these pairs there exists a contrast in the syllabification of a particular consonant sequence. In the first, the medial sequence *-mpl-* is syllabified in two different ways; in the compound *camp leader*, the boundary lies between the *p* and the *l* and in the word *employ* between the *m* and the *p*. We may prove this by observing an unreleased *p*˺ in the former and an aspirated p^h in the latter, whose phonetic realization is dictated by the position of stops within the syllable.[76] In the second pair, *t* occupies the coda of the first syllable in *post-rio*[77] while it is maximized in the onset of the second syllable in *Postrio*.[78] As with /p/ in the previous pair, these differences in syllabification result in an unreleased *t*˺ in the former and an aspirated t^h in the latter.

Such differences in syllabification are due to differences in the placement of prosodic word (ω) boundaries. The ω is a universal prosodic category,[79] widely accepted to be the domain of syllabification in most (but not all) languages (Booij 1995, Revithiadou 2011). In languages like English, which obey the Maximal Onset Principle (MOP), onsets will only be maximized within the ω. It is for this reason that *p* occupies the coda of the first syllable in *camp leader* but occupies the onset of the second syllable in *employ*, resulting in the complex onset *-pl-*. The former consists of two ωs; the latter one. In *post-rio*, the ω boundary is located at the morpheme boundary (between *t* and ɹ), whereas

75 See Giegerich 1999:239ff. for additional examples.

76 Kahn 1980:73.

77 In the sense "after (one's time in) Rio (de Janeiro)".

78 The name of a restaurant in San Francisco, CA.

79 See section 2.2 for an overview of the prosodic hierarchy.

in the monomorphemic word *Postrio*, it is located at the beginning, once again resulting in onset maximization. These differences in syllabification arise from differences in ω parsing.

Cross-linguistically it is clear that certain affixes may themselves constitute their own ω.[80] Such affixes are called **non-cohering** and in English include *sub-, un-, -ly*, and *-ful* (among others).[81] Since each affix constitutes its own ω, each is syllabified independently from its stem, hence [səb]$_\sigma$[lu]$_\sigma$[nr̩]$_\sigma$ 'sublunar', [ʌ̃n]$_\sigma$[ĩn]$_\sigma$[tʰɛ̃n]$_\sigma$[ʧə]$_\sigma$[nl̩]$_\sigma$ 'unintentional', [wik˺]$_\sigma$[li]$_\sigma$ 'weakly', and [blɪs]$_\sigma$[fl̩]$_\sigma$ 'blissful'. All other affixes are **cohering** affixes, which are not syllabified independently of their stems, and hence do not constitute their own ωs. In English these include the Latinate afffixe *in-*, *-al*, *-ity*, affixes which also trigger phonological processes such as place assimilation (e.g. (148a.) *impure*), palatalization (e.g. (148b.) *presidential*) and the shift of stress (e.g. 148b.), (148c) *originality*). Note the cosyllabification of each cohering affix with its preceding stem.

(158) a. /ɪn/ + /pjuɹ/ → [ĩm]$_\sigma$[ˈpʰjuɹ]$_\sigma$
b. [ˈpʰrɛ]$_\sigma$[zɪ]$_\sigma$[dɛ̃nt]$_\sigma$ → [ˌpʰrɛ]$_\sigma$[zɪ]$_\sigma$[ˈdɛ̃n]$_\sigma$[ʧ l̩]$_\sigma$
c. [ə]$_\sigma$[ˈɹɪ]$_\sigma$[ʤɪ]$_\sigma$[nl̩]$_\sigma$ → [ə]$_\sigma$[ˌɹɪ]$_\sigma$[ʤə]$_\sigma$[ˈnæ]$_\sigma$[lɪ]$_\sigma$[ɾi]$_\sigma$

Affixes may be identified as cohering or non-cohering through various other means in addition to contrasts in syllabification.[82] First, certain phonological processes may be restricted either within or at the edges of ωs.[83] An example of such an edge rule may be observed in Dutch, where, like many of the world's languages, obstruents are devoiced in word-final position.[84]

80 Booij 2005.

81 Indo-Europeanists will be reminded of the pada endings of Sanskrit, which include the loc.pl. *-su* and the case endings beginning in *-bh-*. As non-cohering affixes these endings followed the rules of exterior sandhi.

82 Much of this discussion has been taken from Revithiadou 2011, to which I refer the reader for a more in-depth account. Other diagnostics of the ω as a phonological constituent include minimal word requirements (cf. section 3.3.6), reduction under coordination, and language games.

83 As Selkirk (1980:119ff.) discusses, a number of phonological processes target the right edge of a ω in Sanskrit, such as consonant cluster simplification (*achāndst* → *achān*) and the neutralization of laryngeal features (*vīrudh* → *vīrut*). It is likely similar processes existed in PIE as well.

84 Examples taken from Grijzenhout & Krämer 2000.

(159)	a. *pad*	/pɑd/	'toad'	[pɑt]
	b. *poes*	/puːz/	'cat'	[puːs]
	c. *rood*	/roːd/	'red'	[roːt]

But we find that obstruent devoicing occurs in environments beyond word-final position.

(160)	a. *Rode Kruis*	'Red Cross'	[roːdəkrəys]
	b. *rodig*	'reddish'	[roːdəx]
	c. *Roodkapje*	'Little Red Ridinghood'	[roːtkɑpjə]
	d. *rood-achtig*	'reddish'	[roːtɑxtəx]

In examples (150a.) and (150b.), /d/ remains voiced as expected, since it is not located at the end of the word. However, in examples (150c.) & (150d.), devoicing occurs unexpectedly: while one may explain its occurrence in *Roodkapje* by assimilation with the following [k], (s)he cannot in *rood-achtig*, since /d/ precedes a vowel. As Booij (2005) convincingly demonstrates, final devoicing does not merely occur at the end of grammatical words, it more specifically occurs at the end of prosodic words. The suffix *-achtig* is a non-cohering affix, which entails that the /d/ of *rood* lies at the end of a ω, and hence devoicing occurs. And it may be argued that it is for this reason that devoicing occurs in the compound *Roodkapje* as well.

The domain of a phonological process may also be restricted to within the ω. For example, in French, stem-final high vowels become glides before another vowel within the same ω, though remain vocalic if said vowels occur in a separate ω.

(161)	a. *colonie*	[kɔlɔni]	'colony'
	colonial	[kɔlɔnjal]	'colonial'
	b. *anti-alcoolique*	[ãtialkɔlik]	'anti-alcohol'
		*[ãtjalkɔlik]	
	c. *tissue-éponge*	[tisyepɔ̃ʒ]	'terry-cloth'
		*[tisɥepɔ̃ʒ]	

In (151a.), the vowel /i/ in *colonial* is realized as [j] since it immediately precedes the vowel [a] of the cohering suffix *-al*. However, in (151b.), because the prefix *anti-* is a non-cohering prefix, and in (151c.), because a compound boundary always creates a ω boundary, glide formation does not take place.[85]

85 As discussed in Giegerich 1999, English [j, w]-sandhi occurs within a ω (*seeing* [sijɪŋ], *doing* [duwɪŋ]) but does not across a ω boundary (re[ʔ]invest, pro[ʔ]active, de[ʔ]escalate).

A second diagnostic lies in the analysis of certain prosodic properties within a word, such as tone and stress. We often find that tonal properties are governed within ωs in certain ways,[86] but more importantly for our purposes, in accent-bearing languages (which PIE is believed to have been)[87] each ω is assigned one primary word ictus. It is for this reason that the Eng. words *parent* and *parental* each contain a single stress, whereas the word *parenthood* contains two. The first two words consist of a single ω, whereas the last contains two, as *-hood* is a non-cohering affix.[88]

(162) a. *parent* [ˈpʰæɹənt]
b. *parental* [pʰəˈɹɛntəl]
c. *parenthood* [ˈpʰæɹəntˌhʊd]

How is all of this relevant to our understanding of the syllabification of the nasal-infixed presents? Well, were one to analyze certain affixes in PIE as being non-cohering, such affixes would be syllabified independently from its stem, and they would therefore be syllabified differently from "normal" polymorphemic sequences which consist of a root plus *x* number of cohering affixes. Perhaps, then, forms such as **bʰindénti* and **méntim* were actually parsed as two separate ωs: $[b^{h}\text{i̯dénti̯}]_{\omega}$ + $[\text{n}]_{\omega}$ and $[\text{ménti̯}]_{\omega}$ + $[\text{m}]_{\omega}$, whereby creating our exceptional syllabifications. In other words, **-n(e)-* and **m* would be reconstructed as non-cohering affixes.

However, should we pursue such an explanation we would encounter multiple problems. First, aside from the unexpected syllabifications themselves, there are no phonological processes that warrant the assumption of /n(e)/ or /m/ as distinct ωs. Second, there is no evidence that primary stress was assigned to either /n(e)/ or /m/ in addition to the stem. Thus, there is only one accent reconstructable for a form such as **bʰinétsti, *bʰindénti* 'bite(s)', not two: *ˣbʰéi̯nétsti, ˣbʰéi̯ndénti*. Third, the assumption of distinct ωs in these cases creates an unavoidable circular argument, as we would claim certain suffixes to be non-cohering because they syllabify strangely, and vice versa. These objections notwithstanding, let us test the hypothesis tentatively proposed above and assume the parsings $[b^{h}\text{i̯dénti̯}]_{\omega}$ + $[\text{n}]_{\omega}$ and $[\text{ménti̯}]_{\omega}$ + $[\text{m}]_{\omega}$.

86 See Revithiadou 2011 for discussion, with references.

87 See 1.3 for discussion of pitch accent.

88 Explain why the primary stress has become secondary in the suffix.

In order for us to couch this hypothesis within OT, we will need to assume the following two alignment constraints (McCarthy and Prince 1993):

(163) a. ALIGN(ω,L,σ,L): the left edge of each ω aligns with the left edge of a σ. Assign one * for each segment intervening between misaligned edges.

b. ALIGN(ω,R,σ,R): the right edge of each ω aligns with the left edge of a σ. Assign one * for each segment intervening between misaligned edges.

Both constraints demand the identity of a prosodic word edge with a syllable edge, one focused on the left edge, the other the right. Though we currently have no reason to assume that in PIE one was ranked more highly than the other in the grammar, let us assume that ALIGN(ω,L,σ,L) was ranked more highly, given the preference for ONSET MAXIMIZATION in PIE.[89]

(164)

*[ménti̯]$_\omega$ + [m]$_\omega$	ALIGN-L (ω,σ)	ONSET	★PK/*m*	★PK/*n*
a. ☞ *[mén]$_\sigma$[ti]$_\sigma$[m̥]$_\sigma$		*	*	
b. *[mén]$_\sigma$[ti̯m̥]$_\sigma$	*!*		*	
c. ☹ *[mén]$_\sigma$[tim]$_\sigma$	*!*			

*[bʰi̯dénti̯]$_\omega$ + [n]$_\omega$	ALIGN-L (ω,σ)	ONSET	★PK/*m*	★PK/*n*
a. ☞ *[bʰi]$_\sigma$[n̥]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$		*		*
b. *[bʰi̯n̥]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$	*!*			*
c. ☹ *[bʰin]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$	*!*			

The tableaux in (154) reveal a problem even more serious than the ones discussed above. Because each ω is syllabified independently, under this analysis we actually generate the ***wrong*** syllabifications: $^{\mathrm{X}}$[bʰi]$_\sigma$[n̥]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$ and $^{\mathrm{X}}$[mén]$_\sigma$[ti]$_\sigma$[m̥]$_\sigma$! It thus appears that we cannot invoke ω boundaries to explain the exceptional syllabifications of either the weak stem of the nasal-infixed presents or the *méntim* type, and so we must seek another solution.

89 In truth it does not matter, for the assumption of a highly ranked ALIGN-R would reach the same conclusions.

4.7 Solution 4: Syllabification & Syncope

The final—and my opinion correct—solution to our problem of exceptional syllabifications in PIE *as a whole* begins with a curious pair of words as spoken in a number of English dialects, first cited by Vennemann (1988:70).

(165) a. *apron* [e͡ɪ]$_\sigma$[p$^{\mathrm{(h)}}$ɹn̩]$_\sigma$
b. *lantern* [ˈlæn]$_\sigma$[t$^{\mathrm{(h)}}$ɹ̩n]$_\sigma$

This seemingly innocuous pair creates a conundrum for our understanding of syllable formation. If syllabification is an automatic process and affects all sequences equally, how can the sequence /Pɹn/ be syllabified as [Pɹn̩] in one instance but as [Pɹ̩n] in the other? We cannot claim that these are the only possible syllabifications for these particular sequences, since the opposite syllabifications are found in other words: [tɹn̩] in [me͡ɪ]$_\sigma$[t$^{\mathrm{(h)}}$ɹn̩]$_\sigma$ 'matron' and [pɹ̩n] in [p$^{\mathrm{h}}$ɹ̩n]$_\sigma$ 'Pern'.[90] It appears that both syllabifications are possible for either sequence.

The answer to this conundrum lies in the underlying forms of each word in question, which I would contend are /e͡ɪpɹɑn/ and /læntɛɹn/, respectively. This contention does not merely rely on orthography, as such URs may be proven through the use of wug tests, in which native English speakers are asked to change each noun into an *-ic* adjective: "That's an [e͡ɪ]$_\sigma$[ˈp$^{\mathrm{h}}$ɹɑ]$_\sigma$[nɪk]$_\sigma$ style of garment." and "That's a [læn]$_\sigma$[ˈt$^{\mathrm{h}}$ɹ̩]$_\sigma$[nɪk]$_\sigma$ (or perhaps [læn]$_\sigma$[ˈt$^{\mathrm{h}}$ɛɹ]$_\sigma$[nɪk]$_\sigma$) piece of equipment." Though both words sound pretty silly, they are indeed "grammatical"; one only needs to contrast "That's an [eɪ]$_\sigma$[ˈp$^{\mathrm{h}}$ɹ̩]$_\sigma$[nɪk]$_\sigma$ style of garment." and "That's a [læn]$_\sigma$[ˈt$^{\mathrm{h}}$ɹɑ]$_\sigma$[nɪk]$_\sigma$ piece of equipment", which are impossible pronunciations. In order to test my own intuitions against other native speakers, I conducted a study in fall 2013 in which I surveyed thirty-seven students, who were both native English speakers and at least partly proficient in IPA. The goal of this study was to elicit the pronunciations of the words *apronic* and *lanternic*, through comparison of actual *-ic* words in English: *acidic, heroic, numeric*, and *alphabetic*. For *apron* + *-ic*: 27/37 indicated their preferred form as [e͡ɪ]$_\sigma$[ˈp$^{\mathrm{h}}$ɹɑ]$_\sigma$[nɪk]$_\sigma$ (vel sim.), 5/37 as [ˈe͡ɪ]$_\sigma$[p$^{\mathrm{h}}$ɹə]$_\sigma$[nɪk]$_\sigma$, 1/37 wrote nothing, and 3/37 had other answers (likely due to an imperfect grasp of IPA). For *lantern* + *-ic*: 33/37 indicated [læn]$_\sigma$[ˈt$^{\mathrm{h}}$ɹ̩]$_\sigma$[nɪk]$_\sigma$ (vel sim.), 2/37 [læn]$_\sigma$[ˈt$^{\mathrm{h}}$ɛɹ]$_\sigma$[nɪk]$_\sigma$, 1/37 nothing, and 1/37 refused *-ic* suffixation and

90 Pern is a fictional planet created by Anne McCaffrey for the science fiction book series, *Dragonriders of Pern*.

indicated [ˈlæn]$_σ$[tʰɹ̩n]$_σ$[laɪk]$_σ$. This informal study appears to show that my suspicions were indeed correct.[91]

We may therefore conclude that in English when a R + R sequence is created in the derivation, the sonorant chosen as the syllable nucleus is always ***preceded*** by a vowel in its underlying form. Such a synchronic situation makes good diachronic sense, as syllabic sonorants almost always derive from an intermediate stage of reduced vowel (ə) + R (Bell 1978:165–8).[92]

(166) a. [ˈeɪp⁽ʰ⁾ɹɑn] > [ˈeɪp⁽ʰ⁾rən] > [ˈeɪp⁽ʰ⁾ɹn̩]
b. [ˈlænt⁽ʰ⁾ɛɹn] > [ˈlænt⁽ʰ⁾ərn] > [ˈlænt⁽ʰ⁾r̩n]

Indeed, it turns out that in English as well as in German *all* syllabic sonorants occur in free variation with the sequence of ə plus sonorant (Scheer 2004:309), no matter what type of segment is preceding. This suggests that all syllabic sonorants are produced in these languages via syncope: /VR/ → [R̩]. In German both liquids (universally /l/, plus /r/ in rhotic varieties) and nasals may be syllabic, typically occurring in word-final position when the vowel of a vowel-initial suffix is syncopated (Scheer 2004:304).[93] Thus, the infinitives [geːbə̃n] *geben*, [hɛlfə̃n] *helfen*, and [zaːgə̃n] *sagen* alternate with [geːbn̩], [hɛlfm̩], and [zaːgŋ̍], respectively.

One finds a more striking parallel to our situation in PIE within the West Slavic languages Czech and Polish,[94] where a special set of sonorants, known as 'trapped' sonorants, has developed in words such as Cz. *rzi* and Pol. *rdza*, both monosyllables meaning 'rust'. While the conditions for trapped sonorants are much stricter in Czech than they are in Polish, they function in the same way in both languages. Trapped sonorants differ from syllabic sonorants in syllabicity, with the former occupying complex, SSP-defying onsets (such as [trf-] and [kln-]) and the latter occupying the nucleus. Syllabic sonorants thus phonologically behave like vowels, rendering them visible to processes of stress assignment and able to count in metrical verse, whereas trapped sonorants

91 See appendix D for the survey used in the study.

92 Scheer 2004:309[172] suggests that the syllabic sonorants attested in the world's languages *always* arise through the syncope of a preceding vowel, but I find this highly dubious. One needs only to point to PIE syllabifications such as **ḱunés* 'dog' (gen.sg.) (← *ḱu̯onés/), and there is certainly no evidence that such sonorants were 'trapped' (i.e., **ḱu̯nés*)! Another counterexample may be seen in American Eng. [pɹ̩ˈɹɑgətɪv] 'preregotive', in which onset /ɹ/ → [ɹ̩].

93 Cf. Wiese 1996:247.

94 Scheer 2004:283ff.

do neither. While Polish does not contain any syllabic sonorants per se,[95] Modern Czech is teeming with them, many which derived from sonorants that were trapped in Old Czech. Thus, 'to last', 'reed', and 'I curse' in (157) below all contain syllabic liquids in Modern Czech, each coming from a trapped sonorant in Old Czech.[96]

(167)

	Common Slavic	Old Czech	Polish	gloss
CRVC	trŭvati	[trva]$_\sigma$[ti]$_\sigma$	[tr̥fat͡ɕ]$_\sigma$	'to last'
	trŭstina	[trsti]$_\sigma$[na]$_\sigma$	[tʂt͡ɕi]$_\sigma$[na]$_\sigma$	'reed (plant)'
	klĭnǫ	[klnu]$_\sigma$	[klnę]$_\sigma$	'I curse'
CVRC	gŭrdlo	[hr̩]$_\sigma$[dlo]$_\sigma$	[gar]$_\sigma$[dwo]$_\sigma$	'throat'
	pĭrs-	[pr̩s]$_\sigma$	[pierɕ]$_\sigma$	'breast'
	vĭlkŭ	[vl̩k]$_\sigma$	[vilk]$_\sigma$	'wolf'

For our purposes, the crucial detail on which we should focus our attention is the provenance of each type of sonorant. In Old Czech and Polish, trapped sonorants only came about if historically the sonorant was *followed* by a *jer*,[97] thus CS *trŭvati* > OCz. *trvati*, Pol. *trwać* 'to last'. On the other hand, if a sonorant was *preceded* by a *jer*, that sonorant was vocalized in Old Czech (and still continued in Modern Czech) and developed into a V + R sequence in Polish, thus CS *vĭlkŭ* > OCz. *vl̩k*, Pol. *wilk* 'wolf'.[98]

(168)

CRŬC

OCz. CRC   Pol. CRC

Cz. CR̩C

CŬRC

Cz. CR̩C   Pol. CVRC

95 Gladney 2004.

96 The primary argument is versification; see Scheer 2004:345ff., with references. I am indebted to Mark Lauersdorf for his help with the Slavic forms.

97 Common Slavic ĭ or *ŭ*.

98 According to Stieber (1968:52ff.) the aforementioned VR sequences developed from the Common West Slavic **R̥*. If this is true, then an earlier stage of Polish had the same inventory of sonorants as Old Czech. Carlton (1991:151–2), however, argues that there is "very little evidence that such a phase in the development of *tŭrt* ever existed."

Thus, we see divergent treatments of sonorants adjacent to syncopated *jers* in the history of early West Slavic. And just like in English and German, a syllabic sonorant was created only when the syncopated vowel preceded the sonorant in question: /VR(C_0)/ → [RR̥(C_0)].

As it turns out, vowels were also subject to syncopation in PIE by **quantitative ablaut**, which eliminated vowels in (mostly) unstressed syllables if the resulting syllable structure was a licit one.[99] And by the same processes occurring in English, German, and early West Slavic, the sonorant chosen as the syllable nucleus in a derived **R* + **R* sequence was invariably the one *following* the underlying syncopated vowel: */RVR(C_0)/ → *[RR̥(C_0)]. This becomes clear if we inspect the derivation of any PIE word, for which we assume ablaut to have been a synchronic rule. Let us examine two representative words, *[$h_1$léu̯d^h]$_\sigma$ [mn̥]$_\sigma$ 'growth' (nom./acc.sg)[100] and *[mén]$_\sigma$[tim]$_\sigma$ 'mind' (acc.sg.). The syllabification of the suffix of the former behaves like Eng. *apron*, the latter like *lantern*.

(169)	a. */$h_1$léu̯d^hmen/	>	*[$h_1$léu̯d^h]$_\sigma$[mən]$_\sigma$	>	*[$h_1$léu̯d^h]$_\sigma$[mn̥]$_\sigma$
	b. */ménteḭm/	>	*[mén]$_\sigma$[təḭm]$_\sigma$	>	*[mén]$_\sigma$[tim]$_\sigma$

But how exactly do we know that the forms given in (159) are the underlying forms? Performing a wug test would of course be impossible—the speakers in question have been gone for at least six millenia! Fortunately, in both cases it is quite clear where the underlying vowels were located, as both were proterokinetic nouns. We may observe the unsyncopated **e* of the suffix in the oblique cases (here the genitive singular).[101]

99 See section 1.3 for an overview of ablaut.

100 Continued by YAv. *uruϑman-* 'growth' (n.); cf. Ved. *ródhati* 'grows', etc. (NIL 245, LIV 248–9).

101 As Götz Keydana reminds me, many of those who work within the compositional framework contend that there was no proterokinetic class at all, and that proposed examples thereof should in fact be lumped together with hysterokinetic nouns. For reasons of accessibility, the analysis in this chapter will work within the traditional paradigmatic framework; however, the conclusions reached here are by no means invalidated within the compositional approach. In fact, should one reconstruct */mentí-/ or */mntí-/ as the proto-form of this stem, the current proposal will lead to the correct syllabification: **mn̥tí-*.

(170) a. */h$_1$leu̯dʰménes/ > *[h$_1$ləudʰ]$_\sigma$[mé]$_\sigma$[nəs]$_\sigma$ > *[h$_1$ludʰ]$_\sigma$[méns]$_\sigma$
b. */mentéi̯es / > *[mən]$_\sigma$[té]$_\sigma$[i̯əs]$_\sigma$ > *[mn̥]$_\sigma$[téi̯s]$_\sigma$

For this set of forms, we know from other paradigms that the genitive singular was underlyingly */es/ (cf. **diu̯és* 'of the sky (god)'). Note in both instances the roots have changed from underlying /(C)ReR(C)/ (which surface in (159) above) to [(C)RR̥(C)].

And so, it appears that the unexpected syllabifications reconstructable for PIE—as well as the expected ones—are to be viewed as the direct result of a preference for nucleification of a segment that was moraic earlier in the derivation before processes of syncope took place. I propose that the rules of Indo-European syllabification be re-envisioned as obeying three straightforward and typologically grounded principles.

a. **Syllabification is persistent throughout the phonological derivation. It occurs pre-syncope, as well as post-syncope.**

Underlying Form	*/h$_1$léu̯dʰmen/	*/méntei̯m/
Syllabification	*[h$_1$lé$_\mu$u̯$_\mu$dʰ$_\mu$][me$_\mu$n$_\mu$]	*[mé$_\mu$n$_\mu$][te$_\mu$i̯$_\mu$m$_\mu$]
Syncope	*[h$_1$lé$_\mu$u̯$_\mu$dʰ$_\mu$][mn$_\mu$]	*[mé$_\mu$n$_\mu$][ti̯$_\mu$m$_\mu$]
Resyllabification	*[h$_1$lé$_\mu$u̯$_\mu$dʰ$_\mu$][mn̥$_\mu$]	*[mé$_\mu$n$_\mu$][ti$_\mu$m$_\mu$]
Surface Form	*[h$_1$léu̯dʰ]$_\sigma$[mn̥]$_\sigma$	*[mén]$_\sigma$[tim]$_\sigma$

b. **Sonorants that were moraic earlier in the derivation, remain as such post-syncope.**[102]

a. */sreu̯tós/ → *[sreu̯$_\mu$]$_\sigma$[tós]$_\sigma$ → *[sru$_\mu$]$_\sigma$[tós]$_\sigma$
b. */k̂u̯onbʰí̯s/ → *[k̂u̯on$_\mu$]$_\sigma$[bʰís]$_\sigma$ → *[k̂u̯n̥$_\mu$]$_\sigma$[bʰís]$_\sigma$
c. */gʷʰrensú̯/ → *[gʷʰren$_\mu$]$_\sigma$[sú]$_\sigma$ → *[gʷʰrn̥$_\mu$]$_\sigma$[sú]$_\sigma$
d. */kʷetu̯ortós/ → *[kʷet]$_\sigma$[u̯or$_\mu$]$_\sigma$[tós]$_\sigma$ → *[kʷet]$_\sigma$[u̯r̥$_\mu$]$_\sigma$[tós]$_\sigma$

102 Only pertinent moras have been included in the table below, but of course other segments within these forms do carry weight.

c. **Non-moraic sonorants occupy the syllable nucleus if and only if more important constraints are violated.**[103]

Obeying ONSET

a. PIE */k̂u̯onés/ → *[k̂u]$_\sigma$[nés]$_\sigma$, not X[k̂u̯n̥]$_\sigma$[és]$_\sigma$
b. PIE */kʷetu̯órns/ → *[kʷe]$_\sigma$[tú]$_\sigma$[r̥ns]$_\sigma$, not X[kʷe]$_\sigma$[tu̯ŕ̥]$_\sigma$[n̥s]$_\sigma$

Obeying the MST

a. PIE */k̂u̯onés/ → *[k̂u]$_\sigma$[nés]$_\sigma$, not X[k̂u̯nés]$_\sigma$
b. PIE */kʷetu̯órns/ → *[kʷe]$_\sigma$[tú]$_\sigma$[r̥ns]$_\sigma$, not X[kʷe]$_\sigma$[tu̯rń̥s]$_\sigma$

Principles (a.) and (c.) are typological universals. All languages persistently syllabify (at least) through the domain of the ω, and all syllables respect the phonotactic constraints of the language in question. While it is not possible to demonstrate principle (b.) to be a linguistic universal per se, it has at least one excellent parallel both cross-linguistically and within PIE itself: compensatory lengthening (CL).

Indo-Europeanists are no doubt familiar with many examples of diachronic CL: postconsonantal glide loss in Greek (PGk. **ksénu̯os* > Ion. ξεῖνος 'stranger'), pre-fricative nasal loss in Germanic (**fimf* > OE *fīf*), and CVCV lengthening in Slavic (**domŭ* > Cz. *dūm* 'house'), among others. But we typically do not take into consideration that each of these diachronic processes came into being as *synchronic* phonological processes, which at some point in time ceased to continue as such within the languages in question. Fortunately, there are a number of well-studied examples of synchronic CL, which are still present in the languages of today. One such case comes from Turkish, where the continuants [j], [v], [h], and [ɣ] (in certain dialects)[104] are synchronically deleted in coda position with subsequent compensatory lengthening.

(171)	a. ⌀jle	⌀ːle	'thus'
	b. sevmak	seːmak	'to love'
	c. mehmet	meːmet	'Mehmet'
	d. ʧaɣdaʃ	ʧaːdaʃ	'contemporary'

103 Moraic sonorants may also occupy the syllable onset (thereby losing its mora) for the same reasons: cf. **ĝʰēi̯m̥no-* > Ved. *hāyaná-* 'yearly', YAv. *zaiiana-* 'winterly' (NIL 163), which arguably derives from underlying /ĝʰēi̯meno-/, in which **i̯* would have occupied a coda and therefore have carried a mora. Such instances, however, are comparatively rare.

104 See Kavitskaya 2002:76–7 for discussion, with references.

CL is at its core a phenomenon of weight (i.e., mora) conservation. Thus, in (161a), the loss of the glide [j] results in the reassignment of its mora to the preceding vowel, hence [øːle]. Principle (b.) is also a phenomenon of mora conservation; it keeps the mora originally assigned to the sonorant in the first stage of the derivation intact throughout the entire derivation.

Let us now turn to OT for our final analysis of IE syllabification, which must be conceived of taking place in (at least) two stages. First, there is the initial process of syllabification, resulting in mora assignment. Assignment of moras to all segments in the rhyme is driven by the constraint ranking WBP ('Coda consonants must be moraic') >> DEP-μ ('Do not insert a mora').[105]

(172)

*/ménte̯im/	MST	WBP	ONSET	DEP-μ
a. ☞ *[mé$_{\mu}$n$_{\mu}$] [te$_{\mu}$i̯$_{\mu}$m$_{\mu}$]				***
b. *[mé$_{\mu}$n] [te$_{\mu}$i̯m]		* ! **		

The next tableau illustrates vowel syncope and the conservation of underlying moras. We must first assume a markedness constraint that motivates ablaut, ∅-GRADE, which requires the syncopation of certain underlying vowels within the surface form.[106] For ablaut to have been realized, it is necessary that ∅-GRADE >> MAX-V. Second, one must assume the constraint Max-μ ('Do not delete a mora (μ).'), which crucially outranks ALIGN-L. This creates our exceptional syllabification.

(173)

*/mé$_{\mu}$n$_{\mu}$te$_{\mu}$i̯$_{\mu}$m$_{\mu}$/	∅-GRADE	ONSET	MAX-μ	MAX-V	ALIGN-L
a. ☞ *[mé$_{\mu}$n$_{\mu}$] [ti$_{\mu}$m$_{\mu}$]			*	*	12
b. *[mé$_{\mu}$n$_{\mu}$] [te$_{\mu}$i̯$_{\mu}$m$_{\mu}$]	* !				16
c. *[mé$_{\mu}$n$_{\mu}$] [ti̯m̥$_{\mu}$]			** !	*	8
d. *[mé$_{\mu}$n$_{\mu}$] [ti$_{\mu}$] [m̥$_{\mu}$]		* !	*	*	12

The reader will likely note that I have not yet taken up a firm theoretical position regarding the representation of opacity in OT. Does our derivation require multiple strata and thus Stratal OT? Or can it be couched within monostratal OT using OO-correspondence constraints? The facts above lend themselves

105 McCarthy 2000.

106 See section 1.3 for discussion of syncope.

easily to Stratal OT, as one may assume syncope as a word-level or postlexical process, with syllabification occurring at the stem and/or word levels, respectively. It is also conceivable that we may attribute mora conservation via correspondence of one particular form with other forms within the paradigm. Thus, **méntim* contains a syllabic (i.e. moraic) **i̯* through correspondence with **mn̥téi̯s*, just as **mn̥téi̯s* contains a syllabic **n̥* through correspondence with **méntim*—their relationship is codependent in this regard.

With all of this in mind, let us now return to Schindler's final exception, the nasal-infixed presents.

(174)

Underlying Form	*/bʰei̯nedénti̯/ 'they split'
Syllabification	*[bʰe$_\mu$i̯$_\mu$][ne$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
∅-grade	*[bʰi̯$_\mu$][n][dé$_\mu$n$_\mu$][ti$_\mu$]
Resyllabification	*[bʰi$_\mu$n$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
Surface Form	*[bʰin]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$

The derivation begins with each morpheme containing an underlying vowel: */bʰei̯nedénti̯/ 'they split'. Note that the underlying vowel assumed for each morpheme in */bʰei̯nedénti̯/ is well-motivated. The full grade of the root occurs in the root aorist **bʰeid-* (Ved. *abhet*) from which the nasal-infixed present is derived, the full grade of the infix **-ne-* occurs in the strong form **bʰi-nétsti* (Ved. *bhinátti*), and of course the full grade of the ending surfaces in the form derived. Within the derivation itself, syllabification first takes place, accompanied by mora assignment: *[bʰe$_\mu$i̯$_\mu$][ne$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]. Syncope then occurs, and its output is resyllabified, which results in the surface form: *[bʰin]$_\sigma$ [dén]$_\sigma$[ti]$_\sigma$. Crucially, **i* is chosen as the nucleus of the first syllable because it was assigned a mora earlier in the derivation.

For those working within the compositional approach to PIE morphology, syllabification has already been established to take place before the OXYTONE rule (cf. Kiparsky, forthcoming), and we must posit resyllabification to occur after the ∅-grade rule. Given the mobile paradigm, we will continue to assume that the ending **-énti* was underlyingly accented, and the stem underlyingly unaccented.

(175)

Underlying Form	*/b^{h}ei̯nedénti̯/ 'they split'
Syllabification	*[b^{h}e$_\mu$i$_\mu$][ne$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
Oxytone	*[b^{h}e$_\mu$i̯$_\mu$][né$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
∅-grade	*[b^{h}i̯$_\mu$][n][dé$_\mu$n$_\mu$][ti$_\mu$]
Resyllabification	*[b^{h}i$_\mu$n$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
BAP	—
Surface Form	*[b^{h}in]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$
(Sanskrit	*bhindánti*)

Our approach to syllabification is therefore compatible with both the paradigmatic and compositional approaches.[107]

So what does this mean for Schindler's theory of right-to-left syllabification, and every subsequent theory of IE syllabification that is based off it? In reality, each of these theories reflects an epiphenomenon, a pattern inferred by linguists from the surface reconstructions, and **not** the actual underlying forms. But there is a straightforward reason why Schindler's theory works so well. Surveying athematic suffixes containing two sonorants, each is of the shape *-RVR: **-u̯er*, **-u̯el*, **-u̯en*, **-men*, **-mer*. And in a survey of PIE verbal roots containing two sonorants, **all but one** is of the shape *(C)RVR(C)-: **h_2u̯ers-* 'rain', **d^{h}reu̯g^h-* 'deceive', **tu̯erk̂-* 'cut', **u̯el-* 'roll'.[108] This entails that in the zero-

107 As Götz Keydana reminds me, even though the nasal-infixed present likely derived from the root aorist, it is not the case that the underlying representation of this form contained a full-grade vowel within the root. Fortunately, one could alternatively assume that the form was underlyingly */b^{h}i̯nedénti̯/ instead, with zero grade of the root, and reach the same results. Thus:

(1)

Underlying Form	*/b^{h}i̯nedénti̯/ 'they split'
Syllabification	*[b^{h}i̯$_\mu$][ne$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
Oxytone	*[b^{h}i$_\mu$][né$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
∅-grade	*[b^{h}i$_\mu$][n][dé$_\mu$n$_\mu$][ti$_\mu$]
Resyllabification	*[b^{h}i$_\mu$n$_\mu$][dé$_\mu$n$_\mu$][ti$_\mu$]
BAP	—
Surface Form	[b^{h}in]$_\sigma$[dén]$_\sigma$[ti]$_\sigma$

108 The lone counterexample is what the LIV (81) reconstructs as PIE **b^{h}eru̯-* 'boil' (Lat. *feruō* 'steam, burn, glow, be heated, ferment', Wel. *berw*, Bret. *berv* 'broth, boiling'), which has a well-attested derivative **b^{h}rutó-* 'broth' (Lat. *dēfrutum* 'must-sap', OIr. *bruth* 'heat, anger', etc.). If related to Gk. φρέᾱρ, Arm. *ałbiwr*, Goth. *brunna* 'well' (< PIE **b^{h}reh$_1$u̯r̥*) and OE *brēowan* 'brew' (< PIE **b^{h}reh$_1$u̯-e-* (?); see LIV 96) as many have proposed then **-u̯*, like **-h_1*, must have been a root extension (Schrijver 1991:252–6). It is thus conceivable that

grade of both types, *-RR and *(C)RR(C)-, respectively, the rightmost sonorant will always syllabify, given that it had been moraic before syncope took place, hence *-RR̥ and *(C)RR̥(C)-.

Note that the additional machinery, which Cooper assumes to explain Schindler's 4th exception, is rendered unnecessary by our current analysis of Indo-European syllabification. PIE **-m* may or may not be less sonorous than the other sonorants, but "exceptions" like *méntim* no longer need to be explained as such. Recall the sonority hierarchy posited by Cooper for PIE, containing five resonants of equal sonority:

(176) a, e, o ≫ i̯, u̯, r, l, n ≫ m ≫ obstruents

Under the framework proposed in this chapter we may now adopt a much more sensible and typologically natural sonority hierarchy, which resembles the vast majority of the world's languages:

(177) V ≫ U̯ ≫ L ≫ N ≫ F ≫ P

It is in this way that the metatheses discussed in section 4.1.2 are more easily explained. The metatheses in PIE **k^w(e)tu̯r-* 'four' → **k^w(e)tru-*, **smók̂u̯r̥* → **smók̂ru* 'beard', and **su̯ek̂u̯rh$_2$-* → **su̯ek̂ruh$_2$-* 'mother-in-law' took place because glides were phonologically *more sonorous* than liquids in PIE, with the variation arising due to the conflict between the anti-metathesis constraint LINEARITY[109] and the universal sonority hierarchy (SONORITY-SEQUENCING). Some speakers didn't mind metathesizing to avoid an SSP violation, other speakers did; hence the dialectal variation. Note that in all other regards candidates (a.) and (b.) are equally optimal.

(178)

*/smó$_\mu$k̂$_\mu$u̯e$_\mu$r$_\mu$/	Ø-GRADE	MAX-μ	LINEAR	SON-SEQ	MAX-V	ALIGN-L
a. ☞ *[smó$_\mu$k̂$_\mu$][ru$_\mu$]		*	*		*	10
b. ☞ *[smó$_\mu$k̂$_\mu$][u̯r̥$_\mu$]		*		*	*	10
c. *[smó$_\mu$k̂$_\mu$][u̯e$_\mu$r$_\mu$]	*!					16

the protoform was */b^h(e)reu̯tó-/, which would straightforwardly produce the attested syllabification via the derived stage [b^h(e$_\mu$)re$_\mu$u̯$_\mu$tó$_\mu$-] → [b^{h}ru$_\mu$tó$_\mu$-].

109 See section 3.3.2.

We find alternations such as these in English, too, many of which occur sporadically in dialectal forms. For instance, we find metatheses in our parade examples, *apron* and *lantern*. The pronunciation [ˈlæn][t^(h)ɹn̩] is attested in 1906, in the novel *Beached Keels*, by Henry M. Rideout, p. 229: "Mornin' cap'n," he saluted, with an auriferous grin. "Say, the' ain't no weeck in the big lantrun. Kin I git one ashore, s'pose?"[110] The pronunciation [ˈeɪ]$_\sigma$[p^(h)ɹ̩n]$_\sigma$ is attested in 1535 in the *Bible* (Coverdale) Gen. iii. B: "They sowed fygge leaues together, and made them apurns."[111] Presumably these variant forms arise through the vacillation of the constraints Linearity, NoCoda, and Sonority-Sequencing in the various English dialects.

4.8 Conclusions

To conclude, our new theory of Indo-European syllabification makes three well-founded assumptions. First, syllabification is persistant, occurring in the initial stage of the derivation and (at the very least) after ablaut takes place. Second, after the underlying form is changed via syncope, the weight of sonorants will remain unaltered in the surface form. And lastly, syllabification always respects phonotactic constraints, such as Onset and the MST. The advantage of this new theory is its simplicity, for not only do Schindler's exceptions almost completely disappear, but even better, the regular outcomes and the exceptions of Schindler's rule are driven by the **exact same** principles.

This new hypothesis has a very clear diachronic bent, claiming that historical processes of syncope created the synchronic syllabification we reconstruct for PIE. But is this a diachronic or a synchronic solution, or can it be both? Must we continue to assume that Schindler's rule was (more or less) the actual synchronic rule, with certain exceptions being lexicalized as in Berber? Or might it be possible that what we've motivated as a diachronic process reflects some sort of synchronic reality in PIE? In my opinion, since examples such as English *apron* and *lantern* are derived through synchronic processes of syncope, then such a phenomenon may be claimed to have been a synchronic process in PIE as well.[112] And of course there are other, compelling reasons to assume syncope as a synchronic process operating within the accent/ablaut system, as convincingly shown by Kiparsky, forthcoming.

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110 My colleague (and Southern dialectologist) Jennifer Cramer also points out to me that Western Kentucky University is often pronounced as [wɛstɹn̩] by many Kentuckians.

111 Many of my relatives, who live in central North Carolina, have this pronunciation as well.

112 For a different explanation of the English data, see Kawahara 2002.

And where does that leave PIE **kur-Co-* 'foal'? Is it still necessary to maintain the assumption of a lexicalized syllabification? Under our new framework, it is not. We may in fact derive this form in one of two ways. First, we may assume that the UR was */keu̯rCos/, with the derivation */keu̯rCos/ → *$[\mathrm{ke}_{\mu}\mathrm{u̯}_{\mu}\mathrm{r}_{\mu}]_{\sigma}$ $[\mathrm{Co}_{\mu}\mathrm{s}_{\mu}]_{\sigma}$ → *$[\mathrm{ku}_{\mu}\mathrm{r}_{\mu}]_{\sigma}[\mathrm{Co}_{\mu}\mathrm{s}_{\mu}]_{\sigma}$. However, reconstructing a root of the shape CERR would be highly questionable, and should the barytonic accent in Gk. κύρνοι 'bastards' have been the same in PIE, we would lack the proper motivation for syncope to have occurred,[113] as one would expect *$[\mathrm{ke}_{\mu}\mathrm{u̯}_{\mu}\mathrm{r}_{\mu}]_{\sigma}$ $[\mathrm{Có}_{\mu}\mathrm{s}_{\mu}]_{\sigma}$ → $[\mathrm{ku}_{\mu}\mathrm{r}_{\mu}]_{\sigma}[\mathrm{Có}_{\mu}\mathrm{s}_{\mu}]_{\sigma}$. For this reason, I contend that it would be best to assume that word 'foal' never had a full grade of the root in the first place and was simply stored as */ku̯r-/ in the lexicon. Underlying */ku̯rCos/ surfaced as *$[\mathrm{kúr}]_{\sigma}$ $[\mathrm{Cos}]_{\sigma}$ for the simple reason that glides are more optimal nuclei than liquids, as represented by Cooper's constraint ranking ⋆PK-L ≫ ⋆PK-U̯.[114] However, in our earlier analysis in section 4.4 the derivation failed, due to the high-ranking ALIGN-L constraint.

(179)

*/ku̯r-Co-/	ALIGN-L	⋆PK/N	⋆PK/L	⋆PK/U̯
a. ☹ *kurCo-*	*…*!			*
b. ☞ *k̂u̯r̥Co-*	*…		*	

It is for this reason that we must abandon the reconstruction of Cooper's ALIGN-L constraint, as well as any constraint ranking that prioritizes ONSET MAXIMIZATION in the proto-language (cf. Kobayashi 2004), leading us to the correct result:

(180)

*/ku̯r-Co-/	WBP	⋆PK/L	⋆PK/U̯	DEP-μ
a. ☞ $[\mathrm{kú}_{\mu}\mathrm{r}_{\mu}][\mathrm{Co}_{\mu}\text{-}]$			*	* *
b. $[\mathrm{ku̯ŕ̥}_{\mu}][\mathrm{Co}_{\mu}\text{-}]$		*!		*

We will revisit these ideas in chapter 7.

113 In both the paradigmatic framework (which would claim that full vowels not receiving the ictus are syncopated) and the compositional approach (as only an accented suffix would have triggered ∅-GRADE in the root, and that accented suffix would have surfaced with the ictus).

114 With accent assignment by the BAP.

The Indo-European Syllable

Preliminaries

Ramifications

The Proposal

PART 3

Ramifications

CHAPTER 5

Motivating Sievers' Law

5.1 Introduction and Overview

In part II of this book we established a maximum syllable template (MST) for Proto-Indo-European, through the phonotactic analysis of PIE edge consonant clusters and the assumption of extrasyllabic consonants at word's edge. The MST makes explicit predictions about the possible shapes of PIE words. In this chapter, we will apply the MST to a much pored-over problem within Indo-European Linguistics and theoretical phonology: Sievers' Law (SL). We will first revisit the evidence and original formulation of SL, demonstrating it to have most likely been a postlexical phonological process in PIE, continued in varying degrees by a number of the IE daughter languages. We will then look in detail at Schindler's 1977 analysis of SL, which has been the most widely held view of SL since its publication. From what we now know of the PIE MST, it will become apparent that his analysis must be reconsidered, which will lead us to motivate SL through the avoidance of superheavy syllables at the postlexical level.[1] The reader should bear in mind that the goal of this chapter is by no means to do a complete reanalysis of all the data that is relevant to the problem of Sievers' Law (for which I refer the reader to Barber 2013); rather, the goal is to apply the findings of the previous two chapters to our current knowledge of the problem at hand. For this reason, discussion of (the voluminous) past scholarship will be kept to a bare minimum.

5.2 Overview of Sievers' Law

Sievers' Law has been one of the most perennially discussed phonological problems in Indo-European linguistics and the focus of numerous treatments in the generative phonological literature, particularly with regard to Germanic and Sanskrit.[2] For a comprehensive review of the Indo-European scholarship I refer the reader to Edgerton 1934, Seebold 1972:25ff., Horowitz 1974:11ff., Collinge 1985:159ff., Mayrhofer 1986:164–7, Meier-Brügger 2003:90–1, Sihler 2006, Fortson 2010:71–2, and Barber 2013. While this chapter will not

1 The following chapter is an extended version of Byrd 2010a.

2 See Kiparsky 1998 and Calabrese 1994, 1999 for discussion and references.

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exhaustively cover the more than 100 years of scholarship devoted to the topic in question, it is necessary to provide the reader with a basic overview of the problem.

The original formulation of the law appeared in Sievers 1878, in a discussion of the Goth. *ja*-stem masculine nouns. In this particular class, some genitive singulars are of the shape *-jis*, while others are of the shape *-eis* (*-īs*). Sievers argued that this distinction resulted directly from the length of the preceding syllable. The genitive singular of *hairdeis* 'shepherd' ended in *-eis* (< **-ijis*) because the underlying suffix *-jis* was preceded by two consonants (*rd*), whereas the genitive singular of *harjis* 'army' remained in *-jis* because the suffix was only preceded by one (*r*). Similar phonological alternations may be found in the verbal system as well: classic examples include Goth. *waurkeiþ* 'works' vs. *satjiþ* 'sets', which are both underlyingly suffixed by *-j-*.

Sievers recognized similar alternations of glides and high vowels in Sanskrit,[3] which were restricted to the Rig Veda (Sihler 2006:5). To explain contrasting pairs such as *ajuryá-* 'unaging' / *asūria-* 'sunless' and *ávya-* 'woolen; made from sheep' / *mártia-* 'mortal' Sievers proposed the following rule: "If, in Indic, unaccented (without svarita) *i* or *u* occurs before a vowel ... then ... this segment is realized as a consonant after a light syllable and as a vowel after a heavy syllable."[4] For Sievers, a heavy syllable consisted of a short vowel plus two consonants (VCC) or a long vowel plus one consonant (V̄C); a light syllable consists of a short vowel plus one consonant (VC). Sievers conceived of this phonological process as the alternation of a glide and corresponding high vowel depending the shape of the preceding syllable.

(181) Sievers' Law (Sievers 1878)
[+sonorant, -syllabic, +high] → [+syllabic] / VXC _ V (X = V, C)
If a glide is preceded by a heavy syllable, it is realized as [+syllabic].

Since Sievers' influential and now canonical observations, scholars have steadily proposed a number of parallels from within Indo-European that bolster his observation that this alternation of high vowels and glides may go back to PIE times. Furthermore, many scholars have extended SL to apply to the entire class of PIE resonants (**m, *n, *r, *l, *i̯, *u̯*), such as Osthoff & Brugmann

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3 Sievers 1878:129.

4 Translation by Collinge (1985:159): "Im Indischen unbetontes (nicht svaritiertes) *i* oder *u* vor einem vocal ist consonant nach kurzer, vocal nach langer silbe ohne rücksicht auf die sonstige accentlage des wortes."

1879:14–6[1], Edgerton 1934 and Schindler 1977a. This reformulation is given in (2) below.[5]

(182) Sievers' Law (Resyllabification)
[+sonorant, -syllabic] → [+syllabic] / VXC _ V (X = V, C)
If a non-syllabic sonorant is preceded by a heavy syllable, it is realized as [+syllabic].

While Sievers had originally envisioned this phonological process as being an alternation of high vowel and glide depending on the weight of the preceding syllable, the following analysis will assume SL to be a rule of vowel epenthesis, such that **tertı̯o* → **tertii̯o* and not **tertio-*,[6] since, as has long been recognized, there appears to have been a strong preference in PIE for syllables to contain at least one consonant in the onset.[7]

(183) Sievers' Law (Epenthesis)
$\varnothing \rightarrow \text{R̥}_1$ / VXC _ R_1V (X = V, C)
If a prevocalic non-syllabic sonorant follows a heavy syllable, epenthesize a corresponding syllabic resonant before the resonant in question.

In the following analysis, I will make use of three hypothetical 'roots': **tert-, *tēt-* and **tets-*,[8] where *t* = any consonant, *e* = any short vowel, *ē* = any long vowel, *r* = any sonorant and *s* = any consonant of equal or higher sonority than the preceding *t*.[9] In the derivations, **-i̯o-* will represent any glide- or sonorant-initial suffix that may potentially participate in SL, such that **-i̯o-* may stand for **-i̯ah₂-, *-u̯o-, *-ri-*, etc. Though the present analysis assumes SL to have operated upon all resonants for simplicity of presentation, the core arguments of this paper by no means rest on this assumption. Should one prefer to restrict SL to the PIE glides (**i̯, *u̯*) or even to just **i̯*, (s)he may easily do so through

5 I do not believe in the converse of Sievers' Law; for arguments against this idea, see Balles 1997.

6 Cf. Seebold 1972:29, Kobayashi 2001:93 and Weiss 2009:39.

7 Cf. Mayrhofer 1986:123–4[108].

8 Should one prefer attested roots, one may replace **tert-* with **derk̂-* 'see' (Gk. δέρκομαι, etc.), **tēt-* with **h₁ēd-* (Hitt. *ēdmi*), lengthened grade of **h₁ed-* 'eat' and **tets-* with **h₂u̯eks-* 'grow' (Av. *uxšiieitī*, Gk. αὔξομαι).

9 Such that an SSP violation occurs if syllabified in the same syllable, through sonority rise (*mats.ya-*) or through sonority plateau (*dikʰtʰ.ios*). See sections 2.2 and 3.3.3 for further discussion.

the assumption of additional markedness (or faithfulness) constraints in this paper's analysis, as given in footnote 48, below.

5.2.1 *Evidence in the Daughter Languages*

Languages that provide evidence for SL may be separated into two types: those where some semblance of the law is still productive and those where it is moribund and has been lexicalized. The former is only true in the oldest attested Germanic and Indic. In the Rig Veda we find that SL is most regularly attested in formations with the suffix *-ya-*. After a heavy syllable, there are 1552 instances of *-i(y)a-* but only 91 instances of *-ya-*, a 17:1 ratio; after a light syllable there are 462 instances of instances of *-i(y)a-* and 1747 instances of of *-ya-*, a 5:19 ratio.[10] Other suffixes behave much less consistently. For instance, the dative/ablative case ending *-bhyas* occurs as expected *-bhiyas* only 38.5% of the time after a heavy syllable (Seebold 1972:35), and a resistance to Sievers' Law in the Rig Veda is also found in the dual ending *-bhyām* and the gerund *-tvā*. Moreover, while there is some indication that the 3rd pl. ending *-iré* (**-r̥ré*) originated as a Sievers variant of **-ré* in prehistoric Sanskrit,[11] nowhere does **-tr̥ra-* occur as a variant of the instrumental suffix *-tra-* (< **-tro-, *-tlo-*).[12] It thus appears that Sievers variants are more regularly attested for suffixes of the shape *-RV-* than among those of the shape *-CRV-* in Sanskrit. As we will see, this fact is significant.

In Germanic, most notably in Gothic, I follow Kiparsky (1998) in assuming that SL was driven by a preference for moraic trochees, or feet of the shape (LL) or (H).[13] This most easily explains the application of SL in both monosyllabic roots such as *hairdeis* 'shepherd' (< **hairdijis* < **haird + jis*) and in disyllabic roots such as *ragineis* 'counselor' (< **raginijis* < **raginjis*). Kiparsky (ibid.) argues that Gothic (*hair*)(*dei*)<*s*> 'shepherd' and (*ra.gi*)(*nei*)<*s*> 'counselor' underwent vowel epenthesis (with subsequent glide deletion) in order to avoid

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10 Seebold 1972:31, citing Edgren 1885:78. Of course, not all instances of *-iya-* (especially after a light syllable) are to be attributed to SL; see Schindler 1977:58.

11 According to Praust, the original distribution was *-iré* (< **-r̥ré*) after heavy syllable (*īdhiré, ūciré, vavāśire*) and *-ré* after light (*riricré*, *nunudré*, *ānajre*, *jagr̥bhré*). Praust also points to other possible examples of SL affecting non-glides, such as Ved. *índra-* (see Sihler 2006:98–100 for opposite view) and the pair Ved. *cyautná-* 'work, deed', Av. *šiiaoϑna-*, which at times must be scanned as three syllables. See Praust 2000:429–30 for further discussion and references.

12 Sihler 2006:7.

13 See Kiparsky 1998 for references.

a suboptimal footing **herd(jis)*[14] and **ra(gin)(jis)*. According to Kiparsky, the form *(har)(jis)* does not epenthesize *-i-*, since this would have led to *^{X}ha(rei)<s>*, resulting in the prosodic structure L(H).

Traces of SL are found elsewhere in Germanic, such as in Old English.[15] As in Gothic, heavy root syllables (e.g. **wītjas*) require high vowel epenthesis before a suffix consisting of a jod + vowel (**wītijas*, footed as *(wī)(ti.ja)<s>*), with subsequent vowel contraction (*wītes* 'punishment (gen.sg.)'). Polysyllabic roots also show evidence for SL, such as *æðeles* 'nobility (gen.sg.)', which derives from **æðaljas*, via **æðalijas* (footed as *(a.ða)(li.ja)<s>*). As elsewhere in Germanic and Vedic, SL does not occur within light monosyllabic stems such as **kunjas* > **kunnjas* > *kunnes* 'kin (gen.sg.)', proved by the gemination of *n* in the root *kunn* 'kin'.[16] Although SL only applies to *j*-initial suffixes in attested Germanic, it is possible that it operated on other resonants in Proto-Germanic, such as in the case of the first person plural preterit ending **-mé* > **-m̥mé* > **-um* (e.g., PIE **u̯idmé* 'we know' > Goth. *witum*).[17]

Elsewhere in Indo-European SL has disappeared as a productive phonological process, vanishing without a trace in some, while leaving behind subtle clues of its existence in others. In the former category, one may include Albanian, Armenian, Celtic[18] and Slavic. In the latter lies the rest of Indo-European in varying degrees, both in quantity and in certainty. In Iranian, according to Schindler 1977a:58, the only certain example of SL is Av. *huuō.guua-* (*hauguu̯a-*), a vr̥ddhi formation to an unattested **hu-gú-*, cognate with Ved. *su-gú-* 'having fine cows'. In Tocharian, the suffix **-iyë* possibly originates as a Sievers variant of **-yë*; cf. PToch. **ñəkciyë* 'divine', a derivative of **ñəktë* 'god'.[19] In Greek, it is conceivable that the distribution of *-αν-* and *-ν-* presents originated as Sievers' variants (cf. λαμβάνω vs. κάμνω), though far from certain; more likely is the contrast between **h₂álg(i)i̯os* > Gk. ἄλγιος 'more painful'

14 Since $[\text{herd}]_\sigma$ is a superheavy syllable (syllable of three or more morae), it has one too many morae to form a moraic trochee (Kiparsksy 1998) and so cannot be footed.

15 See Kiparsky 1998 and Adamczyk 2001.

16 Dahl 1938:74ff.

17 Ringe 2006:116ff.

18 See Schrijver 1995.

19 Ringe 1991. It has been proposed by Jasanoff (apud Nussbaum 1986:8) that the pair TA *śaru*, TB śerwe 'hunter' (< PT **k̂eruwe*) provides additional evidence for SL in Tocharian, originating from **k̂ēruwo-* < **k̂ērwo-*, a vr̥ddhi-derivative of PIE **k̂eru̯os* 'stag' (Lat. *cervus*). See, however, Pinault 2008 for an alternate view. I am indebted to Melanie Malzahn for the reference.

and **pedi̯ós* > πεζός 'on foot' (cf. Skt. *pádya-*, Lat. *peius*).[20] In Italic, SL *might* explain certain distributions of roots in the third and fourth verbal conjugations, such as the difference between *capiō/capere* and *sāgiō/sāgīre*, if both derive from simple **-i̯e/o-* presents (**kap-i̯e-* but **sāg-(i)i̯e-*).[21] In Baltic, SL may have produced two separate suffixes from the feminine **-i̯ah₂* declension, *-ia* (< **-i̯a*) and *-ė* (< *-ii̯ā*), though the distribution has become opaque (cf. *eilė* 'row' besides *eilia*).[22] And lastly, in Anatolian, SL is possibly found at a morpheme boundary in forms such as *ardumeni* 'we cut (with a saw)' (< **arduweni*), which may be contrasted with *tarweni* 'we speak', which lacks an epenthetic vowel.[23] Note that in all instances but Av. *huuō.guua-*, the target sonorant in question is suffix-initial: **-RV-* → **-R̥RV-*.

5.2.2 *Einzelsprachlich or Inherited?*

Should we follow Kiparsky in understanding the process of SL in Germanic as being driven by a preference for moraic trochees, then we must accept that the function of SL was different in the other IE languages and in PIE itself, as there is no indication that SL was motivated by such a preference in these languages. For this reason, a number of scholars[24] have argued that the many different reflexes of SL in the attested IE languages prevent us from projecting SL back to the proto-language. Rather, they argue, we must view the several instantiations of "Sievers' Law" as separate phonological processes occurring individually in the daughter languages.

However, as Ringe 2006:120 correctly points out: "The reapplication of Sievers' Law is hard to understand if it was an ordered rule, fossilized within the phonology of the language but no longer operative on the postlexical phonetic level; but it makes sense if Sievers' Law was operating as a surface filter, applying to any derived input that met its structural description in much the same way as modern German obstruent devoicing." Thus, if SL was truly inherited from PIE, we should view it as a postlexical rule carried across the generations, rather than as a historical event. Postlexical rules are phonological

20 See Peters 1980:127ff., Ruijgh 1987 (1996) and Rix 1992. As an anonymous reviewer reminds me, there appears to have been a redistribution of the short and long comparative suffixes at an early stage of Greek, after the loss of SL as a productive rule; hence, the unexpected forms *ἥσσων* 'lesser' and *κακίων* 'worse' (Barber 2013:175).

21 Meiser 1998:90. According to Weiss 2009:40: "The Latin evidence for the operation of Sievers' Law is very scant due to the interference of later sound changes, especially anaptyxis between most consonants and a following *i̯*."

22 Sommer 1914; Horowitz 1974:19.

23 Melchert 1994:57–8.

24 Beginning with Kluge 1891:502 and followed most recently by Sihler 2006:188–91.

processes that apply at the phrasal, or syntactic, level. They typically apply across the board with no regard to morphological boundaries, tend to be exceptionless and frequently produce allophonic variation.[25] Ringe's implicit (and my explicit) claim is that Sievers' Law was a postlexical phonological process in PIE, which was lost, lexicalized or continued in different guises in the IE daughter languages.

To illustrate my claim, let us take the example of final devoicing as a postlexical rule in some hypothetical language, which we will call Proto-XYZ. This process occurs across-the-board, meaning that no phrase-final obstruent can be realized as voiced in an utterance. Throughout the hypothetical years, Proto-XYZ evolves into three daughter languages: X, Y and Z. Each language evolves independently as does the inherited post-lexical rule of final devoicing. In language X, final devoicing disappears altogether. Perhaps this is due to sociolinguistic factors, such that X is influenced areally by a speech community that lacks this particular phonological process. Perhaps the loss of this rule is driven by linguistic factors, such that the final sequence *-DV, where D = any voiced obstruent, undergoes apocope, reintroducing the phonemic status of voiced obstruents in absolute word-final position.[26] In language Y, only a handful of words show alternation of a stem ending in a final voiced obstruent (imagine the opposite of Eng. *wife* : *wives*). Here, too, the rule is lost entirely, with only a handful of traces in the lexicon. Lastly, in language Z, final devoicing persists, but its purpose is altered such that it is unrecognizable. To be on the exotic (and quasi-ridiculous) side, let us say that in language Z all syllable final voiceless stops create a high tone (*-VT$ > -V́$),[27] and this high tone alternates with allomorphs containing a voiced stop (-V́ ~ -VDV). Thus, we may say that final devoicing has continued as a (morpho)phonological process in language Z, but with a function entirely different from that of the proto-language.

It is in this fashion that Sievers' Law, which originally was a postlexical rule, evolved in the attested Indo-European languages. In some subgroups, such as Albanian, Armenian and Slavic, SL was lost without a trace. In others, such as Greek, Iranian and Italic, SL only persists through a handful of archaic forms. And lastly, in other subgroups, such as Indic and Germanic, SL persists to a greater or lesser extent as a synchronic process, which has been altered to suit the needs of the speakers of those languages. Our current task is to devise a postlexical rule that can conceivably evolve into each of the IE systems

25 See Kiparsky 1982.

26 Such as Yiddish. See Albright 2008.

27 For a thorough discussion of 'tonogenesis', see Matisoff 1973.

attested and to arrive at an independently motivated reason for the existence of Sievers' Law at the PIE postlexical level.

5.2.3 *Schindler 1977*

To the best of my knowledge, Schindler (1977a), in his influential review of Seebold 1972, did not conceive of SL as a postlexical process in PIE. His paper arguably constitutes to date the most successful attempt in motivating the original conditions of SL in PIE; it has undoubtedly been the most widely held view in the literature since its publication.[28] In his review, Schindler points out two curious instances of SL not applying in Vedic. First, Schindler (1977a:61) argued that words of the shape **tettio̯-* are not realized as *ˣtettii̯o-*, where *tt* = any sequence of two obstruents (regardless of sonority level). The best example is Ved. *matsya-* 'fish', which is never scanned as *ˣmatsiya-* and must go at least as far back as Proto-Indo-Iranian, as is evidenced by its Avestan cognate *masya-* 'id.' Ruijgh (1996:354) also points to a similar treatment of **tettio̯-* in Ionic Gk., where διξός 'double' derives from **dikʰtʰi̯ós* (cf. διχθά 'in two'). If SL had occurred, one would expect ˣδιχθιός. Second, Schindler (1977:60–1) pointed out that the absolutive **-tu̯V-* (Sanskrit *-tvā́, -tvī́, -tvā́ya*), never shows Sievers variants, with forms such as *gūdhvī́, yuktvā́, bhūtvā́, jagdhvā́ya*, etc., never being scanned as *ˣgūdhuvī́, ˣyuktuvā́, ˣbhūtuvā́, ˣjagdhuvā́*ya, etc.

To prevent forms like *matsya-* and the absolutives from participating in Sievers' Law, Schindler proposes the following syllabifications of our three hypothetical forms: **ter.ti̯o-, *tē.ti̯o-* and **tett.i̯o-* (= my **tets.i̯o-*).[29] These syllabifications, he argues, were not chosen in an entirely ad hoc fashion, but rather confirmed Saussure's syllabifications of the double dental clusters (**méd-t.ro-*),[30] a problem we addressed in section 3.6. Thus, Schindler explains SL to be the result of an avoidance of a complex onset C + R (or C + U̯) in a word-final syllable in PIE (so Meiser 1998:89–90).

Structurally Schindler's hypothesis has proved very attractive, since it allows us to collapse SL together with Lindeman's Law[31] (LL), thereby viewing long

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28 Cf. Peters 1980:129ff., Mayrhofer 1986:164–8, Meiser 1998:89ff., Praust 2000, Meier-Brügger 2003:90–1, Weiss 2009:39–40 and Fortson 2010:72.

29 Schindler 1977a:60[4]. Note that in this analysis, $[\text{tets}]_\sigma$ represents any sequence in which there is a SSP violation. Should fricatives (**s* and laryngeals) be more sonorous than stops as discussed in section 2.2, then this would imply that the sequences $^*[\text{test}]_\sigma$ and $^*[\text{teh}_x\text{t}]_\sigma$ were legal syllables in PIE. See footnote 65 below for how this may be relevant to our understanding of Sievers' Law.

30 Mayrhofer 1986:111.

31 Lindeman 1965. Barber 2012 convincingly demonstrates that the disyllabic pronunciations of underlying monosyllabic words is exceedingly archaic in Sanskrit, and therefore must go back to an earlier stage, which was (in my opinion) PIE.

Lindeman variants such as **di̯i̯ḗu̯s* 'sky (god)' (← */di̯ḗu̯s/) as the result of SL in certain sandhi configurations.[32]

(184) Lindeman's Law (Schindler 1977a)
[+son, -syll] → [+syll] / #[+obst]$_0$ _ [+syll][-syll]$_0$#
If a non-syllabic sonorant follows a single obstruent and precedes a vowel in a monosyllable, it is realized as [+syllabic].

Classic examples include **di̯ḗu̯s* 'sky god' (Gk. Ζέυς), which alternates with **dii̯ḗu̯s* (Skt. *diyā́us*), and **du̯ohₓ* 'two' (Skt. *dvā́*), which has a variant **duu̯ohₓ* (Lat. *duō*).

Schindler envisioned SL and LL to be identical processes, most notably in two regards. First, he claimed, both processes occurred in the final syllable of a word. While this goes without saying for LL (which applies only in monosyllables), Schindler noted that SL is frequently not attested in words such as *vāiśvānará-* 'pertaining to all men', which never scans in five syllables (i.e. ˣ*vāiśuvānará-*). He explains this lack of application by restricting SL to the final syllable of a word. Second, once Schindler had identified the syllabifications **ter.ti̯o-, *tē.ti̯o-* and **tett.i̯o-* (= my **tets.i̯o-*) he was able to define the targeted sequence as a syllable onset consisting of a consonant + non-syllabic sonorant ($TR-). His reformulation is given in (175).

(185) Sievers'/Lindeman's Law (Schindler 1977a:64)
[+son, -syll] → [+syll] / $[-syll]$_1$_[+syll][-syll]$_0$#
In the final syllable of a word, if a non-syllabic sonorant is preceded by a consonant and followed by a vowel, it is realized as [+syllabic].

There are two problems with Schindler's ingenious analysis, however. First, as Collinge (1985:165) points out, we have no reason to believe that a sequence **C + R* was disfavored in PIE onsets, as can be shown by a sizeable number of roots and words in 1: **ti̯egʷ-* 'withdraw', **tu̯erk-* 'cut', **tréi̯es* 'three', **pleh₁-* 'fill', etc. Second, the syllabification of **tetsi̯o* as **tets.i̯o* is problematic, since there is no direct evidence for this type of syllabification attested in the IE languages. This renders Schindler's analysis completely circular. Of course, more seriously, if the independently-motivated MST holds true for PIE syllabification, Schindler's syllabification of **tetti̯o-* (= my **tetsi̯o-*) as **tett.i̯o-* (= my **tets.i̯o-*) was in fact impossible for a speaker of PIE, since an SSP violation was prohibited in a medial coda. Following the MST, we now contend that this sequence

32 Cf. Meier-Brügger 2003:142: "On the one hand, we have ##... *V̄#*dii̯ḗu̯s* and ##... *V̄R#*dii̯ḗu̯s*, on the other ##... *K#*di̯ḗu̯s* ..."

must have been syllabified as **tet.si̯o-* and so we need to devise an alternate solution.

5.3 Motivating Sievers' Law: The Avoidance of Superheavy Syllables

The MST, which dictates the largest possible syllable in PIE, predicts the following syllabifications of our hypothetical root shapes **tert, *tēt and *tets* to have been possible:

(186) */tert/ → *[tert]$_\sigma$ (superheavy σ)
/tēt/ → *[tēt]$_\sigma$ (superheavy σ)
but */tets/ → *[tet]$_\sigma$s, (heavy σ, with an unsyllabified consonant)

The first two roots **tert* and **tēt* are both entirely syllabifiable and form a superheavy syllable, or a syllable consisting of more than two morae. The last root **tets* must be syllabified as [tet]$_\sigma$s, since the second obstruent in coda position violates the SSP.

Let us assume that the syllabifications of these roots were realized as such at the derivational stage where SL occurred, driven by the desire for PIE speakers to keep morphemes syllabically distinct from one another. If so, the suffixation of **-i̯o-, *-u̯o-*, etc. would have resulted in the following syllabifications:

(187) **tert-* + **-i̯o-* → *[tert]$_\sigma$ [i̯o]$_\sigma$
**tēt-* + **-i̯o-* → *[tēt]$_\sigma$ [i̯o]$_\sigma$
**tets-* + **-i̯o-* → *[tet]$_\sigma$[si̯o]$_\sigma$

Should we assume that such morphological boundaries were relevant within the phonological derivation, it now becomes clear what the motivation was for SL in PIE: the avoidance of a superheavy syllable. While *[tet]$_\sigma$[si̯o]$_\sigma$ does not contain a superheavy syllable at the postlexical level, *[tert]$_\sigma$ [i̯o]$_\sigma$ and *[tēt]$_\sigma$[i̯o]$_\sigma$ do, which is what prompts the resyllabification and insertion of a syllabic sonorant (SL).

Unlike Schindler's explanation of SL above, the avoidance of superheavy syllables is extremely well founded typologically[33] and is seen elsewhere in PIE and the attested IE languages.[34] Certain instances of Schwebeablaut, or the metathesis of a root sonorant from coda to onset position (**derk̂-* 'see' > **drek̂-*),

33 Cf. Zec 1995:100ff. and see Sherer 1994:11 for references.

34 Seebold 1972:132, Hoenigswald 1988:202–3, Kobayashi 2001:92ff. & 2004:26.

suggest such a dispreference,[35] and the avoidance of (super)heavy syllables may also have played a part in the analogical replacement of weak full-grade forms with the zero-grade in roots of the shape *TeR(T) (i.e., **ter*(*t*)- → **tr̥*(*t*)-): e.g., *[kom]$_σ$[h$_1$ei̯t]$_σ$s 'fellow traveller' → *[kom]$_σ$[h$_1$it]$_σ$s > Lat. *comes, -itis* 'companion'.[36] Later in IE there are additional, language-specific processes of superheavy syllable avoidance. The most widespread is Osthoff's Law, whereby a long vowel is shortened if it precedes a resonant + consonant: */V̄/ → [V] / _RC.[37] For example, the well attested word for 'wind', PIE **h$_2$u̯eh$_1$n̥to-*, is realized as Post-PIE **u̯ēnto-* with loss of laryngeal, which is subsequently shortened to **u̯ento-* (Latin *ventus*, OIr. *fét* 'whistle', Goth. *winds*, etc.). Kobayashi has also argued for Brugmann's Law to be the result of the blocking of the sound change **o* > **ā* in IIr. closed syllables, once again to avoid a superheavy syllable.[38]

Attributing SL to the avoidance of a superheavy syllable has been proposed elsewhere before,[39] though with no explanation as to why there even existed a superheavy syllable in these sequences. If PIE speakers wanted to avoid superheavy sequences, then why was */tert + i̯o/ even syllabified as *[tert]$_σ$[i̯o]$_σ$ in the first place? If we follow Ringe in assuming that SL was a postlexical process in PIE, then the answer is straightforward: when syllabified at the stem (and word) level, *[tert]$_σ$[i̯o]$_σ$, *[tēt]$_σ$[i̯o]$_σ$, etc. were the most optimal forms. Once these forms were fed into the postlexical level, however, there was a violation of a constraint that blocks superheavy syllables, prompting the epenthesis of a sonorant, whose quality was copied from the adjacent non-syllabic resonant.

5.3.1 *Framework Used in Analysis*

Our formal analysis of Sievers' Law will employ a Stratal Optimality Theory framework, a framework introduced in section 4.5. The reader will recall that Stratal OT assumes multiple stratified constraint systems in the grammar and is by-and-large an OT adaptation of the earlier, rule-based Lexical Phonology; for discussion with references, see Kaisse and Shaw 1985.[40] These strata are typically threefold and are arranged in the following order: STEM, WORD and POSTLEXICAL (or phrasal). By reintroducing the phonological cycle into the

35 For example, Skt. *dr̥ś-* 'see' takes the shape *darś-* in *darśati, dadarśa*, but *drak-* in *adrākṣīt* (not **adārkṣīt*) and *drakṣyáti* (not **darkṣyáti*). Cf. Anttila 1969:52ff.

36 See Jasanoff 2003:43ff. and Vijūnas 2006:90ff. for discussion with references.

37 See Collinge 1985:127–31, Kobayashi 2001:94 and Fortson 2010:70–1.

38 Kobayashi 2001:94, 2004:26–7.

39 Hoenigswald 1988:202, Fullerton 1992:85–6, Neri 2003:32[69].

40 For extensive discussions of Stratal OT, see Kiparsky 2000 and more recently Bermúdez-Otero, forthcoming.

grammar, Stratal OT provides a response to the ever-vexing problem of opacity in OT. Unlike classical OT, where there is one level of constraint rankings, constraints may have different rankings at each phonological level in Stratal OT.[41]

The first stratum in the grammar, the stem level, is where roots combine with certain affixes, which are usually derivational.[42] The output produced at this level is not a morphological word and therefore is not uttered *per se*. To give a concrete example of a PIE form derived by Stratal OT, let us examine the hypothetical root **tert-* once again, which is derived as an adjective with the suffix **-i̯o-*.

(188) Stem Level: **tert-* + **-i̯o-* → *$[\text{tert}]_\sigma[\text{i̯o}]_\sigma$

This form *$[\text{tert}]_\sigma[\text{i̯o}]_\sigma$ was never uttered by a PIE speaker, as additional overt inflectional morphology was required.

The second stratum in the grammar, the word level, will not be addressed directly in our SL analysis. Here, inflectional endings will be added:

(189) Word Level: *$[\text{tert}]_\sigma[\text{i̯o}]_\sigma$ + *-s* (nom.sg.) → *$[\text{tert}]_\sigma[\text{i̯os}]_\sigma$

It is this form that is fed into the postlexical grammar.

The last stratum in the grammar, the postlexical level, is where rules occur across the board with no regard to morphological category. It is here that SL is hypothesized to have occurred.

(190) Postlexical Level: *$[\text{tert}]_\sigma[\text{i̯os}]_\sigma$ → *$[\text{ter}]_\sigma[\text{ti}]_\sigma[\text{i̯os}]_\sigma$

Note that at each level there is a syllabification cycle. At the stem level, the coalescence of the root and suffix produces an initial syllabification, which favors keeping morphemes syllabically distinct, if possible. At the word level the nominative singular case ending is added, which must be syllabified and therefore is adjoined to the nearest syllable $[\text{i̯o}]_\sigma$. Lastly, at the postlexical level, we find syllabic repartition as the result of SL, which is driven by the avoidance of the superheavy syllable *$[\text{tert}]_\sigma$.

41 Though this analysis adopts Stratal OT as its framework of choice, the reader should bear in mind it may be conducted using a ruled-based framework as well, though certain elements of the analysis, such as the The Emergence of the Unmarked (TETU) phenomenon inferred at the postlexical level, would be lost (for which see section 5.3.3).

42 See Bermúdez-Otero, forthcoming for discussion with examples.

5.3.2 *The Stem Level*

Let us now turn to the formal analysis of Sievers' Law. Strata that are relevant here are the stem and postlexical levels. The constraints used at the stem level are given in (181) below.

(191) Constraints Used at Stem Level

a. MST: The syllable in question cannot violate the PIE MAXIMUM SYLLABLE TEMPLATE CCVCC, where the coda cannot violate the Sonority Sequencing Principle. Assign one * for each violation.
b. PARSE: Syllabify all segments. Assign one * for each segment not syllabified.
c. DEP-V(OWEL): Don't insert a vowel. Assign one * for each instance of vowel epenthesis.
d. MAX-C(ONSONANT): Don't delete a consonant. Assign one * for each consonant lost.
e. ALIGN(-MORPH-L): The left edge of a morpheme coincides with the left edge of a syllable.[43] Assign one * for each violation.
f. *SUPERHEAVY (*SPRHVY): No syllable may consist of three or more morae. Assign one * for each superheavy syllable.

To conduct this analysis, we must rank these constraints in the grammar, postulating their positions as precisely as possible and providing external evidence whenever we can. This ranking is given in (182) below, with justifications presented in a footnote.[44]

(192) Stem Level Constraint Ranking
MST >> DEP-V >> MAX-C >> PARSE >> ALIGN >> *SUPERHEAVY.

43 Following Kager 1999, who posits this constraint in his analysis of Lenakel epenthesis (115ff.) and Diola-Fogny stray erasure (136).

44 MST >> all, as there is no sequence reconstructable for PIE (at any phonological level) that violates the maximum syllable template. MST >> DEP-V as well, since *ph_2trés* → *$[\text{pəh}_2]_\sigma[\text{trés}]_\sigma$. As we saw in section 3.2.1, DEP-V >> MAX-C, because *d^hugh_2trés* → *$[\text{d}^\text{h}\text{uk}]_\sigma[\text{trés}]_\sigma$ and not $^\text{X}[\text{d}^\text{h}\text{ug}]_\sigma[\text{h}_2\text{ə}]_\sigma[\text{trés}]_\sigma$ (or the like). Next, we should postulate that MAX-C >> ALIGN, because *d^hugh_2- + -ter-* → *$[\text{d}^\text{h}\text{ug}]_\sigma[\text{h}_2\text{ter}]_\sigma$, not $^\text{X}[\text{duk}]_\sigma[\text{ter}]\sigma$ and *$h_2$uksto* → *$[\text{h}_2\text{uk}]_\sigma[\text{sto}]_\sigma$, not $^\text{X}[\text{h}_2\text{uk}]_\sigma[\text{to}]_\sigma$. For the justification of the constraint ranking DEP-V >> MAX-C >> PARSE, see section 3.7. Note, too, that we must rank PARSE >> ALIGN, as PIE preferred to syllabify morphemes in different syllables in favor of avoiding syllabification. Lastly, ALIGN >> *SUPERHEAVY, based on the assumptions of this analysis.

Let us now proceed to examine the predictions of these constraint rankings in this analysis of SL, beginning with the syllabification of */tert+i̯o/ at the stem level. For reasons of brevity, only */tert+i̯o/ will be discussed, since */tert+i̯o/ and */tēt+i̯o/ behave in an identical fashion.

(193) Stem */tert+i̯o/

/tert+i̯o/	MST	Dep-V	Max-C	Align	★SprHvy
a. ☞ [tert]$_\sigma$[i̯o]$_\sigma$					*
b. [ter]$_\sigma$[i̯o]$_\sigma$				*!	
c. [ter]$_\sigma$[i̯o]$_\sigma$			*!		
d. [ter]$_\sigma$[ti]$_\sigma$[i̯o]$_\sigma$		*!		*	

Here we see that syllable and morpheme boundary are kept identical, due to the constraint ranking Align >> *Superheavy.

(194) Stem */tets+i̯o/

/tets+i̯o/	MST	Dep-V	Max-C	Parse	Align	★SprHvy
a. [tets]$_\sigma$[i̯o]$_\sigma$	*!					*
b. [tet]$_\sigma$s[i̯o]$_\sigma$				*!	*	
c. ☞ [tet]$_\sigma$[si̯o]$_\sigma$					*	
d. [tet]$_\sigma$[i̯o]$_\sigma$			*!			
e. [tet]$_\sigma$[si]$_\sigma$[i̯o]$_\sigma$		*!			*	

Because /s/ violates the MST in the root *tets*, it cannot be syllabified in the same syllable as /tet/. Since candidate (b.) violates both Parse and Align, it is harmonically bound to candidate (c.), which only violates Align. Root-final /s/ is therefore syllabified with the following suffix.

(195) Stem */tr̥k+tu̯o/

/tr̥k+tu̯o/	MST	Dep-V	Max-C	Align	★SprHvy
a. [tr̥kt]$_\sigma$[u̯o]$_\sigma$	*!			*	*
b. ☞ [tr̥k]$_\sigma$[tu̯o]$_\sigma$					
c. [tr̥k]$_\sigma$[u̯o]$_\sigma$			*!		
d. [tr̥k]$_\sigma$[tu]$_\sigma$[u̯o]$_\sigma$		*!			

Here, in our hypothetical absolutive form, the candidate *[tr̥k]$_{\sigma}$[tu̯o]$_{\sigma}$ is chosen, which violates neither Align nor *Superheavy.

5.3.3 *The Postlexical Level*

Let us now proceed to the postlexical level, for which we must make two assumptions. First, since these are phonological processes at the phrasal, or syntactic, level, morpheme boundaries become irrelevant.[45] For this reason, Align is no longer a relevant constraint in the analysis. Second, the constraints Max-C and Dep-V must be re-ranked, as this is required for vowel epenthesis (SL) to occur and not deletion—we do not find ^{X}[ter]$_{\sigma}$[i̯os]$_{\sigma}$ from *[tert]$_{\sigma}$[i̯os]$_{\sigma}$, etc. Furthermore, two additional constraints become relevant at the postlexical level.

(196) Additional Constraints at the Postlexical Level

a. Faith(σ): If x_i belongs to σ_i in the input, and x_i has an output correspondent x_o, x_o must belong to a syllable σ_o that corresponds to σ_i.[46] In other words, do not alter the syllabification of the base form. Assign one * for every instance in the output a segment is syllabified in a syllable different from that of the input.

b. *ComplexOnset: Onsets may not consist of more than one consonant in the output. Assign one * for each violation.

The first constraint, Faith(σ), is required to ensure that winning candidates of the input forms *[tet]$_{\sigma}$[si̯os]$_{\sigma}$ & *[tr̥k]$_{\sigma}$[tu̯o]$_{\sigma}$, which satisfy the constraint *ComplexOnset, do not win. The latter constraint, *ComplexOnset, is crucial in the choice of **tertii̯os*, and not **terti̯os*, as the winning candidate. The interaction of these newly added constraints is given in (187).

(197) Postlexical Constraint Ranking[47]

MST, Parse, Max-C >> *Superheavy >> Faith(σ) >> *ComplexOnset >> Dep-V.

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45 Known as 'Bracket Erasure'; see Kiparsky 1982:11.

46 I thank Kie Zuraw for her assistance in the formulation of this constraint.

47 The postlexical constraint ranking will be justified as follows. First, MST, Parse and Max-C >> all, since they are never violated in outputs produced at the postlexical level. Max-C >> *Superheavy, as we find *[i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$ 'yoke', not ^{X}[i̯eu̯]$_{\sigma}$[trom]$_{\sigma}$. More generally, it may be said that the constraint Max-IO (Max-C, Max-V) >> *Superheavy, since an "Osthoff's Law"-like process did not occur in PIE: **tērtrom* ≯ *^{X}tertrom*. *Superheavy >> Faith(σ), because *[tert]$_{\sigma}$[i̯os]$_{\sigma}$ → *[ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$, not ^{X}[tert]$_{\sigma}$[i̯os]$_{\sigma}$.

The crucial constraint ranking is *SUPERHEAVY >> FAITH(σ) >> *COMPLEXONSET—their interaction is what drives Sievers' Law at the postlexical level.

Turning now to the tableaux, we find that for our hypothetical inputs *[tet]$_{\sigma}$[si̯os]$_{\sigma}$ and *[tr̥k]$_{\sigma}$[tu̯o]$_{\sigma}$, there is no change in syllabification at the postlexical level.

(198) Postlexical *[tet]$_{\sigma}$[si̯os]$_{\sigma}$

/[tet]$_{\sigma}$[si̯os]$_{\sigma}$/	MST	MAX-C	*SPRHVY	FAITH(σ)	*COMPONS	DEP-V
a. [tets]$_{\sigma}$[i̯os]$_{\sigma}$	*!		*	*		
b. ☞ [tet]$_{\sigma}$[si̯os]$_{\sigma}$					*	
c. [tet]$_{\sigma}$[i̯os]$_{\sigma}$		*!				
d. [tet]$_{\sigma}$[si]$_{\sigma}$[i̯os]$_{\sigma}$				*!		*

(199) Postlexical *[tr̥k]$_{\sigma}$[tu̯o]$_{\sigma}$

/[tr̥k]$_{\sigma}$[two]$_{\sigma}$/	MST	MAX-C	*SPRHVY	FAITH(σ)	*COMPONS	DEP-V
a. [tr̥kt]$_{\sigma}$[u̯o]$_{\sigma}$	*!		*	*		
b. ☞ [tr̥k]$_{\sigma}$[tu̯o]$_{\sigma}$					*	
c. [tr̥k]$_{\sigma}$[u̯o]$_{\sigma}$		*!				
d. [tr̥k]$_{\sigma}$[tu]$_{\sigma}$[u̯o]$_{\sigma}$				*!		*

The input *[tert]$_{\sigma}$[i̯os]$_{\sigma}$ is correctly realized as *[ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$, as is given in (190).

FAITH(σ) >> *COMPLEXONSET, because *[tet]$_{\sigma}$[si̯os]$_{\sigma}$ does not undergo SL. MAX-C >> DEP-V, because SL is a process of vowel epenthesis, and not consonant deletion (*[tert]$_{\sigma}$[i̯os]$_{\sigma}$ → *[ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$, and not ˣ[ter]$_{\sigma}$[i̯os]$_{\sigma}$). *COMPLEXONSET >> DEP-V, because *[ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$, and not ˣ[ter]$_{\sigma}$[ti̯os]$_{\sigma}$, is the winning output when *[tert]$_{\sigma}$[i̯os]$_{\sigma}$ is processed at the postlexical level. Lastly, *SUPERHEAVY >> *COMPLEXONSET for reasons of transitivity, because *SUPERHEAVY >> FAITH(σ).

(200) Postlexical *[tert]$_{\sigma}$[i̯os]$_{\sigma}$

/[tert]$_{\sigma}$[i̯os]$_{\sigma}$/	MST	MAX-C	*SPRHVY	FAITH(σ)	*COMPONS	DEP-V
a. [tert]$_{\sigma}$[i̯os]$_{\sigma}$			*!			
b. [ter]$_{\sigma}$[ti̯os]$_{\sigma}$				*	*!	
c. [ter]$_{\sigma}$[i̯os]$_{\sigma}$		*!				
d. ☞ [ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$				*		*

Here we find that the output ^{X}[tert]$_{\sigma}$[i̯os]$_{\sigma}$ is not chosen because the now highly-ranked constraint *SUPERHEAVY is violated. The candidate ^{X}[ter]$_{\sigma}$[ti̯os]$_{\sigma}$, with simple resyllabification, is avoided because of a violation of *COMPLEXONSET, or the avoidance of onsets consisting of more than one consonant. The most optimal form is [ter]$_{\sigma}$[ti]$_{\sigma}$[i̯os]$_{\sigma}$, with vowel epenthesis (Sievers’ Law); this candidate avoids both a superheavy syllable and a complex onset in the output.[48]

Thus we find that SL is motivated by the avoidance of a superheavy syllable (*SUPERHEAVY), coupled with the desire of the PIE speaker to avoid complex onsets (*COMPLEXONSET) at the postlexical level. We are now in a position to address Collinge’s cogent objection to the idea that SL is driven by an avoidance of a sequence $_{\sigma}$[TR- (or $_{\sigma}$[TU̯-): “But it is not totally clear why, if the first consonant of the cluster has become a syllable-coda, the sequence $ty- is then any less acceptable than the word initial ##ty-”.[49] Sievers’ Law is not driven by the avoidance of a complex onset in medial position; rather, Sievers’ Law is driven by the avoidance of a superheavy syllable at the postlexical level, with the most optimal candidate avoiding a complex onset. This is a classic example of “The Emergence of the Unmarked” (TETU), a key tenet of OT: “[A] preference for some universally unmarked structure, such as syllables with onsets,

48 Should one prefer to restrict SL to particular sequences of consonant + sonorant (such as **TU̯*-), (s)he could assume a wide distribution of epenthetic constraints, such as DEP-[i], DEP-[u], DEP-[r̥], etc. that are ranked accordingly at the postlexical level. So, in order to rule out **tert-ro-s* → **tertr̥ros* by SL, we would need to rank DEP-[r̥] above *COMPLEXONSET, making *[ter]$_{\sigma}$[tros]$_{\sigma}$ a candidate more optimal than [ter]$_{\sigma}$[tr̥]$_{\sigma}$[ros]$_{\sigma}$. An alternate way would be to assume two constraints, DEP-V/C_ R “don’t epenthesize a vowel in a cluster of consonant + **m, *n, *r, *l*” and DEP-V/C_U̯ “don’t epenthesize a vowel in a cluster of consonant + glide” (cf. Zuraw 2007:297, following Fleischhacker 2005), with the relevant constraint ranking in PIE: DEP-V/C_ R >> *COMPLEXONSET >> DEP-V/C_U̯.

49 Collinge 1985:165.

can emerge under the right circumstances even if the language as a whole permits the corresponding marked structure." (McCarthy 2008:24–5)

5.3.4 *Overgeneration*

Upon careful inspection, we find that the solution presented above is too powerful: it predicts vowel epenthesis to arise in environments where it never occurs. In fact, the present analysis demands that *every* superheavy syllable located at the postlexical level be 'fixed' with vowel epenthesis, due to the constraint ranking ⋆Superheavy >> Dep-V. This, of course, is clearly false—a form such as **i̯eu̯ktrom* 'binding; cord' (Skt. *yoktra-*), which is composed of the root **i̯eu̯g-* 'yoke; join' plus the instrumental suffix *-tro-* plus acc.sg. *-m*, is predicted to undergo either schwa epenthesis (stem *[i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$ → postlexical *[i̯eu̯]$_{\sigma}$[kə]$_{\sigma}$[trom]$_{\sigma}$) or epenthesis of a corresponding syllabic sonorant (stem *[i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$ → postlexical *[i̯eu̯]$_{\sigma}$[ktr̥]$_{\sigma}$[rom]$_{\sigma}$). Both scenarios are conceivable within the framework of PIE syllabification proposed thus far.

(201) Postlexical *[i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$

/[i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$/	MST	Max-C	⋆SprHvy	Faith(σ)	⋆CompOns	Dep-V
a. ☹ [i̯eu̯k]$_{\sigma}$[trom]$_{\sigma}$			*!		*	
b. [i̯eu̯]$_{\sigma}$[trom]$_{\sigma}$		*!			*	
c. [i̯eu̯]$_{\sigma}$[ktr̥]$_{\sigma}$[rom]$_{\sigma}$				**!	*	*
d. ☞ [i̯eu̯]$_{\sigma}$[kə]$_{\sigma}$[trom]$_{\sigma}$				*	*	*

I presently see two possible routes that one may take to solve this problem of overgeneration. The first, and perhaps simplest, would be to abandon the requirement for syllable onsets at the postlexical level and to follow Sievers 1878 et al. in assuming SL to be a process of resyllabification, not epenthesis, as in (172) above: *[tert]$_{\sigma}$[i̯os]$_{\sigma}$ → *[ter]$_{\sigma}$[ti]$_{\sigma}$[os]$_{\sigma}$. In the OT analysis, we may simply replace the constraint that blocks vowel epenthesis (Dep-V) with one that blocks any change in the feature [syllabic] within the derivation.

(202) Ident(σ): Do not alter the value of the feature [syllabic]. Assign one * for every instance this feature has been altered.

To propose a constraint of this nature for PIE would not be controversial, since the feature [syllabic] alternated frequently, productively, and cyclically in PIE sonorants, whose syllabicity (for the most part) depended on its surrounding phonological environment.[50] In addition, should we view SL as a process of resyllabification, the change of **tertios* to **tertios* (and not *ˣtertəos* or *ˣtertr̥os*) is a given, while the above analysis utilizing epenthesis does not provide a reason why **terti̯os* should epenthesize *[i] (→ **tertii̯os*) and not *[u], *[a], *[r̥], etc. Nevertheless, the assumption of SL as a process of resyllabification does lead to problems in the formal derivation.

(203) Postlexical *[i̯eu̯k]$_\sigma$[trom]$_\sigma$

/[i̯eu̯k]$_\sigma$[trom]$_\sigma$/	MST	MAX-C	*SPRHVY	FAITH(σ)	*COMPONS	IDENT(σ)
a. ☹ [i̯eu̯k]$_\sigma$[trom]$_\sigma$			*!		*	
b. [i̯eu̯]$_\sigma$[trom]$_\sigma$		*!			*	
c. ☞ [i̯eu̯]$_\sigma$[ktr̥]$_\sigma$[rom]$_\sigma$				**	*	*

In example (193) we see that the desired candidate *[i̯eu̯k]$_\sigma$[trom]$_\sigma$ loses, since superheavy syllables are avoided in all cases through sonorant resyllabification.

(204) Postlexical *[tert]$_\sigma$[i̯os]$_\sigma$

/[tert]$_\sigma$[i̯os]$_\sigma$/	MST	MAX-C	*SPRHVY	FAITH(σ)	*COMPONS	IDENT(σ)
a. [tert]$_\sigma$[i̯os]$_\sigma$			*!			
b. ☞ [ter]$_\sigma$[ti̯os]$_\sigma$				*	*	
c. [ter]$_\sigma$[i̯os]$_\sigma$		*!				
d. ☹ [ter]$_\sigma$[ti]$_\sigma$[os]$_\sigma$				*!*		*

In example (194) the candidate [ter]$_\sigma$[ti]$_\sigma$[os]$_\sigma$ is not chosen because it violates FAITH(σ) twice, making [ter]$_\sigma$[ti̯os]$_\sigma$ the most optimal candidate. Now, one might propose to switch the constraints FAITH(σ) and *COMPLEXONSET around (*COMPLEXONSET >> FAITH(σ)), thereby making *[ter]$_\sigma$[ti]$_\sigma$[os]$_\sigma$ the best candidate. This idea fails, however, since we need some mechanism to prevent words of the shape **tetsi̯os* and absolutives such as **tr̥ktu̯o-* from undergoing Sievers' Law, as seen in (195) below.

50 See Kobayashi 2004:27 and section 2.4.

(205) $*[\text{tet}]_\sigma[\text{si̯os}]_\sigma$, $*[\text{tr̥k}]_\sigma[\text{tu̯o}]_\sigma$

$/[\text{tet}]_\sigma[\text{si̯os}]_\sigma/$, $*/[\text{tr̥k}]_\sigma[\text{tu̯o}]_\sigma/$	MST	MAX-C	⋆SPRHVY	⋆COMPONS	FAITH(σ)	IDENT(σ)
a. ☹ $[\text{tet}]_\sigma[\text{si̯os}]_\sigma$				*!		
b. ☞ $[\text{tet}]_\sigma[\text{si}]_\sigma[\text{os}]_\sigma$					**	*
a. ☹ $[\text{tr̥k}]_\sigma[\text{tu̯o}]_\sigma$				*	*	
b. ☞ $[\text{tr̥k}]_\sigma[\text{tu}]_\sigma[\text{o}]_\sigma$					**	*

Thus it seems that SL should not be explained as a process of resyllabification and we should return to the original idea of epenthesis, with minor tweaks to the analysis. These tweaks should not only explain why the forms *ˣi̯eu̯kətrom* and *ˣi̯eu̯ktr̥rom* do not exist; it should also provide a reason for the choice in epenthetic segment in the output, such that **terti̯os* → **tertii̯os* and not *ˣtertui̯os*, etc.

Perhaps a better solution to the problem would be to assume that SL is a process of vowel epenthesis, whose epenthetic segment has completely copied its features from an adjacent sonorant. Such a process of segment harmony is well attested typologically and in Indo-European, most often in partial assimilation. For example, in Sanskrit, sequences that continue *R̥̄ (< PIE *R̥h$_x$) develop an epenthetic vowel, whose quality is affected by adjacent segments: *ū* if following a labial or labiovelar consonant (*pūrṇá-* 'full' < *pl̥h₁nó-*), *ī* otherwise (*tīrṇá-* 'crossed' < PIE **tr̥h₂nó-*).[51] Another example may be found in Old Latin, where a short vowel produced by 'weakening' is rounded to [u] before a *pinguis*, or dark, *l* (**sikelos* > *Siculus* 'an inhabitant of Sicily') and before labial consonants (**pontifaks* 'high priest' > OLat. *pontufex*).[52] In both instances certain features of adjacent consonants have spread to the vowels in question.

To present formally this process of segment harmony in PIE we will need to assume two additional constraints for the postlexical level.

(206) Additional Constraints
   a. DEP[F]$_{IO}$: Every feature of the output has a correspondent in the input. Assign one * for each instance a new feature is inserted.[53]

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51 Fortson 2010:212.

52 Weiss 2009:117–8. I refer the reader to Uffmann 2006:1080ff. for additional examples from non-IE languages.

53 Struijke 2002:153. Note that I assume the default vowel of epenthesis, *[ə], to have been characterized by (a bundle of) features in PIE ([-high]? [-round]?).

b. No-Spread([F], seg): Feature-segment associations in the output must be reflected by the corresponding elements in the input. Assign one * for each violation.[54]

The first constraint, Dep[F]$_{IO}$, requires that no additional feature be present in the surface form that is not underlying. The second, No-Spread([F], seg), prevents the assimilation of features between segments. The necessary constraint ranking will be Dep[F]$_{IO}$ >> ⋆Superheavy >> Faith(σ) >> ⋆ComplexOnset >> Dep-V, No-Spread([F], seg). This will ensure that any segment epenthesized at the postlexical level will have assimilated as much as possible with its surrounding segments.

(207) Postlexical *[ter]$_\sigma$[ti̯os]$_\sigma$

/[tert]$_\sigma$[i̯os]$_\sigma$/	Dep(F)	⋆SprHvy	Faith(σ)	⋆CompOns	Dep-V	No-Spread
a. ☞ [ter]$_\sigma$[ti]$_\sigma$[i̯os]$_\sigma$			*		*	*
b. [ter]$_\sigma$[ti̯os]$_\sigma$			*	*!		
c. [ter]$_\sigma$[tə]$_\sigma$[i̯os]$_\sigma$	*!		*		*	
d. [tert]$_\sigma$[i̯os]$_\sigma$		*!				

(208) Postlexical *[i̯u̯k]$_\sigma$[trom]$_\sigma$[55]

/[i̯eu̯k]$_\sigma$[trom]$_\sigma$	Dep(F)	⋆SprHvy	Faith(σ)	⋆CompOns	Dep-V	No-Spread
a. ☞ [i̯eu̯k]$_\sigma$[trom]$_\sigma$		*		*		
b. [i̯eu̯]$_\sigma$[kə]$_\sigma$[trom]$_\sigma$	*!			*	*	

54 Struijke 2002:154, based on McCarthy 2000:159.

55 At the moment it is not entirely clear to me why the candidate *[i̯eu̯]$_\sigma$[ktr̥]$_\sigma$[rom]$_\sigma$ is not found as a Sievers variant. Perhaps this may be attributed to the markedness of the sequence \$PPR̥- in PIE, as is seen in the simplification of the sequence \$PPN̥-: *#dʰgʰm̥-* → *#gʰm̥-* (Mayrhofer 1986:117–8). Of course, considering that the only word-medial onset clusters that violate the SSP are of the shape *\$$_\sigma$[FP-, it is also likely that word-medial onset **kt-* was banned.

5.4 Consequences of Analysis

Having fixed the problem of overgeneration with the introduction of the constraints Dep[F]$_{IO}$ and No-Spread([F], seg), let's now turn to the consequences of our analysis, of which there are many.

5.4.1 *Advantages*

There are a number of advantages to this analysis of SL. First, by assuming that SL was driven by the desire to avoid superheavy syllables at the postlexical level, we have provided a motivation that is well attested both in Indo-European and cross-linguistically. Unlike many studies of SL in the past, our analysis is not circular, since we have not based the syllabification rules of PIE upon our analysis of Sievers' Law itself. Rather, we have based them on the phonotactic analysis of edge consonant clusters, as I have discussed in the previous two chapters. The adoption of the MST as the largest possible syllable shape in PIE neatly explains Schindler's two exceptions to SL discussed above: the absolutives and words of the shape **tets-i̯os*. SL does not occur in the absolutive **tr̥k-tu̯o-* ([tr̥k]$_\sigma$[tu̯o]$_\sigma$) because a superheavy coda never existed, as one was never created by the morphology. SL did not occur in words of the shape **tetsi̯os*, since the PIE MST did not permit it to be syllabified as [tets]$_\sigma$[i̯os]$_\sigma$ at the stem, word or postlexical levels, because an SSP violation would have resulted in the coda. In both instances Sievers' Law was never triggered at the postlexical level because a superheavy syllable was never created at any point in the phonological derivation.[56]

5.4.2 *Disadvantages*

To my knowledge, the sole downside to the above analysis is that it requires SL and Lindeman's Law (LL) to have been separate phonological processes in PIE. Whereas SL targets syllables of the shape **-RV-* that immediately follow a superheavy syllable such as [tert]$_\sigma$, LL targets the onsets of monosyllabic words of the shape **#TRV-*: **di̯ḗu̯s* 'sky (god)' → **dii̯ḗu̯s*. Their structural descriptions are fundamentally different, and therefore the collapse of SL and LL as a unitary process is a mirage.

As discussed above, Schindler (1977a:64) had assumed that both processes were restricted to the onset of the final syllable of a word. Of course, since

56 As Kie Zuraw points out to me, the above analysis of Sievers' Law, if correct, argues fairly strongly in favor of phonological strata within the grammar, since one phonological structure is shown to be 'fixed' at the stem and word level (**tetsi̯os* → *[tet]$_\sigma$[si̯os]$_\sigma$, to satisfy the MST), while another structure, *[tert]$_\sigma$[i̯os]$_\sigma$, is 'fixed' at the postlexical level (*[tert]$_\sigma$[i̯os]$_\sigma$ → *[ter]$_\sigma$[ti]$_\sigma$[i̯os]$_\sigma$, to satisfy *Superheavy).

LL only applied within monosyllables, his claim here is irrefutable. However, we do find instances of SL outside of this particular configuration, such as in the Ved. hapax legomenon *poṣyā́vant-* 'creating property' as *poṣiyā́vant-* (Sihler 2006:186). If this form is truly archaic, Schindler's formulation of SL cannot explain this form, whereas the above analysis can in a straightforward fashion: the verbal suffix *-ya-* → *-iya-* due to the preceding superheavy syllable *poṣ-* (from earlier **pauṣ-*).[57] Moreover, while Schindler (1977a:62–3) must assume paradigmatic leveling as the source of SL in forms such as *kā́viyasya* 'prophetic; of a kavi (gen.sg.)', the present analysis predicts both *kā́viyas* 'prophetic; of a kavi (nom.sg.)' and *kā́viyasya* 'prophetic; of a kavi (gen.sg.)' to have been created equally by SL, prompted by the avoidance of a superheavy syllable at the postlexical level at the juncture of a superheavy root (*kāv-*) + a suffix of the shape *-RV-* (*-ya-*). As to why SL occurs so frequently in the onset of the final syllable of a word: this must be due to the fact that this position is the most common environment for the juxtaposition of a superheavy syllable (which is always a root) before a syllable of the shape **-RV-* (which is always a suffix).[58]

There is, in fact, another and perhaps more compelling reason to view SL and LL as separate phonological processes, one which is not theory-internal. As Craig Melchert has pointed out to me, should we continue to view SL and LL as the same process, we must accept one of two views: either 1) SL applied to *all* resonants in PIE or 2) LL applied to *only* glides. Should we reject both positions, it would be impossible to view the two rules in question as a unitary phenomenon, since they would not target the same natural class. Though some scholars (beginning with Osthoff and followed most notably by Edgerton 1934:257ff.) have proposed that SL extended to all sonorants,[59] most of the recent IE handbooks and phonological treatments,[60] such as Mayrhofer 1986:167 (which strongly reflects Schindler's views), insist that SL applied almost entirely to glides. This problem deserves a thorough examination, as was recognized by Schindler himself (1977:64[6]).[61]

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57 However, as Brent Vine points out to me, this form may simply be a later derivative of *poṣ(i)ya-* and therefore would provide no evidence of SL occurring in a non-final syllable. Further investigation of the application of SL in non-final syllables is required.

58 So also Barber 2013:50. As for why SL is frequently unattested in vr̥ddhi formations such as *vāiśvānará-* (Schindler 1977:62; cf. also *mā́dhyaṃdina-* 'belonding to midday'), I follow Sihler 2006:186 in viewing this form as a later (likely Indic) innovation, being a redactional substitute for *viśvā́nara-*. For further discussion and forms, see Barber 2013:49–52.

59 See most recently Ruijgh 1996 for Greek and Praust 2000 (see above).

60 Meier-Brügger 2003:90–1; 141–2, Sihler 2006:183, Weiss 2009:39–40, Fortson 2010:72.

61 The IE facts aside, the restriction of SL to glides is understandable, since, as Fleischhacker 2005 shows, *TU̯-* clusters (*pi̯a, ku̯a*, etc.) are more 'splittable' than *TR-* clusters (*pra, tma, kla*, etc.); in other words, *CUU̯-* and *CU̯-* are more perceptually similar to each other than

The second alternative, restricting LL to glides, would be even more problematic. In addition to cases of LL occurring in clusters of the shape C + U̯, such as **d(i)i̯ḗus* 'sky (god)', **d(u)u̯oh$_x$* 'two' and **ḱ(u)u̯ō* 'dog', there are many well-established examples of C + non-glide, such as Lat. *homō*, Goth. *guma* 'man' from **(d^h)ĝ^{h}m̥mō* 'earthling',[62] and Boeotian Gk. βανά 'woman' from **g^{w}n̥nah$_2$*,[63] to name a few. Eschewing solid examples of LL such as these for the sake of collapsing two phonological rules together is in my opinion (and likely in the opinion of many within the IE scholarly community) not the best route to take. Of course, if we accept the findings of my analysis above, which postulates that SL and LL could not have been the same process since Schindler's syllabifications of forms of the shape **tetsi̯os* were in fact impossible, such problems become irrelevant.[64]

5.4.3 *Predictions*

The above analysis provides us with a straightforward definition of Sievers' Law in PIE and makes clear predictions of what should be attested in the Indo-European languages. It proposes that SL originated as a phonological process

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are *CR̥R-* and *CR-* (cf. Sihler 2006:181). In fact, Fleischhacker has demonstrated there to be a gradient scale of 'splittability': in order of least splittable to most, CT → Cm → Cn → Cl → Cr → CU̯ (cf. Zuraw 2007:284). This raises the question, if non-glides *did* participate in SL, can any gradience be found, such that PIE suffixes of the shape **-rV-* were more likely to undergo SL than, say, those of the shape **-lV-, *-nV-* and **-mV-*?

62 Weiss 2009:105.

63 Cf. Vine 1999:560ff.

64 The problem of LL should be approached in much the same fashion as has been done for SL, attempting to answer the following questions: 1) What was the motivation for LL? Was it driven by an avoidance of a complex onset of the shape **TR-*, and if so, why did it only occur in monosyllables? 2) If LL did create sandhi variants within a particular higher level constituent (intonational phrase? utterance?), can the exact conditions be ascertained? 3) Can this phonological process be connected to broader prosodic phenomena in PIE such as foot structure or a minimal word requirement? While the details are not entirely fleshed out, I currently suspect that LL arose as an alternative means to satisfy a minimal word requirement, which demanded that each prosodic word consist of at least two moras. Recall from section 3.3.6 that this requirement triggered monosyllabic lengthening (MSL) in forms such as **nḗ* 'not' and **nṓs* 'us'. In this light we may view LL as another way to make monomoraic prosodic words bimoraic, with the additional advantage of eliminating complex onsets (just as Sievers' Law). Thus, */du̯ó$_{\mu}$h$_1$/ 'two' → *[du̯ó$_{\mu}$<h$_1$>] (with a word-final extrametrical C; see Sandell & Byrd, in preparation) → *[du$_{\mu}$u̯o$_{\mu}$<h$_1$>] > Lat. *duō*. Alternatively, speakers could lengthen the nucleus by MSL: */du̯ó$_{\mu}$h$_1$/ → *[du̯ó$_{\mu}$<h$_1$>] → *[du̯ṓ$_{\mu\mu}$<h$_1$>] > Skt. *dvā́*. I intend to present a fuller account of this hypothesis in a publication in the near future.

that altered suffixes of the shape **-RV-*, and therefore all instances of SL occurring in suffixes of the shape **-CRV-* must be secondary. This fact may explain why certain language groups, such as Germanic, Tocharian, Italic and Baltic, do not provide evidence for SL in suffixes of the shape **-CRV-*. Furthermore, it would explain why instances of certain suffixes such as Ved. *-bhiyas* are actually rarer after a heavy syllable (CVC, CV̄) than are instances of *-bhyas*. Moreover, should one extend SL to apply to all sonorants, it would provide an answer to why no SL variants of the instrumental suffixes **-tro-, *-tlo-, *-dʰro-* and **-dʰlo-* are ever attested, despite the fact that there are certain cases of the perfect ending *-ire* in Sanskrit which may have originated as Sievers' variants to *-re*, as Praust (2000) has argued. Of course, if we follow Schindler in assuming that SL is to be explained as the avoidance of a complex onset **TR-* in a word-final syllable, there is in principle no reason why **-tro-*, etc. should behave any differently from **-ro-*, etc. in this regard.[65]

5.5 Summary and Conclusions

In this chapter, I have proposed that SL was motivated in PIE by the well-attested Indo-European tendency to avoid superheavy syllables in medial position, providing a straightforward motivation to Sievers' Law. The solution is non-circular, as the rules of PIE syllabification used in the analysis are not based on our analysis of SL itself, but rather are based on the independent phonotactic analysis of the PIE phonology as a whole. The solution addresses why SL does not occur in words of the shape **tetsi̯o-* (Ved. *matsya-*) and in the absolutive (Ved. *yuktvā́*), since a superheavy syllable never existed at any point within the derivation. Lastly, the solution predicts all instances of SL occurring in suffixes of the shape **-CRV-* to be secondary, a prediction corroborated by the sparse and irregular attestation of SL within suffixes of this shape throughout the Indo-European languages.

65 An additional prediction is that words of the shape **testi̯o-* and **tehₓti̯o-* should in fact have undergone SL in PIE, since fricatives were likely more sonorous than stops and therefore the coda -FP]$_\sigma$ would not have violated the SSP. In other words, **testi̯o-* and **tehₓti̯o-* would have been syllabified as *[test]$_\sigma$[i̯o]$_\sigma$ and *[tehₓt]$_\sigma$[i̯o]$_\sigma$, respectively, at the stem level and thus would have undergone SL at the postlexical level. This perhaps would explain the form *gabhastyos* 'hands (gen.abl.du.)', which is attested twenty times in the Rigveda and is always to be scanned as *gabhastiyos* (Sihler 2006:187–8). It also appears that the coda **sḱ* created a superheavy syllable, spurring SL: cf. the gerundive *āpŕ̥cchiya* < **pr̥sḱii̯o-* ← **pr̥sḱi̯o-* ← */pr̥ḱ-sḱ-i̯o-/ (with cluster simplification already in PIE).

CHAPTER 6

Motivating Pinault's Law

6.1 Introduction and Overview

In the previous chapter we witnessed the power of the MST in the PIE grammar, not directly through processes of resonant syllabification, stray epenthesis, or stray erasure (as discussed in chapter 3), but rather indirectly in the non-application of SIEVERS' LAW in medial sequences of the shape *-*VPPU̯V*- (PIE *[$\mathrm{h_3}$u̯r̥h_x]$_\sigma$[dʰu̯o-]$_\sigma$ 'raised, upright' > Ved. *ūrdhvá-*, Av. *ərəduua-*, Gk. ὀρθός, Lat. *arduus*, OIr. *ard* and PIIr. *[mat]$_\sigma$[sya]$_\sigma$ > Ved. *matsya-*, Av. *masiia-* 'fish'). In this chapter we will examine a phonological problem similarly influenced by syllable structure, whereby laryngeals were deleted for articulatory reasons but only in instances where the laryngeal in question was syllabified together with a following yod: */-V(C)Ch_x-i̯V-/ → *[-V(C)C]$_\sigma$[h_xi̯V-]$_\sigma$ → *[-V(C)C]$_\sigma$[i̯V-]$_\sigma$. This is the phonological rule known as Pinault's Law (PL).

In his seminal work *Altindische Grammatik*, Wackernagel (1896:81) proposes a number of rules of schwa deletion,[1] one of which occurring before yod: "Ig. ist ə geschwunden: ... Regelmässig vor ... *y*." However, he cites only one example, contrasting reflexes of the *seṭ* root *vad*(*i*)- "speak" (*a-vádi-ṣur, uditá-*) with the derivative *ud-yáte*. Unfortunately this example is not probative, as it is not certain that this root even ended in a laryngeal, for while the LIV (286) assumes the root to have been *h_2*u̯edh*$_{1/3}$-,[2] others reconstruct *h_2*u̯ed-*.[3] In 1982, Georges-Jean Pinault confirmed Wackernagel's proposal in a convincing discussion backed up by a myriad of excellent examples. However, he recognized that two corrections needed to be made to the original formulation. First, the rule should be modernized and thus understood as one of laryngeal deletion, not schwa deletion. Second, the rule must indicate that the **i̯* preceded a vowel, as */Ch_xi̯C/- → **Cih$_x$C*, not ^{X}*CiC-*.[4] Since Pinault's publication,[5]

1 Note that *ə (nearly) always referred to *ə *primum* in pre-laryngealistic times. See 1.2.1.2.

2 As the LIV correctly points out, if there had been a laryngeal here, it could not have been *h_2, as we would expect ^{X}*a-vádhi-*.

3 Such as Beekes 2010:168: PIE *h_2*u̯ed-* > Gk. αὐδή 'human voice, sound, speech'. Gk. αὐδών 'nightingale' is commonly derived from this root, though according to Beekes (2010:27) the connection is a difficult one.

4 For instance */p$\mathrm{h_3}$i̯tós/ → **pih*$_3$*tós* (> Ved. *pītáḥ*), not ^{X}*pitós* (> Ved. ^{X}*pitáḥ*); see 3.3.2.

5 Pinault was not the first to discuss Wackernagel's rule in laryngealistic terms. See Cowgill 1967 (apud Bammesberger 1973:2110), Beekes 1969, and Peters 1980:81[38].

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the vast majority of scholars have accepted his proposal and now consider it to have been a valid law in PIE (cf. Collinge 1995:45, Jasanoff 2002/2003:132, and Ringe 2006:15, among others).

Following Pinault (ibid.), we may characterize the law as follows:

(209) Pinault's Law (Pinault 1982)
PIE $^*\mathrm{h}_x \rightarrow \varnothing$ / C_0__i̯ V
Post-consonantal laryngeals are lost word-medially before a yod plus vowel.

As we shall see in this chapter, Pinault's formulation is indeed correct, with two minor modifications. First, we must introduce syllable boundaries into the structural description, and second, we will need to reconsider which laryngeals were targeted by the rule in question.[6]

6.2 The Data

Let us begin with the data, messy as it is. While there are excellent cases of forms that require deletion (PIE */sokʷh$_2$i̯V-/ → **sokʷi̯V-* > Ved. *sákhye*, Lat. *socius* 'friend'), there are also well-understood forms that do not (PIE **kʷōlh$_1$i̯e-* > Gk. πωλέομαι 'to come/go often'), and still other forms that seem to show both deletion **and** retention (PIE */h$_2$erh$_3$-i̯e-/ > Gk. ἀρόω, Lat. *arāre* 'plow' but PCelt. **ari̯e-*, Lith. *ariù*).

Before examining the evidence in detail, we need to be aware of two forms entertained by Pinault (1982:270) and a third by Piwowarczyk (2008:19ff.), which should not be considered relevant to the discussion.[7]

a. **dʰr̥h$_3$-i̯e-* 'jump' > OIr. (*no*)-*daired* 'jump'. Cf. Gk. θρώσκω 'jump'. Root in question: ***dʰerh$_3$***- (IEW 256; LIV 146–7).
b. **skl̥h$_x$-i̯e-* 'split' > Gk. σκάλλω 'stir up, hoe', Lith. *skiliù* 'strike fire'. Cf. Arm. *celum* 'split, tear' and Hitt. *iškalla-* 'id.'. A laryngeal is assumed due to the acute accent of the Lith. infinitive *skélti*; however, the Greek form may not necessarily reflect an original **skl̥h$_x$-i̯e-* (see Beekes 2010:1340–1 for discussion). Root in question: ***skelh$_x$***- (IEW 923–6; LIV 553).

6 I am indebted to Chiara Bozzone, Jessica DeLisi, and Dariusz Piwowarczyk for their help with a number of matters in this chapter.

7 Cf. also **gʷr̥h$_x$-i̯e-* 'praise' > Lith. *giriù, gìrti*, which LIV 211 cites as a secondary formation.

c. *$*tsp\d{r}h_x$-$\underset{\frown}{i}e$-* 'trample' > Gk. ἀσπαίρω 'to move convulsively, quiver', Lith. *spirìù* 'kick, press to'. The laryngeal is maintained in Ved. *sphūrati* 'kicks'. For the initial **t*-, see Lubotsky 2006, who has argued for this verb to have had the original sense 'to kick with the heel' and to derive from the complex verb **tsperh*$_x$- (← */pd-s-perh$_x$-/) 'to beat with the foot'.[8] Root in question: ***tsperh*$_x$**- (IEW 992–3, EWAia 2.776).

While the forms in question technically do contain laryngeals that follow consonants and precede *i̯ plus vowel, in all three instances the consonant in question is a syllabic resonant (*R̥). It is extremely likely that laryngeals were retained in this environment in PIE; cf. **mih*$_x$-*i̯e*- 'decrease' > Ved. *mī́yate*,[9] **h*$_1$*r̥h*$_1$-*i̯e*- 'row' > Myc. *e-re-e* [erehen], Lith. *iriù*,[10] **ĝn̥h*$_1$-*i̯e*- 'be born' > Ved. *jāyate*,[11] and (likely post-PIE) **b*^{h}*uh*$_2$-*i̯e*- 'become' > Gk. φῡ́ομαι, Lat. *fīō*, etc.[12] Those forms suggesting laryngeal loss should be accounted for as inner-dialectal.[13]

Returning now to the problem at hand, there are three broad types of forms relevant to the discussion of Pinault's Law: those which delete a laryngeal in Pinault's environment, those that retain a laryngeal in this environment, and those forms that are contradictory, in that we find both deletion and retention. Let us examine each in turn.

6.2.1 *Instances of Deletion*

6.2.1.1 Attested in 3 or More Language Families

Unquestionably the best example of PL is */sok^{w}h$_2$-i̯-V/ → **sok^{w}i̯V*-, securely continued by Ved. *sákhye* 'friend (dat.sg.)', Hom. ἀοσσεῖν 'to help', Lat. *socius* 'companion, ally', and PGmc. **sagjaz* 'friend'.[14] The Vedic form is perhaps the most important one, as it requires that we reconstruct a root-final **h*$_2$ in order to explain the aspirated *-kh-*, which undoubtedly arose in the strong cases: **sok^{w}h$_2$ṓ(i̯)* > Ved. *sakhā́* (nom.sg.), Av. *haxay*- 'friend'.[15] Hom. ἀοσσεῖν 'to help'—

8 See Byrd, forthcoming b for discussion.

9 LIV 427.

10 LIV 251.

11 LIV 163–5. OIr. *-gainethar*, MWel. *geni*, MBret. *guenell*, MCor. *genys* likely reflect an inner-Celtic deletion. See Schumacher 2004:135.

12 LIV 98.

13 On the other hand, should we assume that zero-grade ablaut was a synchronic process in PIE (see chapter 4), we could perhaps order PL before processes of syncope, thus */CeRh$_x$i̯e-/ → [CeR]$_\sigma$[h$_x$i̯e-]$_\sigma$ → *[CeR]$_\sigma$[i̯e-]$_\sigma$ → *[CR̥]$_\sigma$[i̯e/o-]$_\sigma$.

14 Mayrhofer 1986:140.

15 See EWAia 684–5, with references. Positing PL to have been restricted to Greek (and other individual branches), Peters (ibid.) claims that deletion never occurred in Ved. *sákhye*, given the 110 syllabic scansions vs. the 34 non-syllabic scansions of *-y-* in the RV.

which derives from PGk. *ha-hokye-ye- and ultimately from PIE *sm̥-sokʷ-i̯e-i̯e- (Ringe 2006:110)—should be analyzed as a *-i̯e- verbal derivative to *sokʷi̯os 'friend' plus the prefix *sm̥- 'together'.[16] If laryngeal deletion had not occurred, *sm̥-sokʷh$_2$-i̯e-i̯e- would have produced PGk. *ha-hokʷaye-ye-, hence Hom. ˣἀοπαεῖν.[17] The thematic noun *sokʷi̯ós is directly continued by Lat. *socius*[18] 'companion, ally' as well as PGmc. *sagjaz 'companion; man, warrior' (OS *segg*, OE *secg*, OIce. *seggr*).[19] These forms make it certain that a noun *sokʷi̯ós existed in PIE, and given the similar form and function of PIE *sokʷh$_2$ō(i̯) (Ved. *sákhā́*), it is very likely that *sokʷi̯ós derived from an underlying */sokʷh$_2$i̯ós/ in PIE. Stem in question: ***sokʷh$_2$-** 'friend' (cf. IEW 896–7).[20]

6.2.1.2 Attested in 2 Language Families

There are two sets of forms attested in two language families that argue in favor of PL. The first, and the one usually cited as the Paradebeispiel of the rule in question, is */kreu̯h$_2$-i̯o-/ → *kreu̯i̯o- 'flesh, gore, blood', */krou̯h$_2$-i̯o-/ → *krou̯i̯o- 'id.', as continued by Skt. *kravya-* 'flesh' and Lith. *kraũjas* 'blood', respectively (Yamazaki 2009:446–7), not ˣ*kraviya-* 'flesh' and Lithuanian ˣ*kraújas*.[21] A laryngeal surfaces in all other attested forms: *kréu̯h$_2$-s (Skt. *kravíṣ-*, Gk. κρέας) and *kruh$_2$- (Ved. *krūrá-*, Av. *xrūra-* 'bloody', Lat. *crū-dus* 'raw', OIr. *crú* 'blood').[22] Unfortunately, Skt. *kravya-* 'flesh' and Lith. *kraũjas* do not provide as clear of an example of PL as one would like, for laryngeal deletion may also be attributed to the Saussure Effect:[23] */krou̯h$_2$-i̯o-/ → *krou̯i̯o-. Stem in question: ***kreu̯h$_2$-** 'flesh, gore, blood' (IEW 621–2).[24]

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16 Cf. Gk. ἀδελφός 'brother' < *sm̥-gʷelbʰos 'he who belongs to the same womb'.

17 Peters (ibid.), though already recognized by Beekes 1969: 234, 254. Cf. Gk ὀπάων 'fellow, companion', from earlier ὀπάϝων (Beekes 2010:1089).

18 Lat. ˣ*socaius*.

19 Laryngeal loss is perhaps required for the delabialization of PGmc. *gʷ to *g; see Ringe 2006:129ff. for discussion.

20 As an anonymous reviewer reminds me, *sokʷh$_2$- was very likely to have been a derivative of the root *sekʷ- 'follow', first derived in the form *sokʷah$_2$ 'fellowship, following', whence *sokʷh$_2$ṓ(i̯) 'a member of the fellowship', whence thematized *sokʷi̯o-.

21 A circumflex accent indicates no laryngeal (cf. *naũjas* 'new' < *nou̯i̯ó-).

22 One would expect *krou̯h$_2$-o- > PGmc. ˣ*hrawwa-* through Verschärfung, however, the form reconstructable is *hrawa-, continued by OHG *(h)rō*, OE *hrēaw*, OS *hrā*, and OIce. *hrār* (Ringe 2006:136).

23 For discussion of the Saussure Effect, see rule (29) in chapter 1.

24 An anonymous reviewer once again reminds me that this may in fact be a collective stem formed to the root *kreu̯-, and hence not count as an example of laryngeal loss.

The second example is much more straightforward. Both Ved. *tányati* 'thunders' and Hsch. τέννει · στένει, βρύχεται 'groans, roars' continue a *-*i̯e-* formation to the root **stenh*$_2$-, which is also attested in OCS *stenjǫ* 'groan'. As a group, these forms can only derive from *(*s*)*teni̯e-*. However, it is clear that this root ended in **h*$_2$: AV *astanīt* 'thundered', Gk. στενάζω 'groan', στεναγμός 'a sigh', στενάχω 'groan, sigh', Lat. *tonitrū*, *-us* 'thunder', Celt. PN *Tanaros*, etc.[25] There is further evidence for laryngeal deletion in the Vedic derivatives *tanyú-* 'roaring', *tanyatā́-* 'thundering', and *tanyatú-* 'thunder (m.)'.[26] Root in question: ***(*s*)*tenh*$_2$- 'to thunder' (IEW 1021; LIV 597).

6.2.1.3 Only Attested in 1 Language Family

The remaining examples of PL are isolated, each attested in only one language family.

a. */dh$_2$i̯-e-/ → **di̯e-* > Ved. (YV+) *ava-dyáti* 'detaches'. A laryngeal is vocalized in the aorist form *dīṣva* 'share!' and triggers compensatory lengthening in *áva adāt* 'cut off'; it may be identified as **h*$_2$ through the Greek cognates δαίομαι 'divide' (< PIE **dh*$_2$*ai̯e/o-*; cf. Skt. *dáyate*),[27] δατέομαι 'divide', and δασμός 'distribution, tribute' (EWAia 717; Beekes 2010:305–6). Root in question: ***dah*$_2$(*i̯*)- 'to share' (IEW 175–6; LIV 103).

b. */gʷerh$_3$-i̯e-/ → **gʷeri̯e-* > Lith. *geriù* (inf. *gérti*) 'to drink'. Since the original present was likely **gʷr̥h*$_3$*é-*, continued by Ved. *girati* 'devours', Waxi *nex̌-γar-* 'swallow', and OCS *žĭrǫ* 'devour', it is probable that */gʷerh$_3$-i̯e-/ was an inner-Baltic innovation. For the quality of laryngeal, cf. Gk. βιβρώσκω 'eat up'. Root in question: ***gʷerh*$_3$- 'to devour' (IEW 474; LIV 211–2).

c. */(s)gʷesh$_2$-i̯e-/ 'extinguish' → *(*z*)*gʷesi̯e-* > Ved. *ní jasyata* 'pine!', Ved. *dásyati* 'to jade';[28] cf. OCS *u-gašetu* (*u-gasati*) 'to extinguish' (Jasanoff 2008). According to the LIV, the Vedic forms may be secondary present formations built to the root aorist, given the more widespread nasal-infixed present formation (Hsch. ζείναμεν, OLith. *gęsa* 'expires'). Ved. *dāsīt* 'extinguished' and Gk. ἔσβη 'expired' suggest a root-final */-h$_2$/. Root in question: ***(*z*)*gʷesh*$_2$- 'to extinguish' (IEW 479–80; LIV 541–3).

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25 One should also point out an additional complication here: the root meaning 'groan' was apparently *aniṭ*. See Narten 1993 for further.

26 EWAia 619, 752–3.

27 Expected root-initial ^{x}*dh-* (< **dh*$_2$-) replaced by *d-* through analogy with the aorist (LIV 103).

28 See EWAia I 711 for discussion of *dásyati* for expected ^{x}*jásyati*.

d. */gʰr̥bh$_2$-i̯e-/ → *g^hr̥bi̯e- > Hitt. *karpiye-* 'lift'. This present indicative formation is quite old, attested at the earliest stages of the language (Oettinger 1979:345, Melchert 1997b:85). This etymology is not certain, as Kloekhorst (2007:453) contends that a voiceless *-p(p)-* could not come from medial **-bh$_2$-*, leading him to derive Hitt. *karpiye-* from **(s)kr̥p-i̯e-* instead, built to the root of Lat. *carpō* 'seize', Gk. καρπός 'fruit', Lith. *kir̃pti* 'shear off', OE *sceorfan* 'bite' (cf. Melchert 1994:92). Root in question: ***gʰrebh$_2$-*** 'to grab' (IEW 455; LIV 201).

e. */h$_1$ish$_2$-i̯e-/ → **h$_1$isi̯e-* > Ved. *íṣyati* 'sends out', Av. *-išiiā* 'incites'. According to the LIV, this formation was possibly an old denominative, though the semantic motivations for the creation of a *-i̯e-* present are far from clear. Root-final */h$_2$/ is still continued in the derivatives Skt. *isnā́ti* 'sends away', Gk. ἰνάω 'pour' (both from PIE **h$_1$isnáh$_2$-*), and Gk. ἰάομαι 'cure'.[29] Root in question: ***h$_1$ei̯sh$_2$-*** 'to push' (IEW 299–301; LIV 234).

f. */k̂h$_3$i̯-é-/ → **k̂i̯é-* > Ved. *sám śyat* 'sharpens' (RV). A root-internal */h$_3$/ must be reconstructed to align its many derivatives across the family, including Skt. *sam śā́ya* 'sharpening', Lat. *cōs, cōtis* 'whetstone', and Arm. *sowr* 'sharp; sword' (EWAia 627). Root-final **i̯* crops up in nominal derivatives as well (such as YAv. *saēni* 'point' and ON *hein* 'whetstone'), though is absent in the derivatives Lat. *catus* 'wily', MIr. *cath* 'wise'. Root in question: ***k̂oh$_3$(i̯)-*** 'to sharpen' (IEW 541–2; LIV 319–20).

g. */meĝh$_2$-i̯os/ 'greater' → **meĝi̯os* > Homeric/Attic Gk. μείζων, Ionic Gk. μέζων, Myc. *me-zo* (Beekes 1969:254); cf. Lat. *maior* < **mag-i̯os-* 'greater', either from **məĝi̯os-* (with schwa secundum)[30] ← /m̥ĝh$_2$-i̯os/ or (more likely) a later creation built to the root of *mag-nus* 'great'. It is not clear if **-h$_2$* (which was likely suffixal originally; see NIL for references) was absent in the comparative form for morphological or phonological reasons (or both). Root in question: ***meĝ(h$_2$)-*** 'great' (IEW 708ff.; NIL 468–78).

h. */sh$_1$i̯-é-/ → **si̯é-* > Ved. *(áva, ví) s(i)yáti* 'looses' (see EWAia 720 for related forms) and, according to the LIV, perhaps Hitt. *siēzzi* 'throws, shoots, stings'. Kimball (1987) would prefer to connect this Hittite form with Skt. *ásyati* 'shoots', which she derives from **h$_1$s-i̯é/ó-*, though note that this particular word-initial consonant cluster **h$_1$si̯-* would be a type 3b cluster[31] and would therefore be uncertain. Kloekhorst (2008:694–5) suggests that *siya-* may have been "secondarily … transferred to the *i̯e/a*-class … on the basis of reinterpretation of 3pl.pres.act. *šii̯-anzi* as *šii̯a-nzi*", and would

29 See García Ramón 1986.

30 For further discussion of schwa secundum, see chapter 1 for rule (21).

31 That is, a cluster reconstructed for paradigmatic and/or etymological reasons; see 1.2.2.

in this case also exhibit deletion of *h_1 in the sequence *sh_1*i̯*-, either in PIE or at some point within Anatolian. Root in question: ***seh**$_1$- 'to sow' (IEW 889–90; LIV 517) or ***seh**$_1$**(i̯)**- 'to release' (IEW 889–91; LIV 518).

i. */skh$_x$-i̯e-/ → **ski̯e-* > Lat. *ne-sciō, -scīre* 'not know'. Rix (1999:526–7) reconstructs a laryngeal on the basis of the perfect (**sekh*$_x$*uh*$_2$*a* ↣ **sekau̯ai* > Lat. *secuī*), though note that a laryngeal is also necessary for the Italic derivatives Lat. *secāre*, Umbr. *pru-sekatu* 'let it be cut' (see below) and the unlenited *-kk-* in Hitt. *šākki* 'knows' (Kloekhorst 2008:696). Kloekhorst (ibid.) reconstructs the root as **sekh*$_1$-, a point to which we will return in 6.5 below. Root in question: ***sekh**$_x$- 'to cut' (IEW 895–6; LIV 524).

j. */telh$_2$-i̯e-/ → **teli̯e-* > Gk. τέλλω 'I finish' (Peters 1980: 88[38], Beekes 2010:1462). This formation is quite uncertain—the LIV prefers an original nasal-infixed present, with analogical substitution of root vowel (**tl̥ne-* > **talnō* → **telnō* > τέλλω) and Beekes (ibid.) questions the root itself, suggesting that it derived from the same root as (περι-)τέλλω 'turn in circles' (**kʷel-* 'turn') instead. Root in question: ***telh**$_2$- 'to bear, endure' (IEW 1060–1; LIV 622).

k. */terh$_1$-i̯e-/ → **teri̯e-* > Gk. τείρω 'exhaust, distress, trouble' (ˣτερέω). While it is likely that this root ended in a laryngeal (cf. Gk. τέρετρον 'auger' < **térh*$_1$*trom*), it is not certain that Gk. τείρω was inherited from PIE. In fact, the LIV suggests that the expected form ˣτερέω was replaced by Gk. τείρω due to homonymy with the future ˣτερέω, the latter which is still present in Eust. τερέσσω. Root in question: ***terh**$_1$- 'to bore, rub' (IEW 1071–2; LIV 632).

l. */tu̯erh$_x$-i̯ah$_2$-/ → **tu̯eri̯ah*$_2$- > Gk. σειρή 'cord, rope' (Beekes 2010:1316). Due to the acute accent of Lith. *tvérti* 'to catch, to contain', this root must have ended in a laryngeal, which was likely deleted in the prehistory of Gk. σειρή. Deletion may have also occured in Lith. *teriù* < **tu̯eri̯e-* ← */tu̯erh$_x$-i̯e-/. Other derivatives include OCS *tvorjǫ* 'make, do' and Gk. σορός 'urn', Russ. *tvor* 'creature, form' (both from **tu̯orh*$_x$*ós*). Root in question: ***tu̯erh**$_x$- 'to enclose, contain' (IEW 1101; LIV 656).

m. */u̯erh$_1$-i̯e-/ → **u̯eri̯e-* > Gk. εἴρω 'say' (ˣἐρέω); cf. Hitt. *weriyezzi* 'shouts', for which it is impossible to know if laryngeal deletion occurred in PIE or later (Beekes 2010:393; Kloekhorst 2008:1002–3). Root final */h$_1$/ is still continued by εἴρηκα 'have said'. The LIV views */u̯erh$_1$-i̯e-/ as an innovative formation in both language families, and just as Gk. τείρω above, was likely created by analogy on the basis of the more widespread future ἐρέω (< **u̯erh*$_1$*s-*). Root in question: ***u̯erh**$_1$- 'to speak' (IEW 1162–3; LIV 689–90).

6.2.2 *Instances of Retention*

6.2.2.1 Attested in 2 Language Families

Let us now turn to those examples of laryngeal retention in the environment of PL. While there are none attested in 3 or more language families, there are two likely examples of retention shared by two language families. The first may be seen in the aforementioned verbal root **sekh$_x$-* 'to detach, cut', in which the root-final laryngeal is retained in Italic (Lat. *secāre* 'to cut', Umbr. *pru-sekatu* 'should cut') and Celtic (OIr. *tescaid* 'cuts', the latter which perhaps derives from an earlier **to-eks-skai̯e-*), both from **s(e)kh$_x$-i̯e-*. Our second example is a *-i̯o-* derivative of ****i̯éu̯h$_1$-*** 'grain' (IEW 512; NIL 407ff.), whose simplex form is widely attested throughout the Indo-European family; cf. Hitt. *ewa(n)-* 'grain', Ved. *yáva-* 'grain, corn', Av. *yauua-* 'grain', Lith. *jãvas* 'cereal', and Gk. φυσί-ζοος 'producing grain'. A laryngeal is maintained in Pinault's environment in */i̯éu̯h$_1$-i̯o-/ → **i̯éu̯h$_1$i̯o-* > Ved. *yáv$_i$ya-* 'grain supply',[32] Lith. *jáuja* 'threshing-floor'. Ved. *-i-* and acute accent of the root in Lithuanian indicate a root-final laryngeal, which the NIL reconstructs as **-h$_1$*, on the basis of the Homeric compound ζεί-δωρος 'giving spelt' (< PGk. *ζεϝε < PIE **i̯euh$_1$-*).[33]

6.2.2.2 Only Attested in 1 Language Family

There are quite a few counterexamples attested in only one language family, though many are questionable.

a. */b^{h}ludh$_2$-i̯e-/ → **b^{h}ludh$_2$i̯e-* > Gk. φλυδᾷ 'dissolves'. This root is only found in Greek and the form in question may also be explained as deriving from */b^{h}ludh$_2$-ei̯e-/. Root in question: ****b^{h}leu̯dh$_2$-*** 'to dissolve' (IEW 159; LIV 90).
b. */delh$_1$-i̯e-/ → **delh$_1$i̯e-* > Lat. *dolāre* 'to mill'. While this formation is only attested in Italic, the root is also found in Baltic (Lith. *delù* 'wear out, disappear', Latv. *dęlu* 'wear out, diminish') and Celtic (MWel. *(d)ethol-* 'select'). The LIV reconstructs root-final */-h$_1$/ on the basis of Lat. *dolēre* 'be painful' (< **dolh$_1$-éi̯e-*), though does not rule out */-h$_2$/ or */-h$_3$/ entirely. Root in question: ****delh$_1$-*** 'to chip' (IEW 194–6; LIV 114).
c. */h$_1$elh$_2$-i̯e-/ → **h$_1$elh$_2$i̯e-* > Gk. ἐλάω 'drive, carry off'. This root is only found in Greek and Armenian (cf. Arm. *eli* 'departed'). The LIV suggests

32 It is possible that this *-i-* is in fact the result of Sievers' Law; thus, */i̯éu̯h$_1$-i̯o-/ → **i̯éu̯h$_1$ii̯o-*. Note, however, that such a reconstruction still requires retention of the laryngeal, as the laryngeal must have been present to create a superheavy syllable in the initial syllable in the first place.

33 See Beekes 2010:496–7 for discussion, with references.

that ἐλάω was analogically built from the aorist ἤλασα. Root in question: ***$h_1$elh_2**- 'to drive' (IEW 306–7; LIV 235).

d. */$h_2$elh_1-i̯e-/ → *$h_2$alh_1-i̯e-* > Gk. ἀλέω 'grind'. For root-final */-h_1/, cf. Gk. ἀλέατα 'wheat-groats', ἀλετρίς 'woman who grinds corn', ἄλεστρον 'fee for milling', etc. The LIV reconstructs a state II root instead, */$h_2$leh_1-/, and derives ἀλέω from either *h_2l̥h_1-i̯e-* or a secondary formation built on the aorist ἄλεσσ-. State II is clearly required for Arm. *aliwr* 'flour' (< PIE *$h_2$léh$_1$u̯r̥*; cf. Gk. ἄλευ-ρον 'flour'),[34] though it remains unclear if a State I counterpart is necessary for Greek (for all forms, see Beekes 2010:65). Root in question: ***$h_2$alh_1**- 'to grind' (IEW 28–9; LIV 277).

e. */h_2h_1s-h_1i̯e-/ → *h_2əh_1s-h_1i̯e-* > Lat. *arēre* 'to be dry' and perhaps TA *asatär*, TB *osotär* 'to dry out' (Ringe 1987:115–8). For initial laryngeal, cf. Hitt. *ḫāšša-*, Lat. *āra* 'hearth', both from *h_2a$h_1$sah_2* (Kloekhorst 2007:322–3). Root in question: ***h_2ah_1s**- 'to dry out (by heat)' (IEW 68; LIV 257–8).

f. */-h_x + -i̯os-/ → *-h_xi̯os-* > Ved. *-īyas-* (e.g., *távīyas* 'stronger', from virtual *teu̯h_2-i̯os-*). The PIE comparative suffix *-i̯os-* is continued as *-īyas-* in Vedic, which must be attributed to the vocalization of stem final seṭ roots, or at the very least a subset of seṭ roots. Of course, such vocalization could have occurred much later, with the root-final vowel (< laryngeal) having been analogically reintroduced.[35] Suffix in question: ***-i̯os**- (Fortson 2010:135–6).

g. */kʷṓlh_1-i̯e-/ → *kʷṓlh_1i̯e-* 'make a turn (iterative)' > Gk. πωλέομαι 'to come/go often'. This formation is only attested in Greek, alongside the much more widespread */kʷolh_1-ei̯e-/ (> CLuv. *kuwalīti* 'turns', Ved. *cārá-yati* 'puts in motion', Gk. πολέω). Moreover, as Craig Melchert points out to me (p.c.), Gk. πωλέομαι may also derive from */kʷṓlh_1-ei̯e-/. It is thus unclear if this form should be reconstructed for PIE. Root in question: ***kʷelh_1**- 'encircle' (IEW 639–40; LIV 386–7).

h. */pṓth_2-i̯e-/ → *pṓth_2i̯e-* 'fly (iterative)' > Gk. πωτάομαι 'to fly around'. It is unclear if this formation goes all the way back to PIE for two reasons. First, only Greek shows such a formation, and as Beekes (2009:1182) discusses, Gk. πωτάομαι 'to fly around' was perhaps more likely to have been an independent formation within Greek, with the unexpected -α- analogically extended from the aorist πτάσθαι, presumably by way of the

34 Arm. *aliwr* may in fact be a loanword from Greek; see Clackson 1994:93–5.

35 In a similar light, Nishimura (2005:178) proposes that the superlative formations seen in Oscan *ualaemom* 'optimum', **valaimas** (PN), and South Picene **uelaimes** (PN), reflect the suffixation of the superlative suffix *-(m̥)mo-* to an earlier comparative *u̯elai̯os*, ultimately from *u̯elh_x-i̯os-*.

present πέταμαι.[36] Second, we cannot be certain that this root even ended in a laryngeal, for related forms *may* point back to a laryngeal-less **pet-*: OIr. *én* 'bird' (< **petno-*, not ^{x}*ethan*),[37] Lat. *penna* 'feather' (< **petna*, not ^{x}*penda*), Gk. πτερόν, Arm. *t'ert'* 'feather' (< **ptero-*, not ^{x}πταρόν, ^{x}*t'art'*), and Ved. *pátati* 'fly, fall' (< **pet-*, not ^{x}*páthati*).[38] Purported root in question: ***peth**$_2$*- 'to fly' (IEW 825–6; LIV 479).

i. */pth$_2$-h$_1$-i̯e-/ → **pəth$_2$əh$_1$i̯e-* (?) > Lat. *patēre* 'extend oneself, be open'. This form serves as the stative counterpart to Lat. *pandō* 'open' (< PItal. **patnō*),[39] which, together with Gk. πίτνημι and the Oscan imperfect subjunctive *patensíns* 'were they to open' (< **pat-ăn(ă)-s-ē-nd*), ultimately derives from PIE **pət-na-h$_2$-*.[40] There appear to be two direct cognates to Lat. *patēre*. The first may be seen in the Oscan expression *víu. pat[ít]* 'the way is open', the second in the Volscan imperative *ar-patitu* (< *ađ-pat-e(i)e-tōd*), which Vine (1993:371–781) traces back to the Proto-Italic causative **pat-ei̯-e/o-*.[41] Unfortunately, these Italic derivatives do not appear to shed much light on the age of Lat. *patēre* or whether root-final */h$_2$/ or the "essive" marker */h$_1$/ were retained in this particular form. Root in question: ***peth**$_2$*- 'to spread' (IEW 824–5; LIV 478–9).

j. */(s)ph$_2$-i̯é-/ > Gk. σπάω 'pull'. Root also continued by Arm. *hanem* 'pull'. According to Klingenschmitt (1982:132) the Armenian formation is an innovation, with analogical long **-ā-*. Root in question: ***(s)pah**$_2$*- 'to extract' (IEW 982; LIV 575).

k. */u̯ṓd^{h}h$_1$-i̯e-/ → **u̯ṓd^{h}h$_1$i̯e-* 'push (iterative)' > Gk. ὠθέω 'push'. OCS *važdǫ* 'accuse' also appears to go back to this form, with analogical replacement of **-i̯é-* by **-éi̯e-* (i.e., **u̯ōd^{h}h$_1$-éi̯e-*).[42] The root-final laryngeal is also continued by Skt. *ávadhīt* 'he killed (aor.)' and related forms, though note aniṭ *a-vadhrá-* 'indestructible'. Following Kloekhorst (2008:352), Beekes (2009:1676–7) prefers to connect Gk. ὠθέω 'push' with Hitt. *ḫuett-* 'draw, pull', thereby deriving the form in question from **h$_2$u̯od^{h}h$_1$-éi̯e-*, which he

36 Likewise, as Weiss 2014 argues, it is unlikely that the much-heralded Lat. form *sopīō* derives directly from PIE **su̯ṓpi̯e-*, but rather was secondarily created from the denominal adjective *sōpītus* 'asleep'.

37 Cf. Zair 2012:185: "It is possible that the Celtic forms are late formations, derived from the neo-*aniṭ* verbal root seen in MW. *ehet* 'flies' < **eks-pet-e/o-*."

38 Hackstein 2002b:141.

39 With metathesis and post-nasal voicing via the *unda* rule (Garnier 2010:351).

40 Garnier, *loc. cit.*

41 See Garnier, *loc. cit.* for discussion, with references.

42 Craig Melchert (p.c.) has again correctly pointed out that Gk. ὠθέω 'push' may also be derived from a proto-form containing the unaccented suffix **-ei̯e-*, namely */u̯ṓd^{h}h$_1$-ei̯e-/.

explains accounts for the lack of digamma in Homeric scansion. However, as Beekes himself acknowledges, one must assume an (ad hoc) pre-Homeric contraction of **awot^h-* > ὠθ-.[43] Root in question: ***u̯ed^hh₁-** 'to push' (IEW 1115; LIV 660).

6.2.3 *Conflicting Data*

a. */dh₁i̯-e-/ → **di̯e-* > Ved. (*ā́, sám*) *dyati* 'binds', OAv. *ni.diiātąm* 'should be bound' OR **dəh₁i̯e-* > Gk. δέω 'I bind'; cf. Hitt. *tiya* 'bind!' Curiously, the laryngeal vocalizes in a simplex (stand-alone) form but is deleted in a complex form (preverb + root). Root in question: ***deh₁-** 'to bind' (IEW 183; LIV 102).

b. */h₂erh₃-i̯e-/ 'plow' → **h₂ari̯e-* > PCelt. **ari̯e-* (OIr. *-air*, MWel *ard-*), Lith. *ariù, árti* OR **h₂arh₃i̯e-* > Lat. *arāre*, Gk. ἀρόω; cf. OCS *orjǫ*, OHG *erien*. Certainly the lectiones difficiliores are the Celtic and Baltic forms; as Garnier (2010:203–5) has noted (among others), it is entirely within reason that root-final */h₃/ would have been reintroduced based on the widespread instrumental noun **h₂árh₃-trom* 'plow' (Lat. *arātrum*, Gk. ἄροτρον).[44] Root in question: ***h₂árh₃-** 'to plow' (IEW 62; LIV 272–3).

c. */sĝ^hh₂-i̯e-/ → **sk̂^hi̯e-*[45] > Skt. (*anu-, ava-, vi-*, etc.) *chyati* 'cuts open' and perhaps GAv. *paitī ... siiōdūm* 'cut open!' OR **sk̂^həh₂i̯e-* > Gk. σχάω 'make an incision'. As with */dh₁i̯-e-/ above, the laryngeal appears to vocalize in a simplex form in Greek but be deleted in a complex form in Indo-Iranian.[46] However, according to Rasmussen (1989:61), Gk. σχάω is better derived from **sk̂^hh₂-éi̯e-*, though there is absolutely no direct or indirect evidence in favor of such an onset ever surfacing in PIE. Root in question: ***sk̂^hah₂(i̯)-** 'to cut' (IEW 919; LIV 547).

d. */u̯emh₁-i̯e-/ → **u̯emi̯e-* > Lith. *vemiù* (*vémti*) OR **u̯emh₁i̯e-* > Gk. ἐμέω. Since the original present formation was almost certainly an athematic root present (Skt. *vamiti*, Lat. *uomō* < **u̯emō*), both the Greek and Lithuanian forms are likely secondary. Root in question: ***u̯emh₁-** 'to vomit' (IEW 62; LIV 272–3).

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43 For Melchert (1979), the actual Hitt. cognate of Gk. ὠθέω 'push' is *wizza-, wiwid(a)-* 'strike, pierce; press, urge'.

44 See Beekes 2010:417 for further discussion, with references.

45 With devoicing of */ĝ^h/ via Siebs' Law; see Mayrhofer 1986:92[13].

46 As the reader will discover, this observation will be of great importance in our analysis.

6.2.4 *Discussion*

To review, scholars have reconstructed a number of instances of the sequence */-Ch$_x$i̯-/ in pre-vocalic position. Many of these appear to undergo laryngeal deletion, but some do not. However, it would be foolish of us to view each example in the same light. Some stems, such as **sokʷi̯V-* 'friend' (← */sokʷh$_2$i̯V/) are virtually guaranteed for the proto-language, while others, such as **pṓth$_2$ i̯e-* 'flit around' (← */pṓth$_2$ i̯e-/) are not, likely being einzelsprachlich innovations. For this reason, it would be prudent to sort the aforementioned stems into three different categories: **likely, uncertain**, and **dubious**. Likely stems are considered likely to have existed in PIE, as they are attested in multiple branches and/or lack a plausible alternative explanation. Uncertain stems do have alternative explanations, but it is difficult to choose between them. Finally, dubious stems are derivatives of roots attested in a single branch whose reconstructions are improbable (and therefore are unlikely to have existed in PIE), such as the root-final */-h$_2$/ in */pṓth$_2$i̯e-/. For the sake of clarity, I have cited the number of branches within parentheses in which the form in question is attested.

(210) Overview of Examples and Counterexamples

	Likely	**Uncertain**	**Dubious**
*/h$_x$/ → ∅	*/dh$_2$i̯e-/ (1)	*/dh$_1$i̯e-/ (1)	*/gʷerh$_3$i̯e-/ (1)
	*/h$_1$ish$_2$i̯e-/ (1)	*/h$_2$arh$_3$i̯e-/ (2)	*/gʰr̥bh$_2$i̯e-/ (1)
	*/k̂h$_3$i̯e-/ (1)	*/kre/ou̯h$_2$i̯o-/ (2)	*/meĝh$_2$i̯os/ (1)
	*/(s)gʷesh$_2$i̯e-/ (1)	*/sh$_1$i̯é-/ (1)	*/telh$_2$i̯e-/ (1)
	*/sokʷh$_2$i̯V/ (4)	*/sk̂h$_2$i̯e-/ (1)	*/terh$_1$i̯e-/ (1)
	*/skh$_x$i̯e-/ (1)		*/u̯emh$_1$i̯e-/ (1)
	*/(s)tenh$_2$i̯e-/ (2)		*/u̯erh$_1$i̯e-/ (1)
	*/tu̯erh$_x$i̯ah$_2$-/ (1)		
*/h$_x$/ → **h$_x$*	*/i̯eu̯h$_1$i̯o-/ (2)	*/delh$_1$i̯e-/ (1)	*/bʰludh$_2$i̯e-/ (1)
	*/sekh$_x$i̯e-/ (2)	*/-h$_x$i̯os-/ (1)	*/h$_1$elh$_2$i̯e-/ (1)
		*/h$_2$h$_1$sh$_1$i̯e-/ (1)	*/h$_2$elh$_1$i̯e-/ (1)
		*/(s)ph$_2$i̯é-/ (1)	*/kʷṓlh$_1$i̯e-/ (1)
		*/pth$_2$h$_1$i̯e-/ (1)	*/pṓth$_2$-i̯e-/ (1)
		*/u̯ṓdʰh$_1$i̯e-/ (1)	

Since Pinault's proposal, a number of scholars have dismissed certain forms proposed to be examples of the phonological rule in question. For instance, as seen above, the NIL (409, 448) suggests that Skt. *kravya-*, Lith. *kraũjas* are better derived from **kro̯u̯i̯os*, not **kre̯u̯i̯os*, with loss of **h_2* by the Saussure Effect. Kloekhorst (2008:452–4), following Sturtevant (1930:155–6), contends that Hitt. *kar(ap)piezzi* 'lifts up' derives not from the root **$g^hreb^hh_2$-* 'grab' (which he assumes to be continued by Hitt. *karāp-* 'devour') but rather **(s)kerp-*, the root of Lat. *carpō* 'seize', Lith. *kir̃pti* 'cut off'; thus PIE **(s)kr̥p-i̯e-* > *karpiezzi*. Lastly, Baldi (1974:83) argues PIE **sok^wi̯ós* 'friend' to have been a **-i̯o-* derivative of PIE **sek^w-* 'follow' (Lat. *sequitur*, etc.) and denies the underlying laryngeal altogether, the laryngeal in PIIr. **sak^hHāi̯* 'friend' notwithstanding. Such interpretations, together with the striking conflicting data in 6.2.3 above, have led Piwowarczyk (2008:36) to conclude that "Pinault's rule is only valid for the material of the more recently attested Indo-European languages and … [did not occur in] the whole area of Indo-European." Thus, according to Piwowarczyk, PL occurred independently in only three IE branches: Indo-Iranian, Celtic, and Baltic. On the other hand, scholars have dismissed a number of those instances where PL does not seem to have occurred. For instance, as discussed above, Beekes (2009:1676–7) contends that Gk. ὠθέω 'push' does not derive from **u̯ṓd^hh_1-i̯e-*, but rather from **h_2u̯od^hh_1-éi̯e-*, with pre-Homeric contraction of **$awot^h$-* > ὠθ-. He also suggests that Gk. πωτάομαι 'to fly around' was an independent formation within Greek (2009:1182), with the unexpected -α- analogically extended from the aorist πτά-σθαι, presumably by way of the present πέταμαι, made likelier by the fact that 'to fly' was originally laryngeal-less **pet-*.

We therefore seem to have reached an impasse. Whether one accepts or denies the existence of PL now rests largely on one's preference for particular etymologies and one's particular conception of the PIE grammar. I therefore suggest that we take a different approach to the problem at hand, focusing less on specific nuanced arguments for or against the etymologies cited above (for the time being) and turning our attention to larger, more fundamental questions.

a. The position of the laryngeal in PIE */sok^{w}h$_2$i̯ós/ 'friend' is quite different from */skh$_x$-i̯e-/ 'cut' (Lat. *ne-sciō*). While both laryngeals are situated in between a dorsal stop and a yod plus vowel, the former is in true word-medial position, the latter is part of a highly complex word-initial consonant cluster. Might it be possible that there are certain instances of laryngeal deletion cited above which were not caused by PL? Could other phonological factors (such as placement within the word and/or syllable) be the motivation for laryngeal loss?

b. Is it significant that each of the examples of PL attested in two branches or more exhibit the loss of *h_2? Thus, */sokʷh_2i̯ós/ → *sokʷi̯ós (Lat. *socius*), */kre/ou̯h_2i̯os/ → *kre/ou̯i̯os* (Ved. *kravya-*), and */(s)tenh_2i̯eti/ → *(*s*)*teni̯eti* (Hsch. τέννει). Moreover, is it also significant that certain cases of *h_1 are conspicuously absent from the examples of Pinault's Law that have been deemed **likely**?

c. And lastly, can one establish a good phonetic or phonological reason for laryngeals to be deleted before *i̯ and after a C in word-medial position?

6.3 Motivating Pinault's Law: The Impossibility of a Palatalized Pharyngeal

As we shall soon discover, the answer to each of these questions is yes. But in order to arrive at that point, we must first address the final question. Can one establish a good phonetic or phonological reason for the laryngeals to have been deleted before *i̯ and after a consonant in word-medial position? In other words, why *should* Pinault's Law have occurred in the first place? The solution to this problem lies in the amassed properties of all of the world's languages, in which we may examine how other, non PIE-speaking peoples handle sequences of the shape -Ch_xi̯-. So, phonologically, do we expect PL to occur? Yes, but only if we make two reasonable assumptions. First, *h_2 (at the very least) was phonemically a pharyngeal consonant, likely the voiceless pharyngeal fricative /ħ/. This is the view of the majority of Indo-Europeanists[47] and one which we will revisit later on in this chapter. Second, the post-consonantal sequence *h_x + *i̯, when uttered, would have approximated a palatalized *$h_x{}^j$. We may informally define palatalization as the simultaneous articulation of a consonant + [j][48] or more formally as the coarticulation of a segment with the phonological features [○DORSAL, +high, -low, +front, -back].[49]

Having made these two assumptions we may now put forth a hypothesis. Pinault's Law occurred in PIE because it is impossible—or at the very least extremely difficult—to articulate a palatalized pharyngeal. This statement may be verified in two different, but intimately connected ways. First, we may

47 See 1.2.1.2.

48 Zsiga 2000:71.

49 Hayes 2008:88.

examine palatalization statistics, which will tell us that cross-linguistically palatalized pharyngeals are indeed disfavored.[50] Second, we may examine the inner workings of the upper vocal tract, which present a very straightforward articulatory reason for the avoidance of palatalized pharyngeals.

Let us begin with the typological facts. Of the 693 languages surveyed by Ruhlen (1975), 46/693 exhibit phonemic palatalization (**7%**). Of those 46 languages, 39/46 permitted palatalized coronals (**85%**), 20/46 palatalized velars (**43%**), 13/46 palatalized labials (**28%**), 5/46 palatalized /h/ (**11%**), and 0/46 possessed phonemic palatalized pharyngeals (**0%**). This leads one to assume a palatalization hierarchy (Bessell, ibid.): Coronals > Velars > Labials > Glottals > Pharyngeals.[51] Though not cited in the hierarchy, it appears that three languages of the Northwest Caucasus (Abkhaz, Abaza, and Ubykh) contain palatalized uvular stops and fricatives, for which the tongue body in front of the primary uvular articulation "is raised up toward the hard palate, forming a longitudinally extended articulation" (Catford 1977:290).[52] But there are absolutely no secure instances of pharyngeal consonants secondarily articulated through palatalization. This absence is quite striking given the existence of other types of secondarily-articulated pharyngeals (e.g., labialized pharyngeals) in language families such as Salishan and Northwest Caucasian.[53] These facts lead us to the conclusion that it is simply impossible, or at the very least extraordinarily difficult, to articulate palatalized pharyngeals.[54]

But why is this the case? The reason is quite straightforward—they are mutually incompatible articulations. This immediately becomes apparent

50 This discussion is based on Bessell 1993:45. It is quite telling that Bhat 1978, in his seminal discussion of palatalization, makes no mention of palatalized pharyngeals. This is also true for the more recent overview by Kochetov 2010.

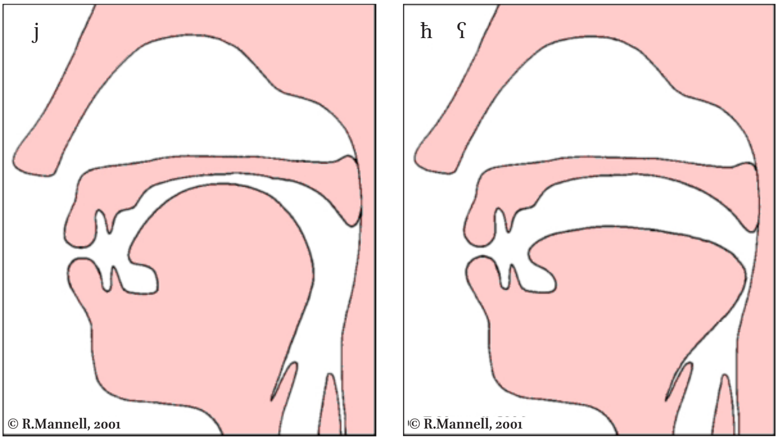
51 It is striking that each instance cited of glottals + j are always [hʲ], and we may add to this list Rom. [hʲ]; cf. /monah/ 'monk' + /i/ → *monahʲ* 'monks' (Spinu et al. 2011). These facts seem to argue strongly in favor of *h_1 as having been */h/; however, note that according to Catford (1977:289), there is perhaps one case of "slightly palatalized /ʔʲ/" in the Abdzakh dialect of Adyghe, a NW Caucasian language.

52 Note that Lomtatidze (1967a, 1967b) characterizes some of these segments in Abaza and Abkhaz as palatalized pharyngeal ejectives. I have found no other scholars that verify his findings.

53 Bessell 1993:44.

54 There is even further evidence of the incompatibility of palatals and pharyngeals. To cite two additional examples: the spread of pharyngealization (better known as emphasis) in Arabic is most likely to be blocked by segments articulated with the front tongue body, such as [i, j]; see Thompson 2006. Moreover, as Haeri (1992) discusses, pharyngealized coronals ([ṭ, ḍ]) are depharyngealized in certain sociolects of Cairene Arabic before a high front vowel [i], with subsequent palatalization: /faaḍi/ → [faad͡ʒi](Haeri 1992:171ff.).

by examination of their polar opposite featural matrices: palatals are typically expressed as [◦DORSAL, +high, -low, +front, -back],[55] pharyngeals as [◦DORSAL, -high, +low, -front, +back]. Thus, in PIE the palatal segment *i̯ (/j/) was articulated with the tongue body high and forward and the tongue root advanced, while *h_2 (/ħ/) was articulated with the tongue body low and back and the tongue root retracted.[56]



In short, this cross-linguistic lack of palatalized pharyngeals may simply be attributed to the impossible coarticulation of the pharynx and hard palate.[57] In other words, a segment cannot be [◦DORSAL, ±high, ±low, ±front, ±back].[58]

55 See Keating & Lahiri 1993 for a more nuanced analysis of palatal features.

56 I am indebted to Robert Mannell for his permission to use the above images.

57 "Coarticulation, very broadly, refers to the fact that a phonological segment is not realized identically in all environments, but often apparently varies to become more like an adjacent or nearby segment. The English phoneme /k/, for instance, will be articulated further forward on the palate before a front vowel ([k̟iː] *key*) and further back before a back vowel ([k̠ɔː] *caw*); and will have a lip position influenced by the following vowel (in particular, with some rounding before the rounded vowel in [k̠ʷɔː] *caw*)." (Kühnert & Nolan 1997:61–2).

58 One may verify the above hypothesis through an informal experiment as well. While presenting the findings of this chapter to three separate audiences of diverse backgrounds (roughly 300 people), I first asked the attendees to make the "Darth Vader sound", which is a voiceless pharyngeal fricative (many thanks to Jay Jasanoff for teaching me this). The

This same articulatory incompatibility (known as **gestural conflict**) was undoubtedly the source of vowel coloring in the lowering of */e/ to **a* and *ə to **ă* adjacent to **h_2* and in the backing (plus rounding) of */e/ to **o* and *ə to **ŏ* adjacent to **h_3*.[59] In each case the non-back mid vowels in question assimilate to adjacent pharyngeals through lowering and/or retraction.

Of course, it is not the case that all **h_x* + *i̯* sequences were forbidden in PIE. There are scores of forms reconstructed for PIE of the shape *-*Vh_xi̯e*- in which laryngeals were maintained as evidenced by the compensatory lengthening of a preceding vowel in the daughter languages; cf. **dʰéh_1-i̯e*- 'suckle' (Gk. θῆσθαι, Arm. *diem*, Latv. *dêju*, OHG *tāen*),[60] **(s)tah_2-i̯e*- 'steal' (Hitt. *tāyezzi*, Ved. *stāyát* 'secret', OLat. *ne … tātōd* 'let one not steal'),[61] and **poh_3-i̯-éi̯e*- 'makes drink' (Ved. *pāyáyati*).[62] In our analysis of Sievers' Law in the previous chapter, we discovered that all PIE words were optimally syllabified by morpheme. Since *-*h_x*- was morpheme-final and *-*i̯*- morpheme-initial in the aforementioned forms **dʰéh_1-i̯e*- 'suckle', **(s)tah_2-i̯e*- 'steal', and **poh_3-i̯-éi̯e*- 'makes drink', each **h_x* + **i̯* sequence surfaced as heterosyllabic, resulting in *[dʰéh_1]$_\sigma$ [i̯e-]$_\sigma$ 'suckle', *[(s)tah_2]$_\sigma$[i̯e-]$_\sigma$ 'steal', and *[poh_3]$_\sigma$[i̯é]$_\sigma$[i̯e-]$_\sigma$ 'make drink', respectively. Thus, we may say that PL did not occur when the sequence **h_x* + **i̯* was heterosyllabic.

However, the *-*h_x*- was also morpheme-final and *-*i̯*- morpheme-initial in the most likely cases of PL, **sokʷh_2-i̯o*- 'friend', **kreu̯h_2-i̯o*- 'flesh, blood, gore', and **(s)tenh_2-i̯e*- 'thunder'. We are therefore led to posit heterosyllabic **h_x* + **i̯* sequences here as well, since a morpheme boundary lies between the laryngeal and **i̯* in each case: ˣ[sokʷh_2]$_\sigma$[i̯o-]$_\sigma$ 'friend', ˣ[kreu̯h_2]$_\sigma$[i̯o-]$_\sigma$ 'flesh, blood, gore', and ˣ[(s)tenh_2]$_\sigma$[i̯e-]$_\sigma$, respectively. But as we have learned thus far, such expected syllabifications were avoided in the face of inviolable or highly-ranked phonotactic constraints in PIE. Thus, **sokʷh_2-i̯o*- 'friend' could only be syllabified as *[sokʷ]$_\sigma$[h_2i̯o-]$_\sigma$ in order to satisfy the MST, which prevents violations of the Sonority Sequencing Principle (SSP) in word-medial

audience members would then be guided to articulate a voiced palatal glide [j], which as English speakers they could do with ease. I then asked for the audience to articulate the Darth Vader sound once again, but this time with [j] at the same time. The response from the audience was unequivocal: the coarticulated segment in question was for all purposes impossible for them to make. I encourage the reader to try this on her own.

59 See 1.2.1.2.

60 LIV 138.

61 LIV 616.

62 LIV 462.

codas.[63] Moreover, speakers would have been led to syllabify **kreu̯h₂-i̯o-* 'flesh, blood, gore' and **(s)tenh₂-i̯e-* 'to thunder' as *[kreu̯]$_\sigma$[h₂i̯o-]$_\sigma$ 'flesh, blood, gore' and *[(s)ten]$_\sigma$[h₂i̯e-]$_\sigma$, respectively, given the application of Szemerényi's Law (*RF]$_\sigma$) in word-medial position, at least at some early point in PIE.[64] In short, the phonotactic constraints MST and *RF]$_\sigma$ would have "forced" a morpheme-final laryngeal into the onset of the following syllable, thereby creating a tautosyllabic consonant cluster *$_\sigma$[h_xi̯-. Thus, we may say that PL occurred only when the sequence *h_x + **i̯* was tautosyllabic.

(211) Pinault's Law (Revised)
PIE *$h_x \rightarrow \varnothing$ $_\sigma$[___ i̯
A laryngeal is deleted in an onset before a tautosyllabic yod.

There are countless cross-linguistic parallels in which consonant clusters are permitted when heterosyllabic but avoided when tautosyllabic. For instance, in English the sequence *-tn-* is permitted heterosyllabically in monomorphemic *witness* and the sentence *sit next to me*, but there are no such words as *ˣ**tn**ack* or *ˣwark**tn**er*. Similarly, we may say *Geo**rg**ia* but not *ˣ**Rj**ohn, Su**bw**ay* but not *ˣ**Bw**ay, Ca**lt**ech* but not *ˣ**Lt**ech*, and *Ke**nt**ucky* but not *ˣ**Nt**ucky*. We may observe similar facts in any language of our choosing that permits consonant clusters. To take an example from the ancient Indo-European world, speakers of Old Irish could say *áinsem* 'accusation' but not *ˣ**ns**em, fi**ndf**adach* 'blessed' but not *ˣ**ndf**adach*, and *co**rpth**i* 'corporeal' but not *ˣ**rpth**i*. In each of the illicit cases from English and Old Irish cited above, the illegal onsets in question violated either the SONORITY SEQUENCING PRINCIPLE (SSP; cf. *ˣ**Rj**ohn, ˣ**ndf**adach*) or certain highly-ranked phonotactic constraints in the language, such as the prohibition of adjacent labials in the onset of *ˣ**Bw**ay*. As **i̯* was more sonorous than *h_x in PIE (confirmed by both nucleus selection and laryngeal metathesis)[65] and since SSP violations were tolerated in onset clusters anyhow,[66] it is clear that PL may not be viewed as a syllabically-motivated process of stray erasure. Rather, instances of laryngeal loss within Pinault's environment must be attributed to a specific, highly-ranked phonotactic constraint that targeted syllable onsets. Following the arguments laid

63 See 3.3.3.
64 See 3.3.5.
65 See 3.3.2.
66 See 3.3.9.

out above, I propose that this phonotactic constraint bans the onset sequence of pharyngeal plus yod.[67]

(212) $^{*}{}_{\sigma}$[ħj-
A sequences of pharyngeal plus yod is banned in onset position.

Syllable boundaries constitute the bounding domain for palatalization in other languages, such as Turkish,[68] where an underlying velar stop (/k g/) surfaces as palatal ([c ɟ]) in the vicinity of a front vowel (a process known as velar fronting), though only when this vowel occurs within the same syllable as the underlying velar stop.[69]

(213)	a. *kir*	'dirt'	[cir]
	göys	'chest'	[ɟøjs]
	b. *kol*	'arm'	[kol]
	gaz	'gas'	[gaz]
	c. *dic*	'upright'	[dic]
	renk	'color'	[reɲc]
	ok	'arrow'	[ok]
	d. *istimlak*	'expropriation (nom.sg.)'	[istimlak]
	istimlaki	'expropriation (acc.sg.)'	[istimla:ci]

The reader will note that velar fronting occurs in both pre-vocalic position (203a) and post-vocalic (203c) position. However, a reference to vowels alone will not suffice in light of forms such as *renk* [reɲc] 'color' and *istimlaki* [istimla:ci] 'expropriation (acc.sg.)' with intervocalic /k/. As Myers & Crowhurst (ibid.) explain, the simplest explanation to velar fronting in Turkish refers to the position of underlying velar stops with respect to front vowels within the same syllable. As they demonstrate, the proposed syllable boundaries

67 Note that many of the arguments presented here also hold true for uvular fricatives (as per Kümmel 2007:336), sounds which are rarely palatalized (see above) and which are also characterized as [-high, +back, -front].

68 Another possible example comes from Lardil (Donegan & Stampe 1978). Note that it is not the case that all instances of palatalization look to the syllable as its domain of application. For instance, in German, palatalization occurs irrespective of syllable boundaries: cf. Da[χ], Dä.[ç]er beside flu[χ]t, flü[ç].tig. Thus: /χ/ → [ç] / [+syll, +front] ___. For further discussion, see Wiese 1996:209ff., with references.

69 First suggested by Clements & Sezer 1982. The following discussion is based on the work of Scott Myers and Megan Crowhurst at http://www.laits.utexas.edu/phonology/turkish/index.html.

may be independently confirmed by other phonological processes that occur in Turkish, such as syllable-final obstruent devoicing.

(214) Turkish Velar Fronting

$$\begin{bmatrix} -son \\ -syll \\ \circ DOR \\ +back \end{bmatrix} \rightarrow [-back] \;/\; [\,\_\_\; \begin{bmatrix} +syll \\ -back \end{bmatrix} \alpha \;\_\_\,]_{\sigma}$$

Turkish velars are realized as palatal when occurring in the same syllable as front vowels.

The palatalization of velar stops is also restricted to syllables in Sipakapense (Barrett 1999), a Mayan language spoken in the Western highlands of Guatamala. Here the phonemes /k/ and /k'/ (ejective /k/) will surface as palatal stops with a slight offglide ([cʲ] and [cʲ'], respectively) when preceding the vowels /i/ or /e/, though only within the same syllable.[70]

(215) Sipakapense Velar Fronting

a.	/k-ixiim/	[cʲxiim]
	3pPOS-corn	'their corn'
	/k-uleew/	[kleew]
	3pPOS-land	'their land'
b.	x-∅-k-t'is/	[xcʲt'is]
	COM-3sABS-3pERG-sew	'they sewed it'
c.	/t-∅-k-k'is	[tcʲcʲ'is]
	DUB-3sABS-3pERG-finish	'They will (probably) finish it.'
d.	/k-∅-k-keem/	[kcʲcʲéem]
	COM-3sABS-3pERG-weave	'They are/were weaving'
e.	/k-i'-k-s(i)k'-ij/	[cʲiʔk.scʲ'ij]
	INC-3pABS-3pERG-call-MOD	'They called them.'

Palatalization may affect both single consonants (205a) and a maximum of two velar stops in highly complex onset clusters (cf. 205b–205d). Crucially, velars are not targeted for palatalization when they occupy a tautosyllabic coda or occupy another syllable altogether; thus, in (205d) /k-∅-k-keem/ → [kcʲcʲeem]

70 I am indebted to Rusty Barrett for his help with this matter, in both analysis and data.

(with extrasyllabic [and therefore not tautosyllabic] word-initial [k-]) and in (205e) /k-i'-k-s(i)k'-ij/ → [cʲiʔk.scʲ'ij], not ˣ[cʲiʔcʲ.scʲ'ij].[71]

Nevertheless, these processes in Turkish and Sipakapense—while indeed instances of palatalization that make reference to the syllable—are not exact parallels of Pinault's Law. In the case of Turkish, the phonological trigger is a front vowel located in the same syllable, not an immediately following tautosyllabic /j/. And in Sipakapense, while the consonants targeted are always in onset position, the trigger is a nuclear /i/ and /e/, and again, not a /j/. Of course, it is widely known that /j/ is one of the commonest triggers of palatalization; cf. PIE **ti̯egʷetor* >> Gk. σέβεται 'is in awe' (Rix 1992:90),[72] PIE **di̯eu̯-* > Hitt. *šiū(na)-* 'god' (Melchert 1994:118), PGmc. **drankjan* > Eng. *drench*, etc. But is it possible to find examples of palatalization triggered solely by an immediately following tautosyllabic /j/ as has been proposed for PL? We need not leave the Indo-European family to find such an example, for in Latvian the underlying alveolar consonants /t, d, t͡s, d͡z, s, n, r, l/ are palatalized to [ʃ, ʒ, t͡ʃ, d͡ʒ, ʃ, ɲ, rʲ, ʎ] (respectively) by a following /j/, though only when both segments occur within the onset of the same syllable (Urek 2013). Consider the following nouns, all of the second declension:

(216) Latvian Palatalization

	nominative singular	genitive singular	gloss
a.	[ska.pis]	[ska.pja]	'closet'
	[buo.mis]	[buo.mja]	'pole'
b.	[la.sis]	[la.ʃa]	'salmon'
	[briː.dis]	[briː.ʒa]	'moment'
c.	[puː.slis]	[puː.ʃʎa]	'bladder'
	[ku.snis]	[ku.ʃɲa]	'flux'
d.	[val.sis]	[val.ʃa]	'waltz'
	[gul.snis]	[gul.ʃɲa]	'tie'
e.	[suːt.nis]	[suːt.ɲa]	'envoy'
	[biːd.nis]	[biːd.ɲa]	'gauge'

71 Rusty Barrett points out to me that, like in PIE, morphology can change the expected syllable structure within the derivation, such that /a-kmiʔx/ (2sPOS-shirt) 'your shirt' is first realized as [a.cʲmiʔx] (hence the palatalization), in order to maintain root identity, with subsequent resyllabification to [acʲ.miʔx].

72 For the original cluster, cf. Skt. *tyajate* 'worships'.

The forms given in (206a.) make it clear that the underlying form of the nominative singular is /-is/, the genitive singular /-ja/. As illustrated in items (206b.)–(206e.), the latter ending /-ja/ triggers the palatalization of stem-final alveolar consonants with subsequent deletion of the /j/,[73] though only when both are found within the same syllable.[74] As Urek (ibid.) argues, syllabification in Latvian is governed by both the SSP and the maximal onset principle (MOP),[75] which explains why certain onset clusters are permitted in word medial position (such as /briː.dja/, /ku.snja/ → [briː.ʒa], [ku.ʃɲa]) and why the underlying clusters in /valsja/, /gulsnja/, /suːtnja/, /biːdnja/ may only be syllabified as [val.sja], [gul.sja], [suːt.nja], and [biːd.nja], respectively. Such syllabifications account for the lack of palatalization of the initial consonant of the medial consonant sequence: [val.ʃa], [gul.ʃa], [suːt.ɲa], [biːd.ɲa]. We have therefore found a perfect parallel to the explanation put forth for Pinault's Law above, a case of palatalization which is restricted to onset position and only triggered by /j/.

But why should a syllable boundary function as a barrier to palatalization? Perhaps the most straightforward explanation would follow the notion that "temporal patterns in speech production are characteristic of phonological organization" (Shaw et al. 2009:188). In other words, the timing of segments *spanning* constituents such as the phonological phrase and the phonological word is fundamentally different from the timing of segments located *within* said constituents. But may the same be said of syllables? May one also assume that the timing of segments within syllables differs from segments that are articulated across a syllable boundary? And might this difference in timing explain why the consonant sequence /ħ + j/ is forbidden only tautosyllabically in PIE?

To answer such questions we must now turn to a seminal study conducted by Byrd (1996:212), who tested the hypothesis that "temporal coproduction in consonant sequences is greater if the consonants are tautosyllabic, less if they are heterosyllabic". If this were true then the PIE onset sequence $*_{\sigma}$[ħ̆j- ([sok^{w}]$_{\sigma}$[h$_{2}$i̯ós]$_{\sigma}$ 'friend') would be more coarticulated than the heterosyllabic sequence *-ħ]$_{\sigma}$[j- ([(s)tah$_{2}$]$_{\sigma}$[i̯e-]$_{\sigma}$ 'steal'). Byrd conducted an electropalatographic study of timing patterns in adjacent consonants, which she elicited in the utterances of five speakers of American English. Following the important findings of Hardcastle & Roach (1979), Byrd assumes there to be no difference on timing measures in bipartite consonant sequences between a word boundary

73 The same process occurs in all plural cases of the second declension as well.

74 See Urek (ibid.), to whom I am indebted for her kind assistance with this problem.

75 See 2.4.

(-VC # CV́-) and a word-medial coda + onset boundary (-VC.CV-). In other words, a heterosyllabic consonant sequence will exhibit the same amount of coarticulation whether that sequence is situated within the same word or across a word boundary; thus, the tokens *save your* and *savior* are for all purposes articulated in exactly the same way—both as [se͡iv.jɹ̩].[76] Aside from the elicitation "*Say* ***backs*** *Abigail*", Byrd elicits each pair of monosyllabic words within the format "*Type* ___ *again*".

(217)

Consonants C_1C_2	Heterosyllabic sequences C#C	Onset cluster #CC	Coda clusters CC#
d g	*bad gab*		
g d	*bag dab*		*bagged amp*
s g	*bass gab*		
g/k s	*bag sab*		*backs Abigail*
s k	*bass cap*	*a scab*	*mask amp*

76 With these facts in mind we may identify even further instances of palatalization restricted to the syllable onset. For example, in my own dialect of American English there exist two types of palatalization, one bounded to the word, the other restricted to word boundaries. The first obligatorily retracts all [+anterior] obstruents (/s, z, t, d/) to [-anterior] ([ʃ, ʒ, t͡ʃ, d͡ʒ]) before a /j/ within the same word. Compare the pairs: *habi*[*t*] ~ *habi*[t͡ʃ]*ual, gra*[*d*]*e* ~ *gra*[d͡ʒ]*ual, confe*[*s*] ~ *confe*[ʃ]*ional, plea*[*z*]*e* ~ *plea*[ʒ]*ure* (Zsiga 1994:67). The other optionally occurs across a word boundary. Thus, in an informal conversation with one's peers a speaker is more likely to pronounce *might you* as [ma͡ɪt͡ʃ(j)ə], *could you* as [kʰʊd͡ʒ(j)ə], *miss you* as [mɪʃ(j)ə], *use you* as [juʒ(j)ə]—though the extent of which will vary. This type of palatalization is also lexically restricted to certain words such as 'you' and variants thereof, for one cannot pronounce "we brough[t] [y]aks to the zoo" as "we brough [t͡ʃ]aks to the zoo" (Pulleyblank 1989:204). On the other hand, speakers may not pronounce *habitual* as *habi*[*tj*]*ual*, no matter the context. As an obligatory change, the pronunciation is invariably *habi*[t͡ʃ]*ual*. If Hardcastle & Roach are indeed correct that word boundaries are equivalent to syllable boundaries in timing measures, and obligatory palatalization does not occur across a word boundary, then the following two observations will follow. First, we may assume that obligatory palatalization does not occur across a syllable boundary. Second, we may assume that obligatory palatalization only occurs within the same syllable, i.e. in onset position, thereby providing us with an exact parallel to PL. This view is corroborated in English dialects that maintain the historically underlying alveolar obstruent + /j/ sequence in word-initial position: thus, Australian [t͡ʃ]*une*, [d͡ʒ]*une*, etc.

In her study, Byrd analyzed the timing measures of stop + stop, stop + fricative, and fricative + stop sequences, but for our purposes the most important elicitations are *bass cap, a scab*, and *mask amp*, in which the cluster /s + k/ is tested in all syllabic permutations. Of the three types of sequences analyzed this one should pattern more similarly to the proposed PIE sequence of fricative + glide (/ħ + j/).[77] If temporal coproduction in tautosyllabic consonant sequences were greater as originally assumed by Byrd, we would expect tautosyllabic [sk] to be more coarticulated in the pairs *a scab* and *mask amp*, and less coarticulated in *bass cap*. However, her findings run counter to this initial hypothesis—tautosyllabic sequences were not more coarticulated than heterosyllabic ones. In fact, onsets were the least overlapped of the three types of sequences, while coda [sk] and heterosyllabic [sk] behaved similarly. We thus cannot explain the restriction of palatalization to onset position by consonantal overlap, as such measures actually predict palatalization to be more likely to occur in heterosyllabic C + /j/ sequences. In fact, if consonantal overlap were relevant, one would expect PL to occur in */steh$_2$i̯éti/ 'steals' and not */sokʷh$_2$i̯ós/ 'friend'!

What exactly then was the phonetic motivation for the restriction of palatalization to onset position? It is difficult to know the precise answer, but perhaps it may be found in the extensive (and highly influential) work done by Browman and Goldstein over the last three decades, who have demonstrated that the placement of consonants within the syllable may affect the coordination of articulatory gestures in at least two ways. First, onset consonants have a stronger phasing relationship with a following vowel than do coda consonants (Browman & Goldstein 1995). This means that onsets exhibit a greater degree of overlap with a following vowel of the same syllable than a following vowel of another syllable. Thus, the [p] of Eng. *a pin* overlaps more with the following [ɪ] than does the [p] of Eng. *up in*. Moreover, tautosyllabic onset consonant clusters exhibit what is known as the "c-center" effect (Browman & Goldstein 1988), "in which the oral constriction gestures constituting the onset appear to be phased as a single unit with respect to the vowel gesture" (Browman & Goldstein 2000:28). Second, and perhaps more importantly, onset consonants exhibit higher "bonding strength" than do consonants in a coda cluster (Browman & Goldstein 2000), resulting in less variability of gestural overlap, and therefore a more consistent pronunciation. It is perhaps these two phonetic characteristics that lead to the restriction of phonological processes

77 I was unable to find a comparable study that analyzed the timing measures of either a dorsal fricative + glide or (more generally) any fricative + glide.

such as palatalization to onset position in languages like Sipakapense, Latvian, and of course PIE.

Let us now review what we have learned thus far. First, through examination of palatalization statistics and the make-up of the upper vocal tract, we have discovered that palatalized pharyngeals are either impossible (or at the very least extraordinarily difficult) to articulate, thereby explaining the motivation for post-consonantal laryngeal deletion before yod in PIE. We have also seen through cross-linguistic examination that palatalization processes may be bounded to a syllable and have even identified an exact parallel in Latvian to the palatalization proposed for Pinault's Law, wherein /j/ triggers the palatalization of adjacent consonants though only within the onset of the same syllable. And lastly we have discovered in the important work of Browman & Goldstein that there are at least two ways in which a tautosyllabic sequence such as **-h_xi̯-* would have behaved as a single unit as compared to an identical heterosyllabic sequence. It is for these reasons that we may claim that the former sequence would more closely approximate a palatalized laryngeal (**-$h_x{}^y$-*) than would a heterosyllabic **-h_xi̯-* one; as a result, PL did not occur when the sequence **-h_xi̯-* = / V__V.

There are additional complications, however. Earlier it was assumed that at the very least **h_2* was phonemically a pharyngeal consonant; however, it is highly likely that both **h_2* and **h_3* were pharyngeal consonants, given their sonorant-like behavior and the vowel coloration effects reconstructable for PIE.[78] On the other hand, **h_1* shows no such vowel coloration. This is to be expected if **h_1* is a "true" laryngeal consonant, [h] or [ʔ]; cf. Wilson (2007:55): "Because the tongue is not the primary articulator for a laryngeal sound, gestural conflicts between laryngeals and surrounding vowels do not exist. Thus, on purely phonetic grounds, it is expected that laryngeals would not lower/retract vowels …" In short, it is likely that both **h_2* and **h_3* were pharyngeal segments ([ħ], [ʕ⁽ʷ⁾]) but **h_1* was a glottal consonant ([h] or [ʔ]). If PL occurred because a palatalized pharyngeal consonant was banned and **h_1* was not a pharyngeal consonant, then it follows that PL should not affect **h_1*. Pinault's Law therefore should be formulated as follows:

(218) Pinault's Law (Final)
PIE *$h_{2/3} \rightarrow \varnothing$ / $_{\sigma}$[__ i̯
A second or third laryngeal is deleted in an onset before a tautosyllabic yod.

78 See 1.2.1.2.

6.4 Implications

Should the above hypothesis prove to be correct, it would provide additional evidence that the laryngeal phonemes *h_2 and *h_3 were fundamentally different from *h_1 with respect to features. While it is likely that the laryngeals as a whole formed a natural class of "post-velar" fricatives within PIE, it is clear that *h_2 and *h_3 were featurally more similar to each other than to *h_1. For instance, as we have discussed previously, due to the retraction of the tongue *h_2 and *h_3 colored adjacent non-back mid vowels in PIE, while *h_1 did not. Moreover, according to most scholars *h_2 and *h_3 were both continued (in part) as phonemes in many of the attested Anatolian languages, while *h_1 likely was not.[79] Contrast PIE **$h_2$ant-* 'face' (Lat. *ante*, Gk. ἀντί) > Hitt. *ḫant-* 'front', Lyc. *xñtawa-* 'rule', PIE **$h_3$op-* 'work' (Lat. *ops*, Ved. *apas*) > Hitt. *ḫappariye-*, Lyc. *epirije-* 'sell' with PIE **$h_1$ésti* > Hitt. *ēšzi*, Lyc. *esi* 'is' (Melchert 1994:72). That *h_2 and *h_3 merged into one phoneme in Hittite and Luvian (*/x/ or */ħ/) in word-initial position gives further credence to the hypothesis that these segments were featurally very similar, and they likely ceased to be contrastive when obstruents were devoiced in this position (cf. Melchert 1994:22). Lastly, it is probable that the two sets of laryngeals had divergent treatments in the (word-final?)[80] environment *i __]$_\sigma$ in Greek and Tocharian (Ringe 1996, Malzahn 2010).[81] While PIE *-ih_1 is continued as *ī in both branches (cf. *u̯ī́k̑m̥tih_1* 'twenty' > Dor. Gk. Ϝίκατι, PToch. **wī́kəmti* > A *wiki*, B *ikäṃ*), it is clear that PIE *-ih_2 becomes *-ja in both (cf. PIE **bʰér-ont-ih_2* > PGk. φέροντjα, PToch. **pərëntsa* > Gk. φέρουσα 'carrying (nom.fem.sg.)', TB *prentsa* 'pregnant'),[82] and it is likely that *-ih_3 > *-jV as well, at least in Tocharian (PIE **prótih_3kʷom* 'face' > PToch. **prótyakʷ-* > TB *pratsāko*, TA *pratsak* 'chest').[83] Note that divergent treatments of *i + h_x should

79 Melchert 1994:65. Kloekhorst (2004) assumes *h_1 was continued as a glottal stop /ʔ/ in Anatolian; if true, then these featural differences would be confirmed.

80 This change perhaps occurred word-medially, too, if Lex Francis-Normier is correct (Francis 1970, Normier 1977, Klein 1988, Rasmussen 1990–1).

81 Jared Klein reminds me that Gk. ὄσσε 'two eyes' appears to derive from **$h_3$okʷi̯e*, ultimately from **$h_3$okʷih_1*. However, this reflex need not be lautgesetzlich; it may be accounted for by analogy, as the normal dual ending to consonant stems was in -ε. Thus, **$h_3$okʷih_1* > PGk. **okʷī* ⇝ PGk. **okʷje* > ὄσσε.

82 Examples from taken from Ron Kim's *Introduction to Tocharian*, accessed April 2014 at https://www.academia.edu/2525466/Introduction_to_Tocharian.

83 Cf. Ved. *prátīkam*, Gk. πρόσωπον 'face'.

also be explained by gestural conflict, motivated for the same articulatory reasons as assumed in our formulation of Pinault's Law above.[84]

In the section above we have discovered that Pinault's Law was a process of laryngeal deletion bounded to syllable's edge. Such bounding domains are implicative (cf. Hayes 2009:212–3)—if a certain sequence was banned at the edges of syllables, then it was also banned at the edges of feet, phonological words, phonological phrases, etc., since the edges of these prosodic categories also coincide with the edges of syllables.[85] Thus, if the onset sequence *$_{\sigma}$[h$_{2/3}$i̯- were blocked in PIE, then it follows that the word-initial sequence *#h$_{2/3}$i̯- was blocked as well. Likewise, if the onset *$_{\sigma}$[h$_1$i̯- were a licit sequence in PIE, then word-initial *#h$_1$i̯- was a licit sequence as well.

Our study of PL therefore significantly impacts our conception of word-initial laryngeal + yod sequences in PIE. Since we may now say that in PIE the only licit *$_{\sigma}$[h$_x$i̯- sequence was *$_{\sigma}$[h$_1$i̯-, our hypothesis puts forth an indirect argument that *all* word-initial **h$_x$i̯-* sequences should be reconstructed as **h$_1$i̯-*. Up until this point, scholars have fairly universally reconstructed for the proto-language the laryngeal-less sequence **i̯* and the sequence **h$_x$i̯-* with an unspecified laryngeal in word-initial position. These sequences merge together in all IE branches but in Greek, where one finds the divergent treatments ζ and ʿ (rough breathing). While there has been much disagreement over the provenance of both segments in Greek for almost a century, a consensus has recently emerged,[86] whereby ζ derives from laryngeal-less **i̯-* and ʿ from **h$_x$i̯-*.[87] We may now slightly modify this view by postulating (with Bozzone) that ʿ can only derive from **h$_1$i̯-*, as this was the only possible word-initial laryngeal + yod sequence in PIE. Thus, PIE **i̯ugóm* 'yoke' > Skt. *yuga-*, Lat. *iugum*, Gk. ζυγόν, while **h$_1$i̯ékʷr̥* 'liver' > Skt. *yákr̥t*, Lat. *iecur*, Gk. ἧπαρ.

As Bozzone (2013) discusses in great detail, there are many reasons to think that this was true. For starters, the relative pronoun **h$_1$i̯ó-* (> Gk. ὅς, Skt. *yá-*,

84 That is to say, the transition from the high-front vowel **i* to the low-back segments **h$_2$* and **h$_3$* prompted the epenthesis of a transitional schwa, versus expected loss plus compensatory lengthening of the preceding **i*. For what it is worth, when recording the story **H$_3$rḗk̂s dei̯u̯ós-kʷe* (*The King and the God*) for *Archaeology Magazine* in the on-line feature "Telling Tales in Proto-Indo-European" (http://www.archaeology.org/exclusives/articles/1302-proto-indo-european-schleichers-fableart_page2), it was physically impossible for me to pronounce **pótnih$_2$* 'wife' as [pɔtniħ]. After a number of attempts I eventually gave up and settled on the articulatorily-easier pronunciation [pɔtniɑħ], exactly as the Tocharians and the Greeks had done.

85 Extrasyllabicity aside.

86 See Bozzone 2013:1–2 for references, with discussion.

87 There are of course other sources of both segments in Greek; see Rix 1995.

etc.) has long been connected with the proximal deictic **$h_1e\underset{\frown}{i}$*- 'this' (Skt. *ayám*, Lat. *is*), illustrating that the sequence **$h_1\underset{\frown}{i}$*- was indeed continued by rough breathing in Greek. Bozzone (ibid.) adduces additional examples, such as ἑσμός 'swarm of bees' (< PIE **$h_1\underset{\frown}{i}eh_1$*- 'throw, send'; cf. Lat. *iēcī* 'I threw'),[88] ἅγιος 'holy' (< PIE **$h_1\underset{\frown}{i}a(h_2)\hat{g}$*- 'worship';[89] cf. Skt. *yaj*- 'sacrifice'), and ὑσμίνη 'battle' (< PIE **$h_1\underset{\frown}{i}e\underset{\frown}{u}d^h$*- 'move', cf. Ved. *yūyudhir* 'bellicose'). She further shows that PIE **h_1* is maintained as rough breathing before syllabic **i* as well, essentially directly continuing its original pronunciation from the proto-language, as seen in ἵημι 'I send' (< PIE **$h_1i\text{-}h_1\underset{\frown}{i}eh_1$-mi*) and most significantly ἵππος (< **$h_1ə_2\hat{k}\underset{\frown}{u}$-o*-, with schwa secundum[90] ← */$h_1\hat{k}\underset{\frown}{u}$-o-/), whose initial rough breathing has vexed scholars for ages. This sound law only occurred in word-initial position, hence the lack of rough breathing in λεύκ-ιππος '(riding/famous for) white horses' and Λεύκ-ιππος (PN).

The restriction of PL to syllable-initial **$h_{2/3}$*- holds further ramifications for our reconstructions of PIE. No longer should scholars argue on phonological grounds against the existence of the Essiv (zero-grade verbal derivatives in *-$h_1\underset{\frown}{i}$é/ó*-; LIV 25) as being contrary to Pinault's Law (Jasanoff 2002:132), though, of course, this does not necessarily entail that the Essiv itself existed as a verbal category. Individual etymologies will also need to be revisited, such as the widely-accepted reconstruction of PIE **$h_2\underset{\frown}{i}u\text{-}g^wih_3$*- 'life everlasting', which Weiss (1994) proposes to be the source of Gk. ὑγιής 'healthy', Cypriote Gk. <*u-wa-i-se/za-ne*> ὐϝαις ζαν 'forever and ever', Lat. *iūgis* 'everflowing', Av. *yauuaējī* 'living forever', and Goth. *ajukdūþs* 'eternity'. While a reconstructed, underlying */$h_2\underset{\frown}{i}$(e)u-$g^w ih_3$-/ (which must have surfaced as **$\underset{\frown}{i}$(e)ugih$_3$*- via Pinault's Law and the *boukolos* rule) may still be viewed as the source of the majority of forms cited above, one will need to modify the etymology of the Greek forms, either by assuming an ad hoc dissimilatory change of /*h_2/ to **h_1* before yod in word-initial position (though I suspect this may cause more problems than it solves; see Bozzone 2013:7–8), or through the adoption of the alternative etymology **$h_1su\text{-}g^wih_3$*- 'having a good life' (Saussure 1892), with loss of laryngeal in compounds. As discussed by Southern 2002, it is possible that the underlying onset of the root */$h_2\underset{\frown}{i}e\underset{\frown}{u}$-/ 'lifetime' is continued by Gk. ζ in the plurale tantum ζειαί 'spelt, one-seeded wheat', from the original meaning

88 Peters 1976.

89 The reconstruction of */h_2/ here depends on one's belief in */a/-vocalism vs. the assumption of Lubotsky's Law; see Byrd, forthcoming a for further discussion, with references.

90 Cf. Hackstein 2012:111, Hackstein 2013.

‘the grain of life’. Underlying */h_2i̯u-/ could only have surfaced as **i̯u-* in PIE, which in turn underwent the normal treatment to ζ in word-initial position.[91]

6.5 Conclusions

To conclude, we have confirmed Wackernagel’s and Pinault’s hypothesis that laryngeals were deleted in word-medial position before a yod plus vowel. In fact, it is a phonological rule that we *expect* to have occurred, one which is confirmed by the cross-linguistic absence of palatalized pharyngeals and the common-sense gestural conflict that arises. Through our investigation we learned that Pinault’s Law should be restricted to */h_2-/ and */h_3-/ in onset position, putting forth a very powerful indirect argument in favor of all word initial **h_xi̯-* sequences as having been **h_1i̯-*. But our hypothesis is not perfect—it does not account for all of the unexpected exceptions to PL detailed above. Fortunately, however, none of these examples is found in more than one language at a time. Moreover, most were deemed “dubious”, making an einzelsprachlich account possible for many of them. Thus, as discussed above, **h_1* deletion did not actually occur in some ancestral form of Gk. τείρω (*ˣterh₁i̯e-*) or Lith. *vemiù* (*ˣu̯emh₁i̯e-*), as these forms were secondarily created within the languages themselves. Similarly, Gk. πωτάομαι ‘flit around’ (*ˣpṓth₂i̯e-*) and Gk. ἐλάω ‘drive’ (*ˣh₁elh₂i̯e-*) are not convincing cases of **h_2* and **h_3* retention, either, as both were inner-Greek formations.

But that does not mean that all examples and counterexamples to PL have been accounted for, as there are forms remaining that need to be given serious thought. Let us do so by returning to our table of examples and counterexamples to PL from above. I have eliminated all of the dubious reconstructions, including only the “likely” and “uncertain” instances of laryngeal deletion and laryngeal retention. Problematic forms are indicated in bold.

91 This would hold true for all other derivatives of */h_2i̯eu̯(h_1)o-/ ‘grain’ (such as Hitt. *ewa*(*n*)-; see section 6.2.2 above). Pace Southern (ibid.), we need not assume a conditioned split of */h_2i̯-/ in Greek.

(219) Likely and Uncertain Examples and Counterexamples

	Likely	**Uncertain**
*/h$_x$/ → ∅	***/dh$_2$i̯e-/**	***/dh$_1$i̯e-/**
	*/h$_1$ish$_2$i̯e-/	*/h$_2$arh$_3$i̯e-/
	***/k̂h$_3$i̯e-/**	*/kre/ou̯h$_2$i̯o-/
	*/(s)g^{w}esh$_2$i̯e-/	***/sh$_1$i̯é-/**
	*/sok^{w}h$_2$i̯V	***/sk̂h$_2$i̯e-/**
	***/skh$_x$i̯e-/**	
	*/(s)tenh$_2$i̯e-/	
	***/tu̯erh$_x$i̯ah$_2$-/**	
*/h$_x$/ → **h$_x$*	*/i̯eu̯h$_1$i̯o-/	*/delh$_1$i̯e-/
	***/sekh$_x$i̯e-/**	***/-h$_x$i̯os-/**
		*/h$_2$h$_1$sh$_1$i̯e-/
		*/(s)ph$_2$i̯é-/
		*/pth$_2$h$_1$i̯e-/
		*/u̯ṓd^{h}h$_1$i̯e-/

The reader will note that over half of the examples may be accounted for by our modified version of PINAULT'S LAW: 12⁄22. Laryngeals were predictably deleted in */h$_1$ish$_2$i̯e-/ 'push', */(s)tenh$_2$i̯e-/ 'thunder', and */h$_2$arh$_3$i̯e-/ 'plow', and retained in */(h$_2$)i̯eu̯h$_1$i̯o-/ 'pertaining to grain', */delh$_1$i̯e-/ 'chip', and */(s)ph$_2$i̯e-/ 'extract'.[92] Forms that cannot be explained by the present rule may be classified into one of two categories: stems with unspecified laryngeals and stems with laryngeal loss in the word-initial sequence */(C)Ch$_x$i̯-/ (note that */skh$_x$i̯e-/ falls into both). It is quite straightforward to account for the first group—we need only to assign */h$_1$/ in instances of laryngeal retention and */h$_{2/3}$/ in cases of laryngeal loss.

(220) Roots with Unspecified Laryngeals

a. */-h$_1$ + i̯os-/ → **-h$_1$i̯os-* (comparative suffix)

b. */sekh$_1$i̯e-/ → **sekh$_1$i̯e-* 'cut'

c. */skh$_1$i̯e-/ → **ski̯e-* 'cut'

d. */tu̯erh$_{2/3}$i̯ah$_2$-/ → **tu̯eri̯ah$_2$-* 'cord'

92 Note that following the MST PIE */(s)ph$_2$i̯e-/ could only have surfaced as **(s)pəh$_2$i̯é-*.

Two clarifications are in order. First, while the _-īyas-_ suffix could only have been _inherited_ from PIE through the sequence _*-h$_1$i̯os-_, it certainly spread with ease to other seṭ roots once the three laryngeals merged as one in proto-Indo-Iranian.[93] Thus, the _-ī-_ of _távīyas_ 'stronger' does not derive directly from the */h$_2$/ of PIE _*teu̯h$_2$-i̯os-_[94] but was rather analogically introduced through the influence of forms such as _várīyas_ 'wider' (< PIE _*u̯erh$_1$-i̯os-_). Second, the vocalized laryngeal in _*sekh$_1$i̯e-_ 'cut' (Lat. _secāre_, etc.) may only be explained by */h$_1$/, which is in fact the laryngeal Kloekhorst (2008:697) prefers, since PIE */sekh$_2$+ei̯/ should have resulted in Hitt. _^{X}šakkai_ (cf. _mallai_ 'mills' < _*molh$_2$ei̯_), not attested _šakki_. Note, however, this requires that we have some mechanism to delete an */h$_1$/ in */skh$_1$i̯e-/. This brings us to the second category.

(221) Word-initial */(C)Ch$_x$i̯-/ Sequences
- a. */dh$_1$i̯e-/ → _*di̯e-_ 'bind' > Ved. (_ā́, sám_) _dyati_ 'binds', OAv. _ni.diiātąm_ 'should be bound'
- b. */dh$_2$i̯e-/ → _*di̯e-_ 'share' > Ved. (YV) _ava-dyáti_ 'detaches'
- c. */k̂h$_3$i̯é-/ → _*k̂i̯é-_ 'sharpen' > Ved. _sám śyat_ 'sharpens'
- d. */sh$_1$i̯é-/ → _*si̯é-_ 'release' > Ved. (_áva, ví_) _s$_{(i)}$yáti_ 'looses'
- e. */skh$_x$i̯e-/ → _*ski̯e-_ 'cut' > Lat. _ne-sciō_ 'do not know'
- f. */sk̂^{h}h$_2$i̯e-/ → _*sk̂^{h}i̯e-_ 'cut' > Skt. (_anu-, ava-, vi-, etc._) _chyati_ 'cuts open', GAv. _paitī … siiōdūm_ 'cut open!'

There are two curious facts about the forms above. First, in all instances but one laryngeal deletion is restricted to Indo-Iranian, though I suspect scholars would prefer not to restrict this process of laryngeal deletion to a single sub-branch given the compelling Latin form _ne-sciō_, which is widely derived from PIE */ne + skh$_x$i̯e-/. Second, deletion appears only to occur in the sequence */(C)Ch$_x$i̯-/ in complex verbal forms, in which the verb in question is preceded by a preverb or negation. In fact, when */sk̂^{h}h$_2$i̯e-/ (Skt. (_anu-, ava-, vi-_, etc.) _chyati_ 'cuts') occurs without a preverb, vocalization occurs (Gk. σχάω); similarly, a laryngeal is vocalized in simplex */(s)ph$_2$-i̯é-/ > Gk. σπάω 'to pull out'.

How should we account for deletion processes only occurring in complex forms? Recall that an underlying word-initial consonant cluster */(C)CHC-/ was unsyllabifiable in PIE. Such a sequence will trigger either schwa epenthesis (*/ph$_2$tr-és/ → _*pəh$_2$trés_ 'father (gen.sg.)'; */dh$_1$só-/ 'divine' → _*dəh$_1$só-_) or consonant deletion (*/ph$_2$ter-/ → _*pter-_ (Av. (_p_)_tā_). In other words, there were two strategies to 'fix' this unsyllabifiable sequence: PIE */#Ch$_x$C-/ → _*Cəh$_x$C-_ or

93 See Kobayashi 2004:131–2 for discussion, with references.

94 Expected deletion of */h$_2$/ is likely reflected by the more archaic RV form _táv-yas-_.

**CC-*. In chapter 3 we analyzed these two divergent outcomes through a set of constraints, which are given below.

(222) Constraints for Word-Initial "Pinault's Law"
- a. MST: The largest possible syllable was of the shape CCVCC, and the coda must obey the SONORITY SEQUENCING PRINCIPLE. Assign one * for every violation.
- b. INTACT: Do not delete the root in its entirety. Assign one * for every violation.
- c. DEP-V: Every vowel in the output has a correspondent in the input. Assign one * for each instance.
- d. MAX-C: Every non-laryngeal consonant in the input has a correspondent in the output. Assign one * for each instance.
- e. MAX-H: Every laryngeal consonant in the input has a correspondent in the output. Assign one * for each instance.

The constraint rankings were deemed to be as follows: MST, INTACT >> DEP-V >> MAX-C >> MAX-H. For our purposes, the crucial constraint to focus on is INTACT, which originally stated that one cannot delete a root in its entirety. This was reasonably postulated given the fact that when a morpheme (in particular a root) has zero phonological content, speakers cannot in good faith recognize its semantic content. But the same may be said of less drastic phonological deletions; if a speaker uttered */dh$_1$i̯e-/ 'bind' or */dh$_2$i̯e-/ 'detach' (with coincidentally opposite meanings!) as **di̯e-* in its simplex form the listener would not know what to make of it. No doubt in these situations schwa epenthesis was the most optimal choice—"Did you mean **dəh$_1$i̯e-* or **dəh$_2$i̯e-*"? However, such confusion would be avoided in the presence of a preverb, as only certain preverbs were used with the roots in question. Thus, in Sanskrit we find *sám dyati* 'binds' but *ava dyáti* 'detaches'. The meaning 'bind' only occurs with the preverbs *ā́* and *sám*; 'detach' only with *ava*. Let us now then, revise our INTACT constraint as follows: speakers must be able to recognize the semantic content encoded within the root.[95] It is through observance of this undominated constraint that we find alternation between stray epenthesis and erasure.

95 Alternatively, one may maintain the formulation of INTACT as given in (212b) and appeal to anti-homophony effects instead. See Blevins 2003, Gessner & Hansson 2004, and Kaplan 2011 for further discussion.

(223) PIE */dh$_1$i̯e-/ 'bind'

*/dh$_1$i̯-e-/	MST	INTACT	DEP-V	MAX-C	MAX-H
a. [dh$_1$i̯e-]$_\sigma$	*!				
b. ☞ [dəh$_1$]$_\sigma$[i̯e-]$_\sigma$			*		
c. [i̯e-]$_\sigma$		*!		*	*
d. [h$_1$i̯e-]$_\sigma$		*!		*	
e. [di̯e-]$_\sigma$		*!			*
*/som + dh$_1$i̯-e-/					
a. [dh$_1$i̯e-]$_\sigma$	*!				
b. [dəh$_1$]$_\sigma$[i̯e-]$_\sigma$			*!		
c. [i̯e-]$_\sigma$				*!	*
d. [h$_1$i̯e-]$_\sigma$				*!	
e. ☞ [di̯e-]σ					*

CHAPTER 7

The Indo-European Syllable: A Review

We have now reached a point in our study where we are able to present a more successful overall formulation of PIE syllabification. Our initial discussion in 2.4 showed that Schindler's nearly universally accepted iterative 'right-to-left' algorithm has been made obsolete by Kobayashi's ONSET MAXIMIZATION principle (2004), which in turn was improved upon by Cooper's ALIGN-L hypothesis (2012). Moreover, by assuming the constraint ranking COINCIDE "A complex onset belongs to an initial syllable" >> ALIGN-L (μ, PRWD) "Align every mora with the left edge of the prosodic word" Cooper is able to reconcile the seemingly contradictory phenomenon of ONSET MAXIMIZATION (e.g., **ḱu̯ń̥bʰ is*, not *ˣḱumbʰ is*) besides the curious property identified by Hermann (1923:351ff.)—the division of medial VCCV sequences as VC.CV even when CC was a legal onset, a property detectable in the meters of the oldest Sanskrit and Ancient Greek.[1] However, at the end of chapter 4 we discovered that Cooper's framework (just as Kobayashi's) prevents us from positing securely reconstructable forms like **kúrCos* 'foal, bastard' to have existed in PIE.

(224)

*/ku̯r-Co-/	ALIGN-L	*PK/N	*PK/L	*PK/U̯
a. ☹ *kurCo-*	*...*!			*
b. ☞ *ku̯r̥Co-*	*...		*	

We therefore abandoned Cooper's framework in search of one that accounts for all reconstructable forms.

(225)

*/ku̯r-Co-/	WBP	*PK/L	*PK/U̯	DEP-μ
a. ☞ [kú$_\mu$r$_\mu$][Co$_\mu$-]			*	**
b. [ku̯ŕ̥$_\mu$][Co$_\mu$-]		*!		*

But a new problem arises. Within our new framework (which lacks COINCIDE and ALIGN-L) how exactly may we explain the syllabification of VC.CV in forms such as **put.ló-* (*ˣpu.tló-*) 'son'?

1 See also Marchand 1958:77ff. and Keydana 2004:173.

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Before addressing this quandary, let us revisit the two main insights into the Indo-European syllable in the preceding chapters. We began our study by following the DECOMPOSITION THEOREM, which suggests that we as scholars may infer possible medial syllabifications in PIE through our knowledge of consonant sequences at word's edge, leading us also to assume for PIE the existence of extrasyllabic consonants at word's edge, a property that is quite common cross-linguistically. It is with these two assumptions that we may now reconstruct a Maximum Syllable Template (MST), an undominated constraint bundle which required that all word-medial consonant sequences in PIE conform to a particular shape. It has been defined as follows: "The maximum PIE syllable consists of two consonants in the onset and two consonants in the coda. The onset may violate the SONORITY SEQUENCING PRINCIPLE (SSP); the coda may not." If a sequence violating the MST did not contain a syllabifiable resonant (e.g., */tentós/ → *[tntós] → [tn̥tós] 'stretched') or possible extrasyllabic segment(s) (e.g., *[nokʷ]$_σ$ts 'night (nom.sg.)'), that sequence would undergo either consonant deletion (STRAY ERASURE) or vowel epenthesis (STRAY EPENTHESIS), depending on whether the resulting cluster was legal in PIE. We have identified three such instances of stray erasure, LEX SCHMIDT-HACKSTEIN (more precisely formulated as the loss of laryngeal in the sequence *PH.CC), the avoidance of *s-epenthesis in the *métron* rule, and the deletion of **t* in PInd. *$*h_x o\hat{k}th_x tí$- (> Skt. *asītí-* 'eighty'), and two of stray epenthesis, whereby *[ə] is inserted in cases of schwa primum (PIE *$*d^h h_1$só-* 'divine' → *[dʰəh$_1$]$_σ$[só-]$_σ$) and schwa secundum (*$*d^h\hat{g}^h$més* → *[dʰəĝʰ]$_σ$[més]$_σ$). Given that both schwa primum and schwa secundum were syllabically-motivated processes of schwa epenthesis in word-initial syllables, it was argued that we should now identify the two processes as the exact same rule: the epenthesis of schwa indogermanicum.

In addition to these phonological rules, we have seen that the MST provides a straightforward explanation for a curious feature identified by Schindler (1977a) regarding Sievers' Law (SL): its non-application within medial sequences of the shape *-OOR- (or perhaps more specifically *-OOU̯-), such as is found in Ved. *matsya-* 'fish' and PGk. *$*dik^h t^h$i̯o-* 'double' (> Ion. *diksós*). The MST predicts SL not to have occurred since *-OO]$_σ$ was not a legal medial coda in PIE (where *-OO]$_σ$ stands for *-PP]$_σ$ and *-PF]$_σ$), thereby resulting in a violation of the SSP. We also learned that the MST—in conjunction with the medial application of SZEMERÉNYI'S LAW—accounts for why all word medial sequences of the shape */-VCh$_x$i̯-/ were initially syllabified as *[-VC.h$_x$i̯-] in PIE, which led to the subsequent simplification of the sequence *$_σ$[h$_x$i̯-, in cases where */h$_x$/ = */h$_2$/ or */h$_3$/. This impossible coarticulation of a tautosyllabic pharyngeal plus */i̯/ explains why a laryngeal is lost via PINAULT'S LAW in PIE */sokʷh₂i̯os/ (→ *sokʷi̯os), but not in PIE */steh₂i̯eti/ (→ *stah₂i̯eti). As the basis of one of the most widespread phonological conspiracies in PIE, the MST was an extremely powerful constraint. It not only directly triggered a number of phonological rules, it indirectly affected other rules as well. But the MST was not the only conspiracy in PIE. We have seen others:

(226) a. OCP

The OCP, as discussed in section 2.1.1, was an undominated constraint in PIE which militated against certain types of geminate sequences. While monomorphemic sequences were tolerated in certain "expressive" words (Watkins 2013) such as **atta* 'daddy' (Lat. *atta*, Goth. *atta*), **kakka* 'poo-poo' (MIr. *caccaim*, Russ. *kákata*), and **anna* 'momma' (Hitt. *annaš*), geminates were strictly banned across a morpheme boundary (Meillet 1934). The OCP spurred a number of important phonological changes within the proto-language, such as the double dental rule, the *métron* rule, among others.

b. *SUPERHEAVY

It is likely that syllables containing three or more morae were disfavored in PIE, but not completely blocked. For instance, it is very likely that *SUPERHEAVY triggered Sievers' Law at the postlexical level (*[mert.i̯o-] → **mertii̯o-*; see ch. 5), and it is possible, though by no means definite, that certain cases of Schwebeablaut and the analogical replacement of weak full-grade forms with the zero-grade in roots of the shape *CeR(C) were perhaps also motivated by violations of this constraint. However, further research should be conducted before one may claim so with certainty.

c. *RF]$_\sigma$

The coda sequence sonorant + fricative, while legal in late PIE, was blocked at an earlier stage of the proto-language. In addition to the well-established cases of fricative deletion in SZEMERÉNYI'S LAW in */ph₂térs/ 'father (nom.sg.)' (→ *[ptḗr]) and PIE **u̯édorh₂* 'water (nom./acc.~pl.) (→ *[u̯é]$_\sigma$[dōr]$_\sigma$), it was argued that the constraint *RF]$_\sigma$ prompted certain isolated (and therefore archaic) cases of laryngeal deletion in the medial sequence *RH.CC (such as the aforementioned */ĝenh₁mneh₂/ → *[ĝen]$_\sigma$[mnah₂]$_\sigma$).

I do not believe that these are the only phonological conspiracies reconstructable for PIE. Another likely example may be pieced together in the many rules of laryngeal feature neutralization (16) within PIE: voicing assimilation, word-final voicing (17), and Siebs' Law, each presumably triggered by the constraint

AGREE.[2] As discussed in 2.1.1, we do not recognize these conspiracies merely to restate the facts within a new phonological framework; rather, we do so because they provide us with a predictive power largely absent within rule-based phonology, one which helps us to more precisely reconstruct the PIE language.

At any rate, while the powerful MST constraint gives us precise instructions on what could be syllabified in PIE, it says very little about the placement of syllable boundaries and the assignment of syllable nuclei. In chapter 4, where we conducted a lengthy analysis of the exceptions to Schindler's syllabification algorithm, we discovered that the widespread process of syncope in PIE known as ø-grade made a dramatic impact on the way syllables were parsed at the surface in PIE. In this discussion we identified three basic properties.

a. **Syllabification is persistent throughout the phonological derivation. It occurs pre-syncope, as well as post-syncope.**

Underlying Form	*/h$_1$léu̯d^{h}men/	*/méntei̯m/
Syllabification	*[h$_1$lé$_\mu$u̯$_\mu$d$^h{}_\mu$][me$_\mu$n$_\mu$]	*[mé$_\mu$n$_\mu$][te$_\mu$i̯$_\mu$m$_\mu$]
Syncope	*[h$_1$lé$_\mu$u̯$_\mu$d$^h{}_\mu$][mn$_\mu$]	*[mé$_\mu$n$_\mu$][ti̯$_\mu$m$_\mu$]
Resyllabification	*[h$_1$lé$_\mu$u̯$_\mu$d$^h{}_\mu$][mn̥$_\mu$]	*[mé$_\mu$n$_\mu$][ti$_\mu$m$_\mu$]
Surface Form	*[h$_1$léu̯d^h]$_\sigma$[mn̥]$_\sigma$	*[mén]$_\sigma$[tim]$_\sigma$

b. **Sonorants that were moraic earlier in the derivation, remain as such post-syncope.**[3]

a. */sreu̯tós/	→	*[sreu̯$_\mu$]$_\sigma$[tós]$_\sigma$	→	*[sru$_\mu$]$_\sigma$[tós]$_\sigma$
b. */k̑u̯onb^{h}i̯s/	→	*[k̑u̯on$_\mu$]$_\sigma$[b^{h}ís]$_\sigma$	→	*[k̑u̯n̥$_\mu$]$_\sigma$[b^{h}ís]$_\sigma$
c. */g^{wh}rensú̯/	→	*[g^{wh}ren$_\mu$]$_\sigma$[sú]$_\sigma$	→	*[g^{wh}rn̥$_\mu$]$_\sigma$[sú]$_\sigma$
d. */k^{w}etu̯ortós/	→	*[k^{w}et]$_\sigma$[u̯or$_\mu$]$_\sigma$[tós]$_\sigma$	→	*[k^{w}et]$_\sigma$[u̯r̥$_\mu$]$_\sigma$[tós]$_\sigma$

2 "Obstruent clusters should agree in laryngeal features" (cf. Jessen & Ringen 2002:193).

3 Only pertinent moras have been included in the table below, but of course other segments within these forms do carry weight.

c. **Non-moraic sonorants occupy the syllable nucleus if and only if more important constraints are violated.**[4]

Obeying ONSET
a. PIE */k̑u̯onés/ → *[k̑u]$_\sigma$[nés]$_\sigma$, not ˣ[k̑u̯n̥]$_\sigma$[és]$_\sigma$
b. PIE */kʷetu̯órns/ → *[kʷe]$_\sigma$[tú]$_\sigma$[rn̥s]$_\sigma$, not ˣ[kʷe]$_\sigma$[tu̯ŕ̥]$_\sigma$[n̥s]$_\sigma$

Obeying the MST
a. PIE */k̑u̯onés/ → *[k̑u]$_\sigma$[nés]$_\sigma$, not ˣ[k̑u̯nés]$_\sigma$
b. PIE */kʷetu̯órns/ → *[kʷe]$_\sigma$[tú]$_\sigma$[rn̥s]$_\sigma$, not ˣ[kʷe]$_\sigma$[tu̯rń̥s]$_\sigma$

As pointed out in chapter 4, properties a. and c. are linguistic universals, and as a phenomenon of moraic conservation that may be reconstructed as a synchronic process for PIE, property b. has an excellent parallel in other (likely) synchronic processes of compensatory lengthening, such as STANG'S LAW and SZEMERÉNYI'S LAW. These principles line up well with both the paradigmatic and compositional approaches, and as Norbert Oettinger reminds me (p.c., November 2012) argue strongly in favor of a *Schwundstufe* morphophonological approach (*/h$_1$esénti̯/ → **h$_1$sénti* 'they are') instead of a *Nullstufe* one (*/h$_1$sénti̯/ → **h$_1$sénti*). And as Olav Hackstein reminds me (p.c., November 2014), such views line up precisely with those of Schindler's:[5] "Aber unbetonte *e*-Stufen dürfen im großen und ganzen als sekundär betrachtet werden. Eine voridg. Regel, nach der unbetontes e (è) schwand, läßt sich für alle phonologischen Kontexte, vortonig und nachtonig, sichern." (Schindler 1975:261)

Though in the beginning we followed Cooper's assumption of COINCIDE and ALIGN-L as the underlying principle of syllable division in PIE, the above principles render them unnecessary in our understanding of why onsets were maximized in word-initial position in cases such as **k̑u̯ń̥bʰis* 'with dogs'. The maximization of the word-initial onset in this form was a by-product of the derived moraic *[n$_\mu$] in the initial syllable: */k̑u̯ó$_\mu$n-bʰi̯s/ → [k̑u̯ó$_\mu$n$_\mu$]$_\sigma$ [bʰí$_\mu$s$_\mu$]$_\sigma$ → *[k̑u̯´n$_\mu$]$_\sigma$[bʰí$_\mu$s$_\mu$]$_\sigma$ → **k̑u̯ń̥bʰis*. We also discovered in chapter 5 that an additional nod to morphology is required by a phonologically-sensible

4 As noted previously, moraic sonorants may also occupy the syllable onset (thereby losing its mora) for the same reasons: cf. **ĝʰēi̯m̥no-* > Ved. *hāyaná-* 'yearly', YAv. *zaiiana-* 'winterly' (NIL 163), which arguably derives from underlying /ĝʰēi̯meno-/, in which **i̯* would have occupied a coda and therefore have carried a mora.

5 And many others as well. See, for example, Griepentrog 1995:447ff.

analysis of SIEVERS' LAW, further demonstrating that the purely phonological characterization of the IE syllable by past scholars must now be abandoned. There we learned that margins were maximized at the stem level of the derivation (the first stratum), though only within its given morpheme, in order to obey the highly-ranked ALIGN constraint. The syllabification generated at the stem level could then be modified at a higher stratum (word or postlexical) should the re-ranking of certain markedness constraints in the grammar demand it.

(227) Syllabification by Morpheme
Syllabify according to morpheme at the stem level. Avoidance of marked sequences may change this formulation later in the derivation.

(228) Stem */tert+i̯o/

/tert+i̯o/	MST	DEP-V	MAX-C	ALIGN	*SPRHVY
a. ☞ $[\text{tert}]_\sigma[\text{i̯o}]_\sigma$					*
b. $[\text{ter}]_\sigma[\text{ti̯o}]_\sigma$				*!	
c. $[\text{ter}]_\sigma[\text{i̯o}]_\sigma$			*!		
d. $[\text{ter}]_\sigma[\text{ti}]_\sigma[\text{i̯o}]_\sigma$		*!		*	

It is in this way that we are able to motivate SIEVERS' LAW, a rule which was triggered by the avoidance of a superheavy syllable at the postlexical level.

(229) Postlexical $*[\text{tert}]_\sigma[\text{ti̯os}]_\sigma$

$/[\text{tert}]_\sigma[\text{i̯os}]_\sigma/$	DEP(F)	*SPRHVY	FAITH(σ)	*COMPONS	DEP-V	NO-SPREAD
a. ☞ $[\text{ter}]_\sigma[\text{ti}]_\sigma[\text{i̯os}]_\sigma$			*		*	*
b. $[\text{ter}]_\sigma[\text{ti̯os}]_\sigma$			*	*!		
c. $[\text{ter}]_\sigma[\text{tə}]_\sigma[\text{i̯os}]_\sigma$	*!		*		*	
d. $[\text{tert}]_\sigma[\text{i̯os}]_\sigma$		*!				

With all of this mind, we may now return to the problem of unexpected bipartite cluster division *VC.CV (Hermann 1923), reconstructable for words such as $*[\text{h}_2\text{aḱ}]_\sigma[\text{ros}]_\sigma$ 'pointy' (Gk. ἄκρος, OIr. *ēr*) and $*[\text{put}]_\sigma[\text{los}]_\sigma$ 'little one' (Ved. *putrá-* 'son', Osc. **puklum** 'id.'), a phenomenon that only thus far Cooper's

Align-l hypothesis has been able to explain.[6] The notion that IE syllables were optimally parsed according to morpheme explains more than Sievers' Law—it is able to explain the *VC.CV phenomenon as well. Consider the following: aside from baby words such as **atta* 'daddy' and **kakka* 'poo-poo', disyllabic sequences of the shape *VCCV were overwhelmingly dimorphemic in PIE.[7] Moreover, since the minimal root structure was of the shape *CVC in PIE,[8] it follows that a sequence *VCCV would frequently consist of a root ending in *VC plus a suffix beginning in *CV. Following the principle of PIE syllabification given in (217), each such sequence would have been syllabified as *VC.CV.[9]

But there are two other possible permutations of a dimorphemic *VCCV, both of which are attested: */VCC + V/ and */V + CCV/. The first, *VCC (root) + *V (suffix) must always be parsed as *VC.CV: PIE **bʰei̯d-* 'split' + *e.ti* → **bʰéi̯.de.ti*, not *^{X}bʰéi̯d.e.ti*. This may be attributed to a requirement that a syllable onset be filled at the stem, word or postlexical level (Onset)[10] or to the avoidance of a superheavy syllable at the postlexical level, as discussed in detail above. The second, *V (root) + *CCV, (suffix) is trickier. Were words like **h$_1$i-tro-* (> OIr. *ethar* 'ferry boat') and **tn̥-tlo-* (> Lith. *tiñklas* 'net') syllabified as *[h$_1$i]$_\sigma$[tro]$_\sigma$ and *[tn̥]$_\sigma$[tlo]$_\sigma$, respectively, in PIE?[11] And if so, could there have existed a syllabic contrast between a hypothetical **u̯r̥-tro-* 'repellent' (*[u̯r̥]$_\sigma$[tro]$_\sigma$)[12] and a hypothetical **u̯r̥t-ro-* 'turned' (*[u̯r̥t]$_\sigma$[ro]$_\sigma$)? This analysis predicts that there may have been such a contrast.[13]

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6 As we saw in section 2.4, this syllable division is not predicted (and therefore must be explicitly denied) by a system of IE syllabification that maximizes all onsets to the left edge with no consideration of morpheme boundaries, as suggested by Kobayashi and others.

7 Matters get trickier with the disyllabic trimorphemic sequences (such as **u̯ḗk̂-s-m̥* 'carried'), whose surface form was compelled to violate Align at least once; therefore, the additional markedness constraints discussed elsewhere in this work must be taken into consideration: thus, */u̯ḗĝʰ-s-m̥/ → *[u̯ḗk̂]$_\sigma$[sm̥]$_\sigma$, with cosyllabified **-sm̥*. The forms ^{X}[u̯ḗk̂]$_\sigma$[m̥]$_\sigma$, ^{X}[u̯ḗk̂]$_\sigma$[sə]$_\sigma$[m̥]$_\sigma$, ^{X}[u̯ḗk̂s]$_\sigma$[m̥]$_\sigma$, ^{X}[u̯ḗ]$_\sigma$[k̂sm̥]$_\sigma$, or ^{X}[u̯ḗ]$_\sigma$k̂[sm̥]$_\sigma$ do not surface as they violate Max-C/Onset, Dep-V/Onset, MST / Onset, Align (x2), and Parse, respectively.

8 Benveniste 1935:149ff.

9 Weiss 2009:280.

10 See Keydana 2004.

11 Forms taken from Wodtko et al. 2008.

12 Cf. **u̯ertrom-* > Skt. *vártram* 'protective dam, pond', Av. *varəϑra-* 'shield', MWel. *gwerthyr* 'fortress' (Olsen 1988:7).

13 Note that if the opposite constraint ranking had been true in (220c)—i.e., *ComplexOnset >> Align—we perhaps would expect Sievers' Law to have targeted the majority of instrument nouns: */u̯ertrom-/ → ^{X}[u̯ert]$_\sigma$[rom]$_\sigma$ → ^{X}[u̯er]$_\sigma$[tr̥]$_\sigma$[rom]$_\sigma$ (instead of

(230) a. /VC + CV/ → [VC][CV] (ALIGN >> NOCODA)
b. /VCC + V/ → [VC][CV] (ONSET >> ALIGN)
c. /V + CCV/ → [V][CCV] (?) (ALIGN >> *COMPLEXONSET)

Cases of contrastive syllabifications are quite rare cross-linguistically (as they would have been in PIE), though they do exist. To cite a famous example, note the difference in syllabification between Eng. *mistake* 'error' ([mɪsteɪk]) and *mis-take* 'accidentally pick up' ([mɪstʰeɪk]). The latter must be syllabified as $[\text{mɪs}]_\sigma[\text{tʰeɪk}]_\sigma$, due to the aspiration of /t/ (cf. Davidson-Nielsen 1974:38ff.). Elsewhere in Indo-European we find similar contrasts in syllabification driven by morphology, such as in Greek (cf. ἐκ.λύει '(s)he loosens' (Euripides, *Phoenissae* 695) vs. ἔ.κλυον 'they heard' (Euripides, *Phoenissae* 919)) and in Latin (cf. *ab.rumpō* 'I break off' vs. *tene.brae* 'shadows, darkness' (Plautus)).[14]

But such cases are not true parallels to the principle of syllabification according to morpheme as given in (217) but are rather examples of contrasts in syllabification created by prosodic word (ω) boundaries. Recall from section 4.6 that certain affixes (called non-cohering) may themselves constitute their own ω and therefore act as their own domain of syllabification.[15] This accounts for the difference in syllabification between forms such as Eng. $[\text{sə}]_\sigma[\text{blɪ}]_\sigma[\text{mɪ}]_\sigma[\text{nl̩}]_\sigma$ 'subliminal' and $[\text{səb}]_\sigma[\text{lu}]_\sigma[\text{nr̩}]_\sigma$ 'sublunar', the latter of which contains the non-cohering prefix *sub-*. However, it is clear from our discussion in 4.6 that the acc.sg. ending **-m* and the nasal infix **-n(e)-* were cohering affixes in PIE, as each syllabified with its preceding stem. But is it possible to identify any non-cohering affixes in the proto-language? At the moment, I see direct evidence of two. First, recall that we were able to explain only partly the third exception to Schindler's rule (60c), the cases where $^*\text{CR}_1\text{R}_2\text{V} \nrightarrow {}^*\text{C}\mathring{\text{R}}_1\text{R}_2\text{V}$ as expected, but rather $^*[\text{CR}_1\mathring{\text{R}}_2]_\sigma[\text{V}]_\sigma$, apparently resulting in hiatus. According to Schindler (1977a), this only occurred if $^*[\text{CR}_1\mathring{\text{R}}_2]_\sigma[\text{C-}]_\sigma$ existed elsewhere within same paradigm. The clearest example here is the unexpected syllabification of PIE */tr(e)i̯-ōm/ as **triōm* 'three (gen.pl.)', not *ˣtr̥i̯ōm*. Should one desire to move away from analogy in his explanation, he may account for this anomalous syllabification by simply assuming that **-ōm* was a non-cohering suffix in PIE and was therefore syllabified separately from its stem. But of

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reconstructable $^*[\text{u̯er}]_\sigma[\text{trom}]_\sigma$), though such a suggestion could be salvaged either by a more restrictive formulation of SL or the constraint ranking *COMPLEXCODA >> *COMPLEXONSET. The former suggestion, however, would not explain why the case ending **-bʰi̯os* was largely immune from SIEVERS' LAW.

14 See Devine & Stephens 1994:35 for further discussion.

15 Booij 2005.

course, we would need additional evidence to back up such an assertion. A more certain case of a non-cohering affix is the PIE privative prefix **n̥-* (← */né/ 'not'), which, as Kobayashi (2004:20) correctly points out, is always syllabified apart from the stem to which it is added. Thus, TB *e*(*n*)-, Lat. *in*-, Gk. ἀ-/ἀν-, Goth. *un*-, Skt. *a-/an*-, etc., a syllabification which makes perfect sense if **n̥-* (like Eng. *sub*-) constituted as its own ω. It is likely that other affixes were non-cohering as well, such as the (post-PIE?) augment (cf. ἔ.κλυον 'they heard' above) and perhaps the ancestors of the Sanskrit pada endings in Sanskrit, the cases in **-bʰ-* and the loc.pl. in **-su*. And it is perhaps (partly) for this reason that each was syllabified apart from the stem to which it was added: thus, **vr̥t.sú* 'turning' not *ˣvr̥.tsú*.

These facts aside, it is well known that morpheme boundaries do influence the assignment of syllable structure as well as syllabically-influenced phonological processes (Trommer 2011), even in cases which do not involve ω boundaries, just as has been proposed for PIE in (217). For instance, in Axininca Campa, an Arawakan language spoken in Peru, the form /i + N + koma + i/ 'he will paddle' surfaces as [i.ko.ma.ti] and not ˣ[i.ko.mai], with an epenthetic [t] inserted to separate the final two morphemes. According to McCarthy & Prince (1993), this is not an isolated phenomenon, as "underlying /V-V/ sequences at stem-suffix juncture are never parsed as tautosyllabic", a property driven by the constraints ONSET and ALIGN-RIGHT, the latter which requires that every stem coincide with the right edge of a syllable boundary. Crucially, as McCarthy & Prince point out, ALIGN-RIGHT "does not demand that every syllable-edge coincide with a stem-edge", a property which would lead to the requirement that all roots and affixes be monosyllabic.

(231)

/i + N + koma + i/	ONSET	ALIGN-RIGHT	DEP-C
a. ☞ [i.ko.ma.ti]			*
b. [i.ko.mai]		*!	
c. [i.ko.ma.i]	*!		

As was the case for the PIE ALIGN constraint posited in ch. 5, ALIGN-RIGHT is not undominated in Axininca Campa, for a violation of ONSET requires the syllabification of a stem-final consonant within the onset of the following suffix (McCarthy & Prince 1993). This is directly comparable to the PIE syllabification of */bʰei̯d + e + ti/ as **bʰéi̯.de.ti*.[16]

16 Note that the candidate [iñ.čʰik.i] is also blocked by a CODA-CONDITION; see McCarthy & Prince (1993).

(232)

/iñ+ čʰik + i/			Onset	Align-Right
a.	☞	[iñ.čʰi.ki]		*
b.		[iñ.čʰik.i]	*!	

In addition to the Axininca Campa examples cited above, McCarthy & Prince (1993) find evidence in favor of Align-Right elsewhere through the augmentation of sub-minimal roots in Axininca Campa, augmentation in Lardil, the preservation of word-final pharyngeal codas in Hebrew and Bedouin Arabic, and right-edge consonant extrametricality in Kamaiurá. For additional examples of morphology affecting syllable structure, see Nespor and Vogel 1986, Booij 1995, Kager 1999:115, 136, Raffelsiefen 2005, and various contributions in Hall and Kleinhenz 1999.[17] The constraint Align, which we have assumed to be relevant at the lexical level in PIE, is thus grounded in the phonological literature, and helps to explain two seemingly unrelated processes, Sievers' Law and VC.CV syllabification. It therefore marks a step forward in our understanding of the Indo-European syllable. Indeed, I would contend that each of the major solutions presented in this book constitute similar advancements, as each connects multiple phonological processes reconstructable for PIE, yet remains grounded in the work done in linguistic typology and phonological theory and, most importantly, in the data that are securely reconstructable through careful philological analysis.

Of course, much more can—and should—be said about the Indo-European syllable. I envision a number of directions in which scholars may proceed in future research.[18]

– Recall from ch. 4 that the property of onset maximization found in forms such as **k̂u̯n̥bʰis* 'with dogs' may now be generated in the same manner as the "exceptional" syllabification seen in forms such as **méntim* 'mind (acc.sg.)'.

17 For a general overview of the relevance of morphology within phonology, see Trommer 2011. See also Cho 1998, who, in a study of Korean palatalization using an electro-magnetic midsagital articulometer and electropalatography, shows that intergestural timing and temporal overlap is linked to the lexical item that the coordinating gestures belong to (e.g. tautomorphemic, heteromorphemic, lexical compound).

18 The reader should note that these are not the only unanswered questions to arise within this work, as many may be found scattered in the footnotes of the preceding pages.

(233)

	*/k̂u̯o$_{\mu}$n$_{\mu}$b^{h}i$_{\mu}$s$_{\mu}$/	Ø-GRADE	ONSET	MAX-μ	MAX-V
a. ☞	*[k̂u̯ń̥$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]			*	*
b.	*[k̂u̯ó$_{\mu}$n$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]	*!			
c.	*[k̂u][ń̥$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]		*!	*	*

(234)

	*/mé$_{\mu}$n$_{\mu}$te$_{\mu}$i̯$_{\mu}$m$_{\mu}$/	Ø-GRADE	ONSET	MAX-μ	MAX-V
a. ☞	*[mé$_{\mu}$n$_{\mu}$][ti$_{\mu}$m$_{\mu}$]			*	*
b.	*[mé$_{\mu}$n$_{\mu}$][te$_{\mu}$i̯$_{\mu}$m$_{\mu}$]	*!			
c.	*[mé$_{\mu}$n$_{\mu}$][ti̯m̥$_{\mu}$]			**!	*
d.	*[mé$_{\mu}$n$_{\mu}$][ti$_{\mu}$][m̥$_{\mu}$]		*!	*	*

But how exactly may we account for the fact that *[k̂ú$_{\mu}$m$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$][19] does not surface as the most optimal form? I see two possible solutions. First, one may invoke the constraint DEP-μ ("Do not insert a mora") for PIE, being mindful of the fact that mora transfer from nucleus to onset is almost never allowed cross-linguistically (cf. Topintzi 2010).

(235)

	*/k̂u̯o$_{\mu}$n$_{\mu}$b^{h}i$_{\mu}$s$_{\mu}$/	Ø-GRADE	ONSET	MAX-μ	DEP-μ
a. ☞	*[k̂u̯ń̥$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]			*	
b.	*[k̂u̯ó$_{\mu}$n$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]	*!			
c.	*[k̂ú$_{\mu}$m$_{\mu}$][b^{h}i$_{\mu}$s$_{\mu}$]			*	*!

Or perhaps, similar to the analysis in Kobayashi 2004:23, NOCODA indeed outranked *COMPLEXONSET.

19 With place assimilation, as discussed in 1.2.1.2.

(236)

*/k̑u̯o$_\mu$n$_\mu$b^{h}i$_\mu$s$_\mu$/			ø-GRADE	MAX-μ	NOCODA	*COMPONS
a.	☞	*[k̑u̯ń̥$_\mu$][b^{h}i$_\mu$s$_\mu$]		*		*
b.		*[k̑u̯ó$_\mu$n$_\mu$][b^{h}i$_\mu$s$_\mu$]	*!			
c.		*[k̑ú$_\mu$m$_\mu$][b^{h}i$_\mu$s$_\mu$]		*	*!	

At this moment, it is far from clear how these constraints interact, nor entirely apparent how one many ascertain these constraint rankings in a non-circular fashion.

- Cross-linguistically, it is very common for unstressed vowels and nuclei of lower sonority to license fewer consonants in the syllable margins. Could this have also been the case in PIE? That is to say, would it be possible to reconstruct a REDUCED SYLLABLE TEMPLATE for PIE? If so, perhaps we may identify the rule *#CCN̥ → *#CN̥- (PIE *$d^h\hat{g}^h$m̥(m)-* > Gk. *k^hamaí* 'on the ground') as an instance of STRAY ERASURE, given the low sonority of the nuclei **m̥* and **n̥*.
- The reconstruction of a PIE MAXIMUM SYLLABLE TEMPLATE has neatly explained a number of syllabically-motivated phonological processes. May we identify similar phenomena within the prehistories of the individual IE daughter languages? There are of course a number of exemplary studies on the syllable in ancient Greek (Steriade 1982, Devine & Stephens 1994, Zukoff, in preparation, etc.), Sanskrit (Steriade 1988, Kobayashi 2004, Keydana 2006, etc.), and Germanic (Kiparsky 1998, Pierce 2006), but the other branches are in need of similar scrutiny. See, however, Kavitskaya 2001 (Hittite) and most recently DeLisi 2013 (Armenian).
- ø-GRADE has been reconstructed as a synchronic rule for PIE and may be ordered before or after other (morpho-)phonological processes. Is it possible to find further interaction between ø-GRADE and other phonological rules? And more generally, may we identify interactions between certain phonological rules and other aspects of the morphology in PIE?
- Lastly, our research into the IE syllable has exposed a larger and even more poorly understood problem within our reconstructions: the status of other prosodic categories within PIE. While we do understand a certain amount about the accentuation system within the proto-language through the reconstruction of accent-ablaut classes, we know very little about how PIE speakers parsed feet, prosodic words, prosodic phrases, and even higher

prosodic categories. Time and time again it has been shown that such constituents may act as possible domains for phonological processes; as such, an accurate portrayal of the phonological prehistories of the ancient IE languages will not be complete until we gain this knowledge. Recent advances in the study of structure of the foot and prosodic word in PIE have been made, for which I refer the reader to Keydana 2012 and Sandell & Byrd, in preparation.

Appendices

The Indo-European Syllable

Preliminaries

Ramifications

The Proposal

PART 4

Appendices

Appendix A: Index of Indo-European Roots & Words

This index contains all of the reconstructed and attested forms cited in *The Indo-European Syllable*, with each reconstructed root and word having both an underlying and surface form. The reader should note the following:

a. In order to be inclusive to the paradigmatic and compositional approaches, accents have been omitted from the underlying forms.
b. For similar reasons, full-grade, *o*-grade, and lengthened grade vocalisms are not consistently assumed for underlying forms and are only present when they are (1) found in some attested form or (2) necessary to derive the correct syllabification of a R + R sequence.
c. For reasons of space, overlong glosses and page numbers have been cited in footnotes.
d. The roots cited in footnote 177 on pages 129–30 and in Appendix B (PIE Edge Phonotactics) have not been fully listed below.
e. Uncertain forms have been marked with a (?).

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Underlying	Reconstructed	Attested
*/bʰer-/ 'carry'	**bʰére-* (30, 36, 60)	Lat. *ferō*, Gk. φέρω, Gk. φέρει
	**bʰered, -ond*[3]	
	**bʰérontih*$_2$ (233)	Gk. φέρουσα, TB *prentsa*
	**bʰibʰérti* (119)	Skt. *bibhárti*
*/bʰerh$_2$-/ 'rush'	**bʰ*$^{e}/_{0}$*rh*$_2$- (92, 119)	Hitt. *parḫzi*, Gk. πορφῦ́ρω
*/bʰeru̯-/ 'boil'	**bʰeru̯-* (175–6)	Lat. *feruō*, Wel. *berw*, Bret. *berv*
	**bʰrutó-* (175–6)	Lat. *dēfrutum*, OIr. *bruth*
*/bʰes-/ 'blow'	**bʰes-* (57)	Skt. *bábhasti, bhastrā*, Gk. ψύω
*/bʰreh$_1$u̯-/ 'brew'	**bʰreh*$_1$*u̯r̥* (175)	Gk. φρέᾱρ, Arm. *ałbiwr*, Goth. *brunna*
	**bʰreh*$_1$*u̯-e-* (175)	OE *brēowan*
*/bʰreh$_2$ter-/[4]	**bʰrah*$_2$*t(e)r-* (37–9)	Skt. *bhrā́taram, bhrā́trā, bhrā́tr̥ṣu*
*/bʰu̯h$_2$-/ 'become'	**bʰuh*$_2$*i̯e-* (210)	Gk. φῦ́ομαι, Lat. *fīō*
*/de/ 'to'	**de* (115–6)	Lat. *quande*, *inde*
	**do* (115–6)	OCS *do*
	**dē* (115)	Gk. δή, Lat. *dē*, OIr. *dí*
	**dō* (115)	Lat. *dōnec*, OIr. *do, du*, Eng. *to*
*/deh$_1$-/ 'bind'	**dəh*$_1$*i̯e-*[5]	Gk. δέω, Hitt. *tiya*
	**di̯e-* (218)	Skt. *dyati*, OAv. *diiātąm*
	**dəh*$_1$*mn-* (94)	Gk. δέμνια, Ion. κρήδεμνον
*/deh$_2$(i̯)-/ 'share'	**di̯e-* (212, 238–9)	Ved. *ava-dyáti*
	**deh*$_2$- (212)	Ved. *áva adāt*
	**d(ə)h*$_2$-[6]	Skt. *dīṣva, dáyate*, Gk. δαίομαι, δατέομαι, δασμός
*/deh$_3$-/ 'give'	**doh*$_3$- (11, 25, 58, 62)	Lat. *dōnum*, Gk. δίδωσι
	**dəh*$_3$- (10, 11)	Skt. *-di-*, Gk. δοτός, Lat. *datus*
*/dei̯k̂-/ 'point'	**dei̯k̂(s)mn̥* (127)	Att. παράδειγμα, Epid. παρδειχματων
*/dek̂m/ 'ten'	**dék̂m̥* (7, 24)	Gk. δέκα, Lat. *decem*
*/dek̂s-/ 'be brave'	**dek̂s-* (126)	Ved. *dakṣáyanti*, Gk. δεξιτερός, Lat. *dexter*

3 (22, 60, 62)

4 'brother'

5 (218, 238–9)

6 (94, 212, 238–9)

Underlying	Reconstructed	Attested
*/dek$^{(w)}$s-/ ‘indicate’	*dek$^{(w)}$sto- (126)	Av. _daxšta-_
*/delh$_1$-/ ‘chip’	*delh$_1$- (215, 237)	Lat. _dolāre_, Lith. _delù_, Latv. _dęlu_, MWel. (_d_)_ethol-_
*/denk̂-/ ‘bite’	*deŋk̂tro- (61)	Skt. _dáṁṣṭra-_
*/derk̂-/ ‘see’	*derk̂- (185, 193)	Skt. _darśati, dadarśa_, Gk. δέρκομαι
	*drek̂- (193)	Skt. _adrākṣīt, draksyáti_
*/deru̯-/ ‘tree’	*d$^e/_o$ru̯V- (73)	Lith. _dervà_, OCS _drěvo_, Gaul. _derwen_, Gk. δουρός
*/dh$_3$ĝ^{h}mo-/ ‘askew’	*dəh$_3$ĝ^{h}mó- (94)	Gk. δοχμός, Skt. _jihmá-_
*/di̯eu̯-/ ‘shine’	*di̯ḗu̯s (21, 147, 191, 228)	Hitt. _šiū_(_na_)-, Gk. Ζεύς
	*dii̯ḗu̯s (21, 191, 204, 206)	Ved. _d_(_i_)_yáuḥ_
	*diu̯és (73, 147, 171)	Skt. _diváḥ_, Gk. Διός
	*di̯ḗm (20, 50)	Skt. _dyā́m_, Ζήν
	*diu̯ots (147)	CLuv. _Tiwaz_
	*di̯ut- (147)	Skt. _dyut-_
	*dei̯u̯os (147)	Lat. _dīuus_
*/dom-/ ‘house’	*dṓm (20, 44, 46–7)	Gk. δῶ, Arm. _tun_
	*domo- (172)	Cz. _dūm_
*/drak̂u̯er/ ‘tear’	*drak̂u̯r̥ (143)	Arm. _artawsr_
	*dák̂ru- (143)	Gk. δάκρυ, OLat. _lacruma_, Goth. _tagr_
*/drem-/ ‘run’	*dedrom- (119)	Hom.Gk. ἀνα-δέδρομε
*/drem-/ ‘sleep’	*dr̥mi̯e- (141)	Lat. _dormiō_
*/du̯oh$_1$/ ‘two’	*du̯óh$_1$ (21, 191)	Skt. _dvā_
	*duu̯óh$_1$ (21, 191, 206)	Lat. _duō_, Gk. δύω
*/d^{h}eĝ^{h}om-/ ‘earth’	*d^h(e)ĝ^{h}ōm[7]	Hitt. _tekan_, Gk. χθών
	*d^{h}əĝ^{h}més[8]	Hitt. _taknaš_
	*ĝ^{h}m̥m-[9]	Gk. χαμαί, Lat. _humus, homō_
*/d^{h}eh$_1$-/ ‘put; do’	*d^{h}eh$_1$- (30)	Gk. (ανά)-θημα
	*d^{h}əh$_1$tó-[10]	Skt. _hitá-_, Gk. θετός, Lat. _factus_
	*d^{h}əh$_1$s-[11]	HLuv. _tasan-za_, Skt. _dhíṣṇya-_, Gk. θεός, Lat. _fānum_
	*-Vtsk̂e- (91, 123)	Toch. _-tk-_

7 (24, 29, 44, 127)
8 (9, 24, 31, 33, 96, 242)
9 (21, 24, 203, 206, 252)
10 (10, 11, 27, 31, 33)
11 (11, 30, 94–6, 98, 124, 238, 242)

Underlying	Reconstructed	Attested
	*ḱé dʰeh$_1$- (91)	TB *kätk-*
	*u̯i dʰeh$_1$- (91)	Skt. *vidh-*, TB *wätkᵃ-*
	*ga(h$_2$) dʰeh$_1$- (91)	Gk. γηθέω, Lat. *gaudēre*, Toch. *kātk-*
	*su̯é dʰeh$_1$- (91)	Ved. *svadhā́*, Lat. *suēscō*
*/dʰeh$_1$-/ 'suckle'	*dʰéh$_1$i̯e- (224)	Gk. θῆσθαι, Arm. *diem*, Latv. *dêju*, OHG *tāen*
*/dʰerh$_3$-/ 'jump'	*dʰr̥h$_3$- (209)	Gk. θρώσκω, OIr. (*no*)-*daired*
*/dʰers-/ 'dare'	*dʰors- (111)	Goth. *gadars*
	*dʰr̥s- (111)	Ved. *dhr̥ṣṇóti*
*/dʰgʷʰei̯-/ 'perish'	*dʰ(zʰ)gʷʰitó (103)	Gk. ἔφθιτο
*/dʰreu̯bʰ-/ 'break'	*dʰrubʰi̯e- (78)	Gk. θρύπτω
*/dʰ reu̯gʰ-/ 'deceive'	*dʰ reu̯gʰ- (175)	
*/dʰu̯gh$_2$ter-/[12]	*dʰugh$_2$ter-[13]	Skt. *duhitár-*, GAv. *dugədar-*, Gk. θυγάτερ-, TA *ckācar*, TB *tkācer*, HLuv. *t*(*u*)*watra/i-*, Lyc. *kbatra-*, Slav. **dъšti*, Lith. *duktė̃*
	*dʰuktr-[14]	NPers. *duxtar-*, Arm. *dster*, Gaul. *duxtir*, Goth. *dáuhtar*, Osc. **fuutreí**
*/dʰu̯h$_2$mó-/ 'smoke'	*dʰuh$_2$mó- (30)	Ved. *dhūmá-*, Lat. *fūmus*
*/eḱ(s)/ 'outside'	*eĝ (57, 60, 132)	
	*eḱsto- (132)	Gk. ἐχθ(ρ)ός, Lat. *extrā*
*/eti̯/ 'still'	*éti (47)	Ved. *áti*, Gk. ἔτι, Lat. *et*
*/ĝei̯s-/ 'gravel'	*ĝei̯s- (112)	Lith. *žiezdrà*, *žiẽz*(*g*)*dros*
*/ĝenh$_1$-/ 'be born'	*ĝenh$_1$-[15]	Skt. *janima*, *jánitrī-*, Lat. *germen*, *genitrix*, Gk. γένεθλον
	*ĝen- (90)	Dor. Gk. γέννᾱ, Skt. *janman-*, *jantú-*
	*-ĝno- (33, 79)	Gk. νεογνός, Lat. *prīvignus*
	*ĝn̥h$_1$i̯e- (210)	Ved. *jāyate*, OIr. *·gainethar*, MWel. *geni*, MBret. *guenell*, MCor. *genys*
	*ĝn̥h$_1$tó- (149)	
*/ĝeu̯s-/ 'taste'	*ĝ(o)us- (111)	Ved. *juṣāṇá-*, Goth. *kausjan*

12 'daughter'
13 (12, 27–8, 57, 88–90, 124, 195)
14 (25, 88–90, 95–6, 99, 100, 105, 123, 129–31, 195)
15 (90, 94, 107–12)

Underlying	Reconstructed	Attested
*/ĝneh$_3$-/ ‘know’	_*ĝnoh$_3$-, *ĝn̥h$_3$-_[16]	Gk. ἔγνωκα, ἔγνων, Arm. *caneaw*
	*ĝn̥noh$_3$- (144)	Ved. *jānā́ti*
	_*ĝn̥nh$_3$-_ (144)	OIr. *ad·gnin*, Goth. *kunnan*
*/ĝ^{h}ei̯m-/ ‘winter’	_*ĝ^{h}ei̯m-_ (73, 136)	Hitt. *giman*, Gk. χεῖμα, Lat. *hiems*, Lith. *žiemìnis*
	_*ĝ^{h}im-_ (73–4)	Av. *zimō*, Gk. χιμος, Skt. *himáḥ*
	_*ĝ^{h}ēi̯m̥no-_ (172–245)	Ved. *hāyaná-*, YAv. *zaiiana-*
*/ĝ^{h}eu̯-/ ‘pour’	_*ĝ^{h}eu̯d_ (68)	Skt. *ajuhot*
/ĝ^h(h$_1$?)d^{h}i̯es/[17]	_ĝ^h(z^h)d^{h}i̯és_[18]	Ved. *hyás*, Gk. (ἐ)χθές, Lat. *herī*, OIr. *indé*, Wel. *doe*, Alb. *dje*, Goth. *gistra-*, OE *geostra*
*/ĝ^{h}reb^{h}h$_2$-/ ‘grab’	_*ĝ^{h}reb^h(ə)h$_2$-_ (133)	Skt. *agrabhīṣṭa*, *gr̥bhītá-*, *ágrabhīt*
	_*g^{h}r̥b^{h}n̥h$_2$-_ (149, 161)	Ved. *gr̥bhāyati*, YAv. *gəuruuaiieiti*, OPers. *agarbāya*
	_*g^{h}r̥bi̯e-_ (213)	Hitt. *karpiye-* (?)
*/ĝ^{h}u̯er-/[19]	_*ĝ^{h}u̯er-_ (142)	Ved. *hvárate*, Gk. θήρ, Lat. *ferus* ‘wild’, OCS *zvěrĭ*
	_*ĝ^{h}ru-_ (142)	Ved. *hruṇāti*
*/g^{w}eneh$_2$/ ‘woman’	_*g^{w}énh$_2$_ (110)	Skt. *jáni-*, YAv. *jaini-*, Arm. *kin*, TA *śaṃ*, TB *śana*
	_*g^{w}ḗn_ (110)	OIr. *bé*
	*g^{w}n̥néh$_2$ (21, 206)	Boeotian Gk. βανά
*/g^{w}erh$_3$-/ ‘devour’	_*g^{w}r̥h$_3$é-_ (212)	Ved. *girati*, Waxi *nežɣar-*, OCS *žĭrǫ*
	_*g^{w}r̥h$_x$i̯e-_ (212)	Lith. *giriù*, *gìrti*
	_*g^{w}r̥h$_3$sḱé-_ (212)	Gk. βιβρώσκω
*/g^{w}erh$_x$-/ ‘praise’	_*g^{w}r̥h$_x$i̯e-_ (209)	Lith. *giriù*, *gìrti*
*/g^{w}i̯h$_3$u̯ó-/ ‘alive’	_*g^{w}ih$_3$u̯ó-_ (48)	Ved. *jīvá-*, Lat. *vīvus*
*/g^{w}ou̯-/ ‘cow’	_*g^{w}ṓm_ (141)	Ved. *gā́m*
	_*-gu-_ (187)	Av. *-guua-*
	*g^{w}ou̯kólos[20]	Gk. βουκόλος, OIr. *búachaill*

16 (118, 144)

17 ‘Yesterday’

18 (23, 90, 97, 122)

19 ‘move crooked’

20 (24, 58, 67–8)

Underlying	Reconstructed	Attested
*/gʷʰer-/ 'warm'	*g^{wh} e/o rmós* (20)	Skt. *gharmá-*, Gk. θερμός, Lat. *formus*, Arm. *ǰerm*
*/gʷʰren-/ 'mind'	*g^{wh}r̥n̥sú*[21]	Gk. φρασί
*/$h_1$ed-/ 'eat'	*h_1ēd-* (185)	Hitt. *ēdmi*
	h_1ḗtsti (22, 44)	Hitt. *ēzzazzi*, Welsh *ys*
	$h_1$etsk̂é/ó-[22]	Hitt. *azzik-, azzak-*
	$h_1$etro- (23)	Skt. *átra-*
*/$h_1$ei̯-/ 'go'	*$h_1$ei̯-* (16)	Phryg. *eitou*
	$h_1$id^{h}í (62)	Skt. *ihí*, Gk. ἴθι
	$h_1$itro- (247)	OIr. *ethar*
	komh$_1$its (193)	Lat. *comes*
*/$h_1$ei̯-/ 'this'	*$h_1$ei̯-* (235)	Skt. *ayám*, Lat. *is*
	h_1i̯ó- (234–5)	Skt. *yá-*, Gk. ὅς
*/$h_1$ei̯s-/ 'anger'	*$h_1$ei̯sah$_2$* (112)	Lat. *īra*
	$h_1$oi̯stro/ah$_2$ (14, 112)	Gk. οἶστρος, Lith. *aistrà*, *aistrùs*
*/$h_1$ei̯sh$_2$-/ 'push'	*$h_1$isi̯e-* (213, 237)	Ved. *íṣyati*, Av. *-išiiā*
	$h_1$isnah$_2$- (213)	Skt. *iṣnā́ti*, Gk. ἰνάω
*/$h_1$ek̂u̯-/ 'horse'	*$h_1$ek̂u-* (12)	HLuv. *á-sú-* 'horse'
	h_1ək̂u̯o- (235)	Gk. ἵππος
*/$h_1$elh$_2$-/ 'drive'	*$h_1$elh$_2$-* (215, 237)	Gk. ἐλάω, Arm. *eli*
*/$h_1$emh$_1$-/ 'wipe'	*$h_1$ómh$_1$sei̯* (92)	Hitt. *ānši*
*/$h_1$es-/ 'be'	*$h_1$ési* (23, 44)	Skt. *ási*, Gk. εἶ
	$h_1$ésti[23]	Hitt. *ēšzi*, Lyc. *esi*, Ved. *ásti*
	$h_1$sénti (35–6, 245)	Ved. *sánti*
	$h_1$sti- (117, 123)	
*/$h_1$ger-/ 'awaken'	*h_1g(e)r-* (103, 120)	Gk. ἐγείρω, ἔγρετο
	$h_1$eh$_1$góre- (121)	Ved. *jāgā́ra*, Av. *jaγāra*, Gk. ἐγρήγορε
*/h_1i̯a(h$_2$)ĝ-/[24]	*h_1i̯a(h$_2$)ĝ-* (235)	Skt. *yaj-*, Gk. ἅγιος
*/h_1i̯eh$_1$-/ 'throw'	*h_1i̯eh$_1$-* (235)	Gk. ἵημι, Lat. *iēcī ditto*
	h_1i̯əh$_1$- (235)	Gk. ἑσμός
*/h_1i̯ekʷr/ 'liver'	*h_1i̯ekʷr̥* (234)	Skt. *yákr̥t*, Gk. ἧπαρ, Lat. *iecur*

21 (73, 171, 244)
22 (14, 57, 121, 123)
23 (11, 35–6, 57, 70, 233)
24 'worship'

Underlying	**Reconstructed**	**Attested**
*/h$_1$i̯enh$_2$ter-/[25]	*h$_1$i̯(e)nh$_2$t(e)r-[26]	Ved. *yātar-*, Gk. εἰνατέρες, Lat. *ianitrīcēs*, Arm. *nēr*
*/h$_1$i̯eu̯d^h-/ 'move'	*h$_1$i̯ud^h- (235)	Ved. *yūyudhir*, Gk. ὑσμίνη
*/h$_1$leng^{wh}t-/ 'light'	*h$_1$leŋk^{w}t- (60)	Eng. *light*
*/h$_1$neh$_3$mn/ 'name'	*h$_1$nóh$_3$mn̥ (15, 110)	Ved. *nā́ma*, Lac. ἐνυμα, Lat. *nōmen*, Arm. *anown*, OPhryg. *onoman*
*/h$_1$nek̂-/ 'take'	*h$_1$neŋk̂- (104, 121)	Gk. ἐνεγκεῖν
	*h$_1$nok̂- (104, 121)	OCS *nošǫ*
*/h$_1$reg^{w}os/	*h$_1$reg^{w}os (15)	Gk. ἔρεβος, Arm. *erek*, Goth. *riqis*
*/h$_1$reh$_1$-/	*h$_1$r̥h$_1$i̯e- (210)	Myc. *e-re-e*, Lith. *iriù*
*/(h$_1$)rek̂s-/ 'harm'	*(h$_1$)rek̂s- (126)	Ved. *rákṣas-*, Av. *rašah-*, Gk. ἐρέχθω
*/h$_1$u̯eld^h-/ 'climb'	*h$_1$u̯eld^{h}e- (143)	Ved. *várdhate*
	*h$_1$l(e)u̯d^h- (104, 143)	Ved. *áruhat*, *ródhati*, Gk. ἤλυθον, Goth. *liudan*
	*h$_1$l(e)u̯d^{h}mn̥[27] (170)	YAv. *uruϑman-*
*/h$_1$eu̯k̂-/ 'learn'	*h$_1$unk̂- (147)	Arm. *owsanim*, OIr. *to·ucci*, Lith. *jùnkti*
*/(h$_2$)aks-/ 'axle'	*(h$_2$)aks- (126)	Ved. *ákṣa-*, Lat. *axis*, OE *eaxel*, OSax. *ahsla*
*/h$_2$ed^{h}g^h-/ 'push'	*h$_2$ad^{h}g^h- (125)	Hitt. *ḫatki*, Gk. ἄχθομαι
*/h$_2$eĝ-/ 'drive'	*h$_2$aĝ- (16)	Gk. ἄγω, Arm. *acem*
	*h$_2$ak̂tós (7)	
	*h$_2$áĝros (49, 57)	
	*h$_2$óĝmos (11)	Gk. ὄγμος
*/h$_2$eh$_1$s-/ 'dry out'	*h$_2$ah$_1$sah$_2$ (216)	Hitt. *ḫāšša-*, Lat. *āra*
	*h$_2$əh$_1$sh$_1$i̯e- (216)	Lat. *arēre*, TA *asatär*, TB *osotär* (?)
*/h$_2$ek̂h$_3$-/ 'eat up'	*h$_2$ak̂h$_3$- (12)	Skt. *aśitum*
*/h$_2$ek̂mon-/ 'anvil'	*h$_2$ák̂nes (20, 74)	Skt. *áśnaḥ*, Av. *asnō*
*/h$_2$ek̂ro-/ 'pointy'	*h$_2$ak̂ro- (25, 49, 246)	Gk. ἄκρος, OIr. *ér*, OLith. *ašras*
*/h$_2$elgi̯os/[28]	*h$_2$algi̯os (187)	Gk. ἄλγιος
*/h$_2$elh$_1$-/ 'grind'	*h$_2$alh$_1$- (216)	Gk. ἀλέω, ἀλέατα, ἀλετρίς, ἄλεστρον
	*h$_2$léh$_1$u̯r̥ (216)	Gk. ἄλευρον, Arm. *aliwr*

25 'husband's brother's wife'

26 (94, 107)

27 'growth'

28 'more painful'

Underlying	**Reconstructed**	**Attested**
*/h$_2$enh$_1$-/ 'breathe'	*h$_2$anh$_1$mV-[29]	GAv. *ąnman-*, Gk. ἄνεμος, Lat. *animus*, OIr. *anaimm*
*/h$_2$ent-/ 'front'	*h$_2$ant- (12, 74, 233)	Hitt. *ḫant-*, Lyc. *x̃ñtawa-*, Gk. ἀντί, Lat. *ante*, *antemna*
*/h$_2$erh$_3$-/ 'plow'	*h$_2$ari̯e-[30]	Gk. ἀρόω, Lat. *arāre* 'plow', OIr. *·air*, MWel. *ard-*, OHG *erien*, Lith. *ariù*, OCS *orjǫ*
	*h$_2$arh$_3$s- (92)	Hitt. *ḫaršzi*
	*h$_2$arh$_3$trom[31]	Gk. ἄροτρον, Lat. *arātrum*, Arm. *arawr*, OIr. *arathar*, OWel. *arater*, Wel. *aradr*, OCorn. *aradar*, MBret. *arazr*, Bret. *arar*
*/h$_2$ertko-/ 'bear'	*h$_2$(a)rtsko-[32]	OIr. *art*, Ved. *ŕ̥kṣas*
*/h$_2$eu̯g-/ 'grow'	*h$_2$u̯eks-[33]	Ved. *vakṣáyati*, GAv. *vaxšt̰*, Gk. ἀϝέξω, Eng. *wax*
	*h$_2$uksto- (118, 195)	Pashai *ūṣ/ux*
*/h$_2$eu̯sos-/ 'dawn'	*h$_2$áu̯sōs (23, 29, 44, 46)	Ved. *uṣā́s*, Gk. ἠώς
	*h$_2$au̯sósm̥ (19, 36)	Ved. *uṣā́sam*, Gk. ἠόα
	*h$_2$usés (23)	Ved. *uṣás*
*/h$_2$(h$_1$?)ster-/ 'star'	*h$_2$ster-[34]	Gk. ἀστήρ, Arm. *astł*, Lat. *stēlla*
	*h$_2$str̥- (11)	Ved. *stŕ̥bhis*
*/(h$_2$)i̯eu̯h$_1$-/ 'grain'	*i̯^{e}/$_o$u̯h$_1$-[35]	Ved. *yáva-*, Av. *yauua-*, Gk. ζεί-, -ζοος, Lith. *jãvas*
	*i̯éu̯h$_1$(i)i̯o- (215)	Ved. *yáv$_i$ya-*, Lith. *jáuja*
*/h$_2$i̯eu̯g^{w}i̯h$_3$-/ (?)[36]	*i̯ugih$_3$- (235)	Gk. ὑγιής, Cypriot Gk. *u-wa-i-se/za-ne*, Lat. *iūgis*, Av. *yauuaējī*, Goth. *ajukdūþs*
*/h$_2$k̂eu̯s-/ 'hear'	*h$_2$k̂ou̯s- (104)	Gk. ἀκούω, Goth. *hausjan*
*/h$_2$leg-/ 'worry'	*h$_2$leg- (104)	Gk. ἀλέγω, Lat. *-legō*

29 (11, 17, 92)
30 (209, 218, 237)
31 (94, 107, 218)
32 (24, 70, 127)
33 (14, 22, 126, 185)
34 (11, 15, 117, 123, 129)
35 (215, 235–7)
36 'life everlasting'

Underlying	Reconstructed	Attested
*/h$_2$leks-/ ‘protect’	*h$_2$leks- (126)	Ved. *rákṣati*, Gk. ἀλέξō
*/h$_2$nek̂-/ ‘reach’	*h$_2$ah$_2$nok̂- (119, 121)	Skt. *ānáṃśa*, OIr. *-ánaic*
*/h$_2$ner-/ ‘man’	*h$_2$ner- (28)	Skt. *nara-*, Gk. ἀνήρ
	*h$_2$n̥rés (69, 96)	
	*h$_2$nero- (191, 205)	Skt. *-nará-*
*/h$_2$seu̯s-/ ‘dry’	*h$_2$seu̯s- (104)	Ved. *śuṣyati*, Gk. αὔος
*/h$_2$teu̯g-/ ‘terrify’	*h$_2$tug- (57, 104, 117)	Hitt. *ḫatukzi*, Gk. ἄτυζομενος
*/h$_2$u̯edh$_{(1/3)}$-/[37]	*h$_2$udi̯e- (208)	Skt. *udyáte*
	*h$_2$u̯edh$_{(1/3)}$- (208)	Skt. *avádiṣur*, Gk. αὐδή, αὐδών
	*h$_2$udh$_{(1/3)}$to- (208)	Skt. *uditá-*
*/h$_2$u̯edh$_2$-/ ‘pull’	*h$_2$u̯edh$_2$i̯e/o- (?) (92)	Hitt. *ḫu̯etti(i)ya-*
*/h$_2$u̯eh$_1$nto-/ ‘wind’	*h$_2$u̯eh$_1$n̥to- (193)	Lat. *ventus*, OIr. *fét*, Goth. *winds*
*/h$_2$u̯ers-/ ‘rain’	*h$_2$u̯ers- (175)	
*/(h$_3$)b^{h}ruh$_x$-/ ‘brow’	*(h$_3$)b^{h}ruh$_x$- (101)	
*/h$_3$ek^w-/ ‘eye’	*h$_3$ok^w- (233)	Gk. ὄσσε
*/h$_3$ep-/ ‘work’	*h$_3$op- (12, 233)	Hitt. *ḫappariye-*, Lyc. *epirije-*, Ved. *apas*, Lat. *ops*
*/h$_3$mei̯ĝ^h-/ ‘urinate’	*h$_3$mei̯ĝ^h- (42)	Ved. *méhati*, Gk. ὀμείχω, Lat. *meiō*
	*moi̯ĝ^{h}ó- (42)	Gk. μοιχός
*/h$_3$peu̯s-/ ‘copulate’	*h$_3$pus- (104)	Hitt. *ḫapuša-*, Gk. ὀπυίω
*/h$_3$reĝ-/ ‘rule’	*h$_3$rḗk̂s (6, 8, 14, 85)	Lat. *rēx*, Gaul. *-rix*, Skt. *rāṭ*
	*h$_3$rek̂tós (6)	Gk. ὀρεκτός, Eng. *right*
	*h$_3$reĝ- (6, 104)	Av. *razeyeiti*, Gk. ὀρέγω, Lat. *rēgula*, *regō*, Germ. *Reich*, Eng. *regular, regulation*
*/h$_3$u̯erh$_x$d^{h}u̯o-/[38]	*h$_3$u̯r̥h$_x$d^{h}u̯o- (208)	Ved. *ūrdhvá-*, Av. *ərəduua-*, Gk. ὀρθός, Lat. *arduus*, OIr. *ard*
*/h$_x$ok̂toh$_x$/ ‘eight’	*h$_x$ok̂toh$_x$ (125)	Skt. *aṣṭāu*
	*h$_x$ok̂h$_x$tí (125, 242)	Ved. *aśītí-*
*/i̯ek$^{(w)}$s-/ ‘appear’	*i̯ek$^{(w)}$s- (126)	Ved. *yakṣanta*, Yagh. *yaxš-*
*/i̯eu̯g-/ ‘yoke’	*i̯ugóm (234)	Skt. *yuga-*, Gk. ζυγόν, Lat. *iugum*
	*i̯eu̯g- (144)	Ved. *yójam*, GAv. *yaogət*
	*i̯uk- (158)	Ved. *áyukta*

37 ‘speak’

38 ‘upright’

Underlying	**Reconstructed**	**Attested**
	*i̯unékti (144)	Ved. _yunákti_
	*i̯uŋgénti[39]	Ved. _yuñjánti_, YAv. _yunjiṇti_, Lat. _iungō_, Lith. _jùngiu_
	*i̯éu̯ktro-[40]	Skt. _yoktra-_
*/i̯u̯(h$_x$?)s/ 'y'all'	_*i̯ū(h_$_x$_?)s_ (116)	Skt. _yūyám_, Av. _yūš_, Lith. _jū́s_, OCS _vy_
*/k̂eh$_3$(i̯)-/ 'sharpen'	_*k̂i̯é-_ (213, 238)	Ved. _sám śyat_
	_*k̂Vh_$_3$_(i̯)-_ (213)	Skt. _sam śā́ya_, YAv. _saēni_, Lat. _cōs, cōtis_, Arm. _sowr_, ON _hein_
	_*k̂əh_$_3$_-_ (213)	Lat. _catus_, MIr. _cath_
*/k̂erd-/ 'heart'	_*k̂ḗr_ (24)	Hitt. _ker_, Gk. κῆρ
	*k̂r̥dii̯o- (141)	OIr. _cride_
	*k̂ertro- (23)	Goth. _hairþram_, OHG _herdar_, OE _hreþer_, Lith. _kartóklys_
*/k̂erh$_2$-/ 'head'	_*k̂erh_$_2$_-_ (110)	Hitt. _kitkar_
	*k̂erh$_2$_srom_ (94, 107)	Lat. _cerebrum_
*/k̂(e)rngo-/ 'horn'	_*k̂r̥ŋgo-_ (150)	Hitt. _karkidant-_, HLuv. _zurnid-_, Skt. _śr̥nga-_, Gk. κραγγών, Norwegian _hork_
*/k̂eru̯o-/ 'stag'	_*k̂eru̯o-_ (187)	Lat. _cervus_, TA _śaru_ (?), TB _śerwe_ (?)
*/k̂lei̯to-/ 'leaned'	_*k̂litó-_ (72, 139)	Ved. _śritá-_, Av. _srita-_, Gk. κλιτός
*/k̂leu̯-/ 'hear'	_*k̂lu-_ (248)	Gk. ἔκλυον
	*k̂lutó- (72, 139)	Ved. _śrutá-_, Gk. κλυτός, Lat. _inclutus_, OIr. _cloth_
*/k̂u̯on-/ 'dog'	_*k̂u̯ṓ_ (21)	Ved. _śvā́_, OIr. _cú_
	_*k̂uu̯ṓ_ (206)	Ved. _śuvā́_, Gk. κύωη
	*k̂únes[41]	Ved. _śúnaḥ_
	*k̂u̯ń̥bʰis[42]	Skt. _śvábhis_
	_*k̂u̯n̥ko-_ (147)	Ved. _śvaka-_
/kakka/ 'poo-poo'	_*kákka_ (46, 243, 247)	Gk. κακκάω, MIr. _caccaim_, Russ. _kákatъ_

39 (75, 137, 144–5, 159)
40 (61, 123, 197, 200–3)
41 (34, 73, 75, 136, 168, 172, 245)
42 (71–3, 76, 78, 138, 171, 245, 250–2)

Underlying	Reconstructed	Attested
*/kerh$_x$-/ 'spread'	*k̥rh$_x$e- (90)	Ved. *kiráti*
	*kerd^{h}h$_1$o- (90)	OIr. *fo·ceird*
*/kerp-/ 'pluck'	*k(e)rp- (213)	Gk. καρπός, Lat. *carpō*, Lith. *kir̃pti*, OE *sceorfan*
*/keu̯bh$_2$-/ 'sleep'	*kub(h$_2$)- (91)	MWel. *kyscaf*, Lat. *cumbō*
*/kh$_2$ei̯d-/ 'hit'	*kh$_2$ai̯d- (101–2)	Lat. *caedō*, Alb. *qeth*
*/kreu̯h$_2$-/ 'flesh'	*kr^e/$_o$u̯i̯o-[43]	Skt. *kravya-*, Lith. *kraũjas*
	*kréu̯h$_2$s (211)	Skt. *kravíṣ-*, Gk. κρέας
	*kruh$_2$- (211)	Ved. *krūrá-*, Av. *xrūra-*, Lat. *crūdus*, OIr. *crú*
	*krou̯h$_2$o- (211)	OHG *(h)rō*, OE *hrēaw*, OS *hrā*, and OIce. *hrār*
*/ksneu̯-/ 'sharpen'	*keksnou̯- (?) (14–5, 122)	Skt. *cukṣṇāva*, Av. *kuxšnuuąna-*
*/ku̯/ (quest.part.)	*ku (115–6)	Skt. *kútaḥ*, Av. *kuϑa*
	*kū (115)	Skt. *kū́*, Av. *kū*
*/ku̯rCos/ 'foal'	*kúrnos[44]	Gk. κύρνος
	*kúrkos[45]	Hitt. *kūrkaš*, Pahlavi *kwlk*|, Mod. Pers. *kurra*, Kurdish *kur̠*, Arm. *kʻowrak*
*/kʷekʷlos/ 'wheel'	*kʷekʷlós (119)	Skt. *cakrá-*, Gk. κύκλος, OE *hwēol*
*/kʷelh$_1$-/ 'turn'	*kʷolh$_1$i̯e- (216)	CLuv. *kuwalīti*, Ved. *cāráyati*, Gk. πολέω
	*kʷōlh$_1$i̯e- (?)[46]	Gk. πωλέομαι
*/kʷetu̯or-/ 'four'	*kʷetu̯or- (19)	
	*kʷətu̯or-[47]	Aeol. Gk. πίσυρες, Lat. *quattuor*
	*kʷetur- (73)	Lith. *keturì*, Skt. *catúraḥ*
	*kʷetu̯rto-[48]	Gk. τέτρατος, Lith. *ketvir̃tas*, OCS *četvrŭtŭ*
	*(kʷe)tru- (142, 176)	Av. *čaϑru-*, Gk. τρυ-, Lat. *quadru-*, Gaul. *petru-*

43 (211, 220–1)
44 (36, 79, 148–50, 178, 241)
45 (79, 148–50, 178)
46 (209, 216)
47 (9, 23, 33, 96)
48 (73, 142, 176)

Underlying	**Reconstructed**	**Attested**
*/k$^{(w)}$h$_2$ed-/ ‘crush’	**k$^{(w)}$h$_2$ad-* (101)	Ved. *khā́dati*, YAv. *vīxaδa*, Khot. *khad-*, Bal. *khāδ-*
*/k$^{(w)}$h$_2$eĝ-/ ‘eat’	**k$^{(w)}$h$_2$aĝ-* (101)	Khot. *khāś-*, Parth. *x’z-*, Arm. *xacanem*
*/k^{w}i̯s/ ‘who’	**k^{w}is* (58)	Hitt. *kuiš*, Lat. *quis*
*/k^{w}rmi̯-/ ‘worm’	**k^{w}r̥mi-* (141)	OIr. *cruim*
*/k^{w}sep-/ ‘night’	**k^{w}sep-* (17)	Ved. *kṣáp-, kṣapā́*, Av. *xšap-*, Gk. ψέφος
	**k^{w}spent-* (17–8, 122)	Hitt. *išpant-*
*/lemb^{h}-/ ‘sag’	**l̥mb^{h}e-* (140)	Ved. *rábhate*
*/leu̯h$_x$-/ ‘loosen’	**luh$_x$-* (132–3, 248)	Gk. λύω, Lat. *luō*, *lūstrum* (?)
*/math$_2$-/ ‘tear off’	**math$_2$tó-* (125, 148)	Skt. *mathitá-*
*/me/ ‘me’	**me* (115–6)	Gk. ἐμέ, OIr. *mé*, Goth. *mik*
	**mḗ* (115)	Skt. *mā*, Av. *mā*, Lat. *mēd*, Gaulish *mi*, Wel. *mi*
*/med-/ ‘measure’	**métro-*[49]	Gk. μέτρον
*/meĝh$_2$/ ‘great’	**méĝh$_2$*[50]	Hitt. *mēk*, Ved. *máhi*, Gk. μέγα
	**meĝn-́* (91)	Ved. *mahnā́*
	**məĝno-* (?) (96)	Lat. *magnus*
	**me/əĝi̯os* (213, 219)	Gk. μείζων, Ionic Gk. μέζων, Myc. *me-zo*, Lat. *maior*
*/meh$_2$-/ ‘measure’	**mḗh$_2$u̯r̥* (11)	Hitt. *meḫur*
*/mei̯h$_2$-/ ‘decrease’	**mih$_x$i̯e-* (210)	Ved. *mī́yate*
*/mems-/ ‘meat’	**mēms-* (112)	RCS *męzdrica*, Russ. *mjazdra*
*/mentei̯-/ ‘mind’	**m(e)nti-*[51]	
	**mn̥téi̯-* (171, 174)	
*/mer-/ ‘disappear’	**mertii̯o-* (21)	Ved. *mártiya-*
	**mr̥u̯os* (141)	OIr. *marb*
*/mes-/ ‘stretch’	**m̥si̯e-* (140–1)	Gk. μαίομαι
*/mi̯eĥs-/ ‘set oneself’	**memi̯eĥs-* (126)	Ved. *mimyákṣa*

49 (22–3, 44, 46, 126–7, 243)

50 (11, 17, 28, 53, 61, 91, 96, 105)

51 (75, 136, 138, 140, 161, 166, 170–1, 251)

Underlying	Reconstructed	Attested
*/mneh$_2$-/[52]	*_mnah$_2$-_[53]	Gk. μέμνημαι, ἔμνησα
*/mu̯(h$_x$?)s-/ 'mouse'	*_mūs_ (8, 44, 116)	OE _mūs_
	*_mus-_ (8)	Lat. _musculus_
*/nas-/ 'nose'	*_nās-_ (8, 29, 44)	Lat. _nārēs_
	*_nas-_ (8)	Skt. _nasa-_, OCS _nosŭ_
*/ne/ 'not'	*_ne_ (19, 115)	Skt. _ná_, Lat. _neque_, OCS _ne_, Goth. _nih_
	*_nē_ (19, 115)	Lat. _nē_, OIr. _ní_, OCS _ně-_
	*_n̥_ (248–9)	Skt. _a_(_n_)-, Gk. ἀ(ν), Lat. _in-_, Goth. _un-_, TB _e_(_n_)-
*/neg^{w}t-/ 'evening'	*_n$^o/_e$k^{w}ts_ (14, 22, 242)	Hitt. _nekuz_
*/nei̯g^w-/ 'wash'	*_nik^{w}tó-_ (22, 49)	Skt. _niktá-_, Gk. (ἄ-)νιπτος
*/nemmen/ 'gift'	*_némn̥_ (44)	OIr. _neim_
*/neu̯-/ 'new'	*_nou̯i̯ó-_ (211)	Lith. _naūjas_
	*_neu̯io-_ (8)	Wel. _newydd_
	*_nu_ (19, 115–6)	Skt. _nú_, Gk. νύ, Lat. _nunc_, OIr. _nu_, _no_, Latv. _nu_
	*_nū́_ (19, 115)	Skt. _nū́_, Av. _nū_, Gk. νῦν, OCS _nyně_, Lith. _nūnaĩ_
*/neu̯n/ 'nine'	*_néu̯n̥_ (73, 136)	Skt. _náva_, Gk. ἐννέ(ϝ)α, Lat. _novem_
	*_neu̯n̥ti-_ (73)	Skt. _navatí_, Av. _navaiti-_
*/nei̯mno-/ 'lowland'	*_nimnó-_ (74)	Skt. _nimná-_
*/nos/ 'us'	*_nos_ (116–7)	Hitt. _-naš_, Skt. _nas_, YAv. _nō_, GAv. _nə̄_, Gk. νόσφιν, Alb. _na_
	*_nōs_ (116–7)	Lat. _nōs_, OCS _na_
*/oi̯u̯os/ 'one'	*_oi̯u̯os_ (73, 136)	Av. _aiva_, Cyp. _oiwos_
*/ped-/ 'foot'	*_pṓts_ (35)	Goth. _fotus_
	*_pódm̥_ (7, 35)	Gk. πόδα, Arm. _otn_
	*_péts_ (35)	Lat. _ped-_
	*_pḗd_(_-su_) (35)	OIr. _ís_
	*_bd-_ (35)	Av. _frabdəm_
	*_pedi̯os_ (188)	Skt. _pádya-_, Gk. πεζός, Lat. _peius_
*/peh$_2$s-/ 'protect'	*_pah$_2$s-_ (11, 94)	Hitt. _paḫs-_, Lat. _pāstor_, TB _pāsk-_
*/peh$_2$u̯er-/ 'fire'	*_pah$_2$u̯r̥_ (149)	Luv. _pāḫūr_

52 'remember'

53 (74, 119, 142)

Underlying	Reconstructed	Attested
*/peh$_3$(i̯)-/ 'drink'	*_pibh$_3$eti_ (12)	Ved. _píbati_, Lat. _bibit_, OIr. _·ib_, Arm. _əmpē_
	*_poh$_3$i̯éi̯e-_ (244)	Ved. _pāyáyati_
	*_pih$_3$tó-_ (25, 103, 208)	Skt. _pītá-_, OCS _pitъ_
*/pei̯h$_2$-/ 'fat'	*_pih$_2$u̯erih$_2$_ (8)	Skt. _pī́varī_
*/pek̂-/ 'comb'	*_pek̂-_ (18)	Gk. πέκω, Lith. _pešù_
	*_kten-_ (18, 23)	Gk. κτείς
*/pek̂u̯-/ 'livestock'	*_pk̂u-_ (104)	YAv. _fšu-_, Ved. _kṣu-_, Gk. κύ-κλωψ (?)
*/penk^{w}e/ 'five'	*_péŋk^{w}e_ (10, 172)	Skt. _páñca_, Gk. πέντε, Aeol. πέμπε, Lat. _quīnque_, Goth. _fimf_, OE _fīf_
*/peru̯er/ 'rope'	*_péru̯r̥_ (77)	Gk. πεῖραρ
*/pet(h$_{1/2}$)-/ 'fly'	*_pṓth$_2$i̯e-_ (?)[54]	Gk. πωτάομαι
	*_petnV-_ (217)	Lat. _penna_, OIr. _én_
	*_ptero-_ (14, 98, 217)	Gk. πτερόν, Arm. _tʻertʻ_
*/peth$_2$/ 'spread out'	*_pətnah$_2$-_ (23, 96, 217)	Gk. πίτνημι, Lat. _pandō_, Osc. **patensíns**
	*_pəth$_2$əh$_1$i̯e-_ (?) (217)	Lat. _patēre_, Osc. _pat_[_ít_], Volscan _ar-patitu_
*/pesd-/[55]	*_pezd-_ (17)	Lat. _pēdō_, Russ. _bzdětъ_, Lith. _bìzdas_
	*_bzd-_ (17)	Gk. βδέω
*/ph$_2$ter-/ 'father'	*_pter-_ (97, 238, 243)	Av. (_p_)_tar-_, _fəδr-_
	*_pəh$_2$tér-_[56]	Gk. πατήρ, Skt. _pitár-am_
	*_pə́h$_2$ter_ (31)	Gk. πάτερ
	*_pəh$_2$tr-_[57]	Skt. _pitrā́_, Lat. _patris_, Gk. πατρός
	*_pəh$_2$tŕ̥-_[58]	Skt. _pitŕ̥ṣu_
	*_(pəh$_2$)trui̯o-_ (97)	Skt. _pitr̥vyà-_, YAv. _tūiriia-_, Lat. _patruus_, Slav. _*strui̯o-_, OHG _fatureo_
*/pleh$_1$-/ 'fill'	*_pipleh$_1$-_[59]	Ved. _pipra-_, Gk. πίμπλημι
	*_pl̥h$_1$nó-_ (202)	Skt. _pūrṇá-_

54 (216, 220, 236)
55 'fart (quietly)'
56 (9, 20, 37–40, 57, 97, 101)
57 (9, 27–8, 30–1, 94, 96–101, 117, 131, 195, 238)
58 (75, 137)
59 (118, 121, 191)

Underlying	Reconstructed	Attested
*/pleth$_2$-/ 'broad'	*pleth$_2$- (12, 90)	Ved. *prathimán-*, *prathāná-*
	*p̥lt- (90, 92)	Hitt. *palzaḫḫa-*, TB *plätk-*
*/pneu̯-/ 'breathe'	*pneu̯- (15)	OE *fneōsan*
*/pnksti-/ 'fist'	*pn̥ksti- (118)	OHG *fūst*, OE *fȳst*, OBulg. *pęstъ*
*/prek̂-/ 'ask'	*pr̥sk̂i̯o- (207)	Skt. *āpŕ̥cchiya*
*/pro/ 'forth'	*prómno- (20, 74)	Gk. πρύμνος
*/proti̯h$_3$k^{w}om/ 'face'	*protih$_3$k^{w}om (233)	Ved. *prátīkam*, Gk. πρόσωπον, TA *pratsak*, TB *pratsāko*
*/psten-/ 'breast'	*psten-[60]	Skt. *stána-*, Av. *fštāna-*, OIce. *speni*
*/pster-/ 'sneeze'	*pster- (14, 17, 122)	
*/pteh$_2$k-/ 'crouch'	*ptah$_2$k- (120)	Gk. πτήσσω, Lat. *taceō*, Arm. *tʻakʻeaw*, OHG *dagēn*
*/pu̯h$_2$ro-/ 'purified'	*puh$_2$rós (8)	Lat. *pūrus*
*/pu̯tlo-/ 'child'	*putlos[61]	Skt. *putra-*, Osc. **puklom**
*/sal-/ 'salt'	*sal- (8, 111)	Ved. *salilá-* 'salty', Gk. ἅλς, Lat. *sal-*
*/sed-/ 'sit'	*sed- (10)	Lat. *sedeō*, Arm. *hecanim*
	*nizdó- (10, 22, 28–9)	Skt. *nīḍáḥ*, Lat. *nīdus*, OCS *gnězdo*, Eng. *nest*
	*sedlo- (23)	Lat. *sella*, Gaul. *sedlon*, Goth. *sitls*, OE *setl*, OHG *sezzal*
*/seh$_1$(i̯)-/ 'release'	*si̯é- (213, 238)	Hitt. *siēzzi* (?), Ved. *s$_{(i)}$yáti*
*/seh$_2$u̯ol-/ 'sun'	*sah$_2$u̯l̥ (147)	Ved. *súvar*
	*suh$_2$li̯o- (147, 184)	Ved. *sū́rya-*
*/sekh$_1$-/ 'cut'	*sekh$_1$- (215, 220)	Hitt. *šakki*, Lat. *secāre*, Umbr. *pru-sekatu*, OIr. *tescaid*
	*ski̯e- (214)	Lat. *ne-sciō*
	*sekskV- (106)	OIr. *seisc*, MWel. *hescenn*, MBret. *hesq*
*/sem-/ 'one'	*séms (52, 111)	Gk. εἷς
*/septm/ 'seven'	*septḿ̥ (36)	
*/sĝ^{h}eh$_2$(i̯)-/ 'cut'	*sk̂^{h}i̯e- (218, 238)	Skt. *chyati*, GAv. *siiōdūm* (?)
	*sk̂^{h}əh$_2$(i̯)- (218, 238)	Gk. σχάω

60 (14, 17, 122)

61 (70, 241, 246)

Underlying	**Reconstructed**	**Attested**
*/(s)g^{w}esh$_2$-/[62]	**(z)g^{w}esh$_2$-* (212)	Ved. *dāsīt*, Gk. ἔσβη
	**(z)g^{w}esi̯e-* (212)	Ved. *jasyata, dásyati*
	**(z)g^{w}esn(a)h$_2$-* (212)	Hsch. ζείναμεν, OLith. *gęsa*
*/(s)g^{wh}h$_2$el-/ 'error'	**(z^{h})g^{wh}h$_2$al-* (102)	Ved. *skhalate*, Gk. σφάλλομαι, σφάλλω, Arm. *sxalem*, Lat. *fallō*
*/sh$_2$ei̯-/ 'bind'	**sh$_2$ai̯-* (101)	
*/sh$_2$eu̯-/ 'pour'	**sh$_2$au̯-* (101)	
*/sh$_2$om-/ 'song'	**sh$_2$om-* (101)	Hitt. (*i*)*šḫamai-*, Skt. *sā́man-*
*/si̯eu̯h$_x$-/ 'sew'	**si̯uh$_x$-* (147)	Ved. *syūtá-*, Oss. *xwyj-/xuj-*, Lat. *sūtus*, Lith. *siū́tas*
	**sih$_x$u̯i̯e-* (147)	Ved. *sī́vyati*, Goth. *siujan*
*/sk̂ei̯h$_x$-/ 'shine'	**sk̂inéh$_x$ti* (57, 98)	
*/skab^{h}-/ 'shave'	**skaps-* (60)	Gk. ἔσκαψα
*/(s)kedh$_2$-/ 'scatter'	**skədn̥h$_2$-* (23, 33)	Gk. σκῖδναμαι, TA *knāṣ*, TB *katnaṃ*
*/skelh$_x$-/ 'split'	**sk(e)lh$_x$-* (209)	Hitt. *iškalla-*, Gk. σκάλλω, Lith. *skiliù*, Arm. *celum*
*/skend-/ 'jump'	**seskond-* (120)	OIr. *sescaind*
*/(s)kers-/ 'cut'	**(s)kers-* (111)	Hitt. *karašzi*, TA *śärs-*, TB *śarsa*
*/smei̯-/ 'smile'	**sesmi-* (119)	Ved. *siṣmiyāṇa-*
*/smok̂u̯er/ 'beard'	**smok̂u̯r̥* (143)	Hitt. *zama(n)kur*, Lith. *smãkras, smakrà*, Latv. *smak(a)rs*
	**smók̂ru-* (143, 176)	Ved. *śmáśru*, Arm. *mawrowkʿ*
*/sneh$_2$-/ 'bathe'	**sn(a)h$_2$-* (57, 93)	Toch. *nāsk-*
*/so, to/ 'that'	**só* (19)	
	**tód* (57)	
	**tosi̯o* (20)	
*/sok^{w}h$_2$-/ 'friend'	**sok^{w}h$_2$oi̯-* (210–1)	Skt. *sakhi-/-āy-*, Av. *haxay-*
	**sok^{w}i̯o-*[63]	Gk. ἀοσσεῖν, Lat. *socius*, OS *segg*, OE *secg*, OIce. *seggr*
*/solh$_2$u̯o-/ 'all'	**solu̯o-* (26)	Skt. *sarva-*, Gk. ὅλος, Lat. *sollus*

62 'extinguish'

63 (25, 209–11, 220–1, 224, 229, 231, 237, 243)

Underlying	Reconstructed	Attested
*/(s)peh$_2$-/ 'extract'	*(s)pəh$_2$- (217, 238)	Gk. σπάω, Arm *hanem*
*/(s)peḱ-/ 'see'	*(s)peḱ- (127)	
*/spend-/ 'libate'	*sespond- (120)	Lat. *spopondī*
*/sreu̯to-/ 'flowed'	*srutó-[64]	Ved. *srutá-*, Gk. ῥυτός, Lith. *srutà*, Latv. *strauts*
*/steh$_2$-/ 'stand'	*sVstah$_2$-[65]	Skt. *tíṣṭ*^{h}*ati*, Av. *hištaiti*, *višastar*^{ə}, OPers. *ahištatā*, Gk. ἵστημι, ἕστηκα, Lat. *sistō*, *stetī*, Umbr. **sestu**, TB *śceścamoṣ*
	*stəh$_2$tó- (11, 14, 122)	Skt. *sthitá-*, Gk. στατός, Lat. *status*
	*stəh$_2$mnó- (94)	OIr. *taman*, Gk. σταμνός, TB *stām*
*/(s)teh$_2$-/ 'steal'	*(s)tah$_2$i̯e-[66]	Hitt. *tāyezzi*, Ved. *stāyát*, OLat. *tātōd*
*/(s)tenh$_2$-/ 'thunder'	*(s)teni̯V-[67]	Ved. *tanyú-*, *tanyatā́-*, *tanyatú-*, Hsch. τέννει, OCS *stenjǫ*
	*(s)tenh$_2$- (212)	AV *astanīt*, Gk. στενάζω, στεναγμός, στενάχω, Lat. *tonitrū, -us*, Celt. PN *Tanaros*
*/sterh$_3$-/ 'spread'	*str̥h$_3$no- (12)	Skt. *stīrṇa-*
*/steu̯-/ 'praise'	*stéu̯n̥ti (35)	Ved. *stávati*
*/stomh$_1$mn/ 'orifice'	*stómn̥ (44)	Gk. στόμα
*/streu̯-/ 'strew'	*streu̯- (14, 117, 122)	Lat. *struō*, OCS *-strujǫ*, Eng. *strew*
*/s(u̯)eḱs/ 'six'	*s(u̯)eḱs (85)	Germ. *sechs*
	*su̯eḱsto-[68]	Ved. *ṣaṣṭhá-*, Gk. ἕκτος, Lat. *sextus*, Goth. *saihsta*, Lith. *šẽštas*, TB *ṣkaste*
*/su̯esor-/ 'sister'	*su̯ésor- (8, 19)	Ved. *svásā*, *svasāraḥ*, Lat. *soror*, OIr. *siur*
*/su̯eḱu̯r-/[69]	*su̯eḱuro- (143)	Ved. *śváśura-*, Gk. ἑκυρός, Germ. *Schwäher*
	*su̯eḱruh$_2$- (143, 176)	Ved. *śváśrū́-*, OHG *swigar*, OCS *svekry*

64 (72–3, 135, 139, 171, 244)
65 (11, 14, 57, 117–21, 142)
66 (224, 231, 243)
67 (212, 221, 224, 237)
68 (12, 14, 57, 72, 118, 122)
69 'parent-in-law'

Underlying	Reconstructed	Attested
*/su̯h$_x$nu-/ 'son'	*suh$_x$nu- (58, 75, 136–7)	Ved. _sūnáu_
*/telh$_2$-/ 'endure'	*teli̯e- (?) (214)	Gk. τέλλω
*/temh$_1$-/ 'cut'	*tómh$_1$os (34)	Gk. τόμος
	*tomh$_1$ós (34)	Gk. τομός
*/temh$_x$sreh$_2$/[70]	*temh$_x$srah$_2$[71]	Skt. _tamisrā_, Lat. _tenebrae_, OHG _dinstar_, Lith. _tim̃sras_
*/ten-/ 'stretch'	*tn̥tós (27, 132, 242)	
	*tn̥tlo- (247)	Lith. _tiñklas_
*/tens-/ 'thin out'	*tens- (112)	OPruss. _tiēnstwei_
*/terh$_1$-/ 'bore'	*teri̯e- (214, 236)	Gk. τείρω
	*terh$_1$trom (94, 107, 214)	Gk. τέρετρον, OIr. _tarathar_, Wel. _taradr_, Corn. _tardar_, MBret. _tarazr_
*/terh$_2$-/ 'cross'	*tr̥h$_2$nó- (202)	Skt. _tīrṇá-_
*/ters-/ 'be dry'	*tr̥sto- (141)	OIr. _tart_
*/tetk̂-/ 'fashion'	*tḗk̂ti (30)	Skt. _tā́ṣṭi_
	*tek̂slah$_2$ (125)	Lat. _tēlum_, RCS _tesla_, OIr. _tál_, Ogam _TALA-GNI_, ON _þexla_, OHG _dehsa(la)_
	*tétk̂on- (125)	Ved. _tákṣan-_, Av. _tašan-_, Gk. τέκτων
*/teu̯h$_2$i̯os/ 'stronger'	*teu̯i̯os (238)	Ved. _távyas-_
*/th$_2$eu̯s-/ 'be quiet'	*th$_2$(a)u̯s- (102)	Hitt. _tuḫuššiyezzi_, Skt. _tūṣṇī́m_, CLuv. _taḫušii̯a-_, GAv. _tušnā_, OPruss. _tusnan_, MIr. _tó_, Wel. _taw_
*/ti̯egʷ-/ 'withdraw'	*ti̯egʷ- (191, 228)	Skt. _tyajate_, Gk. σέβεται
*/tk̂ei̯-/ 'inhabit'	*tsk̂ei̯- (104)	Ved. _kṣéti_
*/tk̂en-/ 'strike'	*tsk̂en- (104)	Gk. κτείνω
*/tréi̯-/ 'three'	*tréi̯es (14, 57, 191)	Ved. _tráyaḥ_, Gk. τρεῖς, Eng. _three_
	*tri-[72]	
*/tsel-/ 'steal'	*tsel- (98)	Eng. _steal_
*/tsperh$_x$-/ 'heel'	*tspr̥h$_x$- (102, 210)	Ved. _sphūrati_, Gk. ἀσπαίρω, Lith. _spiriù_
	*(t)persnV- (14, 57)	Ved. _pā́rṣṇi_, Gk. πτέρνη, Lat. _perna_, Goth. _faírsna_

70 'darkness'

71 (94, 107, 248)

72 (75, 136–7, 143, 248)

Underlying	Reconstructed	Attested
*/tu̯/ ‘you’	*tu (19, 115–6)	Hitt. *tuk*, Gk. σύ, Latv. *tu*, OE *þu*, OIr. *tussu*
	*tū́ (19, 115)	Lat. *tū*, Av. *tū*, Hom. Gk. τῡ́νη, OCS *ty*, OE *þū*
*/t(u̯)e/ ‘you (acc.)’	*t(u̯)e (115–6)	Gk. σέ, τέ
	*t(u̯)ē (115)	Skt. *tvā́*, Av. *ϑβā*, Lat. *tēd*
*/tu̯er-/ ‘agitate’	*tu̯er- (143)	Ved. *tvárate*, *turáṇas*, OE *weran*, OHG *dweran*
	*tru- (143)	Gk. ὀτρῡ́νω
*/tu̯erh$_{2/3}$-/ ‘enclose’	*tu̯erh$_x$- (214)	Lith. *tvérti*
	*tu̯eri̯ah$_2$- (214, 237)	Gk. σειρή
	*tu̯orh$_x$ós (214)	Gk. σορός, Russ. *tvor*
*/tu̯erk̂-/ ‘cut’	*tu̯erk̂- (175)	
*/u̯d/ ‘up’	*ud (60, 115)	Skt. *úd*
	*ūd (115, 117)	Goth. *ut*, Eng. *out*, Germ. *aus*
*/u̯e/ ‘or’	*u̯e (115–6)	Skt. *ivá*, Lat. *-ve*
	*u̯ē (115)	Skt. *vā*, Gk. ἦ(ϝ)ε, ἤ, Av. *vā*
*/u̯ed^{h}h$_1$-/ ‘push’	*u̯ṓd^{h}h$_1$i̯e- (217–8, 220)	Gk. ὠθέω, OCS *važdǫ*
	*u̯ed^h(h$_1$)- (218)	Hitt. *wizza-*, *wiwid(a)-*, Skt. *ávadhīt*, *a-vadhrá-*
*/u̯eĝ^h-/ ‘convey’	*u̯ek̂s- (22, 60, 72, 247)	Skt. *vakṣ-*, Cyp. *éwekse*, Lat. *vēxī*
*/u̯eh$_1$d^{h}rom/[73]	*u̯ed^{h}rom (26)	OCS *vedro*, Eng. *weather*
*/u̯ei̯d-/ ‘see’	*u̯id- (187)	Goth. *witum*
	*u̯itstó-[74]	Skt. *vittá-*, Gk. (ἄ)ϊστος, Germ. *gewiss*
	*u̯oi̯tsth$_2$a (?) (126)	
*/u̯ei̯k-/ ‘settlement’	*u̯oi̯koï (8)	Gk. οἴκοι
*/u̯ek^w-/ ‘speak’	*u̯ṓk^{w}s ‘voice’ (21, 29)	Av. *vāxš*, Lat. *vōx*
*/u̯el-/ ‘roll’	*u̯el- (175)	
*/u̯emh$_1$-/ ‘vomit’	*u̯emh$_1$i̯e- (218)	Gk. ἐμέω, Lith. *vemiù*
	*u̯emh$_1$e- (218, 236–7)	Skt. *vamiti*, Lat. *vomō*
*/u̯erh$_1$-/ ‘speak’	*u̯eri̯e- (214)	Hitt. *weriyezzi*, Gk. εἴρω
	*u̯^{e}/$_o$rd^{h}h$_1$o- (90)	Hesych. ἔρθει, Lat. *verbum*, Lith. *var̃das*

73 ‘weather’

74 (22, 44, 48, 122, 127)

Underlying	**Reconstructed**	**Attested**
	*_u̯(e)rh$_1$mn̥_ (90)	Gk. ῥῆμα, TA _wram_
*/u̯erh$_1$i̯os/ 'wider'	*_u̯erh$_1$i̯os_ (238)	Skt. _várīyas_
*/u̯ertro-/[75]	*_u̯ertro-_ (247)	Skt. _vártram_, Av. _varəϑra-_, MWel. _gwerthyr_
*/u̯eth$_2$-/ 'say'	*_u̯eth$_2$-_ (91)	OLat. _votāre_, OIr. _as:pena_, TB _wätk^a-_ (?)
*/u̯i̯eh$_1$-/ 'turn'	*_u̯i̯eh$_1$t_ (77)	
*/u̯i̯eth$_2$-/ 'sway'	*_u̯i̯eth$_2$-_ (74, 136)	Ved. _vyathate_
*/u̯i̯h$_1$ró-/ 'man'	*_u̯ih$_1$ró-_ (26, 111)	Ved. _vīrá-_, Lith. _výras_
	*_u̯iró-_ (26)	Lat. _vir_, OIr. _fer_, Goth. _wair_
*/u̯i̯(h$_x$?)s/ 'poison'	*_u̯īs-_(8, 29)	Av. _vīš_, Lat. _vīrus_
	*_u̯is-_ (8)	Ved. _viṣá-_, Av. _viša-_
*/u̯i̯dk̂mtih$_1$/ 'twenty'	*_u̯īk̂m̥tih$_1$-_ (233)	Dor. Gk. ϝίκατι, TA _wiki_, TB _ikäṃ_
*/u̯lei̯k^w-/ 'be wet'	*_u̯lei̯k^w-_ (142)	
*/u̯lk^{w}os/ 'wolf'	*_u̯ĺ̥k^{w}os_ (36, 143, 169)	Ved. _vŕ̥ka-_, Eng. _wolf_
	*_lúk$^{(w)}$os_ (143)	Gk. λύκος, Lat. _lupus_
*/u̯odr/ 'water'	*_u̯ódr̥_ (37)	
	*_u̯edṓr_ (105–13, 243)	Hitt. _úidār_, Gk. ὕδωρ
*/u̯orh$_1$ĝent-/ 'fat'	*_u̯orh$_1$ĝent-_ (92)	Hitt. _úarkant-_
*/u̯os/ 'y'all'	*_u̯os_ (115)	Skt. _vas_, YAv. _vō_, GAv. _vō_
	*_u̯ōs_ (115, 117)	Lat. _vōs_, OCS _va_
*/u̯p/ 'up'	*_ub_ (60, 116)	Lat. _sub_
	*_ūb_ (116–7)	OHG _ūf_, OCS _vy-sokъ_
*/u̯reh$_1$ĝ-/ 'break'	*_u̯eu̯roh$_1$ĝ-_ (121)	Gk. ἔρρωγε
*/u̯reg-/ 'track'	*_u̯rége-_ (74)	Ved. _vrájant-_
	*_u̯ŕ̥gi-_ (149)	Hitt. _ūrki-_

75 'protection'

Appendix B: Proto-Indo-European Edge Phonotactics

Directly attested, unless otherwise noted; (i) = Indirectly attested; (e/s) = Reconstructed for etymological / structural reasons[1]

Word-Initial

Bipartite

#PN-:

*pn-, *dm-, *dʰm-, *ĝn-, *ĝʰn-, *gn-, *gʷn-, *gʷʰn-.[2]

#PL-:

*pr-, *pl-, *tr-, *k̂r-, *k̂l-, *kr-, *kl-, *kʷr-;[3]
*dr-, *dl-, *ĝr-, *ĝl-, *gr-, *gl-, *gʷr-;[4]
*bʰr-, *bʰl-, *dʰr-, dʰ-l-, *gʰr-, *gʰl-, *gʷʰr-.[5]

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1 All clusters inferred and all representative examples containing said clusters have been taken from IEW, LIV, NIL, EWAia and Schindler 1972, unless otherwise noted. Given the limited number of references, this appendix of edge clusters should not be considered exhaustive. Questionable reconstructions will be marked with a (?). Note that a number of sequences containing laryngeals have been omitted, if they are not attested in languages in which laryngeals are not vocalized. For example, at this point it is difficult to decide whether _*kréu̯h$_2$s_ 'flesh', continued solely by Ved. _kravis-_ and Gk. _kréas_, was realized as such (with a tripartite coda) or as _*kréu̯h$_2$əs,_ though perhaps the loss of laryngeal in Av. _mraot̰_ 'spoke' speaks in favor of a tripartite coda.

2 _*pneu-_ 'breathe', _*dmah$_2$-_ 'build', _*dʰmeh$_x$-_ 'blow', _*ĝnoh$_3$-_ 'know', _*ĝʰneu̯-_ 'be ashamed'(?), _*gnet-_ 'knead', _*gʷnah$_2$-_ 'woman', _*gʷʰnént_ 'they slayed'.

3 _*prek̂-_ 'ask', _*pleh$_1$-_ 'fill', _*tréi̯es_ 'three', _* k̂reth$_2$-_ 'loosen, slacken', _*k̂lei̯-_ 'lean', _*kreu̯h$_2$s_ 'flesh', _*klep-_ 'steal', _*kʷrei̯h$_2$-_ 'buy'.

4 _*drák̂u̯r̥_ 'tear', _*dlongʰo-_ 'long', _*ĝrei̯-_ 'extend', _*ĝlei̯-_ 'rush, attack' (?), _*gres-_ 'devour', _*glei̯h$_x$-_ 'coat, paste', _*gʷrih$_x$-_ 'heavy'.

5 _*bʰrā́ter-_ 'brother', _*bʰleg-_ 'shine', _*dʰregʰ-_ 'run', _*dʰlas-_ 'squeeze' (?), _*gʰrebh$_2$-_ 'grab', _*gʰlendʰ-_ 'look; shine', _*gʷʰren-_ 'diaphragm'.

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#PU̯-:

*ti̯-, *di̯-, *d^{h}i̯- (i), *k̂i̯-, *ĝi̯-, *ĝ^{h}i̯-, *ki̯-, *g^{w}i̯-;[6]

*tu̯-, *du̯-, *d^{h}u̯-, *ĝu̯-, *k̂u̯-, *ĝ^{h}u̯-.[7]

#RR-:

*mn-, *mr-, *ml-, *mi̯-;[8]

*u̯r-, *u̯l-, *u̯i̯-.[9]

#FR-:

#sR-: *sm-, *sn-, *sr-, *sl-, *su̯-, *si̯-;[10]

#h1R-(i): *h_1n-, *h_1r-, *h_1l, *h_1u̯, *h_1i̯-;[11]

#h2R- (i): *h_2 m-, *h_2n-, *h_2r-, *h_2l-, *h_2u̯-;[12]

#h_3R- (i): *h_3m-, *h_3n-, *h_3r-, *h_3l-, *h_3u̯-;[13]

#FF-:

#sh$_x$-(i): *sh$_2$-;[14]

#h$_x$s- (i): *h_1s-, *h_2s-.[15]

#FP-:

#sP-: *sp-, *st-, *sk̂-, *sk-, *sk^w-;[16]

#zP-: *zg^w-;[17]

#z^{h}P-: *z^{h}b^h-, *z^{h}d^h-, *z^{h}g^{wh}-;[18]

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6 *ti̯eg^w- 'withdraw oneself', *di̯eu̯- 'heaven', *d^{h}i̯ah$_2$mn̥ 'sign' (?), *k̂i̯eh$_1$- 'dark-colored' (?), *ĝi̯eu̯h$_x$- 'chew' , *ĝ^{h}i̯em- 'winter', *ki̯eh$_1$- 'move', *g^{w}ĝi̯oh$_3$- 'live'.

7 *tu̯erk- 'cut', *du̯oh$_x$ 'two', *d^{h}u̯or- 'door', *k̂u̯on- 'dog', *ĝu̯erh$_x$- 'be hot', *ĝ^{h}u̯er- 'be crooked'.

8 *mnah$_2$- 'think about', *mreĝ^{h}u- 'short', *mleu̯h$_2$- 'speak' , *mi̯eu̯h$_1$- 'move'.

9 *u̯reh$_1$ĝ- 'break', *u̯lei̯k^w- 'moisten', *u̯i̯eh$_1$- 'wrap'.

10 *smer- 'think about', *snei̯g^{wh}- 'snow', *sreu̯- 'flow', *slei̯ĝ- 'smear', *su̯ah$_2$d- 'sweet', *si̯eu̯h$_x$- 'sew'.

11 *h$_1$neu̯n̥ 'nine', *h$_1$rem- 'become quiet', *h$_1$leud^h- 'climb; grow', *h$_1$u̯eg^{wh}- 'speak solemnly', *h$_1$i̯ó- 'which'.

12 *h$_2$meh$_1$- 'mow', *h$_2$nek̂- 'obtain; arrive', *h$_2$reu̯i- 'sun', *h$_2$leg- 'attend to, worry', *h$_2$u̯eks- 'grow'.

13 *h$_3$mei̯ĝ^h- 'urinate', *h$_3$neid- 'abuse', *h$_3$reĝ- 'rule; stretch', *h$_3$lei̯sd^h- 'slide' (?), *h$_3$u̯ath$_2$- 'injure'.

14 *sh$_2$om- 'song'.

15 *h$_1$sénti 'they are', *h$_2$seu̯s- 'become dry'.

16 *spek̂- 'look at', *stah$_2$- 'stand', *sk̂eh$_x$(i̯)- 'shine', *skab^h- 'shave', *sk^{w}al- 'big fish'.

17 *sg^{w}es- 'extinguish'. Cf. Southern 2000:36.

18 Or #sP^h- by Siebs' Law. *sb^{h}eng- 'shine', *sd^{h}erb^h- 'become fixed', *sg^{wh}al- 'make a mistake' (?).

#h_1P- (i): *h_1*d*-, *h_1*g*-, *h_1*g^wh*-;[19]
#h_2P- (i): *h_2*t*-, *h_2*k*-;[20]
#h_3P- (i): *h_3*p*-, *h_3*k^w*-.[21]

#PF-:
#Ps-: **ps-*, **ts-*, **ks-*, **k^ws-* (i);[22]
#PH- (i): **th$_2$-*, **kh$_2$-*.[23]

#PP-:
#TK-: **tḱ-*, **tk-*, **d^hĝ^h-*, **d^hg^wh-*;[24]
Other #PP: **pḱ-*, **pt-*.[25]

Tripartite

#FPR-:
#sPR-: **spr-*, **spl-*, **str-*, **skr-*;[26]
#*h$_x$*PR-: only attested in **h$_3$b^hruh$_x$-* 'brow' (i).[27]

#OsC-:
#h_xsC- (i): **h$_1$st-*, **h$_1$z^hd^h-*, **h$_2$st-*, **h$_3$sl-*;[28]
#PsC-: **pst-*, **bzd-* (e/c), **ksn-*, **ksu̯-*, **k^wsp-* (e/c).[29]
#PPC-: Only reconstructable in **ĝ^hd^hi̯-* (i).[30]

19 **h$_1$dont-* 'tooth', **h$_1$ger-* 'wake up', **h$_1$g^whel-* 'wish'.
20 **h$_2$teu̯g-* 'terrify', **h$_2$ḱou̯s-* 'hear'.
21 **h$_3$pus-* 'copulate; marry' (?), **h$_3$k^wV-* 'eye'.
22 **pseh$_x$-* 'tear; rub', **tsel-* 'steal', **kseu-* 'shave', **k^wsep-* 'dark'.
23 **th$_2$au̯s-* 'be quiet' (?), **kh$_2$aid-* 'hit' (?).
24 Perhaps #TsK-. **t(s)ḱei̯-* 'inhabit', **t(s)keh$_1$-* 'acquire', **d^h(z^h)g^hŏ̄m-* 'earth', **d^h(z^h)g^whei̯-* 'be destroyed'.
25 **pḱu-* 'cattle', **ptero-* 'feather'.
26 **spreg-* 'crackle', **splend-* 'shine', **streu̯-* 'strew', **skreb-* 'scrape'.
27 The oblique of **h$_1$étmō* 'breath, soul' (Ved. *ātmā́*), is often reconstructed as **h$_1$tmen-* (cf. Ved. *tmánā.* 'soul (instr.sg.)'), though the only evidence is of structural/etymological nature.
28 **h$_1$stí-* 'existence', **h$_1$zd^hi* 'be!', **h$_2$ster-* 'star', **h$_3$slei̯d^h-* 'slide' (?).
29 **psten-* 'breast, nipple', **bzdV-* 'fart lightly', **ksneu̯-* 'sharpen', **ksu̯ei̯b^h-* 'throw, jerk' (?), **k^wspent-* 'night'.
30 **g^hd^hi̯és* 'yesterday'. Perhaps also **tḱi̯-* if the reconstruction **tḱi̯ah$_2$ino-* 'bird of prey' is correct (see Clackson 1994:143–4 and EWAia II 662 for discussion, with references).

Word-Final

Bipartite

-RO#: **-ms, *-nd, *-ns, *-nh₂* (i), **-rd, *-ls, *-u̯d, *-u̯s, *-i̯d.*[31]

-OT#: **-pt, *-k̂t, *-st.*[32]

-OF#:
 -Os#: **-ps, *-ts, *-k̂s, *-ks, *-kʷs;*[33]
 -Oh$_x$ # (i): **-dʰh₂, *-ĝh₂.*[34]

Tripartite

-CCT#: **-k̂st, *-rst, *-u̯h₂t* (i);[35]
-RCs#: **-nts, *-ŋks, *-rks, *-lks, *-u̯ks;*[36]
-OCs#: **-sts, *-kʷts;*[37]
-CCH# (i): **-zdʰh₂*[38]

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31 **ǵʰi̯éms* 'winter', **-nt* '3rd pl. secondary ending', **-Vns* 'masc.acc.pl.', **gʷénh₂* 'woman', **kʷért* 'cut (3 sg. impfct.)', *sáls* 'salt', **di̯ḗu̯s* 'sky (god)', **stḗu̯d* 'praised (3 sg. impfct.)', **h₁éi̯d* 'went (3 sg. impfct.)'.

32 **h₁épt* or **h₁ḗpt* 'seized (3 sg. impfct.)', **u̯ḗk̂t* 'wished (3 sg. impfct.)', **h₁ést* 'was (3 sg. impfct.)'.

33 **h₂áps* 'water', **póts* 'foot', **h₃rḗk̂s* 'king', **i̯uks* 'joining, harnessing', **u̯ṓkʷs* 'voice'.

34 **-medʰh₂* '1st pl. M/P secondary ending', **méĝh₂* 'great'.

35 **h₂u̯ḗkst* 'carried (3 sg. aor.)', **dʰḗrst* 'fastened (3 sg. aor.)', **mleu̯h₂t* 'spoke (3 sg. impfct.)'.

36 **h₁dó/énts* 'tooth', **stríŋks* 'owl'(?), **i̯órks* 'doe', **h₂álks* 'courage', **lé/óu̯ks* 'light'.

37 **Kó/ésts* 'hunger' (Vijūnas 2006:92), **nékʷts* 'night (gen.sg.)'.

38 **-mezdʰh₂* '1st pl. M/P secondary ending' (?), if not **-mezdʰh₂a.*

Appendix C: Glossary of Concepts and Constraints

This glossary contains all of the Optimality Theoretical constraints used in *The Indo-European Syllable*, with certain important concepts listed as well. Note that the constraints which have ultimately been deemed relevant for the reconstruction of PIE have been set in bold.

∅-Grade	Short mid vowels must be deleted in certain morphological conditions (before accented morphemes?)
Agree	Obstruent clusters should agree in laryngeal features.
Align	Align-Morph-L. The left edge of a morpheme coincides with the left edge of a syllable.
Align-l	Align morae to the left edge of the prosodic word.
AlignNuc	Align (Nucleus, R, σ, R): Align the right edge of a syllable nucleus with the right edge of a syllable.
***App**	*Appendix. Extrasyllabic consonants may not surface in the output form.
***BadApp**	*BadAppendix. Illicit extrasyllabic segments, such as extra-syllabic medial segments and extrasyllabic resonants, may not surface in the output form.
*CHCC	The sequence *CHCC is prohibited in the output.
Coincide	A complex onset belongs to an initial syllable.
*CompCoda	*ComplexCoda. Codas may not contain more than one consonant in the output.
***CompOns**	*ComplexOnset. Onsets may not contain more than one consonant in the output.
Dep[F]$_{IO}$	Every feature of the output has a correspondent in the input.
Dep-μ	Every mora in the output has a correspondent in the input.
Dep-[s]	Every **s* in the output has a correspondent in the input.
Dep-V	Every vowel in the output has a correspondent in the input.
DT	Decomposition Theorem. Medial consonant clusters are decomposable into a sequence consisting of a coda plus onset, whose syllable division is produced by the interaction of a speaker's knowledge of consonant sequences at word's edge and syllable markedness constraints.
Faith(σ)	If x_i belongs to σ_i in the input, and x_i has an output correspondent x_o, x_o must belong to a syllable σ_o that corresponds to σ_i. (Do not alter the syllabification of the base form.)

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*FinalVoice	No surface form may contain a final voiced obstruent.
*$_\sigma$[ħj-	A sequence of pharyngeal plus yod is banned in onset position.
HNuc	When there is more than one segment which can become the nucleus of a syllable, the nucleus is assigned to the one with the highest sonority.
Ident(σ)	Corresponding input and output segments have identical values for the feature [syllabic].
Ident(Voice)	Corresponding input and output segments have identical values for the feature [voice].
Intact	Do not delete the root in its entirety or to the extent that it is no longer semantically recognizable.
***Kʷu̯/*u̯Kʷ**	A labiovelar may not be directly adjacent to a *u̯ in the output.
License	Consonants must be properly licensed.
Linear	Linearity. Do not metathesize.
Max-C	Every non-laryngeal consonant in the input has a correspondent in the output.
Max-H	Every laryngeal consonant in the input has a correspondent in the output.
MaxLink-μ	Do not delink a mora (μ) from a segment associated with said mora in the input.
Max-T	Every dental stop in the input has a correspondent in the output.
Max-μ	Every mora in the input has a correspondent in the output.
Max-μ-BA	Every mora in the base has a correspondent in the output.
MST	Maximum Syllable Template. The maximum PIE syllable consists of two consonants in the onset and two consonants in the coda. The onset may violate the SSP; the coda may not.
NoCoda	No syllable may have any consonants in the coda.
No-Spread	No-Spread([F], seg). Feature-segment associations in the output must be reflected by the corresponding elements in the input.
OCP	The Obligatory Contour Principle. Two identical (heteromorphemic) segments may not be adjacent to each other.
Onset	A syllable must have an onset.
***Pk/O**	Obstruents may not occupy the syllable nucleus.
***Pk/R**	Resonants may not occupy the syllable nucleus.
Parse	Syllabify all segments.
*$_\sigma$[PPR	The sequence two stops + sonorant (**r, *l, *m, *n, *u̯*) is prohibited in the onset of the output.
***RF$**	The output may not have the sequence sonorant + fricative immediately preceding a syllable boundary.

*RH$	The output may not have the sequence sonorant + laryngeal immediately preceding a syllable boundary.
SSP	SONORITY SEQUENCING PRINCIPLE. Between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted.
***SUPERHEAVY**	No medial syllable may consist of three or more morae.
WBP	Coda consonants must be moraic.
W-S(I)	For any I, a syllable-initial segment, there is a word such that its initial segment is identical to I.
W-S(F)	For any F, a syllable-final segment, there is a word such that its final segment is identical to F.
*VCHCV	The sequence *VCHCV is prohibited in the output.

Appendix D: Research Study on *-ic* Formations

Name ______________________

Native Languge ______________________

Other Languages Spoken Fluently ______________________

This is **acid**. Something pertaining to acid is [əsɪdɪk].

This is a **hero**. Someone pertaining to a hero is [   ].

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This is an **apron**. Something pertaining to an apron is [ ].

This is a **number.** Something pertaining to a number is [ ].

This is a **lantern.** Something pertaining to a lantern is [ ].

This is the **alphabet**. Something pertaining to the alphabet is [ ].

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