SYLLABLE NUCLEUS AND MARGIN
IN GREEK, VEDIC, AND PROTO-INDO-EUROPEAN

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Adam Cooper

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Adam Cooper, Ph. D.
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This dissertation advances the dialogue between two oftentimes disjointed subfields of language study: historical Indo-European linguistics and theoretical phonology. From a perspective that is simultaneously empirical, theoretical, and historical in nature, its goal is to develop updated analyses of key aspects of syllable structure in the sound systems of the ancient Indo-European languages and the proto-language itself.

The dissertation comprises two parts. The subject of Part I is the syllable nucleus: in particular, we develop a new Optimality-Theoretic analysis of Proto-Indo-European sonorant vocalization, whereby sonorants become syllable nuclei to enable the syllabic parsing of otherwise unsyllabifiable strings of segments, but remain consonantal otherwise. Additionally, when two sonorants are in sequence and neither is vowel-adjacent, the second consistently vocalizes, regardless of which is more sonorous, as in Meillet 1937, later formalized in Schindler's (1977) rule-based account. Our analysis provides a comprehensive account of the data, improving upon previous Optimality-Theoretic analyses. Furthermore, we also take steps to more explicitly position Proto-Indo-European within a typology of languages with syllabic consonants.

The subject of Part II is syllable margins. We first reevaluate the evidence for and against medial consonant cluster syllabification in Vedic Sanskrit, reconfirming the traditionally posited heterosyllabic treatment VC.CV. We then develop an analysis of this treatment, one which, in view of data from 'perfect union vowel' epenthesis, compels us to reconsider the notion of

locality in Pater's (2009) constraint indexation approach to morphologically-conditioned phonology. Moving beyond Vedic, in the interests of reassessing the reconstructed state-of-affairs in the proto-language, we consider evidence from the development of Ancient Greek and evaluate the reconstructed Proto-Indo-European syllabifications VOO.RV, VR.OOV, ultimately demonstrating the difficulty of capturing both of these treatments in one and the same account.

Finally, uniting the foci of Parts I and II, we address the compatibility of the righthand vocalization of sonorants on the one hand, and the treatment VC.CV on the other, and develop a unified analysis capable of generating both.

BIOGRAPHICAL SKETCH

Adam Isaac Cooper was born in 1980 in Stamford, Connecticut. He grew up there and in Wilton, attending Bi-Cultural Day School and later Stamford High School. After graduating from the latter in 1999, he enrolled in Cornell University, from which he eventually earned a B.A. in Classics in 2003. After taking a year off to further explore his newfound interest in the study of language, revealed to him only in the spring of his senior year, he entered the graduate program of the Department of Linguistics in the fall of 2004, earning his M.A. in Linguistics in 2008.

To my grandparents

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Other members of the faculty of the Department of Linguistics also deserve mention here. If not for the captivating efforts of Prof. Wayne Harbert, who taught the Introduction to Linguistics course I took in the spring of my senior year, I may never have made the realization that what I enjoyed most about working towards my undergraduate degree in Classics was studying the ins-and-outs of the ancient languages themselves. Likewise, I also credit Prof. Carol Rosen's course on Typology, which I took in an interim year between undergraduate and graduate school, as further reinforcing this epiphany. In addition, I would like to acknowledge those faculty who have taught me during my time in the program, and in so doing have helped in rounding out my knowledge of the field: Dorit Abusch, John Bowers, Abby Cohn, Molly Diesing, Sue Hertz, Amanda Miller, Mats Rooth, Michael Wagner, and John Whitman.

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CHAPTER 1

INTRODUCTION

1.1 Overview of the Project

This dissertation will advance significantly the much-needed dialogue between Indo-European studies and current phonological theory initiated in my earlier work (Cooper 2009, to appear), which examined the avoidance of similar sounds in the Proto-Indo-European root-syllable and the perceived exceptionality of the Proto-Indo-European plain voiced stop consonants. From a perspective that is simultaneously empirical, theoretical, and historical in nature, the primary goal of the project is to develop updated analyses of the role of the syllable and syllable structure in the sound systems of the ancient Indo-European languages, in the interest of better understanding these languages, and also, more importantly, reconstructing syllabification for Proto-Indo-European itself. In doing so I intend to demonstrate the continued relevance of both Proto-Indo-European and the ancient Indo-European languages to contemporary linguistic theory, and, moreover, to reaffirm the value of the syllable as a unit of phonology, necessary for these languages' formal representation. Highlighting the insights that Proto-Indo-European and syllable theory can reveal about each other, I hope this dissertation makes a solid contribution to the scholarly tradition of each.

As a language reconstructed from careful study of languages both ancient and modern, Proto-Indo-European has typically, if understandably, eluded the notice of proponents of modern phonological theory. While the earliest attested daughter languages may have fared somewhat better in this regard, no doubt due to their actually being documented, their position can hardly be considered robust. In the area of syllabification and syllable structure, the distance between the fields is particularly noticeable: the traditional account of Proto-Indo-European syllabification (originally proposed in Schindler 1977b, reiterated in Mayrhofer 1986, Szemerényi 1996, Fortson 2004, Weiss 2009b, et al.) exemplifies an older, largely outdated theoretical approach, which, while achieving more-or-less descriptive adequacy, is at the same time narrowly focused on the identification of syllabic nuclei, to the exclusion of the remaining structure (onsets, codas) within and across syllable boundaries. Further, discussion of syllable 'weight', which in contemporary theory is directly tied to syllable structure as dictated by the position of syllable boundaries, is often discussed in the Indo-European literature in simple segmental terms (Seebold 1972), which may maintain descriptive adequacy but lack the explanatory grounding that invocation of theory would provide.

Meanwhile the syllable, recognized already by the ancient Indo-European grammarians (Sanskrit *akṣara* 'imperishable', Greek *syllabḗ̜* 'that which is held together'), but failing to garner significant mention in earlier work on generative phonology (e.g. Chomsky and Halle 1968), subsequently flourished as a means of accounting for a plethora of phenomena related to languages' sound systems, including segment alternations, insertions, and deletions, stress assignment, and rules for licit shapes of words and morphemes (see Blevins 1995, Zec 2007 for an overview). More recently, however, the unit has been challenged by claims that its empirical significance is in fact far more limited than has been conceived (e.g., Blevins 2003, Steriade 1999a, Côté 2000, etc.). Yet I believe it to be capable of shedding light on the workings of Proto-Indo-European – and vice versa – and as such, that its continued use in phonological theory is more than warranted.

1.2 Structure of the Dissertation

The dissertation consists of two parts. The first is concerned with the syllable nucleus: specifically, developing a new analysis of the phenomenon of sonorant vocalization in Proto-Indo-European, which is motivated by a need to render syllabifiable otherwise unsyllabifiable strings of segments. In Chapter 2 we lay the groundwork for this discussion by reviewing the descriptive generalizations and previous accounts, both rule- and constraint-based. In Chapter 3 we take the first steps toward constructing the analysis in Optimality Theory, by formally encoding in the constraint ranking the Proto-Indo-European preferences for which segments can be syllabic and which cannot be. We follow up on this initial work with an exploration of directionality in phonological theory in Chapter 4, a concept key to Schindler (1977b)'s original rule and insufficiently translated into subsequent Optimality-Theoretic accounts; we propose, after Mester and Padgett (1994), a solution invoking Alignment, although we depart from their own approach by advocating moras, rather than syllables, as the phonological unit to be assessed. In Chapter 5 we entertain an alternative account to that developed in Chapters 3 and 4, one which assigns a crucial role to morphological structure in the determination of which sonorants vocalize, and under what circumstances, but ultimately find it unjustifiably cumbersome. Finally, we conclude Part I in Chapter 6, extending the analysis to a wide array of environments to demonstrate its empirical adequacy, reevaluating a series of exceptions to Schindler's generalization, and considering the phenomenon from a typological perspective.

The complementary focus of Part II is syllable margins. In particular, our interests lie in examining the treatment of medial sequences of consonants, which traditionally, both for the ancient Indo-European languages, and by extension, Proto-Indo-European itself, has been analyzed as heterosyllabification, VC.CV. In Chapter 7 we study the evidence for and against this view as it applies to Vedic Sanskrit, reconciling the contradictory claims ultimately in favor of it. We then proceed in Chapter 8 to develop an Optimality-Theoretic analysis of consonant cluster syllabification in Vedic Sanskrit, over the course of which we will come to critically reevaluate approaches to morphologically-sensitive phonology, most recently the constraint indexation approach developed by Pater (2006, 2009). In Chapter 9 we turn to medial consonants in Proto-Indo-European, examining evidence from the history of Ancient Greek which we argue fills a gap in our understanding left open by consideration of Vedic Sanskrit, and also considering the capacity of Optimality Theory, as a current framework in phonological theory, to generate the traditional, though typologically problematic, duo of syllabifications VR.OOV, VOO.RV.

Finally, we conclude in Chapter 10, tying together the foci of Parts I and II by adapting our analysis of sonorant vocalization, which is ostensibly coda-minimizing in nature, to also account for heterosyllabific VC.CV, which is just the opposite. A unified analysis of these two phenomena thus faces a potential ranking paradox in an Optimality-Theoretic framework, one we successfully resolve by appeal to the notion of Positional Markedness (Zoll 1998).

1.3 The Formal Framework

The phonological framework we will use to model the data is that of Optimality Theory (Prince and Smolensky 1993 [2004]).[1] Optimality Theory is a constraint-based approach to phonology, in which the path from phonological input to output is no real path at all, in the traditional step-wise derivational sense. Rather, there are three components to the theory: GEN, CON, and EVAL. For a given input, GEN generates an infinite set of possible output candidates, or realizations.

[1] For a more detailed discussion of the theory, the reader is referred to the work cited, as well as to McCarthy and Prince 1995 and Kager 1999.

CON is the set of (in the strongest version of the theory, universal) violable constraints on linguistic structure, of which there are two basic types: markedness constraints, which place conditions on well-formedness; and faithfulness constraints, which require preservation of (some aspect of) input structure. A language-specific ranking of these constraints constitutes the basis against which the set of output candidates generated by GEN is assessed in the third component of the theory, EVAL; generally, a candidate satisfying a higher-ranked constraint, even at the cost of violating a number of lower-ranked constraints, will be preferred over one satisfying a number of lower-ranked constraints, but violating a higher-ranked constraint. Finally, of course, there is also a LEXICON, the storehouse of underlying forms of morphemes, which contains all non-predictable aspects thereof and lacks language-specific restriction ('Richness of the Base').

As an example, we can consider the effect of two different rankings of two markedness constraints that will come to play a role in the discussion to follow, *COMPLEX$_{\text{ONSET}}$ ('No complex onsets') and NOCODA ('No codas'): either *COMPLEX$_{\text{ONSET}}$ can outrank NOCODA, as in (1), or NOCODA can outrank *COMPLEX$_{\text{ONSET}}$, as in (2):

(1) *Ranking:* *COMPLEX$_{\text{ONSET}}$ » NOCODA

/VCCV/	*COMPLEX$_{\text{ONSET}}$	NOCODA
a. V.CCV	*!	
☞ b. VC.CV		*

(2) *Ranking:* NOCODA » *COMPLEX$_{\text{ONSET}}$

/VCCV/	NOCODA	*COMPLEX$_{\text{ONSET}}$
☞ a. V.CCV		*
b. VC.CV	*!	

Given an input string /VCCV/, the operative ranking results in the selection, all else being equal, of a distinct optimal output: VC.CV if *COMPLEX$_{\text{ONSET}}$ dominates, but V.CCV if NOCODA does.

As we will see, Optimality Theory, given its ability to elegantly capture the operation of conspiracies, provides an attractive framework for the modeling of phenomena connected to prosodic optimization, and in particular, syllable structure optimization.

1.4 A Note about Transcription and *

We conclude this introductory chapter with a brief note about the way in which linguistic data are transcribed and annotated throughout this dissertation. For the representation of Proto-Indo-European, we use the system of transcription standardly employed in the field of Indo-European linguistics, found in handbooks such as Fortson 2004 and Meier-Brügger 2002, 2010. As compared to the International Phonetic Alphabet (IPA), some of the chief distinctions relevant for this volume include use of the symbols <i̯, u̯> to represent the palatal and labiovelar approximants (glides) (= IPA <j, w>); use of the diacritic <ˆ> to indicate palatovelar quality (as in <k̂, ĝ, $\hat{g}^{h}$>); and use of the diacritic <◌̥> to indicate syllabic status (= IPA <◌̩>).

For the representation of data from unrelated languages, including Cairene and Iraqi Arabic (Chapter 4), and Micmac, Shuswap, and Imdlawn Tashlhiyt Berber (Chapter 6), we rely on the systems employed by the respective sources, as cited.

Finally, as the asterisk <*> has one meaning (reconstructed status) in historical linguistics, another meaning (ungrammaticality) in other subfields of linguistics – of relevance here, phonology – it is important to strive for clarity of presentation in in a work such as this, which crosses sub-specialization. Therefore, we maintain the historical linguistic use of <*> to indicate reconstructed status, and employ the dagger <†> to indicate ungrammatical (and/or unattested) status (although we do use <*> in the forms of various Optimality-Theoretic constraints, in the usual way).

PART I:

THE NUCLEUS:

SONORANT VOCALIZATION IN PROTO-INDO-EUROPEAN

CHAPTER 2

LAYING THE GROUNDWORK

2.0 Introduction

Perhaps the most basic and securely-reconstructed syllable-related phenomenon in Proto-Indo-European is the allophonic distribution of sonorant consonants: in certain environments these segments serve as the nucleus of a syllable, i.e., they are vocalic, while in others they are consonantal. For reasons that will become clear, the facts of the phenomenon have been subject to formal debate; as such they present an opportunity for a fresh consideration of the data and their analysis. Such is the focus of the following chapters.

In this chapter we lay the groundwork for this exercise, beginning in section 2.1 with the facts as reconstructed, citing the account of Meillet (1937). In section 2.2 we present the traditional rule-based analysis of Schindler (1977b). In the interests of laying a more concrete foundation for the analysis, we present in 2.3 the results of a survey of verbal data. We conclude in 2.4.

2.1 The Generalization

As his discussion is more descriptive in nature, Meillet (1937: 134-136)'s account provides a worthwhile starting point for the exploration to follow. His particular focus is on the behavior of sonorants in sequence; specifically, he distinguishes five cases of sonorant + sonorant sequences, based on the surrounding environment. His discussion of these cases are given in (1); translations are mine.

(1) a. "Between two consonants after a short syllable[1] or in the initial syllable of the word: the first sonorant is a consonant, the second a vowel: thus Sanskrit *srutáḥ* 'flows', Greek ῥυτός [*hrutós*]; Sanskrit *śvábhiḥ* 'by dogs' (from **ḱwn̥bhis*) and not *śumbhiḥ*; Greek φρασί [*p^{h}rasí*] (from **bhrn̥si*) in Pindar and in Old Attic, etc.; Lithuanian *ketvir̃tas* 'fourth', Old Slavic *četvrŭtŭ* representing **k^{w}etwr̥tos*[2]."[3] (134)

b. "Between a preceding consonant of a short syllable and a vowel: the first sonorant is a vowel, the second is a consonant: Skt. *śúnaḥ* 'of the dog', Gk. κυνός [*kunós*]; Skt. (accus.) *catúraḥ* 'four', Lith. (nom.) *keturì* (the Gk. τέτταρες [*téttares*], τέτταρας [*téttaras*], is analogical; cf. Doric τέτορες [*tetores*] and Ionic τέσσερες [*tesseres*]); Skt. *diváḥ* 'of the sky', Gk. Διϝός [*díwos*]; Avestan *zimō* 'of the winter', Gk. -χιμος [-*k^{h}imos*], Skt. *himáḥ* 'winter'."[4] (135)

c. "After a vowel, before a consonant or the end of the word: the first sonorant is a consonant, the second a vowel; thus Skt. *náva* 'nine', Latin *nouem*, Gk. ἐννέ(ϝ)α, [*enné(w)a*] from **néwn̥*, or Skt. *nava-tíḥ* 'ninety', from *newn̥tis*, Old Prussian *newīnts* 'ninth', Gothic *niunda* (from **newunđa-*) 'ninth'." (135)

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[1] "After a long syllable, clear examples are lacking."

[2] Meillet notes in the context of this form the metathesis of **-u̯r-* to **-ru-*, which can also occur between consonants – e.g. Avestan *čaθru-* (in *čaθru-ratuš* 'which has four masters'), Gk. τρυ- [*tru-*] (from *πτρυ- [**ptru-*]), Lat. *quadru-* (thus *quadru-pes*, with a secondary *d*; cf. ci-dessus), Gaulish *petru-* (thus *Petru-corii* next to *Tricorii*) – adding that "this reversal remains true to the rule in that the sonorant vowel follows the sonorant consonant" (134).

[3] Meillet continues: "From the rule it follows that there does not exist in Indo-European a diphthong constituted by a sonorant vowel plus a sonorant second element of the diphthong; so when, in a word of Indo-European date, Germanic has *ur* and Lithuanian *ir*, *ur*, before consonant, it never goes back to ancient **i*+**r*, **u*+**r*, but rather to ancient **r̥*. There are exceptions to this principle in the nasal-infix presents (see p. 215), which present such diphthongs as **in*, **un*, **r̥n*: Skt. *ri-ñ-cánti* 'they leave', next to *riṇákti* 'he leaves', Lat. *li-n-quō*, OPruss. (*po*)-*lī-n-ka* 'it remains', or Skt. *kr̥-n-tán* 'turning' (present participle of *kr̥ṇátti* 'it turns')" (134). The nasal-infix presents constitute one of Schindler (1977b)'s exceptional cases of sonorant vocalization; see the next section and also the discussion in Chapter 6.

[4] But note also the following: "So Skt. *pitr*(*i*)*yaḥ* 'paternal', Gk. πάτριος [*pátrios*], Lat. *patrius* are troublesome: we expect PIE **pətr̥yos*; we are in the presence of an alteration due to analogy. In a general way, the application of the rule is limited by many analogical actions; thus Sanskrit has *śuśruve* 'it was understood', *śuśrūyā́t* 'he hears', etc. But Lithuanian opposes *tvìrtas* 'solid', from **twr̥̄tos*, to *turė́ti* 'have' (literally 'take'), from **tur-*; from the same Skt. *cakr̥vā́n* 'having done' has for a genitive *cakrúṣaḥ*" (135).

d. “Between two vowels: the first sonorant is the second element of a diphthong and the other is a consonant: thus Old Persian *aiva* ‘one’, Cypriot οιϝος [*oiwos*] ‘single’ and Old Lat. *oinos* (whence *ūnus* ‘one’, Goth. *ains*, OPruss. *ainan* (acc.), Gk. οἰνή [*oinę̄́*] ‘ace’; Lith. *dervà* (acc. *der̃vą*) ‘fir wood’, OSlav. *drěvo* (Russian *dérevo*), Welsh *derwen* ‘oak’, Homeric (gen.) δουρός [*dǭrós*] (concealing δορϝός [*dorwós*]).”[5] (135)

e. “In initial position: there is no general rule: Thus **y* is a consonant before no other sonorant, but **w*, **r*, **l*, **n*, **m* can be a consonant before **y*; **w* can be a consonant before **y*, **r*, **l*, thus Gk. ϝρήγνῡμι [*wrę̄́gnūmi*], but it is always a vowel before **n* and **w*; etc. The examples are rare and even entirely lacking for some groups.” (136)

This descriptive generalization of the behavior of sonorants serves as the basis for the formal account posited by Schindler (1977b), reviewed in the following section.

2.2 The Traditional Account

Arguably the first formalization of the facts of nucleus selection in Proto-Indo-European was made by Schindler (1977b: 56-57). In this review of Seebold (1972), Schindler begins by establishing the rule for the vocalization of sonorants; his formulation is given in (2).

(2) $$\begin{bmatrix}+\text{son}\\ -\text{syll}\end{bmatrix} \rightarrow [+\text{syll}] \;/\; \begin{Bmatrix}[-\text{syll}]\\ \#\end{Bmatrix} \_\_\_ \begin{Bmatrix}[-\text{syll}]\\ \#\end{Bmatrix}$$

[5] But also: “The **y* has a place apart, and some groups in which it appears do not conform to the general rule; thus a group like **ewye* has **u* as the second element of a diphthong and **y* a consonant in Slavic, Lithuanian, Gothic, but **w* and **y* are both consonants in Sanskrit, Greek, Italic, Celtic; for example to Lith. *naũjas* ‘new’, Goth. *Niujis* (from **neuyos*), Sanskrit answers *návyaḥ* ‘new’, Greek νεῖος [*nę̄os*] (from νεϝyος [*newyos*]), Gaulish *Novio-* (*Noviodūnum* ‘new citadel’), etc. The Avestan writing *naoya-* is ambiguous” (135).

This rule states that sonorants are realized as syllabic between non-syllabic segments (or word boundary and non-syllabic segment); in other words, whenever they are not vowel-adjacent. This rule is meant to apply iteratively, beginning from the right edge of the word and moving leftward. The *Paradebeispiel* for the phenomenon is the instrumental plural form of 'dog', **k̑u̯n̥-bʰis* (Vedic *śvábhis*): absent Schindler's rule the expectation is that the glide *u̯* should vocalize over the nasal; in fact it can do so, but only when the nasal is followed by a vowel: compare the genitive singular of the same, **k̑un-ós* (Gk. *kunós*).

In addition to his rule, Schindler notes five types of exceptions to this general process, given in (3); translations are once again my own.

(3) a. Root- and word-initial groups /u̯r-, u̯l-, u̯i̯-/ and /mr-, ml-, mn-/ (and /mi̯-/, if already PIE) are unchanged before a vowel.

b. In the weak forms of nasal-infix presents *n* is non-syllabic, i.e. /n/ then is not subject to the principle, when it is a verbal infix (e.g. PIE */i̯u̯ng-/ → **i̯ung*- instead of †*iu̯n̥g*-.

c. In the accusative of acrostatic and proterokinetic *i*-, *u*- and *r*-stems /m/ remains non-syllabic (PIE *-im*, *-um*, *-r̥m*).

d. In *men*-stems /m/ was not syllabic in the sequence /CmnV/, but rather disappeared (type Ved. *áśman-* : *áśnaḥ*).

e. Sonorant groups between *C* and *V* (/CR_1R_2V/), in which the syllabification *CR̥₁R₂V* would be expected, were then frequently realized as *CR₁R̥₂V*, when in the same paradigm /CR_1R_2C/ → *CR₁R̥₂C* also appears. See e.g. Gk. gen. τριῶν [*triō̑n*] < **triōm* instead of *tr̥i̯ōm* after **tri-C*, or Ved. gen. sg. of feminines from *u*-

adjectives *-v(i)yās* instead of **-uyās* after nom. *-vī*. The age and handling of this analogous phenomenon are not yet known.

Schindler's rule remains the standard conception of the process governing sonorant syllabicity in Proto-Indo-European (Mayrhofer 1986: 162-163, Fortson 2004: 65, Clackson 2007: 35, Meier-Brügger 2010: 228, etc.).[6] Its intuition has also served as the basis for two analyses cast in the constraint-based framework of Optimality Theory (Prince and Smolensky 1993 [2004]), which we discuss in Chapter 3. For now we turn to a discussion of the results of a small survey of sonorants in the verbal system of Proto-Indo-European, which, as we will show, confirm the traditional conception of their behavior, albeit in a somewhat limited capacity.

2.3 A Survey of Sonorants in Proto-Indo-European

In the interests of establishing a firm foundation for the analysis to be undertaken over the next few chapters, we seek first to provide a detailed survey of the behavior of sonorants in Proto-Indo-European. In 2.3.1 we present the distribution of the individual sonorants in an exhaustive array of environments in word-initial, word-medial, and word-final positions. In 2.3.2 we consider the more specific issue of sonorant + sonorant sequences; relying on a principled set of data, we show which combinations are attested with some degree of confidence, and furthermore how they behave as concerns vocalization.

[6] But see Klein (2006: 407), who in view of Ved. *śvásu* (loc. pl. 'dog') versus Gk. *kusí* (dat. pl. 'dog') takes issue with Schindler's rule, due to the unclear nature of the latter form, which suggests that the glide vocalized over the nasal. Contra Klein, we believe that an appeal to analogy to explain the appearance of *kusí* over †*ku̯asi* (which would have been the outcome of **ku̯n̥si*) is not unreasonable, if one takes into account the pattern of e.g. Gk. *p^hrę̄́n* nom. sg. ~ *p^hrenós* gen. sg. ~ *p^hresí* / *p^hrasí* dat. pl. 'midriff'.

2.3.1 General Distribution

As a class, sonorants in Proto-Indo-European appear somewhat restricted overall in their distribution in the word, a fact revealed through consultation of relatively secure reconstructions in *Lexikon der indogermanischen Verben* (Rix et al. 2001; henceforth *LIV*), preliminarily supplemented by *Nomina im Indogermanischen Lexikon* (Wodtko et al. 2008; henceforth *NIL*); we define 'relatively secure' in this context as 1) not annotated with a question mark, in either main root entry or in specific stem formation, and 2) reflected directly in at least one daughter language (i.e., avoiding reflexes annotated with a left square bracket '['). Our findings in this regard are displayed in Tables 2.1-3, which distinguish a multitude of environments in three positions in the word: initial position (i.e., word-initial syllable onset or nucleus; Table 2.1), medial position (i.e., after at least one vocalic element; Table 2.2), and final position (Table 2.3). For each environment we note which sonorants occur in it, and how this sonorant is realized (consonantal or syllabic); actual forms are given in the appendix. The syllabic status is also summarized in the final column; for those environments in which no sonorants occur, the expected status is included parenthetically. Note that for each environment in which a sonorant follows the empty slot, this segment is itself followed by either a consonant or a vowel, so as to accommodate for the fact that _RC sequences (are expected to) pattern with _V sequences, while _RV sequences (are expected to) pattern with _C sequences.

The initial syllable of a word shows the most robust and varied distribution of sonorants. Indeed of the twelve active environments identified in Table 2.1, more than half (those in bold) show at least one instantiation with each sonorant. Of the remaining five active environments, the distribution is less consistent; but we observe that the labial sonorants, nasal *m* and glide *u̯*, seem to be favored in absolute initial position before a consonant, i.e., in #_O or #_RV –

although their realization differs between these two environments – while the coronal sonorants, nasal *n* and liquids *l* and *r*, seem to be favored following an initial sonorant, especially in #R_RC, #R_RV, #R_V; although note, again, that their actual realization in these environments is not uniform. Finally, the last set of environments, those which are vowel-initial, we have included for the sake of completeness, though no actual instantiations could be found. The absence of data in these cases is no doubt tied to the nature of Proto-Indo-European root morphophonotactics, which, if one adopts a strict Benvenistean view (1935: 143-173), disallow vowel-initial roots, and essentially, as a result, vowel-initial forms as well.[7] Nevertheless, the obvious expectation is that in any of these environments, the sonorant will be consonantal.

Table 2.1 Word-initial sonorant distribution in Proto-Indo-European

Environment	**Sonorant**						**Status**
	m	***n***	***l***	***r***	***i̯***	***u̯***	
# _ O	*m̥*	*n̥*		*r̥*		*u*	+syll
# _ R C	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**
# _ R V	*m*					*u̯*	-syll
# _ V	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**
# O _ O	***m̥***	***n̥***	***l̥***	***r̥***	***i***	***u***	**+syll**
# O _ R C	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**
# O _ R V	***m̥***	***n̥***	***l̥***	***r̥***	***i***	***u***	**+syll**
# O _ V	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**
# R _ O	***m̥***	***n̥***	***l̥***	***r̥***	***i***	***u***	**+syll**
# R _ R C			*l*	*r*			-syll
# R _ R V		*n̥*	*l̥*	*r̥*			+syll
# R _ V		*n*	*l*	*r*			-syll
# V _ O							(-syll)
# V _ RC							(-syll)
# V _ RV							(-syll)
# V _ V							(-syll)

[7] But cf. forms like Hittite *alpāš* ‘cloud’, Gk. *alp*^{h}*ós* ‘white leprosy’, Lat. *albus* ‘white’, the protoform of which some have begun with *h_1 so as to maintain this generalization.

Moving on to word-medial position, we find that far fewer of the logically conceivable environments are actually instantiated in any reconstructed Proto-Indo-European forms, with any sonorant at all. This is the case with seven of the twelve environments included here. Of the remaining five, the most robustly-exemplified among them are (designated, again, by boldface) V_O and V_V, in which, being vowel-adjacent, the sonorant is consonantal. Of the remaining three environments, O_V, R_V, and V_RV, no obvious patterns suggest themselves, given that each is exemplified with only a single sonorant; but we do note that in two of the cases this sonorant is a labial.

Table 2.2 Word-medial sonorant distribution in Proto-Indo-European

Environment	**Sonorant**						**Status**
	m	***n***	***l***	***r***	***i̯***	***u̯***	
O _ O							(+syll)
O _ R C							(-syll)
O _ R V							(+syll)
O _ V	*m*						-syll
R _ O							(+syll)
R _ R C							(-syll)
R _ R V							(+syll)
R _ V						*u̯*	-syll
V _ O	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**
V _ RC							(-syll)
V _ RV				*r*			-syll
V _ V	***m***	***n***	***l***	***r***	***i̯***	***u̯***	**-syll**

Finally, we come to word-final position, in which the variety of environments in which multiple sonorants occur is most limited. Indeed there is no single environment in which all sonorants occur. A highly constraining factor in this regard is the fact that, by virtue of Proto-Indo-European morphology, the final position of a word will more often than not be occupied by an ending; there are only so many endings in Proto-Indo-European, and of these, only a few are composed of sonorants. Prominent examples, as consultation of actual forms in the appendix will show, include accusative singular *-*m* and accusative plural *-*ns* (< **-*m*-*s*); locative singular *-*i* and locative plural *-*su*. Still, despite the paucity of data, our expectations about when sonorants should be consonantal, and when they should be syllabic, are generally met. The only exception, noted in bold, is word-final *m* following another sonorant, specifically in accusative singular forms of *i*-, *u*-, and *r*-stems – one of the five exceptional types identified by Schindler. We return to the potential implications of this observation in Chapter 6.

Table 2.3 Word-final sonorant distribution in Proto-Indo-European

Environment	**Sonorant**						**Status**
	m	***n***	***l***	***r***	***i̯***	***u̯***	
O _ #	*m̥*			*r̥*	*i*	*u*	+syll
R _ #	***m***		*l̥*	*r̥*			±syll
V _ #	*m*	*n*		*r*			-syll
O _ O #		*n̥*			*i*		+syll
O _ R #							(-syll)
O _ V #							(-syll)
R _ O #					*i*		+syll
R _ R #							(-syll)
R _ V #							(-syll)
V _ O #	*m*						-syll
V _ R #						*u̯*	-syll
V _ V #							(-syll)

2.3.2 Sonorant Sequences

In addition to assessing the distribution of sonorants in a variety of environments, we sought to examine the more specific issue of their behavior in sequences with other sonorants. Under such circumstances, multiple sonorants may be in a position to vocalize (i.e., may not be vowel-adjacent), but the expectation is that it will be the rightmost one which does so.

In order to evaluate how firm a foundation this generalization rests upon, we undertook a preliminary investigation, the results of which we present now. Generally speaking, though the findings confirm the validity of the generalization, they are nonetheless strikingly limited in their breadth. In any case they suggest the need for further work on this topic.

The source of our data was *LIV*; the focus of the investigation was verbal stem formations requiring zero-grade of the root, a situation in which two sonorants can become adjacent, and one of which may be syllabic. We chose to restrict our scope furthermore to those stems requiring zero-grade of the root throughout the paradigm, as opposed to full or *o*-grade in the singular and zero-grade elsewhere, in the belief that the issue of potential analogical distortion would be thereby minimized.[8] Of all reconstructed present, aorist, and perfect stem formations, only those given in (4) were involved in the study; *LIV* type code is included in parentheses.

(4) *PIE Verbal Stem Formations with Zero-Grade Throughout*

a. Zero-grade root stative: R(z)- Stat. (1c)

b. Present with suffix *-néu̯-/-nu-*: R(z)-*néu̯-/-nu-* (1l)

c. Present with zero-grade root and suffix *-é/ó-*: R(z)-é- (1o)

d. Present with suffix *-sk̂é/ó-*: R(z)-*sk̂é-* (1p)

e. Present with zero-grade root and suffix *-i̯é/ó-*: R(z)-*i̯é-* (1q)

f. Present with suffix *-éi̯e/o-*: R(z)-*éi̯e-* (1s)

One may point out that *i*-reduplicated thematic presents (C_1*i*-R(z)-*é*-; type 1i) and reduplicated thematic aorists (C_1*é*-R(z)-*e*; type 2c) also feature zero-grade of the root throughout, but *LIV* notes as questionable the one relevant form of the former, and the two of the latter, featuring a pair of sonorants.[9] There are also, of course, the nasal-infix presents (R(C_1C_2)-*né/n*-R(C_3) or R(C_1)-*né/n*-R(C_2)-; type 1k), but these seem to behave idiosyncratically, constituting one of Schindler's five exceptional cases, and as such were excluded from consideration.

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[8] But note full-grade analogy elsewhere in the verbal system is still a possibility.
[9] The root in question for the *i*-reduplicated present is 2.**u̯el-* 'turn' (*LIV* 675; *IEW* 1140-1142); for the reduplicated aorist, ?**$k^{(w)}$Rend-* 'cry out' (*LIV* 369; *IEW* [549]) and **u̯reh*$_1$- 'find' (*LIV* 698; *IEW* 1160).

The number of reconstructed instantiations of these individual stem formation types, which feature two root sonorants, is presented in Table 2.4. For each type, we include both those reconstructions annotated in *LIV* as questionable, and those lacking such annotation, deemed here as 'secure'.

Table 2.4 Reconstructed stem form counts, secure and questionable, in Proto-Indo-European

Stem Formation	Secure	Questionable	Total
Zero-grade root stative	1	2	3
i-reduplicated thematic present	0	1	1
Present with suffix *-néu̯-/-nu-*	7	3	10
Present with zero-grade root and suffix *-é/ó-*	12	14	26
Present with suffix *-sḱé/ó-*	13	10	23
Present with zero-grade root and suffix *-i̯é/ó-*	27	31	58
Present with suffix *-éi̯e/o-*: R(z)-*éi̯e-*	3	5	8
Reduplicated thematic aorist	0	2	2
Total	63	68	131

As can be seen, there are only a total of 131 reconstructed verbal stems with uniform zero-grade and two sonorants in the root, about half of which are secure; questionable forms outnumber their secure counterparts in nearly every case, though. By far the most prominent type among these results is the *-i̯é/ó-*present, with double the number of secure forms as the next most prominent type, the *-sḱé/ó-*present.

Our data set is thus limited even at this stage of our investigation; it will only become more so. Zeroing in on the sixty-three secure reconstructions, we first of all exclude the following two forms: present stem **i̯u(u̯)-é-*, built to the root 1.**i̯eu̯-* 'hold, attract' (*LIV* 314; *IEW* 507, 508), since not only does it feature a sequence RRV, but it is also ostensibly exceptional in its vocalization of *u* before *e* (we expect instead †*iu̯e-*); and present stem **(s)lug-i̯é-*, built to the root **(s)leu̯g-* 'swallow' (*LIV* 567-568; *IEW* 964), because of the ambiguity of its reconstruction. Of the remaining sixty forms, note that nearly two thirds, thirty-eight, are of shape RRC, with initial sonorant and a following consonant; the exact distribution, including syllabic outcome, is presented below in Table 2.5.

Table 2.5 RR sequences in Proto-Indo-European uniform zero-grade paradigms, #_ _C

		R_2						**Total**
		m	***n***	***l***	***r***	***i̯***	***u̯***	
R_1	***m***		*n̥* (4)	*l̥* (2)	*r̥* (2)	*i* (4)	*u* (1)	13
	n					*i* (1)		1
	l	*m̥* (1)	*n̥* (1)			*i* (4)	*u* (3)	9
	r					*i* (1)		1
	i̯							0
	u̯		*n̥* (2)	*l̥* (2)	*r̥* (6)	*i* (4)		14
Total		1	7	4	8	14	4	38

In this environment it is expected that the second sonorant should be syllabic, regardless of relative sonority, so as to avoid a vowel-initial word; it is exactly this treatment which is observed.

The remaining twenty-three reconstructed stem forms feature the sonorant sequence flanked by two consonants, CRRC. As such, they constitute a more interesting set of data for our purposes, since the pressures associated with absolute word-initial position are not in play. The constituency of the pairings observed in these forms is shown in Table 2.6; the actual forms are included in the appendix.

Table 2.6 RR sequences in Proto-Indo-European uniform zero-grade paradigms, C_ _C

		R₂						Total
		m	***n***	***l***	***r***	***i̯***	***u̯***	
R₁	***m***							0
	n					*i* (2)		2
	l						*u* (2)	2
	r	*r̥* (1)				*i* (1)	*u* (6)	8
	i̯						*u* (4)	4
	u̯		*n̥* (1)		*r̥* (2)	*i* (4)		7
Total		1	1	0	2	7	12	23

It is consideration of this highly constrained data which arguably can provide the surest basis of evaluation for the generalization that the second of two sonorants is syllabic, regardless of relative sonority. But the variety of pairings observed here is very limited – *m* is indeed not represented in first position, nor is *l* in second position. Perhaps more noticeable is the fact that a clear majority, eighteen, are glide-final. Given that glides / high vowels are traditionally conceived of as highest in sonority within the class of sonorants (subordinate only to non-high vowels), the fact that they are syllabic in these pairings is rather unextraordinary, and need not find special explanation. But there are, however, three cases in which a glide is followed by a non-glide – once *n*, twice *r* – and it is the latter sonorant which apparently is syllabic. Based on these forms alone, it would seem that there is a need to posit a special rule for the behavior of sonorants. Yet we should not lose sight of the scarcity of secure evidence upon which this claim is made.

Finally, we only note for now the existence of one ostensible counterexample to the rule of sonorant vocalization, in which the first sonorant is syllabic rather than the second. The form in question is the *i̯é/ó*-present stem **dr̥m-i̯é-*, built to the root 2.**drem-* (*LIV* 128; *IEW* 226), reconstructed chiefly on the basis of Latin *dormiō*, *-īre* 'sleep'. We consider the implications of this form in Chapter 6, as part of a discussion of the nature of the labial nasal *m*.

2.4 Conclusion

In this chapter we have laid the groundwork for an updated analysis of sonorant consonant syllabicity in Proto-Indo-European. We examined the behavior of sonorants in both descriptive and rule-based theoretical perspectives, and bolstered the associated claims with a fresh review of data. Essentially, an Optimality-Theoretic analysis of nucleus selection in Proto-Indo-European must be able to generate the following patterns of segment syllabicity:

(5) *Generalizations about Syllabicity in Proto-Indo-European*

a. Obstruents are never syllabic.

b. Non-high vowels are never glides, i.e., non-syllabic.

c. Sonorants are syllabic when not adjacent to a syllabic segment.

d. When a sequence of more than one sonorant is not adjacent to a syllabic segment, it is the righthand one which is syllabic, regardless of its relative sonority vis-à-vis the preceding one.

In the next chapter we undertake an analysis which takes none of these generalizations for granted.

CHAPTER 3

RESTRICTING CONSONANT SYLLABICITY

3.0 Introduction

To review, an Optimality-Theoretic analysis of nucleus selection in Proto-Indo-European must be able to generate the following patterns of segment syllabicity:

(1) *Generalizations about Syllabicity in Proto-Indo-European*

a. Obstruents are never syllabic.

b. Non-high vowels are never glides, i.e., non-syllabic.

c. Sonorants are syllabic when not adjacent to a syllabic segment.

d. When a sequence of more than one sonorant is not adjacent to a syllabic segment, it is the righthand one which is syllabic, regardless of its relative sonority vis-à-vis the preceding one.

As we will see below, previous Optimality-Theoretic analyses of the phenomenon have focused primarily, if not exclusively, on accounting for generalizations (1)c.-d. There is room, if not need, then, for a new approach.

In this chapter we undertake an analysis that takes none of the generalizations in (1) above for granted. We seek to comprehensively cover all of them, so as to leave no room for illicit extension or overgeneration. We begin in 3.1 with an assessment of the two previous Optimality-Theoretic accounts, that of Kobayashi (2004) and Keydana (2008 [2010]), and demonstrate their less than comprehensive approach to the data. We proceed to our own analysis in 3.2, where we explore multiple approaches to regulating segment syllabicity within Optimality

Theory. As will be seen, each of these will require the introduction of a constraint labeled $\mathbb{C}$, the identification of which we begin to address in closing this chapter.

3.1 Previous Optimality-Theoretic Analyses

3.1.1 Kobayashi (2004)

As a prelude to his exploration of historical developments in the phonology of Old Indo-Aryan consonants, Kobayashi (2004: 23-24) sets up an Optimality-Theoretic analysis of nucleus selection in Proto-Indo-European. This account relies on the constraints in (2); the definitions are Kobayashi's.

(2) a. HNUC (Prince and Smolensky 1993 [2004]: 72): 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 */ḱu̯nbʰis/ inst.pl. 'dog,' this constraint requires *u̯ to be the nucleus (> ˣ*ḱun-bʰis*); when, on the other hand, **n* becomes the nucleus (> **ḱu̯n̥-bʰis*), 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 syllable codas.[1]

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

[1] Incidentally, ALIGNNUC can equally well be formulated as (σ, R, Nucleus, R), i.e., align the right edge of a syllable with the right edge of a syllable nucleus; a violation of the stated constraint will always entail a violation of this variant, and vice versa, since a syllable nucleus is always necessarily a component of a syllable. More generally, we note that ALIGNNUC seems equivalent in its influence, if not its explicit form, to the more commonly deployed NOCODA. Why this constraint is not used is not clear.

The ranking of these constraints is given in (3), and Kobayashi's sample tableau is reproduced (with some minor reformatting) in (4).

(3) ONSET » ALIGNNUC » HNUC

(4)

/ḱu̯n.bʰis./	ONSET	ALIGNNUC	HNUC
a. ḱun.bʰis.		*!	
☞ b. ḱu̯n̥.bʰis.			*
c. ḱu.n̥.bʰis.	*!		

Before assessing the predictions this analysis makes, both welcome and problematic, we make a couple of comments. First, we note that syllabification is included already in the input, with no further comment; its presence is unusual, if syllabification is to be conceived as predictable, and hence an outcome of the evaluation process. That the assignment would not seem to influence the outcome raises additional questions concerning its justification. We note also that, as this tableau demonstrates, the constraint ONSET need not technically dominate ALIGNNUC; in fact we cannot conceive of a scenario in which such a strict ranking must hold, i.e., a case in which a form containing both an onset and a coda will be evaluated more favorably than a candidate lacking an onset but not having a coda, purely on these grounds. Finally, only the first syllable is evaluated in Kobayashi's original tableau, but one might also consider the permissibility of the second syllable *.bʰis.*, which, because of final *s*, violates ALIGNNUC. Indeed the issue of obstruent-final syllables in this analysis will be considered in more detail shortly.

Kobayashi's analysis is able to straightforwardly account for at least one of the ostensible exceptions noted by Schindler, the behavior of a word-initial sequence of two sonorants. Both segments in initial /u̯r-, u̯l-, u̯i̯-, mr-, ml-, mn-/ are realized as consonants; it is not the case, as might be expected, that the first sonorant is syllabic. The consonantal outcome is generated by the analysis:

(5)

/#RRV/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
☞ a. .RRV			(*)
b. R̥.RV.	*!		

The candidate in (5)a. violates only HNUC, but only if we assume the constraint would be violated by a relatively high sonority segment like *u̯* not being syllabic; meanwhile the candidate in (5)b. violates higher-ranking ONSET, and so is less optimal. Of course we should point out that this account predicts that *any* word-initial sonorant + sonorant sequence should surface without vocalization, not simply those listed above.

Without modification, Kobayashi's account also makes a number of rather problematic predictions, of varying degrees of concern. For instance, while the analysis correctly selects vocalization of *r* over *u̯* in a form like **peru̯r̥*, it does so in part by forcing one syllabification in particular:

(6)

/peru̯r/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
a. per.u̯r̥.		*!	*
b. per.ur.		*!	
☞ c. pe.ru̯r̥.			*
d. pe.rur.		*!	
e. pe.ru.r̥.	*!		

The winning candidate in (6)c. features a complex onset, as opposed to the arguably next most plausible candidate, that in (6)a., with heterosyllabic coda *r* + onset *u̯*. Laying aside the matter of which of these actually ought to be posited for Proto-Indo-European, we do point out that if it is to be (6)a., we cannot, for example, easily introduce the constraint *COMPLEX$_{\text{ONSET}}$ into the ranking, because the position it would have to assume, dominating ALIGN(Nucleus, R, σ, R), would lead to the wrong result in the original case under consideration in (4) above, in which the winning candidate features an initial syllable CCV, as opposed to CVC. This issue is returned to at the end of this chapter, and again in Chapter 10. In addition, there is also the fact that under this analysis a word-initial sonorant is predicted to be consonantal not only before another sonorant, but before an obstruent as well, to avoid a violation of ONSET (note ☹ indicates the desired, though unselected winner):

(7)

/#ROV/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
☞ a. .ROV.			(*)
☹ b. R̥.OV.	*!		

The candidate in (7)a. features a tautosyllabic pre-vocalic sonority reversal, and does not match the evidence of forms such as the weak aorist stem **n̥s-* (> Greek participle *ásmenos*) built to the root **nes-* 'get away' (*LIV* 454-455; *Indogermanisches etymologisches Wörterbuch* [Pokorny 1958; henceforth *IEW*] 766-767), in which the sonorant is syllabic. If we wish the analysis to select (7)b. as the optimal output, we need to introduce the constraint SONORITY-SEQUENCING into a dominant position in the ranking; this constraint would militate against the sonority reversal which candidate (7)a. features so as to incur no violations of ONSET.

Furthermore, for another of Schindler's noted exceptions, the behavior of accusative singular marker *-m* in acrostatic and proterokinetic *i-*, *u-*, and *r-*stems, the analysis predicts that *m* should syllabify over the stem-final sonorant:

(8)

/-i̯-m/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
☹ a. -im.		*!	
☞ b. -i̯m̥.			*

That *m* does not do so, but is in fact consonantal, could conceivably be accounted for as (morpho)phonological idiosyncrasy; still, the lack of an explicit statement to such effect leaves the account less comprehensive than it could be.[2]

The final two predictions of Kobayashi's analysis we consider here each concern the core notion that segments vocalize to minimize syllable codas. Problematically, there is no formal

[2] For further discussion of the status of *m*, see Chapter 6.

mechanism in the account which prevents an extension of this behavior to other environments beyond sonorant + sonorant, and in fact to other segments beyond sonorants. As an example of the first type of extension, consider the tableau in (9), which features a full (non-high) vowel before a sonorant in the input /ph₂ter/, the vocative singular of 'father'.[3]

(9)

/ph₂ter/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
☞ a. ph₂te̯r̥.			*
☹ b. ph₂ter.		*!	
c. ph₂te.r̥.	*!		

Because of the relatively low position of the constraint HNUC, the analysis predicts that the liquid *r* should vocalize, so as to avoid a violation of higher ranked ALIGN(Nucleus, R, σ, R); and because of highest ranked ONSET, the mid vowel's syllabicity is compromised, to avoid an onsetless syllable. We are thus left with the candidate in (9)a., an undesirable result. Moving on to the second type of problematic extension, we turn to consideration of the tableau in (10), which features the familiar input /k̑u̯nbʰis/; we focus here not on the first syllable, but on the second, to exemplify the scenario in question.

(10)

/k̑u̯n-bʰis/	ONSET	ALIGN(Nucleus, R, σ, R)	HNUC
☞ a. k̑u̯n̥.bʰi̯s̥.			*
☹ b. k̑u̯n̥.bʰis.		*!	
c. k̑u̯n̥.bʰi.s̥.	*!		

As can be seen, in principle there is nothing formally encoded in the grammar (i.e. the constraint ranking) that can prevent syllabification of obstruents, in the interest of avoiding a coda and satisfying ALIGN(Nucleus, R, σ, R). Again, the constraint HNUC, which must involve some awareness of the set of potentially syllabic segments in the language, and thus could potentially

[3] Note that the symbol **h₂* represents the second 'laryngeal' of Proto-Indo-European, one of a trio of consonantal phonemes reconstructed for the language, whose exact phonetic nature remains the subject of debate. (Cf. fn. 7 in the previous chapter.)

weigh in on the matter, is rendered inactive in the evaluation process by its low position in the ranking.

In sum, while Kobayashi's formal analysis of nucleus selection in Proto-Indo-European is so far as we have seen able to generate the right results for the vocalization of sonorants occurring in sequence (where the second one is syllabic, regardless of relative sonority), because it is not adequately constrained when it comes to treating sequences featuring vowels and obstruents as well, it is in the end too limited in scope to be taken as a comprehensive view of the issue.

3.1.2 Keydana (2008 [2010])

Keydana's exclusive focus in this paper is the issue of rightward sonorant vocalization in Proto-Indo-European. He connects this phenomenon in sequences like CRRC to the place of articulation of the sonorant in question: coronal sonorants, he surmises, are disfavored in coda position in Proto-Indo-European, hence CRR̥C over †CR̥RC, even if the first sonorant is greater in sonority. This restriction is formalized into the constraint *R/C, defined in (11) along with the other markedness constraints invoked for the Optimality-Theoretic analysis; the faithfulness constraints are presented in (12). (Definitions are Keydana's; translations are my own.)

(11) *Markedness Constraints*

a. *R/C: Coronal sonorants are not licensed in the coda.

b. *(a ⊳ t / Mar): At syllable edge *a* is less preferred than…than *t*.

c. *(t ⊳ a / Peak): In the nucleus *t* is less preferred than…than *a*.

(12) *Faithfulness Constraints*

a. PARSE(μ, Δ): Lexical material μ (features (F) or melodic [?] specification of the segment) must be parsed in a slot of a structural domain Δ: No deletion.

b. FILL(Δ, μ): A slot in a structural domain Δ must be filled with lexical material μ: No epenthesis.

c. LINEARITY(μ_i, δ, t_i): Between a segment μ_i and its trace [?] t_i there should be no other segment δ. [No metathesis.]

PARSE(μ, Δ) and FILL are essentially equivalent to MAX-IO and DEP-IO. Further, I interpret the constraints *(a ⊳ t / MAR) and *(t ⊳ a / PEAK) to encapsulate the complete fixed subhierarchies of the MARGIN and PEAK families (Prince and Smolensky 1993 [2004]; see the next chapter), respectively. This will prove relevant in the evaluation of Keydana's posited constraint rankings; see below.

The first ranking Keydana posits is given in (13); it is intended to generate the correct result in the CRRC case. His sample tableau is reproduced (with some reformatting) in (14).

(13) *Ranking, First Pass*

*R/C, PARSE, FILL, LINEARITY » *(t ⊳ a / PEAK)

(14)

/ḱunb^{h}-/	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
☞ a. .ḱu̯n̥.b^{h}-					*
b. .ḱun.b^{h}-	*!				
c. .ḱnu.b^{h}-				*!	
d. .ḱu<n>.b^{h}-		*!			
e. .ḱu.n□.b^{h}-			*!		

In the case of input /ḱunb^{h}-/, high ranking *R/C disfavors the coronal nasal *n* from occupying a coda position in the associated output syllable. Because of the remaining constraints non-crucially ranked with respect to *R/C, the most optimal means of avoiding this outcome ultimately is to vocalize *n*, as in candidate (14)a. This candidate wins, despite its violation of *(t ⊳ a / PEAK), incurred because it features more sonorous u̯ as non-syllabic.

Keydana explicitly seeks to differentiate cases such as these from those in which the coronal sonorant follows a non-high vowel; in this latter environment, the sonorant never vocalizes. The ranking in (15), which includes highly-positioned *(a ⊳ t / MAR), is introduced to account for this distinct outcome; Keydana's example tableau is reproduced (again, with some minor reformatting) in (16).

(15) *Ranking, Second Pass*

*(a ⊳ t / MAR) » *R/C, PARSE, FILL, LINEARITY » *(t ⊳ a / PEAK)

(16)

/ph$_2$ter/	*(a ⊳ t / MAR)	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
a. ph$_2$te̯r̥.	*!					
☞ b. ph$_2$ter.		*				

For an input such as /ph$_2$ter/, the better candidate, (16)b., satisfies *(a ⊳ t / MAR), while violating *R/C; its competitor is eliminated due to its mirror-image violation profile. Indeed Keydana's approach arguably does one better than Kobayashi's in at least attempting to formally encode in the ranking gradient preference for syllabic peaks and margins, through the constraints *(t ⊳ a / PEAK) and *(a ⊳ t / MAR), instead of introducing a single constraint, HNUC, which must make reference to an external, stipulated (albeit conceivably universal) hierarchy in order to know when a segment can be the nucleus of a syllable.

With respect to the predictions which Keydana's analysis as developed makes about the Proto-Indo-European system, we can identify both positives and negatives. One ostensibly positive result the analysis generates is that, since rightmost contra-sonority vocalization applies only for coronals, Schindler's accusative *-m* exceptions are not unusual, but rather find explanation squarely within the phonological domain:

(17)

/-i̯-m/	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
☞ a. -im.					
b. -i̯m̥.					*!

In fact, the analysis can account for the syllabification of all non-like-manner RR sequences in which the second sonorant is non-coronal (i.e., a glide or *m*) – evaluation simply comes down to the relatively lower-ranked *(t ⊳ a / PEAK), which presumably instantiates a series of preferences in line with a traditional conception of the sonority hierarchy. For glides, this constraint selects the vocalization RG̥:

(18)

/CRGC/	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
☞ a. .CRG̥.C-					
b. .CR̥G.C-					*
c. .CGR.C-				*!	
d. .CR<G>.C-		*!			
e. .CR.G□.C-			*!		

For *m*, it selects the vocalization R̥*m*, as noted above. The analysis also explicitly accounts for the absence of vocalization in obstruents, again given the constraint *(t ⊳ a / PEAK):

(19)

/CROC/	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
☞ a. .CR̥OC.					
b. .CRO̥C.					*!

A sonorant will always vocalize in preference to an obstruent, even if it precedes it.

On the less positive side, the analysis predicts the syllabification **pe.ru̯r̥.*, with complex onset, the potential issue which we have noted above in our discussion of Kobayashi's account. We take high-ranking ONSET into consideration here, a constraint which Keydana acknowledges the influence of in cases like **k̂u.nes*, but does not explicitly include in his ranking for the sake of clarity. Clearly, though, its presence is required for cases like this, to militate against the syllabification *.pe.ru.r̥.*, which avoids a coronal sonorant coda at the cost of an onsetless syllable.

(20)

/peru̯r/	Onset	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
a. .per.u̯r̥.		*!				*
b. .per.ur.		*!				
☞ c. .pe.ru̯r̥.						*!
d. .pe.rur.		*!				
e. .pe.ru.r̥.	*!					

Further, the analysis as developed is unable to make any prediction about the syllabicity of glides following glides and *m* following another nasal, in an environment in which either of two sonorants can presumably be the nucleus of a syllable (e.g., in-between two consonants). By the constraint *(t ⊳ a / Peak), assuming a standard version of the sonority hierarchy, *i̯* and *u̯* should be equally vocalize-able (21), as should *m* and *n* (22).

(21)

/CGGC/	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
☞ a. CGG̥C					
☞ b. CG̥GC					

(22)

/CNmC/	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
☞ a. CNm̥C					
☞ b. CN̥mC					

Indeed it is the case that in these sequences, as in sequences which feature a coronal sonorant in second position, it is the second sonorant which vocalizes, not the first (so at least we think with respect to *m*; we will have more to say about this particular sonorant in Chapter 6). So Keydana's analysis requires some elaboration if it is to capture the system of nucleus selection as a whole; but in and of itself it misses this noteworthy generalization. Finally, the analysis does not weigh in on the case of word-initial sonorants, either before a sonorant (23), in which position they should be consonantal, or an obstruent (24), in which position they should be vocalic. (We annotate each of the candidates in these tableaux with the winning ☞ symbol, since under the given rankings they remain equally viable.)

(23)

/#RRV/	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
☞ a. .RRV					
☞ b. R̥.RV.					

(24)

/#ROV/	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
☞ a. .ROV					
☞ b. R̥.OV.					

For the former case we might reasonably factor into the analysis the ranking in Keydana (2004:5) of Onset over Hnuc (similar in influence to *(t ⊳ a / Peak)), which would prefer the candidate in (25)a. below.

(25)

/#RRV/	Onset	Hnuc
☞ a. .RRV		(*)
b. R̥.RV.	*!	

With this adjustment, the analysis would be able to account for a word-initial consonantal sonorant. But in order to generate an initial vocalic sonorant before an obstruent, a constraint like Sonority-Sequencing would be required as well; this is not a scenario to my knowledge considered by Keydana.

A downright problematic consequence of Keydana's analysis should perhaps by now be obvious, in consideration of the ranking in (15), used to account for the behavior of vowel + sonorant sequences. Once we introduce the constraint *(a ⊳ t / Mar) into the ranking, the correct result is no longer obtained in the main environment Keydana seeks to account for, namely a sonorant + sonorant sequence not adjacent to a vowel:

(26)

/ḱunb^h-/	*(a ⊳ t / Mar)	*R/C	Parse	Fill	Linear	*(t ⊳ a / Peak)
☹ a. .ḱu̯n̥.b^h-	*!					*
☞ b. .ḱun.b^h-		*				
☞c. .ḱnu.b^h-					*	
☞ d. .ḱu<n>.b^h-			*			
☞ e. .ḱu.n□.b^h-				*		

Given high-ranking *(a ⊳ t / MAR), the candidate in 0a., which ought to be most optimal, is ruled out at the outset, because u̯ makes a poorer syllable margin than lower-sonority *n*; all other candidates in 0b.-e. present equally better alternatives. This unwelcome development results from the invocation and non-differentiation of the comprehensive constraint *(a ⊳ t / MAR) in particular, which in its unitary form encapsulates the entire gamut of preferences for syllable margins. To resolve this issue we can unpack the constraint into the finer-grained fixed subhierarchy *MARGIN/LOW-VOWEL » *MARGIN/MID-VOWEL » …, and rank only *MARGIN/LOW-VOWEL and *MARGIN/MID-V over *R/C (alternatively, using a stringency approach – see 3.2.2 below – the single constraint *MARGIN/LOW-VOWEL;MID-VOWEL will suffice). Still, even with this repair strategy the same concern remains – namely, the fact that the analysis is built around the constraint *R/C. This constraint fails to formally capture the generalization that it is always the second of two non-vowel adjacent sonorants which vocalizes, regardless of its relative sonority, and even if it is not coronal (recall the example of glide + glide sequences).

3.1.3 Discussion

As we noted at the outset of this chapter, and as we have observed in the previous two subsections, the Optimality-Theoretic analyses of nucleus selection developed by Kobayashi and Keydana focus almost exclusively on accounting for the behavior of sonorants. This is understandable given that only sonorants involve an instance of allomorphy, meaning a potential for mismatch from input to output (i.e., something to actually analyze). More particularly, with reference to generalization (1)d. above, the phenomenon is one that seemingly bucks our expectations, from a theoretical and cross-linguistic perspective. While clearly aware of the first two generalizations in (1) – concerning the non-alternating status of obstruents and non-high vowels – nonetheless Kobayashi and Keydana fashion analyses which, as constructed, fail to formally account for them – in fact, quite the contrary: Kobayashi's conception of HNUC, and its ranking below ALIGNNUC (= NOCODA), would predict sonorants vocalize even when following a non-high vowel (e.g., †CV̯R̥C); one could even claim the ranking would similarly prefer the syllabification of obstruents in the same environment (e.g., †CV̯O̥C). Keydana's analysis, while formally acknowledging the first two generalizations in the form of the constraints *(a ⊳ t / MAR) and *(t ⊳ a / PEAK), deploys them in such a way as to void any viability his novel constraint *R/C has as a means of accounting for the fourth generalization. In other words, the ends of these efforts are analyses which are, again, unable to generate all the right results.

3.2 Restricting Consonant Syllabicity: A New Approach

In this section we will seek to instantiate into the Optimality-Theoretic constraint ranking the range of preferences demonstrated in Proto-Indo-European for the behaviors of different classes of segment vis-à-vis syllabicity. In particular, we will explore the issue by comparing approaches using two perspectives on such preference scales. In section 3.2.1 we use constraints of the PEAK and MARGIN families that are in a universally fixed ranking (Prince and Smolensky 1993 [2004]), while in section 3.2.2 we use a stringency approach (Prince 1997a et al., de Lacy 2004). Within both of these frameworks we first entertain analyses centered on syllable peak preferences, and follow these with analyses centered on syllable margin preferences. We compare the resulting analyses in section 3.2.3. Finally, in section 3.2.4 we begin to undertake the exercise of identifying the constraint $\mathbb{C}$, which will be found to be a necessary component of each of the analyses developed.

As a prelude to the discussion, we first seek to clarify the general nature of the constraints to be introduced. Members of the PEAK and MARGIN constraint families – whether in a fixed ranking, or stringently related to each other – are generated in connection with a sonority hierarchy, an array of segments along the dimension of the feature 'sonority', which we assume to be an independently existing entity in the grammar. For our purposes we operate with the conception of the sonority hierarchy given in (27), in which segment classes decrease in sonority moving from left to right:

(27) Vowels > Glides > Liquids > Nasals > Obstruents

A few words about this hierarchy are perhaps in order. First, we consider the category of 'glides' to subsume both high vowels *i* and *u* and their corresponding semivowels *i̯* (*j*) and *u̯* (*w*), under the assumption that in Proto-Indo-European high vowels were underlyingly non-syllabic.[4] Further, we choose not to differentiate within the class identified as 'vowels' mid- vs. low-vowels (classifying high vowels elsewhere), nor within the class identified as 'liquids' rhotics vs. laterals, because so far as we can determine for Proto-Indo-European, such distinctions are irrelevant here.[5]

3.2.1 Developing the Analysis 1: Fixed Ranking

The analyses we develop in the next two subsections are built around fixed subrankings of constraints of the PEAK and MARGIN families, as originally introduced by Prince and Smolensky (1993 [2004]).

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[4] A characterization which, incidentally, Pawley (1966) has proposed for the Trans-New Guinea language Kalam (see also Foley 1986).

[5] Although we do note that these subgroups can be distinguished from each other in certain ways – the near, if not complete, absence of *a* in the language as compared to *e* and *o*, and the rarity of *r* in initial position as compared to *l*, come to mind in this context.

3.2.1.1 Building on PEAK Constraints

The PEAK constraint schema is given in (28), and the fixed subhierarchy of this family of constraints, corresponding to the sonority hierarchy in (27) above, is given in (29).

(28) *PEAK/X (Prince and Smolensky 1993 [2004])

No syllable peaks of category X.

(29) *PK/OBSTRUENT » *PK/NASAL » *PK/LIQUID » *PK/GLIDE » *PK/VOWEL

We begin to sketch the analysis first by showing how high-ranking *PK/OBSTRUENT prevents obstruents from ever being vocalic. Consider the following tableau:

(30)

/CROC/	*PK/OBS	*PK/NAS	*PK/LIQ	*PK/GLI
a. CRO̥C	*!			
☞ b. CR̥OC		(*)	(*)	(*)

The interconsonantal environment of the sequence RO (where *R* = any sonorant consonant) in theory provides an opportunity for the obstruent to become syllabic, but it does not – it is the sonorant which preferentially vocalizes, whether it be a nasal, liquid, or glide (or even non-high vowel, given that *PK/VOWEL is lower-ranked as well).

A problematic consequence of this approach should already be apparent: with the fixed ranking of PEAK constraints, with no intervention the more sonorous segment will always be preferably vocalized over the less sonorous one.

(31)

/CGNC/	*PK/OBS	*PK/NAS	*PK/LIQ	*PK/GLI
☹ a. CGN̥C		*!		
☞ b. CG̥NC				*

Here, for a sequence of glide + nasal, the candidate containing a vocalic glide (i.e. a high vowel) is selected as more optimal than one featuring a vocalic nasal, counter to our expectations for

Proto-Indo-European, but arguably consistent with cross-linguistic generalizations of sonorant vocalism.

The appropriate means of avoiding this outcome is to posit some additional constraint(s) $\mathbb{C}$. As shown by the tableau in (32), $\mathbb{C}$ should intervene in the hierarchy, precisely at a point having the effect of conflating the treatment of nasals, liquids, and glides, but crucially excluding obstruents, in the process of nucleus selection.

(32)

/CGNC/	*PK/OBS	$\mathbb{C}$	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. CGN̥C			*		
b. CG̥NC		*!			*

$\mathbb{C}$ must be violated by the otherwise favored candidate, here CG̥NC, such that it is consistently the second sonorant, regardless of relative sonority, which preferably vocalizes. Ideally $\mathbb{C}$ will also negotiate between candidates featuring sonorants of like-sonority (e.g. CNN̥C over CN̥NC); but an additional constraint could also be involved in this particular case. As to the identity of $\mathbb{C}$, we leave this matter aside for now but will return to it later in 3.2.4 and Chapter 4.

The introduction of $\mathbb{C}$ into the ranking may affect the viability of the analysis as concerns nucleus selection in other sequences. If $\mathbb{C}$ is at all concerned with the linear order of segments, at a strictly segmental level or otherwise – e.g., if $\mathbb{C}$ is to be identified with NOCODA (an obvious possibility), a constraint which would penalize righthand segments over lefthand ones – then its influence may have to be appropriately constrained in the case of CVRC sequences. Otherwise it would predict the outcome †CV̯R̥C, analogous to CRR̥C (although in the case of CVOC, high-ranking *PEAK/OBSTRUENT would militate against a syllabic obstruent).

(33)

/CVNC/	*PK/OBS	$\mathbb{C}$	*PK/NAS	*PK/LIQ	*PK/GLI	*PK/V
☞ a. CV̯N̥C			*			
☹ b.CVNC		*!				*

In this example the nasal on the right is preferably syllabic over the non-high vowel to its left, so as to satisfy $\mathbb{C}$.

To resolve this issue, we need to introduce further constraints, which would penalize instances in which non-high vowels are not actually syllabic. The obvious candidate is the relevant MARGIN constraint, *MAR/VOWEL 'No (non-high) vowels as syllable margins'. This constraint should be inserted high enough into the ranking to force the syllabicity of non-high vowels, regardless of any violations of $\mathbb{C}$ which may be consequently incurred:

(34)

/CVNC/	*PK/OBS	*MAR/V	$\mathbb{C}$	*PK/NAS	*PK/LIQ	*PK/GLI	*PK/V
a. CV̯N̥C		*		*			
☞ b. CVNC			*				*

*MAR/VOWEL can be non-crucially ranked with respect to *PK/OBSTRUENT, but must outrank constraint $\mathbb{C}$.

Finally, to ensure that epenthesis is not permitted as a means of repairing illicit sequences featuring sonorants, but rather that vocalization is the preferred strategy, we must also include the constraint DEP-IO, defined in (35) and deployed as in the tableau in (36).

(35) DEP-IO (McCarthy and Prince 1995)

Every output segment should have an input correspondent. (No epenthesis)

(36)

/CRRC/	*PK/OBS	*MAR/V	DEP-IO	$\mathbb{C}$	*PK/NAS	*PK/LIQ	*PK/GLI	*PK/V
☞ a. CRR̥C					(*)	(*)	(*)	(*)
b. CRVRC			*!	*				

The positioning of DEP-IO allows for epenthesis only when the alternative would be a vocalic obstruent; otherwise insertion of a vowel is less preferred than vocalizing a sonorant consonant.[6] As for the ranking of this constraint with respect to *MAR/VOWEL, we note that epenthesis would be doubly disfavored if associated with the marginalization of a non-high vowel (e.g. †CV̯VC). We also expect that a violation of DEP-IO coincides here with a violation of $\mathbb{C}$, since $\mathbb{C}$ disfavors the maintaining of righthand consonants. At this point it appears that no crucial relationship is discernible between these two constraints, although as we have shown in (34) *MAR/VOWEL must outrank $\mathbb{C}$.[7]

This is the final step in the development of an analysis building on the fixed PEAK subhierarchy of constraints. To summarize, we have maintained the following constraint ranking:

(37) *PK/OBSTRUENT, *MAR/VOWEL » DEP-IO, $\mathbb{C}$ »

*PK/NASAL » *PK/LIQUID » *PK/GLIDE » *PK/VOWEL

Note that, while we have included here all of the members of the PEAK subhierarchy, it is only the constraints enclosed in the box which are actually active in the analysis. Again, the constraint $\mathbb{C}$ serves to conflate the segments targeted by the constraints it outranks.

3.2.1.2 Building on MARGIN Constraints

The MARGIN constraint schema is given in (38), and the fixed subhierarchy of this family of constraints, corresponding to our sonority hierarchy in (27), is given in (39).

(38) *MARGIN/X (Prince and Smolensky 1993 [2004])

No syllable margins of category X.

[6] Cf. the positioning of schwa secundum.

[7] Note that, if one understands the process of vocalization as involving addition of some material beyond that occurring in the input, then presumably all candidates would violate DEP-IO. Under this scenario we would have to introduce a variant such as DEP-V-IO, militating against full vowel epenthesis, instead.

(39) *Mar/Vowel » *Mar/Glide » *Mar/Liquid » *Mar/Nasal » *Mar/Obstruent

We begin to develop this approach first by showing how high-ranking *Mar/Vowel prevents non-high vowels from being non-syllabic, as can be seen in the tableau in (40).

(40)

/CVCC/	*Mar/V	*Mar/Gli	*Mar/Liq	*Mar/Nas	*Mar/Obs
a. CV̯C̥C	*!				
☞ b. CVCC		(*)	(*)	(*)	(*)

Here any consonant, sonorant or obstruent, is going to be disfavored as a syllable nucleus in comparison to a non-high vowel.

As with the fixed Peak account constructed in the previous section, the fixed ranking of Margin constraints creates a problem in consideration of sequences of sonorants: in this case, with no intervention the less sonorous segment will always be preferably ‘marginalized’ over the more sonorous one:

(41)

/CGNC/	*Mar/V	*Mar/Gli	*Mar/Liq	*Mar/Nas	*Mar/Obs
☹ a. CGN̥C		*!			
☞ b. CG̥NC				*	

In an interconsonantal sequence of glide + nasal, for example, the fixed ranking preferentially selects the candidate in (41)b., which features a syllabic glide (the corresponding high vowel), as opposed to a ‘marginal’ one.

So as before, to resolve this issue we posit the additional constraint(s) $\mathbb{C}$ intervening in the hierarchy. Its ranking should be above *Mar/Glide, such that the influence of this constraint, and all of the remaining Margin constraints ranked below it, is thereby neutralized. It should furthermore be violated by the otherwise expected winner, for example, candidate b. in the tableau below.[8]

(42)

/CGNC/	*MAR/V	ℂ	*MAR/GLI	*MAR/LIQ	*MAR/NAS	*MAR/OBS
☞ a. CGN̥C			*			
b. CG̥NC		*!			*	

Given the position of ℂ, sonorant consonants are thus not only on the whole more preferably 'marginal' than are non-high vowels, but are equally 'marginal' in comparison to each other, as well.

This approach may have the undesired result of throwing obstruents into the mix as well, rendering them as equally 'marginal' as any sonorant. If we maintain the same assumptions concerning the identity of ℂ as we did earlier, then, given lowest-ranked *MAR/OBSTRUENT also falls below ℂ, we may expect the outcome †CRO̥C, analogous to CRR̥C (though CVOC would still be preferred over CV̯O̥C, because of high-ranking *MAR/VOWEL).

(43)

/CGOC/	*MAR/V	ℂ	*MAR/GLI	*MAR/LIQ	*MAR/NAS	*MAR/OBS
☞ a. CGO̥C			*			
☹ b. CG̥OC		*!				*

To avoid these circumstances, we would seem compelled to introduce the relevant PEAK constraint, *PK/OBSTRUENT, high enough into the ranking to force the marginal status of obstruents over sonorants, as shown in (44).

[8] Again, it would be simplest if ℂ were operative in cases featuring sonorants of equal sonority as well, but we could also conceive of an additional constraint doing this work.

(44)

/CGOC/	*Pk/Obs	*Mar/V	ℂ	*Mar/Gli	*Mar/Liq	*Mar/Nas	*Mar/Obs
a. CGO̥C	*!			*			
☞ b. CG̥OC			*				*

As it did before, this constraint will ensure that obstruents are never viable occupants of a syllable nucleus.

Again, before concluding we also note the importance of preventing epenthesis as a means of rendering syllabifiable a sequence of segments containing sonorant consonants. We introduce the constraint Dep-IO, ranked in the same position as it was above in (36); the same issues identified there concerning this ranking apply.

(45)

/CRRC/	*Pk/ Obs	*Mar/ V	Dep- IO	ℂ	*Mar/ Gli	*Mar/ Liq	*Mar/ Nas	*Mar/ Obs
☞ a. CRR̥C					(*)	(*)	(*)	(*)
b. CRVRC			*!	*				

In sum, starting with the fixed subhierarchy of Margin constraints, we have found that the ranking in (46) is able to generate the desired results.

(46) *Pk/Obstruent, *Mar/Vowel » Dep-IO, ℂ »

*Mar/Glide » *Mar/Liquid » *Mar/Nasal » *Mar/Obstruent

Once again, the box encloses the active constraints of the analysis; indeed only the highest-ranked member of the Margin subhierarchy we have introduced, *Mar/Vowel, falls into this category.

As an interim conclusion, we have shown in these last two sections that analyses built around the fixed subhierarchies of either Peak or Margin constraints converge on a single set of active constraints and associated ranking relevant to both. These constraints and their ranking are presented in (47):

(47) *PK/OBSTRUENT, *MAR/VOWEL » DEP-IO, $\mathbb{C}$

Interestingly, with the stated assumption about the nature of the constraint $\mathbb{C}$, it becomes necessary to introduce both subhierarchies, and interweave their members in a particular way, so as to generate the correct results. As we will see, this is not a strategy required in the development of analyses using the stringency approach to constraint families and ranking.

3.2.2 Developing the Analysis 2: Stringency Approach

Building on work by Prince (1997a, b, c, 1998, 1999), de Lacy (2004) thoroughly develops a stringency approach to constraint formulation, which calls for the members of hierarchical constraint families to refer to contiguous ranges of a given hierarchy beginning with the most marked element. The series of constraints are 'stringent' in the sense that each one is successfully more restrictive, banning what its precedent constraint does, and more. Using stringency, de Lacy develops an account of vowel conflation in stress placement in the Uralic language Nganasan, a phenomenon he shows to be unamenable to analysis using fixed constraint rankings.

Before proceeding to sketch the stringent approaches using PEAK and MARGIN constraints in the following two subsections, we first take some time to present this theory in some further detail. In order to generate stringent series of constraints for the PEAK and MARGIN families in de Lacy's framework (see pp. 150ff.), we must first begin with the assumptions that 1) phonological hierarchies exist as independent entities in the grammar – as we have already touched upon above – and that 2) they are formally expressed by multivalued features, through the conversion process presented in (48).

(48) *Hierarchy to feature conversion* (de Lacy's (4))

For a hierarchy H = | $\alpha > \beta > \dots \gamma$ |

a. There is a phonological feature [H].

b. [H]'s value is a string of length $n - 1$, where n is the number of elements in H.

c. For a value v, [vH] refers to an element E in H such that for every distinct element F in H such that F > E there is a distinct o in v.

The remaining elements in v are x's.

The sonority hierarchy introduced in (27) above is thus expressed as a feature [sonority] with the following values:

(49) *Multivalue sonority features* (modeled after de Lacy's (5))

a.	[*xxxx* sonority]	vowels	d.	[*xooo* sonority]	nasals
b.	[*xxxo* sonority]	glides	e.	[*oooo* sonority]	obstruents
c.	[*xxoo* sonority]	liquids			

Building on these feature values, the relevant sets of constraints are created as spelled out in the steps in (50).

(50) *The form of context-sensitive hierarchy constraints* (de Lacy's (6))

a. H is a hierarchy that must combine with a structural element in constraint form.

b. [H] is the feature derived from H.

c. For every feature value v of [H], there are constraints for every value of α (where α is a prosodic constituent) such that:

i. *HD$_{\alpha}$/v_2, where v_2 contains all and only the o values in v;

ii. *NON-HD$_{\alpha}$/v_3, where v_3 contains all and only the x values in v;

Furthermore, de Lacy schematically interprets the constraints as follows (his (8)):

(51) a. *HD$_\alpha$/vF

Assign a violation for every segment in Hd$_\alpha$ that is [wF], where v is a substring of w.

b. *NON-HD$_\alpha$/vF

Assign a violation for every segment in non-Hd$_\alpha$ that is [wF], where v is a substring of w.

As the prosodic constituent we are concerned with is the syllable (i.e., α = the syllable), we understand the constraint schema in (50)c.i.-(51)a., *HD$_\alpha$, to correspond to *PEAK, and that in (50)c.ii.-(51)b., *NON-HD$_\alpha$, to correspond to *MARGIN. The constraints on syllable-sonority are thus as in (52):

(52) *Syllable-sonority constraints* (modeled after de Lacy's (7))

a.	*HD$_\sigma$ = *PK/[*oooo* sonority]	b.	*NON-HD$_\sigma$ = *MAR/[*xxxx* sonority]
	*PK/[*ooo* sonority]		*MAR/[*xxx* sonority]
	*PK/[*oo* sonority]		*MAR/[*xx* sonority]
	*PK/[*o* sonority]		*MAR/[*x* sonority]
	*PK/[sonority]		*MAR/[sonority]

Replacing the [sonority] feature values in (52) with the corresponding categories on our sonority hierarchy, we end up with the following sets of constraints.

(53) *Syllable-sonority constraints* (modeled after de Lacy's (7))

b. *PK/OBSTRUENT

*PK/OBSTRUENT;NASAL

*PK/OBSTRUENT;NASAL;LIQUID

*PK/OBSTRUENT;NASAL;LIQUID;GLIDE

*PK/OBSTRUENT;NASAL;LIQUID;GLIDE;VOWEL

b. *MAR/VOWEL

*MAR/VOWEL;GLIDE

*MAR/VOWEL;GLIDE;LIQUID

*MAR/VOWEL;GLIDE;LIQUID;NASAL

*MAR/VOWEL;GLIDE;LIQUID;NASAL;OBSTRUENT

It is these constraints, in this form, which will be featured throughout the rest of the discussion.

3.2.2.1 Building on PEAK Constraints

Under the stringency approach, the set of PEAK constraints, freely rankable, is repeated in (54) from (53)a. above.

(54) *PK/OBSTRUENT

*PK/OBSTRUENT;NASAL

*PK/OBSTRUENT;NASAL;LIQUID

*PK/OBSTRUENT;NASAL;LIQUID;GLIDE

*PK/OBSTRUENT;NASAL;LIQUID;GLIDE;VOWEL

As the least preferred syllable nucleus, obstruents are targeted by the core PEAK constraint, as well as every other constraint in the set in (54). In the case of Proto-Indo-European, including *PK/OBSTRUENT in the ranking ensures that obstruents will never be syllabic, as shown by the quasi- tableau in (55):

(55)

/CROC/	*PK/OBS	*PK/OBS;NAS	*PK/OBS;NAS;LIQ	*PK/OBS;NAS;LIQ;GLI
a. CRO̥C	*!	*	*	*
☞ b. CR̥OC		(*)	(*)	(*)

Although each of the four constraints included here disfavor syllabic obstruents, only *PK/OBSTRUENT consistently plays a role in the evaluation process, regardless of whether the preceding sonorant is a nasal, liquid, or glide.

In fact, since Proto-Indo-European shows conflation of these three classes of sonorants as concerns the selection of syllable nuclei, we really need consider active only the first and fourth constraints in (55); *PK/OBSTRUENT;NASAL;LIQUID;GLIDE ranked non-crucially with *PK/OBSTRUENT will be sufficient to disfavor obstruents from occupying the syllable nucleus. But in cases in which two adjacent sonorants consitute a viable nucleus (as they would between consonants), the ranking, featuring these two constraints alone, requires elaboration. As the tableau in (56) shows, *PK/OBSTRUENT;NASAL;LIQUID;GLIDE evaluates both candidates identically, the first of which features a syllabic nasal, the second, a syllabic glide (i.e., high vowel).

(56)

/CGNC/	*PK/OBS	*PK/OBS;NAS;LIQ;GLI
a. CGN̥C		*
b. CG̥NC		*

Selecting the winning candidate in (56)a. necessitates nullification of the remaining relevant PEAK constraints, lest they exert their influence and undesirably select the candidate in (56)b., due to its syllabic glide. We accomplish this as we have previously, by introducing the constraint(s) ℂ, ranking above all other stringent constraints of the PEAK family. ℂ militates against the candidate in which the lefthand sonorant is vocalized.

(57)

/CGNC/	*PK/OBS	*PK/OBS;NAS;LIQ;GLI	ℂ
☞ a. CGN̥C		*	
b. CG̥NC		*	*!

While the importance of crucially ranking $\mathbb{C}$ below *PK/OBSTRUENT;NASAL;LIQUID;GLIDE is not evident in the tableau (57), as both candidates equally violate the latter, nevertheless it is justified in cases featuring non-high vowels – assuming, again, that whatever the identity of $\mathbb{C}$, this constraint prefers righthand segments over lefthand ones – as in the following:

(58)

/CVNC/	*PK/OBS	*PK/OBS;NAS;LIQ;GLI	$\mathbb{C}$
a. CV̯N̥C		*!	
☞ b. CVNC			(*)

Here the crucial ranking selects the correct output, regardless of the satisfaction of constraint $\mathbb{C}$; because it does not violate *PK/OBSTRUENT;NASAL;LIQUID;GLIDE, a form in which the vowel is syllabic will always be preferred.

Finally, once again we conclude the construction of the constraint ranking by eliminating the possibility of epenthesis over sonorant vocalization as a means of rendering a sequence of segments containing sonorants syllabifiable, through introduction of the constraint DEP-IO, positioned as in (59).

(59)

/CRRC/	*PK/OBS	DEP-IO	*PK/OBS;NAS;LIQ;GLI	$\mathbb{C}$
☞ a. CRR̥C			*	
b. CRVRC		*!		*

As is evident in the tableau, DEP-IO must outrank *PK/OBSTRUENT;NASAL;LIQUID;GLIDE, to allow for vocalized sonorants to surface. But it must also crucially rank below *PK/OBSTRUENT, because obstruent vocalization is never permitted, but rather in the relevant forms epenthesis is relied on instead.

To summarize, using stringent PEAK constraints, we posit the following ranking of constraints active in the selection of Proto-Indo-European syllable nuclei:

(60) *PK/OBSTRUENT » DEP-IO » *PK/OBSTRUENT;NASAL;LIQUID;GLIDE » $\mathbb{C}$ » …

Note that all other PEAK constraints must rank below the lowest-ranked constraint, $\mathbb{C}$, in order for the analysis to generate the right results.

3.2.2.2 Building on MARGIN Constraints

Stringent constraints of the MARGIN family are repeated in (61) from (53)b. above.

(61) *MAR/VOWEL

*MAR/VOWEL;GLIDE

*MAR/VOWEL;GLIDE;LIQUID

*MAR/VOWEL;GLIDE;LIQUID;NASAL

*MAR/VOWEL;GLIDE;LIQUID;NASAL;OBSTRUENT

Analogous to the status of obstruents as poor nuclei, non-high vowels constitute poor margins, and so are penalized by all members of the MARGIN family. As shown by the quasi-tableau in (62), we need to minimally include *MAR/VOWEL in the ranking to distinguish non-high vowels from all other segments.

(62)

/CVCC/	*MAR/V	*MAR/V;GLI;LIQ	*MAR/V;GLI; LIQ;NAS	*MAR/V;GLI; LIQ;NAS;OBS
a. CV̯C̥C	*!	*	*	*
☞ b. CVCC		(*)	(*)	(*)

With this constraint active, regardless of whether the following consonant is a sonorant or obstruent, candidates like those in (62)a. will always be disfavored.

But if we want to conflate nasals, liquids, and glides for the purposes of syllable 'marginalization', we cannot do it with a subset of these constraints alone. As the tableaux in (63) and (64) show, while the constraint *MAR/VOWEL;GLIDE;LIQUID;NASAL can select the correct output for a sequence of sonorant plus obstruent (63), it cannot distinguish between sequences of two sonorants (64).

(63)

/CROC/	*MAR/V	*MAR/V;GLI;LIQ;NAS
a. CRO̥C		*!
☞ b. CR̥OC		

(64)

/CGNC/	*MAR/V	*MAR/V;GLI;LIQ;NAS
a. CGN̥C		*
b. CG̥NC		*

For cases such as glide + nasal sequences, we need to introduce a constraint ℂ into the ranking, to negotiate between the two candidates, lest the decision fall to the remaining MARGIN constraints, all of which would favor the candidate in (64)b., featuring the syllabic glide. The position of this constraint should thus be as in (65):

(65)

/CGNC/	*MAR/V	*MAR/V;GLI;LIQ;NAS	ℂ
☞ a. CGN̥C		*	
b. CG̥NC		*	*!

While the relative ranking of ℂ vis-à-vis *MAR/VOWEL;GLIDE;LIQUID;NASAL is non-crucial in the case of any sequence CRRC, the case of CROC in (66) demonstrates the need to rank it lower, under the assumption that the candidate in (66)b., in which the lefthand segment vocalizes, would violate it. (This ranking applies to *MAR/VOWEL as well; for CVOC sequences, CV̯O̥C is not optimal.)

(66)

/CROC/	*MAR/V	*MAR/V;GLI;LIQ;NAS	ℂ
a. CRO̥C		*!	
☞ b. CR̥OC			*

Finally, we note that, interestingly enough, whereas in the previous three accounts constructed we saw fit to introduce the constraint DEP-IO into the ranking to militate against vowel epenthesis, using stringent MARGIN constraints such a strategy is apparently not needed, at least for the context we have been examining:

(67)

/CRRC/	*MAR/V	*MAR/V;GLI;LIQ;NAS	$\mathbb{C}$
☞ a. CRR̥C		*	
b. CRVRC		**!	*

Because maintaining two marginal sonorants incurs two violations of *MAR/VOWEL;GLIDE;LIQUID;NASAL, the candidate in (67)b., which features an epenthetic vowel, loses out to the candidate in (67)a., in which only one sonorant is marginal.

While this aspect of the stringent MARGIN-based approach may appear to make it more favorable, in fact, in consideration of another environment, the ranking established thus far proves critically insufficient. The crucial sequence is COOC; given the constraint ranking, evaluation of the output candidates in (68) would result in an undesired outcome:

(68)

/COOC/	*MAR/V	*MAR/V;GLI;LIQ;NAS	$\mathbb{C}$
☞ a. COO̥C			
b. CO̥OC			*!
☹ c. COVOC			*!

The high-ranking MARGIN constraints have no influence on either of the candidates here (or at least, on either of the segments in each we are focused on, the obstruents), and so evaluation comes down to the constraint $\mathbb{C}$, which we expect to prefer the candidate in (68)a. over those in (68)b.-c., despite the fact that the candidate in (68)c. is the desired winner.

To forestall the possibility of an output featuring a syllabic sonorant being selected as most optimal, we are compelled to introduce into the ranking the core member of the PEAK family of constraints, *PK/OBSTRUENT. This constraint must dominate $\mathbb{C}$, a ranking justified by the revised tableau in (69):

(69)

/COOC/	*Mar/V	*Mar/V;Gli;Liq;Nas	*Pk/Obs	ℂ
a. COO̥C			*!	
b. CO̥OC			*!	*
☞ c. COVOC				*

We now attain the desired result, selection of the candidate featuring an epenthetic vowel, instead of either of those featuring a syllabic obstruent.

Building the analysis on stringent Margin constraints, then, we maintain the following hierarchy of constraints, active for the selection of syllable nuclei in Proto-Indo-European.

(70) *Mar/Vowel, *Mar/Vowel;Glide;Liquid;Nasal, *Pk/Obstruent » ℂ » …

Again, note that all other Margin constraints must rank below the lowest-ranked constraint, ℂ, in order for the analysis to generate the right results.

As we have seen, developing analyses built around stringent sets of either Peak or Margin constraints yields two distinct systems of constraint rankings, which accomplish the same results but come at the problem from two different directions.

3.2.3 Which Analysis?

In the preceding discussion we have found it possible to construct an analysis of nucleus selection in Proto-Indo-European using members of two families of constraints, Peak and Margin, formally instantiated in one of two ways, as fixed subhierarchies, or as freely rankable and set-oriented. What were begun as four different approaches converged on three distinct analyses, as the use of fixed constraints has been shown to require members of both families to work. The active rankings of these three accounts are repeated below in (71).

(71) a. Fixed Peak / Margin Ranking

*Pk/Obstruent, *Mar/Vowel » Dep-IO, ℂ » …

b. Stringent PEAK Ranking

*PK/OBSTRUENT » DEP-IO » *PK/OBSTRUENT;NASAL;LIQUID;GLIDE » $\mathbb{C}$ » …

c. Stringent MARGIN Ranking

*MAR/VOWEL, *MAR/VOWEL;GLIDE;LIQUID;NASAL, *PK/OBSTRUENT » $\mathbb{C}$ » …

Which ranking should we adopt for Proto-Indo-European? While the data are compatible with any of the rankings in (71), we are inclined to adopt and deploy that in (71)a.

On the basis of theoretical 'elegance', comparison of these three analyses is basically a wash. On the one hand, assuming that the stringency formalism is a necessary component of the Optimality Theoretic grammar in any case (see de Lacy 2004), the approach built around stringent PEAK constraints, that in (71)b., is arguably more elegant than either the fixed ranking approach in (71)a. or the stringent MARGIN approach in (71)c., since it requires only one family of constraints to be introduced into the active portion of the ranking. On the other hand, the ranking in (71)a. may be considered simpler, since it derives the same results without resorting to the relatively more complex machinery of stringent constraints.

We prefer the approach in (71)a. because it captures the three generalizations we wish to analyze – the strict non-syllabicity of obstruents, the strict syllabicity of non-high vowels, and the variable status of the remaining sonorants – in the most intuitively satisfying way. Each of the analyses in (71) go about handling these generalizations in its own way. Under the unified fixed ranking approach, the fixed status of both obstruents and non-high vowels is asserted, in the form of the high-ranking constraints *PK/OBSTRUENT and *MAR/VOWEL, and it is the variable status of sonorants which falls out of the ranking. Under the stringent PEAK approach, the fixed status of obstruents is again asserted, but the fixed status of non-high vowels is not; the non-marginalization of any non-high vowel falls out of the ranking, since vocalization of other segments is more highly disfavored. Finally, under the stringent MARGIN approach, the fixed status of non-high vowels is asserted, as is the fixed status of obstruents; but also asserted is the conflation of nasals, liquids, and glides. The distinct focus of each of these approaches is schematized in (72); circled classes of segments are those explicitly targeted by constraints.

(72) a. Fixed PEAK / MARGIN Focus

obstruents   nasals   liquids   glides   vowels

***PK/OBS**   ***MAR/ V**

b. Stringent PEAK Focus

obstruents   nasals   liquids   glides   vowels

***PK/OBS**   ***PK/OBS;NAS;LIQ;GLI**

c. Stringent MARGIN Focus

obstruents   nasals   liquids   glides   vowels

***PK/OBS**   ***MAR/V;GLI;NAS;LIQ**   ***MAR/V**

Viewing the three alternatives from this perspective, the purported elegance gained by the stringent PEAK account in requiring only one constraint type also comes at the cost of asserting the special status of sonorants directly in the constraints, as opposed to having it fall out of the ranking. Since obstruents are never syllabic in Proto-Indo-European, and non-high vowels are always syllabic, if anything is to be encoded directly, it makes more sense for it to be their clearcut, non-alternating behavior. So in a similar way while the fixed PEAK/MARGIN ranking does just this, because it also asserts the like-minded behavior of sonorant consonants, it too is to be dispreferred, proving more cumbersome than the fixed PEAK/MARGIN account.

We acknowledge, of course, that nothing prevents us from targeting both vowels and obstruents using stringent constraints instead of fixed constraints. In fact, given that Proto-Indo-European displays no discernible difference in the syllabicity of mid versus low vowels – as we have already noted above – arguably the fixed unitary *MAR/VOWEL can be reanalyzed as the stringent constraint *MAR/MID-VOWEL;LOW-VOWEL. Rather, our point in this review of the various approaches is simply to emphasize that these constraints treat the unexceptional behavior of one class (obstruent) or another (non-high vowels) as exceptional. In this sense it seems preferable to use the ranking, which relying on fixed constraints has led us to, not because it uses fixed constraints, but because of the way in which the various subphenomena are treated under it.

For the remainder of the discussion, then, we will proceed operating with the constraint ranking in (71)a. as the core of the analysis.

3.2.4 The Nature of the Constraint ℂ

3.2.4.1 The Problem with NOCODA

In developing the Optimality-Theoretic analysis of Proto-Indo-European nucleus selection, we have demonstrated the need to introduce a constraint into the ranking, which prefers, in the appropriate context (e.g., between consonants), the vocalization of the second of two sonorants, regardless of its relative sonority as compared to the first. We labeled this constraint ℂ, but abstracted away from any attempt at identifying it further. We will now begin to consider this issue more closely.

Simply put, ℂ prefers a right-oriented syllabic nucleus over a left-oriented one: the first sonorant is more preferred as (part of) an onset, than the second sonorant is as (part of) a coda. The most obvious candidate for the constraint ℂ, is, then (as has already been noted earlier), NoCoda. Indeed both Kobayashi and Keydana rely on some form of this constraint to motivate nucleus selection in their analyses as well – although Kobayashi casts it as the alignment constraint AlignNuc, and Keydana posits a specified variant targeting only coronal sonorants, *R/C. And for the canonical example of Proto-Indo-European sonorant vocalization, **k̂u̯n̥.b^{h}is*, each approach works – in its own way – as shown in the following tableaux, repeated from the relevant discussion earlier in this chapter.

(73) a. Kobayashi on **k̂u̯nb^{h}is* (2004: 24)[9]

/k̂u̯n-b^{h}is/	Onset	AlignNuc	HNuc
i. k̂un.b^{h}is.		*!	
☞ ii. k̂u̯n̥.b^{h}is.			*
iii. k̂u.n̥.b^{h}is.	*!		

b. Keydana on **k̂u̯nb^{h}is* (2008 [2010]: 61)

/k̂unb^{h}-/	*R/C	Parse	Fill	Linearity	*(t ⊳ a / Peak)
☞ i. .k̂u̯n̥.b^{h}-					*
ii. .k̂un.b^{h}-	*!				
iii. .k̂nu.b^{h}-				*!	
iv. .k̂u<n>.b^{h}-		*!			
v. .k̂u.n□.b^{h}-			*!		

Crucially ranking the constraint against codas (AlignNuc, *R/C) over the constraint encoding preferences for syllable nuclear constituency (HNuc, *(t ⊳ a / Peak)) results in the desired selection of the most optimal output. The same effect is achieved if we introduce NoCoda into the position of $\mathbb{C}$ in any of the three rankings developed in the previous section, as well:

[9] Both tableaux have been reformatted from the authors' own presentations, but not in any way significantly affecting their claims.

(74) a. Fixed PEAK/MARGIN Ranking

/k̑u̯n-bʰis/	*PK/OBS	*MAR/V	DEP-IO	NOCODA	*PK/NAS	*PK/LIQ	*PK/GLI
i. k̑un.bʰis				*!			*
☞ ii. k̑u̯n̥.bʰis					*		

b. Stringent PEAK Ranking

/k̑u̯n-bʰis/	*PK/OBS	DEP-IO	*PK/OBS;NAS;LIQ;GLI	NOCODA
i. k̑un.bʰis			*	*!
☞ ii. k̑u̯n̥.bʰis			*	

c. Stringent MARGIN Ranking

/k̑u̯n-bʰis/	*MAR/V	*MAR/V;GLI;LIQ;NAS	*PK/OBS	NOCODA
i. k̑un.bʰis		*		*!
☞ ii. k̑u̯n̥.bʰis		*		

Of course as we have argued, any of the analyses in (74) should be preferred over those in (73), because of their broader empirical coverage: again, they explicitly force the non-syllabicity of obstruents, but the syllabicity of non-high vowels. But as far as **k̑u̯nbʰis* is concerned, for which neither of these two aspects of the system are relevant considerations (at least in the case of the initial syllable), the approaches in (73) and (74) seem equally adequate.

Yet maintaining only some version of an anti-coda constraint to compel righthand sonorant vocalization ultimately proves inadequate as a means of accounting for all the Proto-Indo-European data, as the system has been reconstructed. An analysis of this nature is unable to handle forms in which the sonorant sequence under examination falls in a non-initial syllable; in such cases NOCODA proves ineffective in distinguishing output candidates, as we will now show.[10]

[10] There is also, more generally, the ostensible challenge of integrating an account of sonorant vocalization into the larger picture of Proto-Indo-European syllabification, which traditionally holds that intervocalic consonant

3.2.4.2 NOCODA in Non-Initial Environments

Recall that Kobayashi's and Keydana's analyses make problematic predictions in the case of a syllabification like **per.u̯r̥*, straightforwardly generated by Schindler's rule and supported by Gk. *pȇrar* 'end, boundary' < **peru̯ar*.[11]

(75) a. Kobayashi's Prediction

/per-u̯r/	ONSET	ALIGNNUC	HNUC
☹ i. per.u̯r̥		*	*!
☞ ii. pe.rur		*	

b. Keydana's Prediction

/per-u̯r/	*R/C	PARSE	FILL	LINEARITY	*(t ⊳ a / PEAK)
☹ i. per.u̯r̥	*				*!
☞ ii. pe.rur	*				

The issue is as follows: once we move beyond consideration of the single syllable in which the candidates for syllabicity find themselves, violations of the NOCODA constraints equalize – the preferred syllable *.u̯r̥* may lack a coda, but its associate *per.* does not; thus each candidate has one coda violation. Consequently, evaluation falls to the lower-ranked nuclear preference constraints (HNUC and *(t ⊳ a / PEAK)), and determination of the more optimal output hinges on which sonorant makes the better nucleus: hence the candidate in (75)a.-b.ii. wins, since it features a vocalic glide over a vocalic liquid.[12]

We obtain similar results if we evaluate the input /per-u̯r/ according to *any* of the three rankings we established in 3.2.1-2, replacing $\mathbb{C}$ with NOCODA in all of them:

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sequences are heterosyllabified (i.e., VC.CV) – see the discussion beginning in Chapter 8; if such an account is to involve NOCODA, we face a potential ranking paradox. This issue is considered in more detail in Chapter 10.

[11] As Keydana points out (2008 [2010]: 55-56), this treatment holds at least of a pre-stage of Greek, if not of Proto-Indo-European itself. See also Schindler (1975), and Hoffmann (1974) for Ved. *párur*.

[12] Arguably more optimal than either of the candidates considered here would be the form **pe.ru̯r̥*, with complex onset instead of coda + onset sequence, already mentioned in the context of Kobayashi's and Keydana's accounts in the previous chapter. However, as there is no independent evidence suggesting such a cluster was licit in Proto-Indo-European (e.g. it does not occur word- or root-initially), we leave this hypothetical syllabification aside.

(76) a. Fixed Peak/Margin Ranking

/per-u̯r/	*Pk/Obs	*Mar/V	Dep-IO	NoCoda	*Pk/Nas	*Pk/Liq	*Pk/Gli
☹ i. per.u̯r̥				*		*!	
☞ ii. pe.rur				*			*

b. Stringent Peak Ranking

/per-u̯r/	*Pk/Obs	Dep-IO	*Pk/Obs;Nas;Liq;Glide	NoCoda
☞ i. per.u̯r̥			*	*
☞ ii. pe.rur			*	*

c. Stringent Margin Ranking

/peru̯r/	*Mar/V	*Mar/V;Gli;Liq;Nas	*Pk/Obs	NoCoda
☞ i. per.u̯r̥		*	*	*
☞ ii. pe.rur		*	*	*

Like Kobayashi's and Keydana's accounts, the approach we developed using a fixed ranking of Peak and Margin constraints also selects the candidate in (76)a.-b.-c.ii. as the winner, because of the more disfavored syllabic liquid. On the other hand, using stringent constraints, at first glance neither candidate emerges as more optimal, since both equally violate the relevant stringent constraint, and NoCoda. But note that the remaining stringent constraints, though thought to be inactive in the language, are nonetheless still present in the grammar; thus in these analyses as well the non-reconstructed syllabification †*pe.rur* will have to win out, since a syllabic liquid violates every constraint that a syllabic glide violates, and more, and a marginal glide violates every constraint that a marginal liquid violates, and more.

The issue, then, is how to differentiate the desired output **per.u̯r̥* from its opponent †*pe.rur* without the involvement of sonority-based preferences on nuclear constituency. As invoking a constraint against codas does not offer a satisfactory translation of Schindler's insight that the rule of sonorant vocalization in Proto-Indo-European operates iteratively from right-to-left, we are compelled to examine more closely the issue of directionality in phonology, and consider other ways in which it has been encoded in Optimality Theory. In the following chapter we undertake this exercise; indeed we have an opportunity to consider the issue of directionality from a novel perspective, as absent in the literature (to our knowledge) has been examination of data in which consonant vocalization – as opposed to epenthesis or syncope – ameliorates poor syllabification profiles.

CHAPTER 4

DIRECTIONAL EFFECTS IN PHONOLOGICAL THEORY

4.0 Introduction

In this chapter we explore the various ways in which directionality has been introduced into phonological theory, in the interest of refining the Optimality-Theoretic analysis of sonorant vocalization in Proto-Indo-European undertaken in the preceding chapter, by providing an identity for the posited constraint $\mathbb{C}$. We begin in 4.1 by reviewing multiple discussions and formal analyses of directionality in syllable structure assignment, framed in both derivational and constraint-based terms. We then move on in 4.2 to consider how such approaches may be adapted to treat directionality in consonant syllabicity, specifically in Proto-Indo-European, and propose an analysis for this language. In 4.3 we consider briefly an alternative to this analysis, built around preferences on consonant moraicity, and show the problems such an approach would involve. We conclude in 4.4.

4.1 Directionality in Syllabification

We review in 4.1.1 some relevant pre-Optimality Theory work on directionality as a parameter of syllable structure assignment, before moving on to consider the ways in which it has been formalized in this framework in 4.1.2.[1]

[1] We do not claim to strive for exhaustivity in the following review. For additional work on directionality, we refer the reader to Kenstowicz and Kisseberth (1979) on Harari and Berhane (1991) on Tigrinya, both Semitic languages.

4.1.1 Derivational Accounts

4.1.1.1 Kaye and Lowenstamm (1981)

As part of their discussion of markedness in syllable structure, Kaye and Lowenstamm (1981) identify two directional syllable structural parsing strategies that are capable of accounting for ostensibly language-specific syllabifications of similar phonological strings. They call these strategies the Rightward Strategy and the Leftward Strategy; both are defined in (1):

(1) a. The Rightward Strategy (their (33))

Scanning a word from left to right, make the first syllable as unmarked as possible. If the resulting syllable on the right conforms to the formal and substantive syllable constraints of the language, then there is a syllable boundary at that point. If the resulting right syllable violates a constraint, move the syllable boundary over one segment to the right and try again. Repeat until the resulting right syllable is licit. After the first syllable boundary has been found, repeat the process for successive syllable until the end of the string is reached (307).

b. The Leftward Strategy (their (36))

Scanning a word from right to left, make the last syllable as unmarked as possible. If the resulting syllable on the left conforms to the formal and substantive syllable constraints of the language, then there is a syllable boundary at that point. If the resulting left syllable violates a constraint, move the syllable boundary over one segment to the left and try again. Repeat until the resulting left syllable is licit. After the first syllable boundary has been found, repeat the process for successive syllable until the beginning of the string is reached (308-309).

To exemplify these strategies, Kaye and Lowenstamm introduce data from English, which they analyze as a language with left-to-right syllabification (e.g. *a.stute* over †*as.tute*, supported by the lack of aspiration associated with the first dental stop), and Polish, which they identify as a language with right-to-left syllabification (e.g. *wys.pa* over †*wy.spa* 'island', based on native speaker judgment[2]).

4.1.1.2 ter Mors (1985)

Ter Mors (1985) invokes directionality to account for the position of the epenthetic vowel in Klamath (Penutian) CCC epenthesis; specifically, she analyzes this language as characterized by right-to-left syllabification. For example, in the underlying form /snogwk/, the triconsonantal sequence can be repaired by an epethetic vowel occurring in one of two locations: either between *g* and *w*, or between *w* and *k*. The surface form of this word, [snogo:k], unambiguously shows that, prior to undergoing an independent vocalization process, the vowel assumes the former position, as in the intermediate form *snogəwk*, not †*snogwək*. This is only possible if syllable structure in this language is assigned in a leftward direction.

4.1.1.3 Noske (1985, 1988)

Noske (1985, 1988) presents data from several processes in the Penutian language Yawelmani suggesting this language also syllabifies from right-to-left. These processes include shortening, elision, and, again, epenthesis. By casting assignment of syllable structure as a directional procedure, Noske is able provide an arguably more elegant analysis of these distinct phenomena. He follows this discussion with consideration of data on epenthesis and syncope in the South

[2] As Kaye and Lowenstamm acknowledge (308), ideally phonological processes such as aspiration will point to syllable breaks, but in the absence of such evidence, native judgments, problematic and inconsistent as they may be, are a potential source of insight.

Semitic language Tigrinya, suggesting this language syllabifies in the opposite direction, from left-to-right. He concludes by positing directionality in syllabification as a parameter set on a language-by-language basis, thereby making explicit the notion implicit in Kaye and Lowenstamm (1981)'s aforementioned presentation.

4.1.1.4 Itô (1989)

Perhaps the most well-known discussion of directional syllabification effects can be found in the work of Itô (1986, 1989). Itô introduces directionality in syllable structure assignment to account for different epenthesis sites in two dialects of Arabic, Cairene and Iraqi, as well as for initial and medial epenthesis in the Austroasiatic language Temiar. We review her analysis of the former here.[3]

In neither Cairene nor Iraqi Arabic are triconsonantal sequences permitted in medial position, so epenthesis serves to render such sequences syllabifiable, when they occur via morphological concatenation. While for a medial sequence -CCC-, there are two potential sites for a vowel to be inserted into – between the first and second consonant, i.e. CVCC, or between the second and third, i.e. CCVC – Cairene and Iraqi differ in that the former consistently epenthesizes CCVC (2), while the latter consistently epenthesizes CVCC (3).

[3] Our purpose here is to review Itô's general framework, not to dwell on how well it fits the Arabic data, the basis of much discussion in the literature over the past three decades. Indeed a few issues which have been raised with Itô's account of the Arabic dialects involve the behavior of consonants at word-edge, the behavior of syncope, and the interaction of epenthesis and stress placement, specifically in Iraqi.

To elaborate just on this last point, syllables headed by epenthetic vowels resolving a single unsyllabifiable consonant (i.e. in words with triconsonantal sequences) are apparently invisible to the rules of stress placement in Iraqi, a result which Itô's account would not predict. Piggott (1995) offers a revised analysis which maintains Itô's directional syllable structure, while Broselow (1992) argues against it, promoting instead an analysis invoking onset/rime syllable constituency. More recently, Kiparsky (2003) has formalized an Optimality Theoretic approach to these data involving semisyllables, unsyllabified moras dominating a single consonant.

(2) *CCC Epenthesis in Cairene Arabic* (from Itô's (41))

a.	/ʔul-t-l-u/	→	*ʔult<u>i</u>lu*	'I said to him'
b.	/katab-t-l-u/	→	*katabt<u>i</u>lu*	'I wrote to him'
c.	/katab-t dars/	→	*katabt<u>i</u>dars*	'you wrote a lesson'

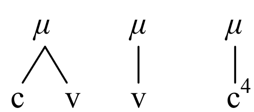
(3) *CCC Epenthesis in Iraqi Arabic* (from Itô's (42))

a.	/gil-t-l-a/	→	*gil<u>i</u>tla*	'I said to him'
b.	/triid ktaab/	→	*triid<u>i</u>ktaab*	'you want a book'
c.	/katab-t ma-ktuub/	→	*katab<u>i</u>tmaktuub*	'I wrote a letter'

To generate these distinct results, Itô posits that while Cairene Arabic and Iraqi Arabic share the same possible moraic and syllable structures, given in (4) and (5), crucially these languages differ with respect to how syllable structure is assigned: Cairene syllabifies from left-to-right, while Iraqi syllabifies from right-to-left.

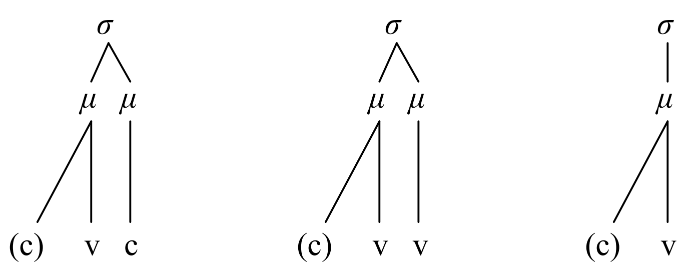
(4) *Permitted Moraic Structures in Cairene and Iraqi Arabic* (Itô's (46))

$$\mu \rightarrow \left\{ \begin{array}{c} \text{(c) v} \\ \text{c} \end{array} \right\}$$



(5) *Permitted Syllabic Structures in Cairene and Iraqi Arabic* (Itô's (47))

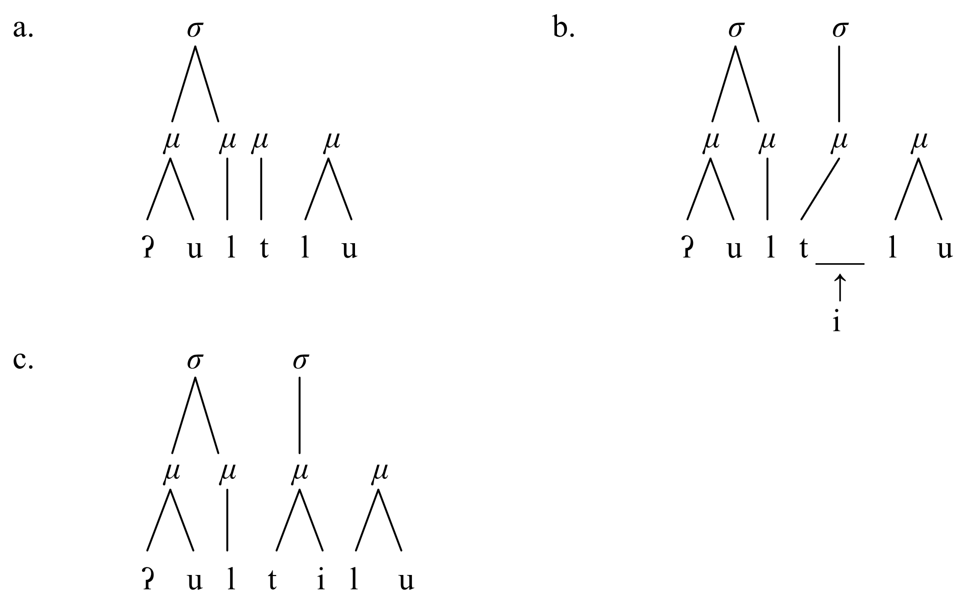
$\sigma \rightarrow \mu\ (\mu)$



[4] Itô uses lowercase letters to indicate melodic rather than skeletal elements.

In Cairene Arabic, once moraic structure has been assigned according to the allowable moraic sequences of the language (cv, v, c, a conception in line with that of Hyman 1985, for whom all segments are dominated by a mora, and in particular onsets and nuclei come to be dominated by the same mora[5]), syllabification proceeds from the beginning of the word to create a CVC syllable out of the initial bimoraic sequence *ʔul-*. As the remaining material cannot constitute a licit syllable in this language, the interconsonantal *-t-* is incorporated into a syllable of its own, as an onset, leaving the remaining two segments, *-lu*, to be incorporated in a syllable of shape CV. Itô schematizes this process as follows (her (50)):

(6) *Left-to-Right Syllabification in Cairene Arbaic*



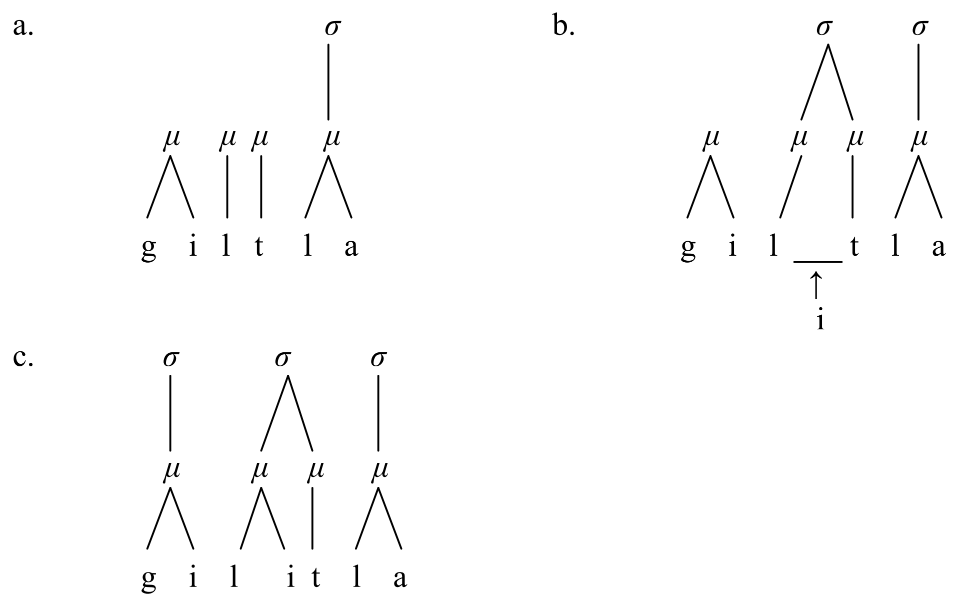
Note that, although the language allows for syllables of shape VC, *t* is prevented from becoming the coda of the syllable headed by the epenthetic vowel (i.e. *ʔul.i̱t.lu*) because of the nature of the epenthesis process, and the nature of moraic structure: only a vowel is inserted into the string,

[5] For Itô, via the general prosodic principle of Maximality, for Hyman, via application of the universal Onset Creation Rule. This conception of moraic structure is more generally in line with the Strict Layer Hypothesis (Selkirk 1984, Nespor and Vogel 1986); there is also of course the alternative advocated by Hayes (1989) et al., in which onsets are adjoined directly to the syllable node.

not a mora. Thus the only moraic structure permitted given the already moraified $[t]_\mu$ is $[tV]_\mu$; the syllable *Vt* would have the bimoraic structure $[V]_\mu[t]_\mu$.[6]

In Iraqi Arabic, on the other hand, once moraification has taken place, syllabification proceeds starting from the end of the word as follows. The largest possible licit syllable at word-edge is *-lu*, of shape CV; anything larger is blocked by the presence of the preceding *t*. This segment, together with the preceding *l*, are both moraic, but cannot themselves constitute a licit syllable. Epenthesis thus occurs, creating a syllable of shape CVC; again, given that only a vowel is inserted, not a mora, this is the only possible repair, operating in this direction. Finally, remaining is the initial sequence *gi-*, which is incorporated into a second CV syllable. This process is schematized by Itô as in (7) (her (51)).

(7) *Right-to-Left Syllabification in Iraqi Arabic*



[6] This means of forcing *t* into a syllable onset position is of course then contingent on a syllable onset sharing a mora with a syllable nucleus (Hyman 1985), rather than being adjoined directly under the syllable node (Hayes 1989). Under this latter view of moraic structure, epenthesis after *t* could be compelled by a preference for onsetful syllables.

Itô's analysis has the additional empirical advantage of straightforwardly accounting for the location of epenthesis in quadriconsonantal sequences in these languages: in both Cairene and Iraqi a vowel inserted as follows: /VCCCCV/ → VCCVCCV. This is exactly as expected given the procedures she defines for rightward and leftward syllabification (operating in languages which disallow onset and coda clusters). Relevant data are given in (8)-(9), and sample syllabifications in (10)-(11).

(8) *CCCC Epenthesis in Cairene Arabic* (from Itô's (41))

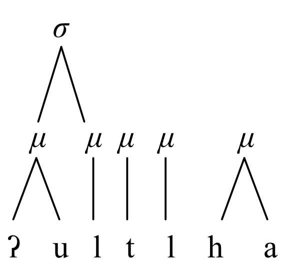
a.	/ʔul-t-l-ha/	→	*ʔultilha*	'I said to her'
b.	/katab-t-l-ha/	→	*katabtilha*	'I wrote to her'
c.	/katab-t-l-gawaab/	→	*katabtilgawaab*	'I wrote the letter'

(9) *CCCC Epenthesis in Iraqi Arabic* (from Itô's (42))

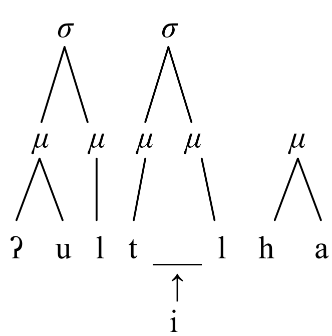
a.	/gil-t-l-ha/	→	*giltilha*	'I said to her'
b.	/triid-l-ktaab/	→	*triidliktaab*	'you want the book'
c.	/kitab-t-l-maktuub/	→	*kitabtilmaktuub*	'I wrote the letter'

(10) *Left-to-Right Syllabification in Cairene Arabic*

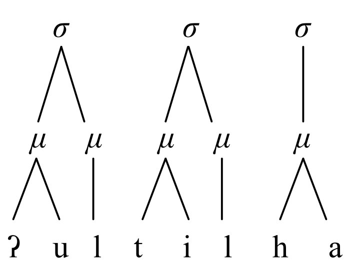
a.



b.

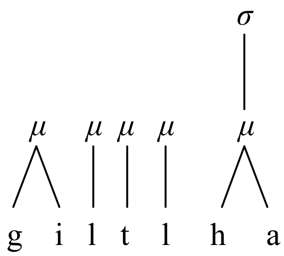


c.

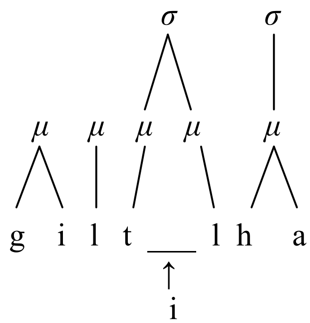


(11) *Right-to-Left Syllabification in Iraqi Arabic*

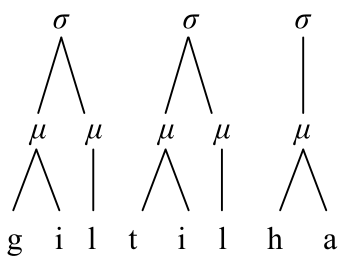
a.



b.



c.



In intervocalic sequences of four consonants, it is the intermediate two which are unsyllabifiable: in (10)-(11), the first consonant is assigned to the coda of the syllable headed by the preceding vowel (Cairene [ʔul]$_\sigma$, Iraqi [gil]$_\sigma$,), while the final consonant is assigned to the onset of the syllable headed by the following vowel (Cairene, Iraqi [ha]$_\sigma$). Left with a sequence CC, the most economical way of rendering it syllabifiable (through epenthesis) is to insert a single intervening vowel: the second consonant thus serves as onset, and the third consonant as coda, to the syllable headed by this epenthetic vowel (Cairene, Iraqi [ti̲l]$_\sigma$).

4.1.2 Optimality-Theoretic Accounts

The directional syllabification effects as analyzed by Itô (1986, 1989) and others are not straightforwardly accounted for in the traditional conception of Optimality Theory. Such effects have been conceived as resulting from a step-wise accretion of syllable structure, but the framework is at its core anti-derivation. Instead, as per the basic tenets of Optimality Theory, the two approaches we review here focus on the agreeability of fully-specified output candidates with syllable-structural preferences captured in the form of constraints, specifically, Alignment constraints (McCarthy and Prince 1993). In 4.1.2.1 we discuss Mester and Padgett (1994)'s syllable-based Alignment, and in 4.1.2.2, Rose (2000)'s consonant-based Alignment.

4.1.2.1 Mester and Padgett (1994)

Following up on the work of McCarthy and Prince (1993), who develop the notion of Alignment constraints as a means of capturing directional foot parsing effects, Mester and Padgett (1994) extend the technique to the realm of syllable structure. They construct an Optimality-Theoretic translation of Itô's analysis of directional effects in Cairene Arabic- and Iraqi Arabic-type languages, which we review now.

The core of Mester and Padgett's analysis is an alignment constraint which they schematize as follows (their (1); the definition is ours):

(12) Syll-Align (Syll,Edge,PrWd,Edge)

Align every syllable with an edge (specified left, right) of the prosodic word.

In view of current conventions in constraint representation, we will henceforth depict this constraint as ALIGN-X(σ, PrWd), where *X* represents the specified margin, either left or right.

Mester and Padgett first account for languages patterning with Iraqi Arabic, which has been described as featuring right-to-left syllabification, as determined by the position of the epenthetic vowel breaking up a triconsonantal sequence (/gil-t-l-a/ → gilt$[la]_\sigma$ → gi$[l\underline{i}t]_\sigma[la]_\sigma$ → $[gi]_\sigma[l\underline{i}t]_\sigma[la]_\sigma$ 'I said to him'). They introduce the left-edge oriented variant of the alignment constraint, ALIGN-L(σ, PrWd), ranking it as follows (their (4)):

(13) ONSET, PARSE,[7] *COMPLEX » ALIGN-L(σ, PrWd), FILL[8] » NOCODA

The following tableaux illustrate how this ranking operates; the first is their (5) (with some formatting adjustments), the second is our application of the ranking to the actual Iraqi form:

(14) *Right-to-Left Syllabification*

a.

/CVCCCV/	FILL	ALIGN-L(σ, PrWd)				NOCODA
		σ_1	σ_2	σ_3	σ_4	
☞ i. CV.C$\underline{V}$C.CV	*		μ	μμμ		*
ii. CVC.C$\underline{V}$.CV	*		μμ	μμμ!		*
iii. CV.C$\underline{V}$.C$\underline{V}$.CV	**(!)		μ	μμ	μμ(!)μ	

b.

/gil-t-l-a/	FILL	ALIGN-L(σ, PrWd)				NOCODA
		σ_1	σ_2	σ_3	σ_4	
☞ i. gi.lit.la	*		*	***		*
ii. gil.ti.la	*		**	***!		*
iii. gi.li.ti.la	**(!)		*	**	**(!)*	

Mester and Padgett assume, after McCarthy, that violation of the syllable-sensitive alignment constraint is measured in moras, the unit immediately below the syllable on the prosodic hierarchy; as they note, counting violations according to syllables will not yield the correct result, though they do not exclude the possibility of counting in segments. In any case, the candidate in (14)a.i. is selected as most optimal because it minimizes violations of ALIGN-L(σ, PrWd) across all three syllables. The initial syllable, being immediately adjacent to the left edge, incurs no violations. As this syllable is open, the second syllable, which follows it, is only one mora away from the left edge (CV_μ.). And as this syllable is closed, the third syllable is three moras away from the left edge ($CV_\mu.CV_\mu C_\mu$.). Thus (14)a.i. incurs in total four violations of ALIGN-L(σ, PrWd), compared to (14)a.ii., which incurs five due to the initial syllable being heavy, and (14)a.iii., which incurs six, due to the creation of an additional syllable.

[7] = MAX-IO in Correspondence Theory (McCarthy and Prince 1995).

[8] = DEP-IO in Correspondence Theory (McCarthy and Prince 1995).

The account of Cairene Arabic-type languages proceeds along similar lines. On the basis of the epenthesis site in triconsonantal sequences, this language has been characterized as assigning syllable structure from left to right (/ʔul-t-l-u/ → [ʔul]$_\sigma$tlu → [ʔul]$_\sigma$[ti]$_\sigma$lu → [ʔul]$_\sigma$[ti]$_\sigma$[lu]$_\sigma$ 'I said to him'). For the Optimality-Theoretic analysis, Mester and Padgett introduce the left-edge variant of the alignment constraint, ALIGN-L(σ, PrWd), and rank it as they did ALIGN-R(σ, PrWd) above, i.e. (their (8)):

(15) ONSET, PARSE, *COMPLEX » ALIGN-R(σ, PrWd), FILL » NOCODA

The tableaux in (16) demonstrate how the ranking works; again, (16)a. corresponds to Mester and Padgett's (9) (with formatting adjustments), and (16)b. includes the actual Cairene form.

(16) *Left-to-Right Syllabification*

a.

/CVCCCV/	FILL	ALIGN-R(σ, PrWd) σ1	σ2	σ3	σ4	NOCODA
i. CV.CVC.CV	*	μμμ	μ!			*
☞ ii. CVC.CV.CV	*	μμ	μ			*
iii. CV.CV.CV.CV	**(!)	μμμ	μ(!)μ	μ		

b.

/ʔul-t-l-u/	FILL	ALIGN-R(σ, PrWd) σ1	σ2	σ3	σ4	NOCODA
i. ʔu.lit.lu	*	***	*!			*
☞ ii. ʔul.ti.lu	*	**	*			*
iii. ʔu.li.ti.lu	**(!)	***	*(!)*	*		

Instead of evaluation according to distance from the right edge of the prosodic word, it is distance from the left edge which is now the decisive factor. The candidate in (16)a.ii. wins due to its minimal violation of ALIGN-R(σ, PrWd), spread out across its three syllables. In short, relegating the lone heavy syllable to the left edge of the prosodic word allows for both it and the following syllables to be that much closer to the right edge of the prosodic word.

With respect to intervocalic sequences of four consonants, as Itô’s analysis was capable of doing, so too can Mester and Padgett’s account generate the same result for both the Cairene and Iraqi Arabic treatment of such sequences, again, VCC<u>V</u>CCV. We see as much in the following two tableaux.

(17) *CCCC: Left-to-Right Syllabification*

/CVCCCCV/	Fill	Align-R(σ, PrWd)				NoCoda
		σ_1	σ_2	σ_3	σ_4	
☞ a. CVC.C<u>V</u>C.CV	*	μμμ	μ			**
b. CVC.C<u>V</u>.C<u>V</u>.CV	**(!)	μμμ	μμ(!)	μ		*
c. CV.C<u>V</u>.C<u>V</u>C.CV	**(!)	μμμμ	μ(!)μμ	μ		*

(18) *CCCC: Right-to-Left Syllabification*

/CVCCCCV/	Fill	Align-L(σ, PrWd)				NoCoda
		σ_1	σ_2	σ_3	σ_4	
☞ a. CVC.C<u>V</u>C.CV	*		μμ	μμμμ		**
b. CVC.C<u>V</u>.C<u>V</u>.CV	**(!)		μμ	μμμ	μμ(!)μμ	*
c. CV.C<u>V</u>.C<u>V</u>C.CV	**(!)		μ	μμ	μμμμ(!)	*

Mester and Padgett do not claim to provide the best Optimality-Theoretic analysis of the directional syllabification effects, but merely intend to demonstrate how such an analysis could work. Indeed they acknowledge a few issues with their approach, as it has been developed. They note first the overlap between the domains of violation for the anti-epenthesis constraint, Dep-IO, and the Align-X(σ, PrWd) constraints, although they also point out that the correct result can be obtained regardless of their relative ranking. More of a concern for them is the fact that the same result can also be obtained with a variety of other techniques: using opposite-edge alignment constraints, i.e. Align(σ, R, PrWd, L) for languages described with right-to-left syllabification, and Align(σ, L, PrWd, R) for languages described with left-to-right syllabification; evaluating syllable distance by segment count instead of mora count; and evaluating segmental distance instead of syllable distance from prosodic word edges. They leave the question open to further research, which of these strategies contributes to a linguistically-significant conception of Alignment.[9]

4.1.2.2 Rose (2000)

In her study of the effect of syllable contact preferences on the positioning of epenthesis in the Ethiopian Semitic language Chaha, Rose (2000: 408-410) reviews the issue of directionality in syllable structure assignment, relevant for her treatment of Chaha medial consonant sequences. She presents in brief the approach of Mester and Padgett (1994), outlined above, and states a few concerns it raises, both of which are already acknowledged by them (although she notes as much only in reference to the first). First, there is the issue of overlap between the Alignment constraint and DEP-IO (their FILL): both constraints disfavor extra syllables, the latter since it militates against epenthesis, and so also indirectly against greater numbers of syllables, the former because more syllables means more violations of it incurred. Rose later shows (422), though, based on evidence from its verbal system, that these constraints occupy distinct positions in the Chaha grammar (constraint ranking), thereby mitigating the issue.

Second, there is the observation that not all coda consonants are necessarily moraic, even in a language in which some codas are: in Arabic, for instance, this claim has been said to hold for final consonants, as opposed to word-internal ones. The lack of a mora in a final syllable renders it impossible for Mester and Padgett's Alignment constraint, keyed as it is to mora count, to differentiate, for example, the right prosodic word-edge alignment of two candidates [CVCVC] and [CVCCV] from an input /CVCC/, since the initial syllable in each would be one

[9] They also leave open the possibility, as suggested in Broselow (1992), that directionality is not actually a factor in the Arabic dialects considered at all, and also acknowledge issues with generating word-initial syllabification patterns.

mora away. This nondefinitive outcome is illustrated in the tableau in (19)a., with the tableau in (54)a., in which the final coda is moraic, for comparison; moras are explicitly included in the output candidates in the interests of clarity.

(19) *Two alternatives for final coda moraicity*

a. Final codas are not moraic

/CVCC/	DEP-IO	ALIGN-R(σ, PrWd) σ_1	σ_2	σ_3
☞ a. $CV_\mu.CV_\mu C$	*	*		
☞ b. $CV_\mu C_\mu.CV_\mu$	*	*		
c. $CV_\mu.CV_\mu.CV_\mu$	**!	**	*	

b. Final codas are moraic

/CVCC/	DEP-IO	ALIGN-R(σ, PrWd) σ_1	σ_2	σ_3
a. $CV_\mu.CV_\mu C_\mu$	*	**!		
☞ b. $CV_\mu C_\mu.CV_\mu$	*	*		
c. $CV_\mu.CV_\mu.CV_\mu$	**!	**	*	

As an alternative, Rose proposes to evaluate alignment of each consonant to a prosodic word edge instead, a strategy which would be able to distinguish [CVCVC] from [CVCCV]. Specifically, she proposes a constraint schema as follows (her (21)):

(20) ALIGN (C-Edge, PrWd-Edge)

Every consonant must be aligned with the edge of some prosodic word.

Distance from the edge in question is measured by intervening segments; for each such segment, a violation of the constraint is incurred. As an illustration, Rose provides the tableau in (21) (her (22), with minor reformatting, including assessment of C_1), which captures with ALIGN-L(C, PrWd) the effect of left-to-right syllable construction.

(21)

/CVCC/	ALIGN-L(C, PrWd) C_1	C_2	C_3
☞ a. CVC.CV		**	***
b. CV.CVC		**	****!

Left-to-right syllabification is characteristic of Cairene Arabic, as we have seen; for more explicit application of Rose's approach to this language, we present the tableau in (22).

(22)

/ʔul-t-l-u/	ALIGN-L(C, PrWd) C_1	C_2	C_3	C_4
☞ a. ʔul.ti.lu		**	***	*****
b. ʔu.lit.lu		**	****!	*****

For the sake of comprehensiveness, we also provide in (23)-(24) tableaux generating the effect of right-to-left syllabification, using the right-edge-oriented variant of (20), ALIGN-R(C,PrWd).

(23)

/CVCC/	ALIGN-R(C, PrWd) C_1	C_2	C_3
a. CVC.CV	****	**	*!
☞ b. CV.CVC	****	**	

(24)

/gil-t-l-a/	ALIGN-R(C, PrWd) C_1	C_2	C_3	C_4
a. gil.ti.la	*****	****	***!	*
☞ b. gi.lit.la	*****	****	**	*

We also extend Rose's analysis to show how consonantal Alignment selects the correct output in cases featuring intervocalic sequences of four consonants, as demonstrated in the following two tableaux.

(25) *CCCC: Left-to-Right Syllabification*

/CVCCCCV/	ALIGN-L(C, PrWd)				
	C_1	C_2	C_3	C_4	C_5
☞ a. CVC.C$\underline{\text{V}}$C.CV		**	***	*****	******
b. CVC.C$\underline{\text{V}}$.C$\underline{\text{V}}$.CV		**	***	*****	*******!
c. CV.C$\underline{\text{V}}$.C$\underline{\text{V}}$C.CV		**	****	******	*****!**

(26) *CCCC: Right-to-Left Syllabification*

/CVCCCCV/	ALIGN-R(C, PrWd)				
	C_1	C_2	C_3	C_4	C_5
☞ a. CVC.C$\underline{\text{V}}$C.CV	*******	*****	****	**	*
b. CVC.C$\underline{\text{V}}$.C$\underline{\text{V}}$.CV	********	******	*****	*!**	*
c. CV.C$\underline{\text{V}}$.C$\underline{\text{V}}$C.CV	********	******	****	**!	*

Again, regardless of the direction in which syllable structure may be thought to be assigned, the result is the same: CVC.C$\underline{\text{V}}$C.CV.

While Rose's use of consonantal alignment does generate the correct results in all these cases, and ostensibly avoids the issue of variable coda weight, the motivation to jettison the syllable-based approach outright is not entirely clear. As Mester and Padgett note, violations of their Alignment constraint could just as easily be calculated on the basis of intervening segments, instead of inteverning moras – in this case, the issue of differentiating right-alignment in candidates for an input /CVCC/ becomes moot:

(27)

/CVCC/	ALIGN-R(σ, PrWd)	
	σ_1	σ_2
☞ a. CVC.CV	**	
b. CV.CVC	***!	

The two violations incurred here by the first syllable of candidate (27)a. correspond to the two segments C, V, which constitute the second syllable and separate the first from the right edge of the prosodic word. Likewise are calculated the three violations incurred by the first syllable of the losing candidate (27)b. So if one can maintain a syllable-based account of syllabification effects, why not do so?

Returning to the issue of word-final coda weight (or lack thereof) in Arabic, we wish to clarify how much an advantage Rose's account can actually claim in its ability to differentiate between outputs [CVCVC] and [CVCCV] to the input /CVCC/, in view of some relevant data from a number of Arabic dialects. As presented by Broselow (1992: 20-21), Cairene, Makkan, Sudanese and Iraqi show varying tolerance for CC sequences, word-final or otherwise:

(28) *Cairene* (Broselow's (16))

a.	VC#	*katab*	'he wrote'
b.	VCC#	*katabt*	'I wrote'
c.	VCC+C	*katabtilu*	'I wrote to him'
d.	VCC#C	*katabti gawaab*	'I wrote a letter'

(29) *Makkan* (Broselow's (17))

a.	VC#	*katab*	'he wrote'
b.	VCC#	*katabt*	'I wrote'
c.	VCC+C	*katabtaha*	'I wrote it (f.)'

(30) *Sudanese* (Broselow's (18))

a.	VC#	*katab*	'he wrote'
b.	VCC#	*katabta*	'I wrote'
c.	VCC+C	*katabtaha*	'I wrote it (f.)'
d.	VCC#C	*katabta kitaab*	'I wrote a book'

(31) *Iraqi* (Broselow's (19))

a.	VC#	*kitab*	'he wrote'
b.	VCC#	*kitabit*	'I wrote'
c.	VCC+C	*kitabitla*	'I wrote to her'
d.	VCC#C	*katabit maktuub*	'I wrote a letter'
	cf.	*kitabt ilmaktuub*	'I wrote the letter'

In accordance with Broselow's classification of Makkan and Sudanese with Cairene, we consider these dialects to maintain active Align-L(C, PrWd) in their constraint rankings, under Rose's approach; Iraqi Arabic, on the other hand, maintains active Align-R(C, PrWd). Yet as we can see here, the prediction that these constraints make about the output of /CVCC/ (the latter prefers [CVCVC], the former, again, [CVCCV]) matches the actual data in only two of the four cases presented here: Sudanese *katabta*, showing an epenthetic vowel which follows the final consonant, and Iraqi *kitabit*, showing one which precedes the final consonant. In the other two languages, Cairene and Makkan, however, word-final CC is simply tolerated (in the examples in b.). This suggests that, while Rose's account can select the correct location for epenthesis, when epenthesis actually occurs – something Mester and Padgett's approach, if mora-counting, cannot – nevertheless even an analysis built around her consonant-based Alignment requires something more to be said in order to satisfactorily account for languages like Cairene and Makkan. How much of a theoretical improvement consonantal Alignment makes is, then, a far less clear-cut matter than Rose makes it out to be.

4.2 Directionality in Consonant Syllabicity: Analyzing Proto-Indo-European

Because it employs consonant vocalization as a means of repairing unsyllabifiable sequences of segments, Proto-Indo-European is significantly different from any of the languages considered in previous studies in this area, for which epenthesis served this function. As such we have a valuable opportunity not only to better understand how the relevant phenomena operate within this language, but also to make a contribution to our understanding of the theory as well.

4.2.1 After Itô (1989)

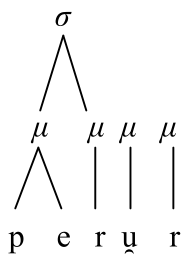
Although we will ultimately develop an analysis couched in Optimality Theory, nonetheless we begin first by conceptualizing the Proto-Indo-European phenomenon within in the framework of Itô (1989), so as to provide a basis of comparison analogous to that obtaining for the Arabic data introduced in 4.1.1.4, which have been analyzed both from a derivational perspective and later from a constraint-based one.

From the perspective of Itô's (1989) framework, crucial for the Proto-Indo-European data is directionality in the process of moraification, not syllabification. Simply plugging the Proto-Indo-European data into Itô's prosodic analysis of epenthesis will not work. Assuming for the moment that Proto-Indo-European shares its set of moraic and syllable structures with Cairene and Iraqi Arabic, we end up with the following structures assigned to the string /per-u̯r/: the moraic structure as in (32), and the syllable structures in (33) and (34), with syllabification proceeding from left-to-right and right-to-left, respectively.

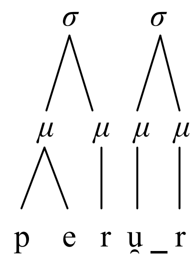
(32)

(33) *Left-to-Right Syllabification*

a.

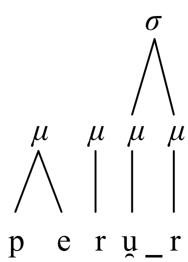


b.

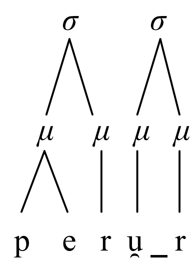


(34) *Right-to-Left Syllabification*

a.



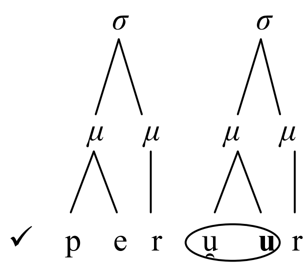
b.



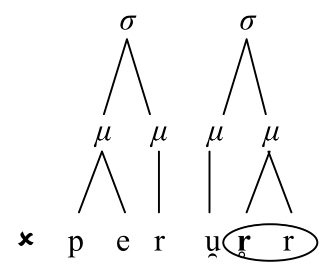
Moraification assigns a mora to the initial CV sequence *pe-*, and a mora to each of the three sonorants remaining in the string; this is the only possible outcome, given the limits on moraic structure (only units with melodies (c)v, c).

We see that under an approach in which epenthesis is the repair mechanism, there is a single possible site for the epenthetic vowel, regardless of the direction in which syllable structure is assigned: between the second and third sonorant. If we assume that sonorant vocalization involves insertion not of a full vowel, but rather of a vocalic element which assimilates to (coalesces with?) an adjacent sonorant, we immediately face a problem: the only permissible way in which such a unit can be incorporated into moraic structure, given the permitted shapes of moras, is if it assimilates to the preceding sonorant *u̯*, yielding a mora of shape cv, as in (35)a.; a mora of shape vc, which would be the result of assimilation to the following *r*, would be illicit, as in (35)b.[10]

(35) a.



b.



The result in both of these cases would be something like †*peru̯ur*.

In fact this result is akin to the treatment of intervocalic sequences of four consonants shared by both Cairene and Iraqi Arabic and reviewed above, that is, /VCCCCV/ → VCC$\underline{\text{V}}$CCV. Once we factor out the final C, which is analyzed as an onset to the syllable headed by the following vowel, and the initial C, which is analyzed as a coda to the syllable headed by the preceding vowel, what we have left are two consonants, each assigned a mora, that cannot be syllabified as is. The most economical solution, given epenthesis as a repair mechanism, is insertion of a single vowel intervening between these two consonants: recall Cairene Arabic /ʔul-t-l-ha/ → *ʔultilha* ‘I said to her’ as compared to Iraqi Arabic /gil-t-l-ha/ → *giltilha* ‘I said to her’, in both of which the epenthetic vowel intervenes between the second and third consonants, *t* and *l*. From this perspective it is not surprising that the syllabifications in (33)-(34) share an identical outcome, even if an undesired one.

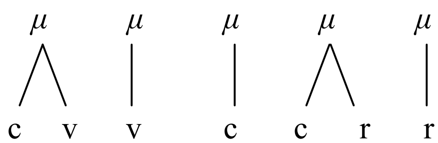
If we want to tackle the Proto-Indo-European data while maintaining the underpinnings of Itô’s approach (i.e. her general theoretical assumptions concerning moraic and syllable structure), then we must recognize for this language a different set of licit moraic structures.

[10] Cf. Steriade’s (1988) comments regarding a translation of her account of Sanskrit sonorant vocalization into moraic theory: if there is no recourse to the structural positions of onset versus rime, and if moras dominate onsets, then there is no way to differentiate the sonorant which does vocalize from the one which does not, since both are ‘moraic’.

Proposing anything different at the level of the syllable will not work; as consideration of the structures in (35) show, the end result is a form consisting of four moras, when the desired outcome, **peru̯r̥*, is one containing three. So moraic structure is crucially what must be differentiated for Proto-Indo-European, in order for an analysis after Itô (1989) to be possible.

We propose that, as Proto-Indo-European allows syllabic sonorants, under Itô's approach moras should be composed of the melodies cv, v, c, and, additionally, cr and r, as in (36).[11]

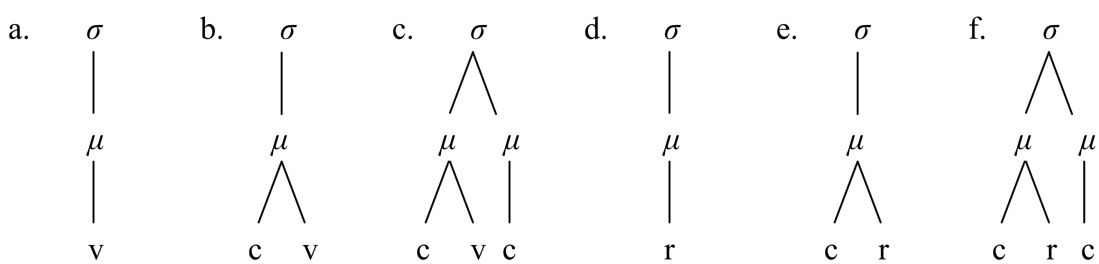
(36) $\mu \rightarrow \{(c)v, (c)r, c\}$



The process of moraification would apply to a string directionally, assigning at any given iteration the largest possible mora, given the set in (36).

For the current purposes we assume that syllables can be of shape V, CV, CVC, R, CR, CRC, with moraic structure as in (37). As with the building of moraic structure, syllable structure is assigned directionally, with the largest possible syllable constructed at any given point in the process, according to the principle of Maximality.

(37)



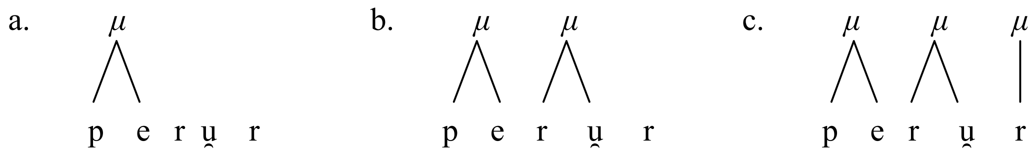
As Itô does, we note that the syllable peak must be associated with the initial mora. But as we are dealing with the potential for syllabic sonorants, we must also stipulate that the leftmost

[11] We abstract away, for the purposes of this exercise, from the treatment of initial consonants in complex onsets, such as the palatovelar in **k̂u̯nb*^{h}*is*.

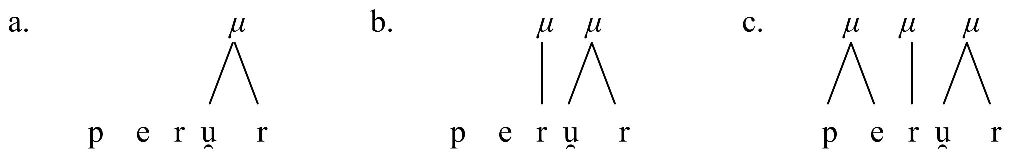
component of this mora constitutes the syllable peak, as otherwise there would be no way of identifying it in a syllable of shape $[[\mathrm{cr}]_{\mu}([\mathrm{c}]_{\mu})]_{\sigma}$, where the initial c is also a sonorant.[12]

Once we apply this revised Proto-Indo-European-specific analysis to the string /per-u̯r/, we find that, as was not the case with Cairene and Iraqi Arabic, different results are obtained depending on the direction in which the process of moraification applies. Moraification operating from left-to-right yields the moraic structure [pe]$_{\mu}$[ru̯]$_{\mu}$[r]$_{\mu}$ (38), while the structure [pe]$_{\mu}$[r]$_{\mu}$[u̯r]$_{\mu}$ is obtained if the process operates from right-to-left (39).

(38) *Left-to-Right Moraification*



(39) *Right-to-Left Moraification*



In turn these distinct moraifications are syllabified in distinct ways. Interestingly, however, in both cases the same syllabification is obtained, regardless of the direction in which syllable structure is assigned.

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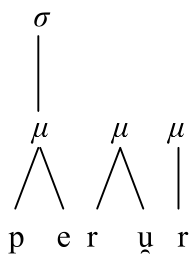
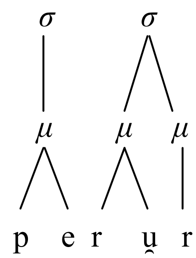
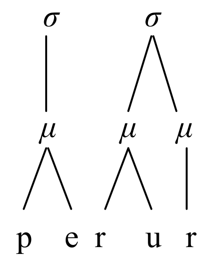
12 We might try to rely on the Onset principle to generate this result, but note *k̑u̯nb*^{h}*is*, in which this principle is satisfied regardless, by the initial palatovelar. Alternatively, we could rely on weak vs. strong labeling, or head designation (Selkirk 1995, Zec 2003). Otherwise it would seem necessary for identification of the peak to be stipulated, although this would not be an issue if the initial sonorant in the sequence were not also moraic, as per Itô's version of moraic theory.

(40) *Left-to-Right Moraification*

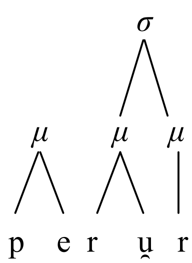
a. Left-to-Right Syllabification

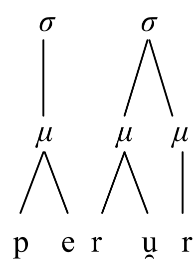
i.


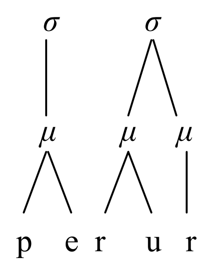
ii.


iii.


b. Right-to-Left Syllabification

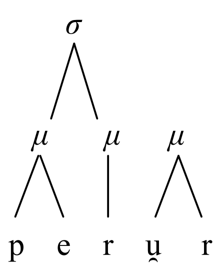
i.


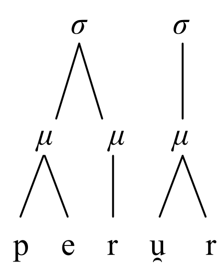
ii.


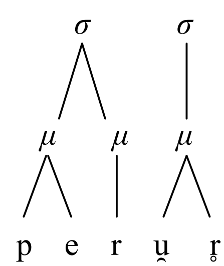
iii.


(41) *Right-to-Left Moraification*

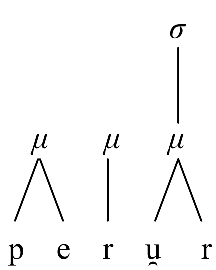
a. Left-to-Right Syllabification

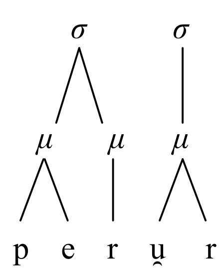
i.


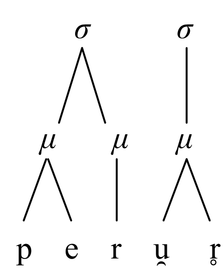
ii.


ii.


b. Right-to-Left Syllabification

i.


ii.


ii.


When moraic structure is assigned from the beginning of the word, the end result is a syllabified form †*pe.rur*, no matter the direction in which syllabification occurs. On the other hand, when moraification proceeds from the end of the word, the end result is the desired syllabified form **per.u̯r̥*, again, regardless of the directionality of the syllabification process. It is clear now that an analysis of Proto-Indo-European sonorant vocalization adapted from Itô's approach to epenthesis in Cairene and Iraqi Arabic crucially hinges, not on the directionality in which syllable structure is assigned, but rather on the directionality in which moraic structure is assigned.

4.2.2 After Mester and Padgett (1994)

Our efforts in the previous section provide a good starting point for adapting Mester and Padgett's approach to directionality effects to the Proto-Indo-European data. As we saw, conceived in Itô's framework directionality in application was crucial not for the process of syllabification, but rather for the process of moraification: specifically, only with moraic structure assigned from right-to-left could the desired result, the syllabified form **per.u̯r̥*, be obtained.

In their paper, Mester and Padgett sought to translate into Optimality Theory the directional syllabification phenomena proposed by Itô for Cairene and Iraqi Arabic. They did so in the form of the Alignment constraint schema in (42), repeated from (12) above.

(42) Syll-Align (Syll,Edge,PrWd,Edge)

Align every syllable with an edge (specified left, right) of the prosodic word.

Specific variants of this constraint were keyed to the right edge of the syllable and prosodic word (to account for left-to-right syllabification in Cairene Arabic) or the left edge of the syllable and prosodic word (to account for right-to-left syllabification Iraqi Arabic). In essence, these constraints serve to successfully replicate the directionality effects because they (indirectly) prefer the end results generated by directional syllabification: a heavy CVC syllable in relatively closer proximity to one edge of the prosodic word or another. The end result of left-to-right syllabification has the CVC syllable closer to the left edge of the prosodic word (*ʔul.ti.la*), which in turn minimizes the distance of each syllable from the *right* edge (hence Syll-Align-R), while the outcome of right-to-left syllabification has the CVC syllable closer to the right edge of the prosodic word (*gi.lit.la*), which in turn minimizes the distance of each syllable from the *left* edge (hence Syll-Align-L).

In principle, if moraification, not syllabification, is key in Proto-Indo-European nucleus selection, then the Alignment constraint to be introduced should be concerned with the proximity of moras, not syllables, to prosodic word edge. We thus propose the following constraint schema:

(43) Mora-Align (Mora,Edge,PrWd,Edge)

Align every mora with an edge (specified left, right) of the prosodic word.[13]

We assess violations of this constraint in terms of segments, as Rose (2000) does, a method which, as Mester and Padgett (1994) point out, is not ruled out under their approach either. The violation count for any given mora, then, is determined by counting the number of segments intervening between the segment which it dominates and the relevant edge of the prosodic word.[14]

[13] This constraint is not to be confused with 'mora alignment' as proposed by Crowhurst (2004), in which the mora is argued to be a unit of alignment evaluation, akin to the approach taken by Mester and Padgett in their original analysis.
[14] We note that this metric is arguably more in line with the view of moraic theory proposed by Hayes (1989), in which onset segments are adjoined directly to the syllable node, as opposed to being subsumed under the nuclear mora, as held to be the case by Hyman (1985) and, as we have seen, Itô (1989). In fact if we factor out such segments in our calculation of moraic distance to prosodic word edge, the analysis still works.

As the desired result could only be obtained when moraification proceeded in a leftward direction, we expect the actual constraint operative for Proto-Indo-European to be Mora-Align-L. This expectation is borne out in consideration of the tableaux in (44)-(45).

(44)

/per-u̯r/	*MAR/ V	DEP-IO	ALIGN-R(μ, PrWd)				*PK/ NAS	*PK/ LIQ	*PK/ GLI
			μ_1	μ_2	μ_3	μ_4			
☹ a. pe$_{\mu}$r$_{\mu}$.u̯r̥$_{\mu}$			***	**!				*	
☞ b. pe$_{\mu}$.ru$_{\mu}$r$_{\mu}$			***	*					*
c. pe$_{\mu}$.ru$_{\mu}$.r̥$_{\mu}$			***	*				*!	*
d. pe$_{\mu}$r$_{\mu}$.u̯V$_{\mu}$r$_{\mu}$		*!	****	***	*				
e. pe̯r̥$_{\mu}$.u̯r̥$_{\mu}$	*!		**					**	

(45)

/per-u̯r/	*MAR/ V	DEP-IO	ALIGN-L(μ, PrWd)				*PK/ NAS	*PK/ LIQ	*PK/ GLI
			μ_1	μ_2	μ_3	μ_4			
☞ a. pe$_{\mu}$r$_{\mu}$.u̯r̥$_{\mu}$			*	**	****			*	
b. pe$_{\mu}$.ru$_{\mu}$r$_{\mu}$			*	***	****!				*
c. pe$_{\mu}$.ru$_{\mu}$.r̥$_{\mu}$			*	***	****!			*	*
d. pe$_{\mu}$r$_{\mu}$.u̯V$_{\mu}$r$_{\mu}$		*!	*	**	****	*****			
e. pe̯r̥$_{\mu}$.u̯r̥$_{\mu}$	*!		**	****				**	

We assume that the input /per-u̯r/ cannot be faithfully realized as such, due to Proto-Indo-European preferences for syllable structure (enforced, for instance, by high-ranking SONORITY-SEQUENCING). We therefore evaluate here five output candidates, each of which departs from the input in some way: two in which a single sonorant is vocalized, *r̥* in (44)-(45)a. and *u* in (44)-(45)b.; one in which both sonorants are vocalized, (44)-(45)c.; one in which epenthesis occurs instead of vocalization, (44)-(45)d.; and one in which both vocalization and marginalization of a non-high vowel occur, (44)-(45)e. As we are contemplating candidates for the posited constraint $\mathbb{C}$, we have located the Alignment constraint in each tableau in the position identified for it: namely, ranked crucially over the sonorant-targeting PEAK constraints, but below *MAR/VOWEL (and below *PK/OBSTRUENT, not included here). Furthermore, we see the importance of assessing violations of the Mora-Align constraints on the basis of segmental distance intervening between mora and prosodic word edge; moraic-based assessment of the Mora-Align constraints would result in a lack of distinction between the candidates in (44)-(45)a.-c., each of which would incur three violations of either ALIGN-R(μ, PrWd) or ALIGN-L(μ, PrWd).

In the tableau in (44), ALIGN-R(μ, PrWd) is included in the ranking, and in part due to its influence the wrong candidate is selected as most optimal, that in (44)b. The desired winner, the candidate in (44)a., loses because of one too many violations of this constraint, as its second mora is associated with the first *r* and thus that much further from the relevant edge of the prosodic word. Evaluation eventually comes down to the low-ranked PEAK constraints, which as we have already discussed should be inactive. On the other hand, the presence of ALIGN-L(μ, PrWd) in the tableau in (45) does contribute to the selection of the desired winner as most optimal. By virtue of the same moraicity of the first *r*, the candidate in (45)a. incurs one fewer violation of this constraint as compared to its serious competitors in (45)b.-c.

If we extend our consideration to the relatively less problematic form **k̂u̯nb^{h}is*, which again in and of itself has found adequate analysis in Optimality-Theoretic terms by appeal to NOCODA-type constraints, we find that introduction of the constraint ALIGN-L(μ, PrWd) into the ranking generates the desired syllabification, just as NOCODA, included here for the sake of comparison, can.

(46)

/k̂u̯n-b^{h}i̯s/	DEP-IO	ALIGN-L(μ, PrWd) μ1	μ2	μ3	μ4	NOCODA	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. k̂u̯n̥$_\mu$.b^{h}i$_\mu$s$_\mu$		**	****	*****		*	*		
b. k̂u$_\mu$n$_\mu$.b^{h}i$_\mu$s$_\mu$		*	**	****	*****!	**			*
c. k̂u$_\mu$.n̥$_\mu$.b^{h}i$_\mu$s$_\mu$		*	**	****	*****!	*	*		*
d. k̂u̯V$_\mu$n$_\mu$.b^{h}i$_\mu$s$_\mu$	*!	**	***	*****	******	**			

Unlike the case of **peru̯r̥*, the primary contenders for most optimal output of the input /k̑u̯n-b^{h}i̯s/ differ in the number of moras they contain: the candidates in (46)b.-c. each have four moras (in two bimoraic syllables), while the candidate in (46)a. has only three (in one monomoraic and one bimoraic syllable). As we have already discussed above, the more units there are in a given output candidate to be assessed by these Alignment constraints, the more violations that candidate will incur. Thus, the candidate in (46)a. wins because it has the fewest moras, three, which means then fewer violations of ALIGN-L(μ, PrWd).

Interestingly, because this winning candidate features fewer moras than any of its competition, in fact it is compatible with either Mora-Align constraint: the tableau in (47) includes ALIGN-R(μ, PrWd) instead (sans NOCODA).

(47)

/k̑u̯n-b^{h}i̯s/	DEP-IO	ALIGN-R(μ, PrWd)				*PK/NAS	*PK/LIQ	*PK/GLI
		μ_1	μ_2	μ_3	μ_4			
☞ a. k̑u̯n̥$_{\mu}$.b^{h}i$_{\mu}$s$_{\mu}$		***	*			*		
b. k̑u$_{\mu}$n$_{\mu}$.b^{h}i$_{\mu}$s$_{\mu}$		****	*!**	*				*
c. k̑u$_{\mu}$.n̥$_{\mu}$.b^{h}i$_{\mu}$s$_{\mu}$		****	*!**	*		*		*
d. k̑u̯V$_{\mu}$n$_{\mu}$.b^{h}i$_{\mu}$s$_{\mu}$	*!	****	***	*				

In view of this finding, we note that although the form **k̑u̯n̥b^{h}is* has enjoyed special status as the *Paradebeispiel* of Proto-Indo-European nucleus selection and sonorant vocalization, in an Optimality-Theoretic approach, in which, after Mester and Padgett, sonorants are vocalized according to how best the result will line up with the prosodic word edge, the importance of this form is diminished: it alone is incapable of revealing which edge is critical. More crucial in this regard is the form **peru̯r̥*, the successful analysis of which can only be achieved with left-oriented ALIGN-L(μ, PrWd), and not with ALIGN-R(μ, PrWd).

It is important to add that, because output candidates are evaluated fully formed in Optimality Theory – that is, application of processes of moraification and syllabification, or lack thereof, cannot effectively be relied on to differentiate viable candidates – it is also possible to analyze the Proto-Indo-European data using Mester and Padgett's own Syllable-Alignment constraint schema. All the candidates we have considered in the tableaux above indeed have syllable structure, and as such are liable to evaluation by a syllable-based Alignment constraint.

While in Itô's framework the direction of syllabification proved to be irrelevant once the appropriate direction of moraification was identified, we will show that, in an Optimality-Theoretic analysis, only one variant of Mester and Padgett's Syllable-Alignment schema is crucially required, namely, ALIGN-R(σ, PrWd). This constraint has been associated with languages like Cairene Arabic, characterized as having left-to-right syllabification, or, put another way, a preference for heavy CVC syllables to occur closer to the left edge of the prosodic word.

We begin with the form **peru̯r̥*, which, as it was in the mora-based Alignment approach, is crucial in this determination. Consider first the tableau in (48), in which ALIGN-L(σ, PrWd) is introduced into the constraint ranking, and the wrong result is obtained.

(48)

/per-u̯r/	*MAR/V	DEP-IO	ALIGN-L(σ, PrWd)			*PK/NAS	*PK/LIQ	*PK/GLI
			σ_1	σ_2	σ_3			
☹ a. per.u̯r̥				**!			*	
☞ b. pe.rur				*				*
c. pe.ru.r̥				*	**!		*	*
d. per.u̯Vr		*!		**				
e. pe̯r̥.u̯r̥	*!			*			**	

ALIGN-L(σ, PrWd) eliminates the desired winner (48)a. due to the two violations incurred by its second syllable: locating the syllable boundary after the first *r* creates a closed syllable, meaning two moras separate the second syllable from the left edge of the prosodic word (the same result holds for the already-eliminated epenthesis candidate (48)d. as well). On the other hand the winner, (48)b., has an initial open syllable, meaning its second syllable incurs only one violation of ALIGN-L(σ, PrWd). As for the candidate in (48)e., in which the full vowel in the first syllable is marginal, and the following *r* is syllabic, if not for high-ranking *MAR/VOWEL, this candidate could be favored to win. Indeed there is no way to rerank the constraints to favor the desired winner, demonstrating that the constraint ALIGN-L(σ, PrWd) cannot be active. If instead we introduce the alternative Alignment constraint, ALIGN-R(σ, PrWd), into the ranking, the desired candidate is selected as most optimal:

(49)

/per-u̯r/	*MAR/ V	DEP-IO	ALIGN-R(σ, PrWd) σ1	σ2	σ3	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☞ a. per.u̯r̥			*				*	
b. pe.rur			**!					*
c. pe.ru.r̥			**!	*			*	*
d. per.u̯Vr		*!	**					
e. pe̯r̥.u̯r̥	*!		*				**	

The winning candidate in (49)a. is favored, as it avoids a marginal vowel or epenthetic segment, and, by closing its first syllable instead of its second (unlike (49)b.), and avoiding introduction of an additional syllable by way of vocalizing both sonorants (unlike (49)c.), it is able to achieve closer distance of each of its syllables to the right edge of the prosodic word.

Having identified the appropriate version of the constraint, a syllable-based Alignment analysis of **peru̯r̥* appears to be as straightforward as a mora-based approach: no additional constraints are needed. Once we add **k̂u̯n̥.bʰis* into the mix, however, we face a problem, as the tableau in (50) shows.

(50)

/k̂u̯n-b^{h}i̯s/	DEP-IO	ALIGN-R(σ, PrWd) σ1	σ2	σ3	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☹ a. k̂u̯n̥.b^{h}is		**			*!		
☞ b. k̂un.b^{h}is		**					*
c. k̂u.n̥.b^{h}is		***!	**		*		*
d. k̂u̯Vn.b^{h}is	*!	**					

Because of the nature of the input here, regardless of which sonorant is vocalized, the syllable boundary in the two most viable candidates in (50)a.-b. is unaffected ([k̂u̯n̥]$_{\sigma}$[b^{h}is]$_{\sigma}$ versus [k̂un]$_{\sigma}$[b^{h}is]$_{\sigma}$). This means that evaluation falls to the lower-ranked PEAK constraints, which as we have already shown should be inert in this language; as a syllabic nasal is worse than a syllabic glide, hence the winner is (50)b.

In order to generate the correct result, we must force the inertness of the PEAK constraints by introducing an additional constraint into the ranking, crucially above *PK/NASAL. As the candidates in (50)a.-b. are distinguished not only by the sonorant which is vocalized, but also by the number of codas contained – in favor of (50)a., which has only one – we propose to introduce the constraint NOCODA. We thus revise the tableau in (50) accordingly, as in (51).

(51)

/k̂u̯n-b^{h}i̯s/	DEP-IO	ALIGN-R(σ, PrWd) σ1	σ2	σ3	NOCODA	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☞ a. k̂u̯n̥.b^{h}is		**			*	*		
b. k̂un.b^{h}is		**			**!			*
c. k̂u.n̥.b^{h}is		***!	**		*	*		*
d. k̂u̯Vn.b^{h}is	*!	**			**			

The analysis now works. Again, active evaluation of the most viable candidates (51)a.-b. does not end with ALIGN-R(σ, PrWd), as both are tied in violations of this constraint due to their initial syllable being a consistent two moras away from the end of the word. Rather, the evaluation persists to lower-ranked NOCODA, which eliminates (51)b. with its two codas, leaving

(51)a. to emerge as most optimal, as it minimizes both distance violations *and* codas (note the ranking of NoCoda is contingent on the evaluation of **per.u̯r̥* above; in view of **k̂u̯n̥.b*^{h}*is* alone, no crucial ranking with the higher constraints suggests itself).

We also note that, as an alternative to NoCoda, we could just as easily introduce the left-aligned variant of the Syllable-Alignment constraint, Align-L(σ, PrWd), and achieve the same result:

(52)

/k̂u̯n-b^{h}i̯s/	Dep-IO	Align-R(σ, PrWd)			Align-L(σ, PrWd)			*Pk/Nas	*Pk/Liq	*Pk/Gli
		σ$_1$	σ$_2$	σ$_3$	σ$_1$	σ$_2$	σ$_3$			
☞ a. k̂u̯n̥.b^{h}is		**				*		*		
b. k̂un.b^{h}is		**				**!				*
c. k̂u.n̥.b^{h}is		***!	**			*	**	*		*
d. k̂u̯Vn.b^{h}is	*!	**				**				

That the analysis would work even in the absence of Align-R(σ, PrWd) again shows how crucial a form like **per.u̯r̥* is in developing an Optimality-Theoretic account: with **k̂u̯n̥.b*^{h}*is* alone Align-L(σ, PrWd) (or NoCoda) would appear to be the only necessary constraint.

Since only the Align-R(σ,PrWd)-based approach works for *both* **peru̯r̥* and **k̂u̯n̥.b*^{h}*is*, arguably any syllable-based Alignment analysis must include it. We could in principle also make use of Align-L(σ, PrWd) as well, though; the tableaux in (53)-(54) demonstrate how such an account would work.

(53)

/k̂u̯n-b^{h}i̯s/	Dep-IO	Align-R(σ, PrWd)			Align-L(σ, PrWd)			*Pk/Nas	*Pk/Liq	*Pk/Gli
		σ$_1$	σ$_2$	σ$_3$	σ$_1$	σ$_2$	σ$_3$			
☞ a. k̂u̯n̥.b^{h}is		**				*		*		
b. k̂un.b^{h}is		**				**!				*
c. k̂u.n̥.b^{h}is		***!	**			*	**	*		*
d. k̂u̯Vn.b^{h}is	*!	**				**				

(54)

/per-u̯r/	*MAR/ V	DEP	ALIGN-R(σ, PrWd) σ1	σ2	σ3	ALIGN-L(σ, PrWd) σ1	σ2	σ3	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☞ a. per.u̯r̥			*				**			*	
b. pe.rur			**!				*				*
c. pe.ru.r̥			**!	*			*	*		*	*
d. per.u̯Vr		*!	**				**				
e. pe̯r̥.u̯r̥	*!		*				*			**	

The constraint ranking must maintain the dominance of ALIGN-R(σ, PrWd) over ALIGN-L(σ, PrWd), since otherwise the wrong result would be predicted for **peru̯r̥*, namely, †*pe.rur*.[15] This approach suggests the superfluity of NOCODA (not included here), since it would lack an active role in the evaluation of either set of output candidates. On the other hand, as we have seen, NOCODA could just as easily play a crucial role in selecting **k̂u̯n̥.b^{h}is*, if we omit ALIGN-L(σ, PrWd) from the ranking; so one could equally well consider ALIGN-L(σ, PrWd) to be unneeded. Which constraint might we eliminate, then? We propose that the account of Proto-Indo-European following Mester and Padgett's syllable-based approach should maintain NOCODA as opposed to ALIGN-L(σ, PrWd). Considering the fact that ALIGN-R(σ, PrWd) is apparently essential regardless, it would arguably be more intuitive to bundle it with another constraint making reference to a right edge, namely, NOCODA (as we saw from Kobayashi's work, this constraint can be schematized as ALIGN-R(NUC, σ), 'Align the nucleus with the right edge of the syllable'),[16] instead of a constraint oriented to an opposite edge.[17] It is also of course the case that

[15] We can compare the situation in Cairene Arabic, as analyzed by Zawaydeh (1997: 203-206): this language requires ALIGN-R(σ, PrWd) to account for epenthesis patterns, but ALIGN-L(σ, PrWd) to account for syncope patterns; in each case the alternative constraint will not work. This presents a paradox in ranking, as high-ranking ALIGN-R(σ, PrWd) would select the wrong result for syncope, while high-ranking ALIGN-L(σ, PrWd) would select the wrong result for epenthesis. As we can see, this is not the case in Proto-Indo-European, in which ALIGN-R(σ, PrWd) can safely outrank ALIGN-L(σ, PrWd) with no ill effect.

[16] Although whether this formulation requires the positing of an explicit nucleus constituent is an issue requiring further consideration.

NoCoda is a constraint whose cross-linguistic credentials have been well-established in the literature; this too may be viewed as a point in favor of its inclusion over Align-L(σ, PrWd). In any case, the more important finding to take away from this discussion is the fact that syllable-based Alignment requires an additional constraint to capture the data, whereas mora-based Alignment does not: Align-L(μ, PrWd) alone can generate the correct results.

Incidentally, we have seen here that indeed both **k̂u̯n̥bʰis* and **peru̯r̥* feature righthand sonorant vocalization, but only the former works with Mester and Padgett's original, unadjusted analysis of right-to-left syllabification. Why should this be so? A key feature distinguishing **k̂u̯n̥bʰis* from **peru̯r̥* is the fact that regardless of which sonorant is vocalized in the former (assuming only one is), the syllable boundary is unaffected ($[\hat{\text{k}}\text{u̯n̥}]_{\sigma}[\text{b}^{\text{h}}\text{is}]_{\sigma}$ versus $[\hat{\text{k}}\text{un}]_{\sigma}[\text{b}^{\text{h}}\text{is}]_{\sigma}$). For **peru̯r̥*, however, which sonorant vocalizes directly affects the syllable structure ($[\text{per}]_{\sigma}[\text{u̯r̥}]_{\sigma}$ versus $[\text{pe}]_{\sigma}[\text{rur}]_{\sigma}$). Once the initial syllable of this form is made heavy as a result of righthand sonorant vocalization, the desired syllabification is disfavored by Align-L(σ, PrWd).

4.2.3 After Rose (2000)

We turn now to consider how Rose's (2000) consonant-based alternative to Mester and Padgett's Syllable-Alignment schema works when applied to the Proto-Indo-European data. To reiterate, Rose advances her approach in view of a concern she cites with Mester and Padgett's approach: namely that, in a language in which final codas are not moraic, Mester and Padgett's constraint Align-R(σ, PrWd), violations of which are calculated in terms of moras, would be incapable of differentiating the candidates CVCVC and CVCCV for an input /CVCC/. A consonant-based Alignment constraint is able to sidestep this issue, and the implication is that it has greater

[17] Again, cf. Zawaydeh's (1997: 203-206) claim that alignment to both edges is a priority for Cairene Arabic, albeit for two different phenomena.

explanatory breadth. As such it is worth exploring its potential for a language like Proto-Indo-European, which is believed to have heavy codas in both medial and final positions in the word.

We first assess the viability of the constraint ALIGN-R(C, PrWd), introduced for descriptively rightward-syllabifying languages like Iraqi Arabic, in which heavy syllables preferentially occur closer to the right edge of the prosodic word. Consider the tableaux in (55)-(56).

(55)

/k̂u̯n-b^{h}i̯s/	DEP	ALIGN-R(C, PrWd) C$_2$	C$_3$	C$_4$	C$_5$	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☹ a. k̂u̯n̥.b^{h}is		***!* (u̯)	** (b^h)	-- (s)		*		
b. k̂un.b^{h}is		***! (n)	** (b^h)	-- (s)				*
☞ c. k̂u.n̥.b^{h}is		** (b^h)	-- (s)			*		*
d. k̂u̯Vn.b^{h}is	*!	***** (u̯)	*** (n)	** (b^h)	-- (s)			

(56)

/per-u̯r/	*MAR/ V	DEP- IO	ALIGN-R(C, PrWd) C$_2$	C$_3$	C$_4$	*PK/ NAS	*PK/ LIQ	*PK/ GLI
☹ a. per.u̯r̥			** (r)	*! (u̯)			*	
☞ b. pe.rur			** (r)	-- (r)				*
c. pe.ru.r̥			** (r)				*!	*
d. per.u̯Vr		*!	*** (r)	** (u̯)	-- (r)			
e. pe̯r̥.u̯r̥	*!		*** (e̯)	* (u̯)			**	

As can be observed, we have problematic results relying on ALIGN-R(C, PrWd), for both **k̂u̯n̥b^{h}is* and **per.u̯r̥*, from two sources. First, there is a general issue with Rose's conception of the Alignment constraint as applied to Proto-Indo-European, in that, as it evaluates only consonantal distance from prosodic word edge, any sonorants which vocalize should not be assessed by it (though as segments they will factor into the calculation of distance) – hence, as fewer consonants mean fewer violations, the candidate in (55)c., in which both sonorants are syllabic, is selected as most optimal. As for the winner in and (56)b., it succeeds because of minimal violations of the low-ranking PEAK constraints, since the Alignment constraint is amenable to either a consonantal or syllabic status for the final liquid, given its immediate proximity to word edge. Second, even if we introduced into the ranking a constraint disfavoring vowel hiatus (ONSET) to avoid this outcome, because the constraint ALIGN-R(C, PrWd) prefers right-edge alignment, vocalization of lefthand sonorants in RR sequences will be favored, as this would allow for the righthand sonorant to be a consonant that much closer to the right edge of the prosodic word. In other words, the candidates in (55)-(56)b. would emerge as victorious, not the desired winners in (55)-(56)a.

If, as we were compelled to do in syllable-based adaptation of Mester and Padgett's approach, we instead consider the constraint associated with left-to-right syllabification, namely ALIGN-L(C, PrWd), we find we can obtain better results, albeit with some necessary adjustment. On a first pass, introduction of ALIGN-L(C, PrWd) into the ranking has no positive effect as far as selection of the syllabifications **k̑u̯n̥b^h^is* and **per.u̯r̥* is concerned, as we face the same general issue of the Alignment constraint's preference for fewer consonants:

(57)

/k̑u̯n-b^h^i̯s/	DEP-IO	ALIGN-L(C, PrWd) C_2	C_3	C_4	C_5	*PK/NAS	*PK/LIQ	*PK/GLI
☹ a. k̑u̯n̥.b^h^is		* (u̯)	*** (b^h^)	*****! (s)		*		
b. k̑un.b^h^is		** (n)	*** (b^h^)	****!* (s)				*
☞ c. k̑u.n̥.b^h^is		*** (b^h^)	***** (s)			*		*
d. k̑u̯Vn.b^h^is	*!	* (u̯)	*** (n)	**** (b^h^)	****** (s)			

(58)

/per-u̯r/	*MAR/V	DEP-IO	ALIGN-L(C, PrWd) C_2	C_3	C_4	*PK/NAS	*PK/LIQ	*PK/GLI
☹ a. per.u̯r̥			** (r)	*!** (u̯)			*	
b. pe.rur			** (r)	*!*** (r)				*
☞ c. pe.ru.r̥			** (r)				*	*
d. per.u̯Vr		*!	** (r)	*** (u̯)	***** (r)			
e. pe̯r̥.u̯r̥	*!		** (r)	*** (u̯)			**	

Again, the candidates in which both sonorants are vocalized win, because they feature the fewest consonants.

Unlike in the case of ALIGN-R(C, PrWd), however, if we introduce into the ranking here a constraint militating against vowel hiatus (i.e., again, ONSET), a successful evaluation becomes possible. The tableaux in (59)-(60) demonstrate as much:

(59)

/k̂u̯n-b^{h}i̯s/	DEP-IO	ONSET	ALIGN-L(C, PrWd) C_2	C_3	C_4	C_5	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. k̂u̯n̥.b^{h}is			*	***	*****		*		
b. k̂un.b^{h}is			**	***	*****!				*
c. k̂u.n̥.b^{h}is		*!	***	*****			*		*
d. k̂u̯Vn.b^{h}is	*!		*	***	****	******			

(60)

/per-u̯r/	*MAR/V	DEP-IO	ONSET	ALIGN-L(C, PrWd) C_2	C_3	C_4	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. per.u̯r̥				**	***			*	
b. pe.rur				**	****!				*
c. pe.ru.r̥			*!	**				*	*
d. per.u̯Vr		*!		**	***	*****			
e. pe̯r̥.u̯r̥	*!			**	***			**	

Ranked over ALIGN-L(C, PrWd), ONSET eliminates the candidates in (59)-(60)c. Evaluation then comes down to the Alignment constraint, and because the candidates in (59)-(60)a. feature righthand sonorant vocalization, the lefthand sonorant is itself not syllabic, but rather a consonant which is comparably closer to the left edge of the prosodic word. If it were syllabic, the righthand sonorant would then be consonantal, and then that much further from the edge in question. Note the crucial ranking of DEP-IO over ONSET is in view of a form such as weak aorist stem **n̥s-*: epenthesis is more strongly disfavored than sonorant vocalization as means of rendering the initial sequence syllabifiable, even if the result is an onsetless initial syllable.

Differentiating the case of **k̂u̯n̥b^{h}is* from that of **per.u̯r̥* analyzed in this way is the fact that, again, the Alignment constraint and NoCoda overlap in their role in the evaluation of the former, while in the evaluation of the latter, Align-L(C, PrWd) is crucial, as violations of NoCoda are equally shared by the two most viable candidates. Still, both cases point to the possibility that NoCoda need not be included in the active constraint ranking at all, and we factor this point into our assessment of Rose's approach.

Rather, in order for Rose's approach to successfully capture the Proto-Indo-European data, we have seen it necessary to introduce the constraint associated with left-to-right syllabification, Align-L(C, PrWd), as well as Onset, to reign in the minimization of violations of the former constraint by means of sonorant vocalization. Equally crucial to a successful analysis, though, is the explicit acknowledgement that syllabic consonants fall outside of the domain of the Align (C-Edge, PrWd-Edge) schema. If this were not the case, the constraint Align-L(C, PrWd) would be useless in differentiating the most viable output candidates for /k̂u̯n-b^{h}i̯s/ and /per-u̯r/, as demonstrated in the following two tableaux:

(61)

/k̂u̯n-b^{h}i̯s/	Dep-IO	Onset	Align-L(C, PrWd) C_2	C_3	C_4	*Pk/Nas	*Pk/Liq	*Pk/Gli
☹ a. k̂u̯n̥.b^{h}is			*	**	***	*!		
☞ b. k̂un.b^{h}is			*	**	***			*
c. k̂u.n̥.b^{h}is		*!	*	**	***	*		*
d. k̂u̯Vn.b^{h}is	*!		*	***	****			

(62)

/per-u̯r/	*Mar/V	Dep-IO	Onset	Align-L(C, PrWd) C_2	C_3	C_4	*Pk/Nas	*Pk/Liq	*Pk/Gli
☹ a. per.u̯r̥				**	***	****		*!	
☞ b. pe.rur				**	***	****			*
c. pe.ru.r̥			*!	**	***	****		*	*
d. per.u̯Vr		*!		**	***	*****			
e. pe̯r̥.u̯r̥	*!			**	***			**	

With syllabic sonorants assessable as consonants, the candidates in (61)-(62)a.-b. share equal violations of the constraint ALIGN-L(C, PrWd), as they contain the same number of consonants (three in the first syllable in (61),[18] four total in (62)), arrayed in the same order. Evaluation thus passes down to the sonorant-targeting PEAK constraints, and the wrong candidate is selected as most optimal (the candidates in (61)-(62)c., which also share violations with candidates a.-b., are eliminated due to higher-ranked ONSET). While it does not sound unreasonable for syllabic consonants to be invisible to the ALIGN (C-Edge, PrWd-Edge) schema, it is nonetheless important to recognize the stipulative nature of this key component of the successful consonant-based Alignment analysis.

4.2.4 Discussion

In this section we offer a few comments on our findings. First, as far as comparing Mester and Padgett's and Rose's approaches, we have seen that the Proto-Indo-European data offer a new perspective, and a new means of differentiating them. Indeed, when used to analyze epenthesis as a repair mechanism for unsyllabifiable sequences of segments, both Mester and Padgett's and Rose's approaches are in agreement in one respect: more epenthesis means more violations. For Rose's ALIGN-X(C, PrWd), insertion of additional vowels increases the distance of at least some consonant(s) from the relevant prosodic word edge. For Mester and Padgett's ALIGN-X(σ, PrWd) – and the variant mora-based schema ALIGN-X(μ, PrWd) we have proposed – epenthesis is doubly deleterious: insertion of additional vowels not only increases the number of moras intervening between other syllables and the relevant prosodic word edge, but also creates new syllables subject to evaluation. As we have seen, this alignment between the two approaches

[18] We abstract away from the second syllable in (61)a., but note that regardless of the treatment of the sonorant *i* vis-a-vis ALIGN-L(C, PrWd), the problematic result illustrated here persists.

breaks down in consideration of the Proto-Indo-European data, in which sonorant vocalization, not epenthesis, is the preferred repair mechanism. All else being equal, vocalizing more will improve a candidate's violations of ALIGN-X(C, PrWd), as there will be fewer consonants to assess the distance of, but vocalizing *less*, like epenthesizing less, will improve a candidate's violations of ALIGN-X(σ, PrWd) (and ALIGN-X(μ, PrWd)), as there will be both fewer syllables to assess the distance of, and smaller distances to assess.

Our findings in the preceding subsections demonstrate the importance of differentiating directionality in sonorant vocalization (nucleus selection) from directionality in syllable structure assignment, even if the two phenomena appear to be intimately related.[19] Yet, given the nature of Optimality Theory, in which fully-structured candidates are evaluated – that is, the processes of moraification and syllabification cannot effectively be distinguished – we have found it possible to subject the same output candidates to analysis using Mester and Padgett's syllable-based Alignment constraint schema, Rose's consonant-based Alignment constraint schema, and our proposed mora-based Alignment constraint schema, and achieve the same results. That such alternatives are possible compels us to consider in the immediate context which approach provides the best fit for Proto-Indo-European, and more generally, how these constraints fare on a broader cross-linguistic scale. We address each of these issues in turn in the following two subsections.

4.2.4.1 Syllable-, Mora-, and Consonant-Based Alignment in Proto-Indo-European

Perhaps the most obvious criterion to consider in assessing the elegance of the competing analyses of Proto-Indo-European is the number of constraints required to generate all the desired

[19] Cf. Itô (1989: n. 30), who notes cases of parallelism in directionality effects, such as between metrical structure building and syllabification in Cairene and Iraqi Arabic (both proceed left-to-right for Cairene and right-to-left for Arabic), and between syllabification and nonconcatenative morphology in Temiar, which both operate right-to-left.

results. To better appreciate the difference in the three accounts, in the following table we summarize, given the Alignment constraint in the leftmost column as a starting point, the additional constraints required for a successful analysis of the two forms which have figured prominently in our discussion, _*peru̯r̥_ and _*k̂u̯n̥b_^{h}_is_.

(63)

	*per.u̯r̥	_*k̂u̯n̥.b_^{h}_is_
ALIGN-R(σ, PrWd)	--	NOCODA / ALIGN-L(σ, PrWd)
ALIGN-L(C, PrWd)	ONSET	
ALIGN-L(μ, PrWd)	--	

Using only ALIGN-R(σ,PrWd) after Mester and Padgett, _*per.u̯r̥_ can be accounted for, but we are compelled to include in addition either the constraint NOCODA or the constraint ALIGN-L(σ, PrWd), so as to account for _*k̂u̯n̥.b_^{h}_is_. Using ALIGN-L(C, PrWd) after Rose, on the other hand, the constraint ONSET is required to account for both _*peru̯r̥_ and _*k̂u̯n̥b_^{h}_is_. No additional constraints are needed using the proposed mora-based ALIGN-L(μ, PrWd).

We can supplement these considerations with some additional data. We begin with the genitive singular form of 'dog', _*k̂u.nos_. This form shows that righthand sonorant vocalization is blocked when the following segment is a vowel, suggesting a dispreference in the language for hiatus and onsetless syllables. As such a dispreference is usually captured in Optimality Theory by the appropriately-ranked constraint ONSET, this form should fall out of the ranking already established around ALIGN-L(C, PrWd), which, as (64) shows, it does:

(64)

/k̂u̯n-os/	DEP-IO	ONSET	ALIGN-L(C, PrWd) C_2	C_3	C_4	*PK/NAS	*PK/LIQ	*PK/GLI
a. k̂u̯n̥.os		*!	*	****		*		
☞ b. k̂u.nos			**	****				*
c. k̂u.n̥.os		*!	****			*		*
d. k̂u̯V.nos	*!		*	***	*****			

The importance of avoiding onsetless syllables outweighs the drive to minimize violations of ALIGN-L(C,PrWd) through vocalization of multiple sonorants.

The tableaux in (65)-(66) show how the syllable-based and mora-based Alignment approaches, respectively, handle **k̂u.nos*.

(65)

/k̂u̯n-os/	DEP-IO	ALIGN-R(σ, PrWd) σ_1	σ_2	σ_3	NOCODA	*PK/ NAS	*PK/ LIQ	*PK/ GLI
a. k̂u̯n̥.os		**			*	*!		
☞ b. k̂u.nos		**			*			*
c. k̂u.n̥.os		***!	**		*	*		*
d. k̂u̯V.nos	*!	**			**			

(66)

/k̂u̯n-os/	DEP-IO	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3	μ_4	*PK/ NAS	*PK/ LIQ	*PK/ GLI
a. k̂u̯n̥.os		**	***	****!		*		
☞ b. k̂u.nos		*	***	****				*
d. k̂u.n̥.os		*	**	***	***!*	*		*
e. k̂u̯V.nos	*!	**	****	*****				

As can be seen, while the syllable-based account does actually select the correct output in (65), it does so only by resorting to the constraints whose influence we have sought to neutralize: the low-ranked sonorant-targeting PEAK constraints. If the position of the glide and nasal were reversed, we would still expect the lefthand sonorant in this case to vocalize, suggesting that the analysis cannot stand as is. Rather, here too we are motivated to introduce the constraint ONSET, ranked at least above *PK/NASAL:

(67)

/k̂u̯n-os/	Dep-IO	Align-R(σ, PrWd) σ_1	σ_2	σ_3	Onset	NoCoda	*Pk/ Nas	*Pk/ Liq	*Pk/ Gli
a. k̂u̯n̥.os		**			*!	*	*		
☞ b. k̂u.nos		**				*			*
c. k̂u.n̥.os		***!	**		**	*	*		*
d. k̂u̯V.nos	*!	**				**			

Note that, once we have introduced Onset into the ranking, we have a means of ruling out an additional candidate not included here, namely †_k̂un.os_, which, differing from the optimal output only in the syllabic affiliation of the nasal, would, absent this constraint, fare just as well in the evaluation.

As for the mora-based Alignment approach depicted in (66), it also generates the correct result, but does so without appeal to the low-ranking Peak constraints. Because fewer moraic segments mean fewer violations overall, the candidate in (66)b. wins the evaluation, since the nasal is not vocalic (as in (66)d.), and hence not moraic. Note that if the nasal were a coda consonant – as in †_k̂un.os_ – it would also be moraic, meaning that the constraint Align-L(μ, PrWd) can also successfully eliminate this form from the competition as well. In view of these findings, we revise the table presented in (63) above as follows.

(68)

	*per.u̯r̥	_*k̂u̯n̥.b^{h}is_	_*k̂u.nos_
Align-R(σ, PrWd)	--	NoCoda (/ Align-L(σ, PrWd))	Onset
Align-L(C, PrWd)	Onset		
Align-L(μ, PrWd)	--		

While at this stage the moraic-based Alignment approach continues to be most attractive in view of its requiring the fewest number of additional constraints – none – to accommodate the forms considered thus far, this distinction breaks down in view of the environment we turn to now. Because we have assessed violations of Align-L(μ, PrWd) in terms of segments, and because this constraint is left-edge-oriented, the segment at this edge of the prosodic word can be moraic essentially for free – such a mora will incur no violations, as there are no segments intervening between the word edge and the segment it dominates. The constraint therefore cannot distinguish between the candidates as in (69), differing only in the moraicity of the initial segment:[20]

(69)

/RRCV/	ALIGN-L(μ, PrWd) μ_1	μ_2
☞ a. $R_\mu R_\mu CV$		*
☞ b. $RR_\mu CV$	*	

While the violation profiles of the two candidates may differ at the level of the mora, more relevant for the purposes of the evalutation is the fact that, overall, each incurs one violation apiece of the constraint ALIGN-L(μ, PrWd). Practically speaking, this means that, although we want the candidate type in (69)b. to emerge as most optimal, the mora-based Alignment approach as developed thus far has no means of ruling out the vocalization of an initial sonorant in situations in which we expect that a following sonorant should vocalize instead.

For a concrete example of this issue, consider the tableau in (70), for the present stem **mn̥-i̯e* (Ved. *mányate*) built to the root 1.**men-* 'think' (*LIV* 435-436; *IEW* 726-728).[21]

[20] We omit from consideration a logically possible third candidate, $R_\mu RCV$, in which only the initial sonorant is moraic, as we believe it would be disfavored by higher-level preferences involving sonority-sequencing and/or the moraicity of (sonorant) codas.

[21] Note in all candidates featuring a single medial consonant – *n* in (70)b.,e., *i̯* in (70)f. – this consonant is grouped with the syllable headed by the following vowel. Such practice, as we have seen in the case of **k̂unos*, conforms with the preferences of ALIGN-L(μ, PrWd), as fewer moraic segments mean fewer violations. On the other hand, ostensibly in spite of this constraint, in all candidates featuring a medial consonant sequence – *-ni̯-* in (70)c.,h. – this sequence is split up across syllables. The issue of such heterosyllabification will be taken up more extensively in Part II of this dissertation.

(70)

/mn-i̯e-/	DEP-IO	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3	μ_4	*PK/NAS	*PK/LIQ	*PK/GLI
a. mni.e-		**	***!					*
☞ b. mn̥.i̯e-		*	***			*		
☞ c. m̥n.i̯e-			*	***		*		
d. mn̥.i.e-		*	**	**!*		*		*
e. m̥.ni.e-			**	***!		*		*
f. m̥.n̥.i̯e-			*	***		**!		
g. m̥.n̥.i.e-			*	**	**!*	**		*
h. mVn.i̯e-	*!	*	**	****				

As we can see, the schematic string $R_\mu R_\mu C$ in (69)a. is ambiguous, in that it can actually correspond to at least two possible syllabifications, assuming the moraicity of coda consonants – either the syllabification $\underset{\circ}{R}_\mu R_\mu$.CV, in which the initial sonorant is syllabic and the second sonorant is a coda (exemplified by the candidate in (70)c.), or the syllabification $\underset{\circ}{R}_\mu.\underset{\circ}{R}_\mu$.CV, in which both sonorants are syllabic and wholly constitute their own syllables (exemplified by the candidate in (70)f.). As we expect, the constraint ALIGN-L(μ, PrWd) assesses both of these candidates equally – each incurs four violations arrayed across the same moraic structure (but not the same syllable structure) – and between them and the candidate in (70)b., which exemplifies the schematic string $RR_\mu C$ in (69)b. and also incurs four violations, is incapable of selecting a single most optimal output. Although ultimately the evaluation presented here comes down to the two candidates (70)b.-c., once the lower-ranked PEAK constraints come into play – the two syllabic nasals of the candidate in (70)f. serve to eliminate it from competition – resorting in such a way to these constraints is an undesirable outcome, as it suggests that if the initial sonorant were instead a sonorant of higher sonority, the candidate in which it vocalizes would be favored, when ideally it should be the second sonorant, again regardless of relative sonority.

To resolve this issue, we need a constraint like ONSET. Its effect can be seen in the tableau in (71).

(71)

/mn-i̯e-/	DEP-IO	ALIGN-L(μ, PrWd)	ONSET	*PK/NAS	*PK/LIQ	*PK/GLI
a. mni.e-		*****!	*			*
☞ b. mn̥.i̯e-		****		*		
c. m̥n.i̯e-		****	*!	*		
d. mn̥.i.e-		*****!*	**	*		*
e. m̥.ni.e-		*****!	**	*		*
f. m̥.n̥.i̯e-		****	*!*	**		
g. m̥.n̥.i.e-		*****!*	****	**		*
h. mVn.i̯e-	*!	*******				

We can also update the summary table introduced in (63) and revised in (68) as follows:

(72)

	**per.u̯r̥*	**k̂u̯n̥.b^{h}is*	**k̂u.nos*	**mn̥.i̯e-*
ALIGN-R(σ, PrWd)	--	NOCODA (/ ALIGN-L(σ, PrWd))	ONSET	
ALIGN-L(C, PrWd)	ONSET			
ALIGN-L(μ, PrWd)	--			ONSET

ONSET is common now to all three approaches. Importantly, once this constraint is introduced into the ranking, it becomes more difficult to differentiate an account built on Rose's consonant-based ALIGN-L(C, PrWd) from one built on our proposed ALIGN-L(μ, PrWd). The fact that, given the set of data we have considered so far here, more forms require the inclusion of this constraint under the former approach compared to the latter one is inconsequential; regardless of how little or how much work it does, once ONSET is part of the analysis, it is part of the analysis.

At this point, then, we find that the consonant- and mora-based Alignment approaches are essentially tied for number of additional constraints required. What bearing does this fact have on the evaluation of comparative theoretical elegance – how do we evaluate between them? And should we be so quick to eliminate syllable-based Alignment from consideration, because it requires more constraints? This issue requires fuller consideration.

For the current purposes, however, we maintain the mora-based approach, because, as we have noted above, assessing consonantal alignment to prosodic word edge à la Rose arguably better reflects a system in which sonorant vocalization is the expectation, not a process restricted to rendering phonological strings syllabifiable – again, more syllabic sonorants means fewer violations. On the other hand, we prefer the mora-based approach to Mester and Padgett's original syllable-based approach, because of the fact that it does require fewer constraints to be introduced, subsuming the role played by NoCoda and / or Align-L(σ, PrWd).[22]

4.2.4.2 Syllable-, Mora-, and Consonant-Based Alignment Cross-Linguistically

At the cross-linguistic level, the proposed moraic Alignment approach also has the benefit of correctly predicting results for the Cairene and Iraqi Arabic data, as Itô has analyzed them.[23] Although in Itô's account, moraic structure could be assigned in either direction in these languages with no effect on the ultimate outcome – the crucial factor being the directionality of the syllabification process – when we seek to translate her insights into the framework of Optimality Theory, it is rather the case that only one of the two moraic Alignment constraints can be employed in either Cairene or Iraqi Arabic to successfully generate the correct results: Cairene requires Align-R(μ, PrWd), as shown in the tableaux in (73), while Iraqi requires Align-L(μ, PrWd), as shown in the tableaux in (74).

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[22] Another potential asset of the mora-based approach we have developed here, as opposed to Mester and Padgett's syllable-based approach, is the prominence it assigns to the left edge of the prosodic word. Indeed, initial position in Proto-Indo-European is privileged in a number of phenomena, such as the *neognós* rule (Weiss 2009b: 113), and, as we will claim, in the distribution of complex onsets (see Chapter 10).

[23] Again, though, cf. Broselow (1992) et al. for a different perspective, in part because of stress placement facts.

(73) *Moraic Alignment in Cairene Arabic*

a. Right-Alignment: failure

/ʔul-t-lu/	DEP-IO	ALIGN-R(μ, PrWd)				NOCODA
		μ_1	μ_2	μ_3	μ_4	
☞ i. ʔu$_\mu$.li$_\mu$t$_\mu$.lu$_\mu$	*	*****	***	**		*
☹ ii. ʔu$_\mu$l$_\mu$.ti$_\mu$.lu$_\mu$	*	*****	****	**!		*
iii. ʔu$_\mu$.li$_\mu$.ti$_\mu$.lu$_\mu$	**!	******	****	**		

b. Left-Alignment: success

/ʔul-t-la/	DEP-IO	ALIGN-L(μ, PrWd)				NOCODA
		μ_1	μ_2	μ_3	μ_4	
i. ʔu$_\mu$.li$_\mu$t$_\mu$.lu$_\mu$	*	*	***	****	******!	*
☞ ii. ʔu$_\mu$l$_\mu$.ti$_\mu$.lu$_\mu$	*	*	**	****	******	*
iii. ʔu$_\mu$.li$_\mu$.ti$_\mu$.lu$_\mu$	**!	*	***	*****	*******	

(74) *Moraic Alignment in Iraqi Arabic*

a. Right-Alignment: success

/gil-t-la/	DEP-IO	ALIGN-R(μ, PrWd)				NOCODA
		μ_1	μ_2	μ_3	μ_4	
☞ i. gi$_\mu$.li$_\mu$t$_\mu$.la$_\mu$	*	*****	***	**		*
ii. gi$_\mu$l$_\mu$.ti$_\mu$.la$_\mu$	*	*****	****	**!		*
iii. gi$_\mu$.li$_\mu$.ti$_\mu$.la$_\mu$	**!	******	****	**		

b. Left-Alignment: failure

/gil-t-la/	DEP-IO	ALIGN-L(μ, PrWd)				NOCODA
		μ_1	μ_2	μ_3	μ_4	
☹ i. gi$_\mu$.li$_\mu$t$_\mu$.la$_\mu$	*	*	***	****	******!	*
☞ ii. gi$_\mu$l$_\mu$.ti$_\mu$.la$_\mu$	*	*	**	****	******	*
iii. gi$_\mu$.li$_\mu$.ti$_\mu$.la$_\mu$	**!	*	***	*****	*******	

If it is the case that the Cairene and Iraqi Arabic data and the Proto-Indo-European data are all amenable to analysis by means of moraic Alignment, but an approach using Mester and Padgett (1994)'s syllable Alignment requires additional constraints to produce a satisfactory account in the case of Proto-Indo-European, then it would seem that maintaining moraic Alignment alone results in the more parsimonious, yet still successful, system.

We can also assess the power of moraic Alignment as compared to consonantal Alignment, the approach advocated by Rose (2000). Admittedly Rose's concern about Mester and Padgett's ALIGN-R(σ, PrWd) assessing violations in terms of moras, when final consonants in Arabic are nonmoraic, applies to the moraic Alignment constraints as well, since the presence or absence of a final mora necessarily impacts the number of their overall violations. This can be observed in the following two tableaux, which in the use of ALIGN-L(μ, PrWd) are meant to represent languages with descriptively rightward syllable structure assignment, like Cairene Arabic.

(75) *Final codas are not moraic*

/CVCC/	DEP-IO	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3
☞ a. $CV_\mu.CV_\mu C$	*	*	***	
b. $CV_\mu C_\mu.CV_\mu$	*	*	**	**!**
c. $CV_\mu.CV_\mu.CV_\mu$	**!	*	***	*****

(76) *Final codas are moraic*

/CVCC/	DEP-IO	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3
a. $CV_\mu.CV_\mu C_\mu$	*	*	***	****!
☞ b. $CV_\mu C_\mu.CV_\mu$	*	*	**	****
c. $CV_\mu.CV_\mu.CV_\mu$	**!	*	***	*****

As we can see, if final codas are not moraic, then the evaluation selects the candidate CV.CVC as most optimal, but if they are, then the evaluation selects the candidate CVC.CV. Perhaps somewhat paradoxically, it is this latter result which Rose's account, assuming final consonant nonmoraicity, also generates. Ostensibly, then, Rose's account is better able to accommodate the word-final consonant data, but we must also bear in mind that, as we saw previously, even her approach cannot adequately account for the actual treatment of CVCC# in Cairene, a sequence which can actually be tolerated without resorting to epenthesis. From this perspective any such superiority arguably becomes questionable.

Interestingly, despite the issue with treating Cairene-type languages, for Iraqi-type languages, the final consonant, if moraic, incurs no violations of ALIGN-R(μ, PrWd) because it is fully aligned with the right edge of the prosodic word; if it is not moraic, then its proximity to this word edge is not assessed in the first place. Either way CV.CVC is selected as more optimal.

(77) *Final codas are not moraic*

/CVCC/	DEP-IO	ALIGN-R(μ, PrWd)		
		μ_1	μ_2	μ_3
☞ a. $CV_\mu.CV_\mu C$	*	***	*	
b. $CV_\mu C_\mu.CV_\mu$	*	***	**!	
c. $CV_\mu.CV_\mu.CV_\mu$	**!	****	**	

(78) *Final codas are moraic*

/CVCC/	DEP-IO	ALIGN-R(μ, PrWd)		
		μ_1	μ_2	μ_3
☞ a. $CV_\mu.CV_\mu C_\mu$	*	***	*	
b. $CV_\mu C_\mu.CV_\mu$	*	***	**!	
c. $CV_\mu.CV_\mu.CV_\mu$	**!	****	**	

This is exactly the result that Rose's account would predict, and if we recall the data cited above, Iraqi does show epenthesis of this type, e.g. *kita<u>bi</u>t* 'I wrote' (31)b. At least as far as Broselow's data indicate, Arabic dialects like Iraqi do not deviate from requiring such epenthesis – i.e., there are no descriptively leftward-syllabifying dialects that, like Cairene, also allow word-final CVCC#. Perhaps this distributional trend can be tied to the invariability of the treatment observed here; in other words, perhaps the disfavored status of final CC is strengthened by the fact that the location of epenthesis is unaffected by the status of the final consonant vis-à-vis moraicity.

Regardless, we have shown that mora-based Alignment fares just as well as Mester and Padgett's syllable-based Alignment in handling Itô's Arabic dialectal data. Its viability as compared to Rose's consonant-based Alignment is less clear in this regard; if anything more data from more languages should be brought into the discussion on this issue.

4.3 Minimized Consonant Moraicity as a Solution?

Before we conclude this chapter, we first consider briefly an alternative to the approaches explored in the previous section for generating both **k̂u̯n̥.bʰis-* and **peru̯r̥*-type forms, one involving restrictions on the assignment of syllable weight. Although this alternative ultimately proves untenable given the workings of Optimality Theory, nonetheless it provides a useful point of comparison.

To begin the discussion, we repeat from Chapter 3 the initial tableau for **peru̯r̥*, showing the inability of the constraint ranking to converge on a single output candidate before reaching the PEAK constraints intended to be inactive in Proto-Indo-European.

(79)

/per-u̯r/	*PK/OBS	*MAR/V	DEP-IO	NOCODA	*PK/NAS	*PK/LIQ	*PK/GLI
☹ a. per.u̯r̥				*		*!	
☞ b. pe.rur				*			*

A revision to the analysis incorporating observations about syllable weight, such that the desired winner in (79)a. can actually be selected, proceeds as follows. We first recognize that a locus of distinction between the candidates in (79)a. and (79)b. lies in the shape of their respective second syllables, either .RR̥. or .CR̥R. These syllable shapes should be crucially different with respect to weight; according to our understanding of Proto-Indo-European syllable structure, as reconstructed based on e.g. metrical practice in Vedic and Ancient Greek, the former is light, while the latter is heavy, as the coda R should be moraic. We might posit that the language disfavors candidate (79)b. precisely because of the bimoraicity of its second syllable. Crucially, though, we cannot straightforwardly enforce this preference by introducing a constraint such as *2μ, which would ban bimoraic syllables, in view of the fact that bimoraic syllables do not seem to be restricted generally in the language (it is after all a quantity-sensitive system), and more specifically, that this constraint would also presumably be violated by candidate (79)a., the initial syllable of which has a coda consonant, and is thus heavy too. Rather, we propose to capture the disfavored status of the syllable .CR̥R. as a consequence of its having two *consonantal* moras, as opposed to the single consonantal mora of syllable .RR̥. in (79)a.

To properly formalize this distinction, we must first introduce a constraint ranking generating moraic coda segments, so that we can actually differentiate light .RR̥$_{\mu}$. from heavy .CR̥$_{\mu}$R$_{\mu}$. Specifically, we rank the constraint *APPENDIX (80)a., which disfavors postvocalic segments from being affixed directly to the syllable node without an intervening mora, over *μ/CONSONANT (80)b., which disfavors consonants from contributing to weight.[24]

(80) a. *APPENDIX (after Sherer 1994)

No appendix segments.

b. *μ/CONSONANT (after Prince and Smolensky 1993 [2004])

Consonants must not be moraic.

The effect of the ranking *APPENDIX » *μ/CONSONANT can be observed in the tableau in (81).

(81)

/CVC/	*APPENDIX	*μ/CONSONANT
a. .CV$_{\mu}$C.	*!	
☞ b. .CV$_{\mu}$C$_{\mu}$.		*

The candidate (81)b. wins because it avoids a violation of *APPENDIX at the cost of a violation of lower-ranked *μ/CONSONANT.

Having established a means of generating the syllabicity of coda consonants, we now turn to the issue of differentiating the light syllable .R$\underset{\circ}{\mathrm{R}}_{\mu}$. from the heavy syllable .C$\underset{\circ}{\mathrm{R}}_{\mu}R_{\mu}$. We observe in this regard the fact that in the latter, not only is the coda consonant moraic, but the syllable nucleus, also a sonorant, is moraic as well. Assuming that this segment retains a consonantal status even in such a position (contra the position we were compelled to adopt when considering Rose's consonant-targeting Alignment schema!), the syllable .C$\underset{\circ}{\mathrm{R}}_{\mu}R_{\mu}$. incurs two violations of the constraint *μ/CONSONANT, while the syllable .R$\underset{\circ}{\mathrm{R}}_{\mu}$. incurs only one.[25]

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[24] Alternatively, we could introduce a relatively high-ranking WEIGHT-BY-POSITION 'Coda consonants are moraic' (after Hayes 1989).

[25] If such an assumption does not hold, and syllabic sonorants should not be considered consonantal for the purposes of this constraint (in line with the way they were treated with respect to ALIGN-X(C, PrWd)), an alternative might be to introduce DEP-μ-IO ('Each output mora must have an input correspondent') instead: the syllable .R$\underset{\circ}{\mathrm{R}}_{\mu}$. can be analyzed as having one inserted mora, while the syllable C$\underset{\circ}{\mathrm{R}}_{\mu}R_{\mu}$. can be analyzed as having two. (Note that as we consider full, non-high vowels to be underlyingly moraic, they are irrelevant to the scope of DEP-μ-IO, and are predicted not to contribute to its violation.)

While we can distinguish these two syllables in isolation, we must recall that they are each a component of a larger form, **per.u̯r̥* or †*pe.rur*. Considered at this level, violations of the constraint *μ/Consonant are equal across the two candidates, as each has one coda consonant, and each has one syllabic sonorant, for a total of two violations apiece:

(82)

/pe$_{\mu}$r-u̯r/	*Appendix	*μ/Consonant
☞ a. pe$_{\mu}$r$_{\mu}$.u̯r̥$_{\mu}$		**
☞ b. pe$_{\mu}$.ru$_{\mu}$r$_{\mu}$		**

This situation is of course highly reminiscent of that which we faced when evaluating the constraint NoCoda as a potential identification for the constraint ℂ: again, NoCoda cannot differentiate between **per.u̯r̥* and †*pe.rur* because each has one coda consonant; whether this segment occurs in the same syllable as the syllabic sonorant does not in the end matter. The tableau in (83), separating out violations per syllable, demonstrates as much.

(83)

/per-u̯r/	NoCoda	
	σ_1	σ_2
☞ a. per.u̯r̥	*	
☞ b. pe.rur		*

Unlike the issue with NoCoda, however, consideration of *μ/Consonant offers us a way to compare **per.u̯r̥* and †*pe.rur*, as we have just observed, since its violations by these two forms are arrayed differently across their two syllables, as the following tableau illustrates:

(84)

/pe$_{\mu}$r-u̯r/	*μ/Consonant	
	σ_1	σ_2
☞ a. pe$_{\mu}$r$_{\mu}$.u̯r̥$_{\mu}$	*	*
☞ b. pe$_{\mu}$.ru$_{\mu}$r$_{\mu}$		**

Again, while both candidates incur two violations, these violations are split up across syllables in (84)a., but localized to a single syllable in (84)a. (.CR̥$_{\mu}$R$_{\mu}$., as noted above). We might claim, then, that the Proto-Indo-European system strives to minimize the number of consonantal moras per syllable, the preference instead being that such moras be spread across multiple syllables.

Such a hypothesis may seem attractive, and appears descriptively adequate, but in fact once we attempt to encode it into the Optimality-Theoretic grammar, its viability suffers on a number of counts. In order for it to work, we would first of all have to assume, as was tacitly done in the tableau in (84), that the constraint *μ/CONSONANT is relativized to the syllable – in other words that, like Mester and Padgett's ALIGN-R(σ, PrWd) constraint, it assesses violations on a syllable-by-syllable basis. Yet as *μ/CONSONANT cannot be easily reimagined as an Alignment constraint (unlike NOCODA, which as we have seen has been formulated as ALIGN-R(Nuc, σ)),[26] the very definition of which concerns assessment of each and every member of a stated category, it is difficult to conceive of a viable way of accomplishing this. To be sure, constraints may be relativized to certain types of syllables (initial, stressed, etc.), or, for that matter, other types of phonological units (place features, manner features, etc.), but so far as we can tell, in such cases no formal distinction is made between the violations incurred by one unit as opposed to another – violations are considered cumulatively. Indeed the cumulativity of constraint violation evaluation in general means that, even if we could reformulate *μ/CONSONANT as an Alignment constraint, it would not be possible under the current conception of Optimality Theory to truly discern and appreciate violations in any non-global way.

Assuming for the moment, however, that a syllable-by-syllable identification of violations, as in the tableau in (84) above, were not merely a convenient representation, but rather possessed some formal substance that the system could be sensitive to, we come to the

[26] ALIGN-R(σ, Appendix) ('Align the right edge of the syllable with the right edge of an appendix') does not preclude the possibility of a coda, and hence, a moraic consonant. ALIGN-R(C, appendix) ('Align the right edge of a consonant with the right edge of an appendix') might work; its viability requires additional consideration.

next issue with instantiating the approach in Optimality Theory. The grammar, specifically the Evaluation component, requires the capability to appreciate and compare different violation profiles for a given constraint. Here, it would need to distinguish between an output candidate with a violation profile of <**> for the constraint *μ/CONSONANT (_*pe.rur_), versus one with a profile of <*,*> (_*per.u̯r̥_), and judge in favor of the latter. In other words, the system needs to be sensitive not just to total violations of a given constraint by each output candidate – and it needs to be sensitive to this, because if there were a candidate with only one violation of *μ/CONSONANT, all else being equal we expect it should be selected as most optimal in comparison to both _*pe.rur_ and _*per.u̯r̥_ – but also, for any given subset of candidates sharing the same number of violations, to how those violations are arrayed across the units assessed (here, syllables). The question is, is such a modification really justified, when a serviceable alternative analysis generating _*per.u̯r̥_ already exists within the more traditional conception of the theory, as we have found in the preceding section; we think not.

4.4 Conclusion

In this chapter we have examined the discussion and formalization in the literature of the concept of directionality in phonological phenomena. Ultimately we have argued that, within the framework of Optimality Theory, the descriptively leftward vocalization of sonorants in Proto-Indo-European is best captured through introduction into the ranking of an Alignment constraint calling for moras to be aligned to the left edge of the prosodic word.

CHAPTER 5

NUCLEUS SELECTION AS A MORPHOPHONOLOGICAL OPERATION

5.0 Introduction

To reiterate, the current reconstructed state-of-affairs for Proto-Indo-European posits the following two claims about the behavior of sonorant segments. The first is, simply, that sonorants have conditioned syllabic allophones in this language; generally speaking, these allophones arise in environments in which no vowel – hence no segment capable of being a syllable nucleus – is found. The second is that, in an environment amenable to the vocalization of either of two sonorants in sequence (e.g., between consonants), it is the second that will be syllabic, regardless of its relative sonority vis-à-vis the first one – so the example of **k̂u̯n̥bʰís* inst. pl. 'dog' is thought to demonstrate.

This reconstruction of the Proto-Indo-European system ostensibly poses a typological issue: although there are parallels to the vocalization phenomenon in other languages, as we will see in Chapter 6 – most striking will be the Salish language Shuswap (as analyzed by Kuipers 1974, 1989), which displays a similar pattern of righthand sonorant vocalization – its inherent insensitivity to the general scheme of sonority gives pause, and could be a source of concern as to the Proto-Indo-European reconstruction. At the least, it invites consideration of alternatives. In this context we might consider the example of the Proto-Indo-European stop series, the perceived typological rarity (non-existence?) of which is often cited in connection with the development of the Glottalic Theory (Gamkrelidze and Ivanov 1973, Hopper 1973). While this approach is highly problematic (see Barrack 2002 for arguments against it), the particular concern of improving the series' typological profile is still nevertheless evident in work as recent as Weiss (2009a).[1]

We may also justifiably reevaluate this account on the basis of its explanatory adequacy. In his discussion of the generalization, Schindler (1977b) notes there are at least five classes of exception which do not follow the rule as formulated. There is certainly room, then, for an alternative analysis; an approach which is capable of integrating into the scope of its explanatory domain at least one of these cases would possess greater explanatory breadth.[2]

The aim of this chapter, then, is to develop and evaluate an alternative to the traditional account of sonorant vocalization. Where the traditional story was purely phonological in nature – Schindler's rule makes no reference to morphological structure, save for word boundaries – the analysis we construct here assumes the relevance of morphological structure. As we will see, however, this alternative approach, incorporating information about such structure with the aim of privileging righthand sonorants for vocalization, proves inelegantly cumbersome once we have instantiated it within the Optimality-Theoretic framework. Ultimately, this inelegance serves to reinforce the validity of the analysis we developed over the course of the previous two chapters.

The rest of the chapter is organized as follows. In 5.1 we sketch out a descriptive account of the Proto-Indo-European sonorant vocalization data from a morphophonological perspective. We then present in 5.2 two analyses developed in a similar vein for Sanskrit, and assess their applicability to Proto-Indo-European. In 5.3 and 5.4 we formalize the analysis, in the former clarifying the nature of zero-grade ablaut from the perspective of moraic theory, and in the latter

[1] There are also the reconstructed syllabifications VR.OOV, VOO.RV, which comprise an ostensibly counterintuitive pairing for a single language to feature. We address this issue in Chapter 9.

[2] This same point comes through in Calabrese (1999: n. 26), whose approach is reviewed in 5.2.2. He argues the Schindlerian view is comparatively deficient, as it does not account for the ostensibly idiosyncratic behavior of sonorants in the nasal infix presents, while his analysis does. We return to these data in Chapter 6.

constructing an Optimality-Theoretic account. In 5.5 we conclude, comparing the analysis developed here with that we have proposed in the preceding chapters.

5.1 Descriptive Analysis

In the interests of developing a potentially more satisfying account of sonorant vocalization in Proto-Indo-European, the analysis we develop in this section factors into the equation morphological information, treating as significant the following two observations.[3] First, we note that many, if not most situations in which a sonorant vocalizes at all in Proto-Indo-European arise as a result of morphologically-conditioned zero-grade ablaut – either of e.g. root, suffix, or ending – by which a full (non-high) vowel is thought to be deleted. The formation of *-i̯é/ó-* present stems, for instance, calls for zero-grade of the root: thus **bʰug-i̯é-* (Lat. *fugiō*, *-ere* 'flee') built to 1.**bʰeu̯g-* (*LIV* 84; *IEW* 152); the position of the root vowel is clear from the desiderative

[3] Note that the fact that we can even entertain in the first place a 'morphophonological' approach, as will be developed here, is primarily due to the nature of the data. The issue of phonology vs. morphology in the vocalization of sonorants could be resolved decisively in the presence (or absence) of evidence showing the vocalization of righthand sonorants following a morpheme boundary, i.e. /R-R/ → RR̥. Unfortunately few examples of sonorant sequences of this type readily present themselves in Proto-Indo-European in the first place, seeing as how they require two adjacent morphemes to be in the zero-grade (else one sonorant or the other would be vowel-adjacent, and hence out of the running for vocalization). Still, we have encountered one such type already, namely accusatives singular of *i*-, *u*-, and *r*-stems, which should come out as *-i̯m̥*, *-u̯m̥*, *-rm̥*, but in fact are reconstructed as *-im*, *-um*, *-r̥m* (e.g. **m(é)n-ti-m* acc. sg. 'thought'). While this third stated exception to Schindler's rule (see Chapter 2) may indicate a morphological influence on syllabification (or at least nuclear selection / sonorant vocalization) – as suggested for instance by Byrd (2010) – we prefer, in view of other idiosyncratic behaviors associated with *m*, an alternative approach built around this sonorant, and couched fully within the phonological domain. We tentatively sketch out this approach in Chapter 6.

As for other sequences of this type that can be reconstructed, the role of analogy in their treatment cannot be discounted. One example that comes to mind can be found in the paradigm of athematic *e*- and *i*-reduplicated presents (*LIV* classes (1g) and (1i)), with strong stems C_1*é*-R(*o*)-, C_1*i*-R(*é*)-, weak stems C_1*é*-R(ø)-, C_1*i*-R(ø)-. The 3rd plural of such presents (built to the weak stem) is marked by an ending *-n̥ti*, even if the root ends in a sonorant, e.g. **bʰi-bʰr-n̥ti* > Ved. *bíbhrati*), from the root **bʰer-* 'carry' (*LIV* 76-77; *IEW* 128-132). This puts this form at odds with the rest of the paradigm, in which *r* is either postvocalic (in the singular) or syllabic (in the dual and 1st, 2nd plural): *bíbharmi*, *bíbharṣi*, *bíbharti*; *bibhṛvás*, *bibhṛthás*, *bibhṛtás*; *bibhṛmás*, *bibhṛthá*). It is tempting to interpret the resistance of the 3rd plural to paradigm leveling as significant; but again, though, the *-n̥ti* form of the ending could have spread via analogy, extended from root-final obstruent examples such as **dʰé-dʰh₁-n̥ti* (> Ved. *dádhati*), from the root **dʰeh₁-* 'place' (*LIV* 136-138; *IEW* 235-239) (and for that matter, would Vedic tolerate a form *bibhṛnti*?).

b^{h}eu̯g-s-* (Gk. *p^{h}eúksomai* 'will flee'). Exceptions do occur, though; the instrumental plural ending **-b^{h}is* does not seem to show an associated full-grade (although if it did, based on Proto-Indo-European morphophonotactics we expect it would probably be a pre-form *-b^{h}ei̯s*). Secondly, for many, if not most situations in which it is the righthand sonorant which vocalizes and not the one to its left – whether it is lower in sonority or not – this sonorant would follow the vowel in an associated full-grade form. This is true for example of the instrumental plural form **k̂u̯n̥-b^{h}ís* (Ved. *śvábhiḥ*), built to the root **k̂u̯ón-* 'dog' (*NIL* 436-440); the position of the stem vowel being evident in strong cases of the paradigm, reflected in e.g. Vedic accusative singular *śvā́nam*. Again, exceptions do seem to occur – one being the present stem **h$_2$u̯id^h-i̯é-* (Ved. *vídhyati* 'injure') built to **h$_2$u̯i̯ed^h-* 'injure' (*LIV* 294-295; *IEW* 1127-1128)[4] – but these should be rare, judging by morphophonotactics (root-internal pre- or postvocalic sonorant sequences are infrequent).

Descriptively speaking, integrating into our analysis information about morphological structure – specifically, the location of vowel vis-à-vis sonorants in associated full grade forms – could help us to understand why the second sonorant vocalizes: being postvocalic in full grade, it is in some way more closely associated to the vowel than the initial sonorant, being prevocalic in full grade. (How this association is best formalized will be addressed below.) The fact that not relative sonority, but position, is ultimately the chief criterion for nucleus selection given two adjacent sonorants is thus arguably made more typologically plausible, once we assume the existence of some kind of intervening vocalic element, at some stage of derivation.

We demonstrate the viability of this approach descriptively with a few examples. Returning to the paradigm of 'dog', given the full-grade root form **k̂u̯ón-*, we posit for the instrumental plural an 'intermediate' form *k̂u̯$_V$n-b^{h}is* (setting aside the matter of the high vowel

[4] This root is exceptional also in its initial sequence of laryngeal followed by two sonorants.

in the ending), where subscript *V* represents the position of the vowel deleted in the transition to zero-grade. The ultimate reconstructed form, **k̂u̯n̥-bʰís*, arises from the vocalization of the nasal, which follows the vowel in the associated full grade, as per our hypothesis – again, it is not that this sonorant is simply the righthand of the two, which would be its significance given the traditional approach.

Now of course we have in the very same paradigm forms in which the *u̯* of the root vocalizes over the *n*. Take genitive singular **k̂un -ós* (Ved. *śúnaḥ*, Gk. *kunós*), for instance; what would the account have to say in this case? Certainly we would have to posit a pre-output *k̂u̯*$_V$*n-os*. Crucially, we must claim that the *n* is unavailable as a target of vocalization, a claim we can motivate if we assume that Proto-Indo-European has a relatively strong dispreference against hiatus and onsetless syllables (which †*k̂u̯n̥os* would have). Once the *n* is unavailable as syllabic segment, the door is open to vocalizing the preceding *u̯*, and vocalization of this sonorant instead is exactly what we reconstruct. In fact this outcome should also be generated in cases in which the vocalic element is only preceded by a sonorant, and followed by an obstruent: the present stem **pr̥k̂-sk̂é-* (Ved. *pr̥cchāti*) built to the root **prek̂-* 'ask' (*LIV* 490-491; *IEW* 821-822) shows as much.

On the subject of obstruents, we note that given a morphophonological perspective on sonorant vocalization, which pays attention to the relationship between full- and zero-grade forms, we are compelled to explain the behavior of zero-grades featuring sequences of obstruents. With respect to such environments, we predict two possible outcomes, characterized according to position in the word. The first is retention in some capacity of the full grade vowel, a result which occurs word-initially. Consider scenarios in which two obstruents would be adjacent as the result of zero-grade ablaut: for example, in *-i̯é/ó*-presents built to roots of shape

OeO. Stem forms of this sort are securely reconstructed for the roots **ped-* 'step' (*LIV* 458; *IEW* 790-2), 1.**pek*^{w}- 'make ready' (*LIV* 468; *IEW* 798), and 1.**tek-* 'extend the hand' (*LIV* 618-619; *IEW* 1057-1058), and all show the presence of an ostensibly epenthetic vowel, to break up the otherwise disfavored obstruent cluster: *p_ed-i̯é- (Ved. *pádyate*), *$p_e k^w$-i̯é- (Ved. *pácyate*), *t_ek-i̯é- (Old English *ðicgan*). The position of this vowel is clearly consistent with the position of the vowel of the associated full-grade. On the other hand, when the zero-grade of a root of shape OeO occurs word-internally, no intervening vowel need surface at all. Take for instance the *i*-reduplicated thematic present stem of **tek̂-* 'give birth' (*LIV* 618; *IEW* 1057), **ti-tk̂-é-* (Gk. *tíktǭ*, with metathesis), which shows no trace of a vowel between the two obstruents of the root.

In terms of syllable structure, we might reanalyze the dual outcome of the vocalic remnant between obstruents as conditioned by whether or not the obstruents in question would otherwise necessarily be tautosyllabic. If so (as in word-initial position), then the full grade vowel persists (in some capacity); but if not (as in word-medial position, where the obstruents could be heterosyllabified), then it is deleted. Furthermore, it is likely not insignificant that of the examples considered here, the word-initial obstruent sequences occur before a consonant (glide *i̯*), while the word-medial sequence occurs before a vowel (*e*). The fact that word-initial *tk̂* is apparently permitted in Proto-Indo-European when before a vowel – as suggested by forms featuring full grade of the root **tk̂ei̯-* 'settle' (*LIV* 643-644; *IEW* 626)[5] – leads us to think that the condition might be extended to involve not only necessary tautosyllabicity, but also consequent phonotactic violation (i.e., no complex onsets of shape OOR). Or it may just simply focus exclusively on the latter, in which case it may be difficult to distinguish this account from one in

[5] Although note this root is rather exceptional, in beginning with two stops. Indeed it has been analyzed as derived from a pre-PIE **tk̂-éi̯/i-*, built to the same **tek̂-* mentioned in the text; another stop + stop-initial root, *$d^h g^{wh}$ei̯- 'perish' (*LIV* 150-152; *IEW* 487), has been treated similarly (Lipp 1994 [2001]).

which the vowel is purely epenthetic, to resolve an illicit sequence, and its position simply analogical to the full-grade form of the root.

Of course in order to prove or disprove this theory with some degree of confidence, there are a number of types of forms we should like to examine the behavior of more closely. Unfortunately given the nature of Proto-Indo-European morphophonotactics, many of these will not actually be predicted to exist. For instance, regarding the outcome between obstruents, it would be helpful to see what would happen in an initial sequence OO_VC and a medial sequence $O_{(V)}O_{(V)}C$ – if there is a schwa-like vowel, and if so, where it occurs – but no forms with such shapes can as yet be identified. Regarding sonorant environments, our theory predicts that in a sequence CRRC, the first sonorant will actually vocalize over the second one, provided an associated full grade CeRRC. Again, though, a relevant form will be difficult, if not impossible, to come by, since roots do not generally feature two postvocalic sonorants. The one example of such contained in *LIV*, **b^h^eru̯-* 'boil' (*LIV* 81; *IEW* 143-145), does seem to show reflexes with vocalized *u̯* – Latin *dēfrutum*, Old Irish *bruth* – but these may be analyzed as built to a root **b^h^reu̯-* instead, the existence of which is justified by Germanic **brewwan*.[6]

5.2 Zero-Grade in Sanskrit

While in the introduction to this section, we noted the limited cross-linguistic corroboration for the phenomenon of sonorant vocalization as traditionally analyzed for Proto-Indo-European, this claim requires some clarification. In fact the situation in Sanskrit shows – not unsurprisingly – a marked similarity. The critical point which still lends credence to the claim of typological scarcity, though, is the fact that some effort has been made in the literature to analyze the

[6] Furthermore, the *u̯* of this root may just be suffixal, as suggested by Latin *fermentum*, Old English *beorma* 'barm'. Additionally, *dēfrutum* should be, by sound change, *debritum*; the fact that it is not may be indicative of a relatively late creation.

Sanskrit data *not* in terms of the traditional view of straightforward righthand vocalization, but rather as a phenomenon crucially attuned to the morphological structure of the Sanskrit root. If such accounts are indeed viable, then Sanskrit cannot be said to provide an attested case of the Proto-Indo-European phenomenon as traditionally conceived either. In this subsection we review two such approaches to the vocalization of sonorants in Sanskrit: Steriade (1988) in 5.2.1, and Calabrese (1999) in 5.2.2. We comment on both in 5.2.3.

5.2.1 Steriade (1988)

As part of the background to her broader examination of reduplication in Sanskrit, Steriade (1988: 94-102) reviews the facts of sonorant syllabicity in this language. Save for some details, Sanskrit essentially (and not surprisingly) reflects the system reconstructed for Proto-Indo-European, including the fact that of two sonorants in sequence, it is the second which vocalizes, provided neither is vowel-adjacent. Importantly, though, Steriade departs from tradition – or what the traditional approach might have to say about Sanskrit – in accounting for the vocalization of the sonorants by acknowledging the morphological relationship between an inflected form and its root, rather than treating forms for these purposes as purely phonological objects. She makes the observation that the sonorant always preferentially vocalized, is the one which follows the vowel in the associated full-grade. The *transition* to zero-grade is a crucial component of her analysis, because it is information contained in the full-grade which bears on the ultimate outcome. All else being equal, the full vowel can be the result of epenthesis (to derive full-grade), or the target of deletion (to derive zero-grade); Steriade opts for the latter, given the vowel's unpredictable position within the root, and the consistent size of the full grade (always a heavy monosyllable) as opposed to the zero grade (sometimes heavy, sometimes not). She then derives zero-grade via the syncope rule in (1):

(1) *Zero-Grade Syncope*

$$\begin{array}{l} a \\ | \\ X \rightarrow \emptyset \text{ / if unaccented} \end{array}$$

This rule holds that, straightforwardly enough, full-grade *a* is deleted if unaccented.

As for the consequent vocalization of sonorants, Steriade conceives of the phenomenon as having three components, as shown in (2).

(2) *Sonorant Vocalization*

a. At every stage in the derivation, the nucleus is the leftmost rhyme segment.

b. Only sonorants can be nuclear.

$$\begin{array}{l} \quad {*}[\text{-son}] \\ \qquad\quad | \\ {}_{\sigma}[\ldots[X\ldots]] \end{array}$$

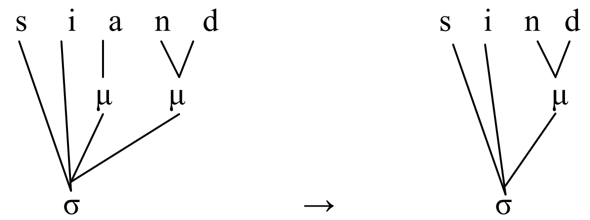
c. Restructuring: a syllable lacking a well-formed nucleus is restructured by reassigning an onset segment to the rhyme.

$[\ldots X_1[X_2\ldots]] \rightarrow [\ldots[X_1X_2\ldots]]$

The point in (2)a. obtains for us the fact that it is righthand (postvocalic, rimal, etc.) sonorants that vocalize. The point in (2)b. obtains for us the fact that righthand (postvocalic, rimal, etc.) obstruents do not vocalize. The point in (2)c. obtains for us the fact that the lefthand (prevocalic, onset, etc.) sonorants vocalize only in the absence of a righthand (postvocalic, rimal, etc.) sonorant.

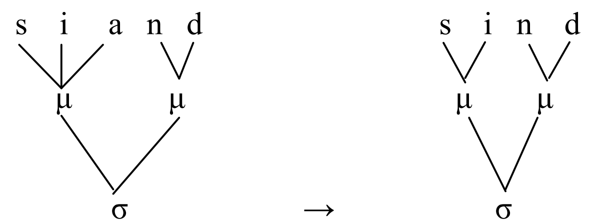
Finally, Steriade notes that, if we wish to translate the account into moraic theory, the facts argue for the representation in (3) as opposed to that in (4) (her (27)-(28), with slight modification): onsets must be differentiated from traditionally rimal segments, even if the concept of the rime is not explicitly invoked; the root under consideration is *syand* 'move on', zero-grade *syn̥d* (surface *syad*), not †*sind*.

(3)



(= syn̥d (→ syad))

(4)



(= †sind)

5.2.2 Calabrese (1999)

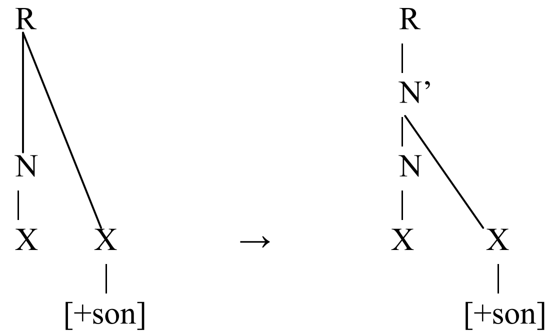
Calabrese (1999: 694-700) presents the approach developed here as a simplified version of Calabrese (1996), which itself is based on Steriade's (1988) proposal as laid out in the previous subsection (696). Like Steriade, he accounts for the zero grade by a rule of syncope, albeit one with a different environment, as shown in (5).

(5) *Zero-Grade Syncope*

X → ø / in certain morphological environments
|
a

This process is usually the second step in the broader phenomenon of sonorant vocalization. In cases in which a postvocalic sonorant becomes syllabic, the syncope of /a/ follows a process of nucleus incorporation, schematized in (6).

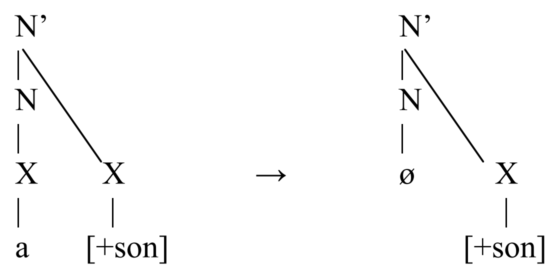
(6) *Nucleus incorporation*



(his (54))

As a result of nucleus incorporation, postvocalic sonorants are in nuclear position. Once this is the case, the syncope occurs, targeting only full grade /a/, which is in nuclear head position:

(7) *Syncope*

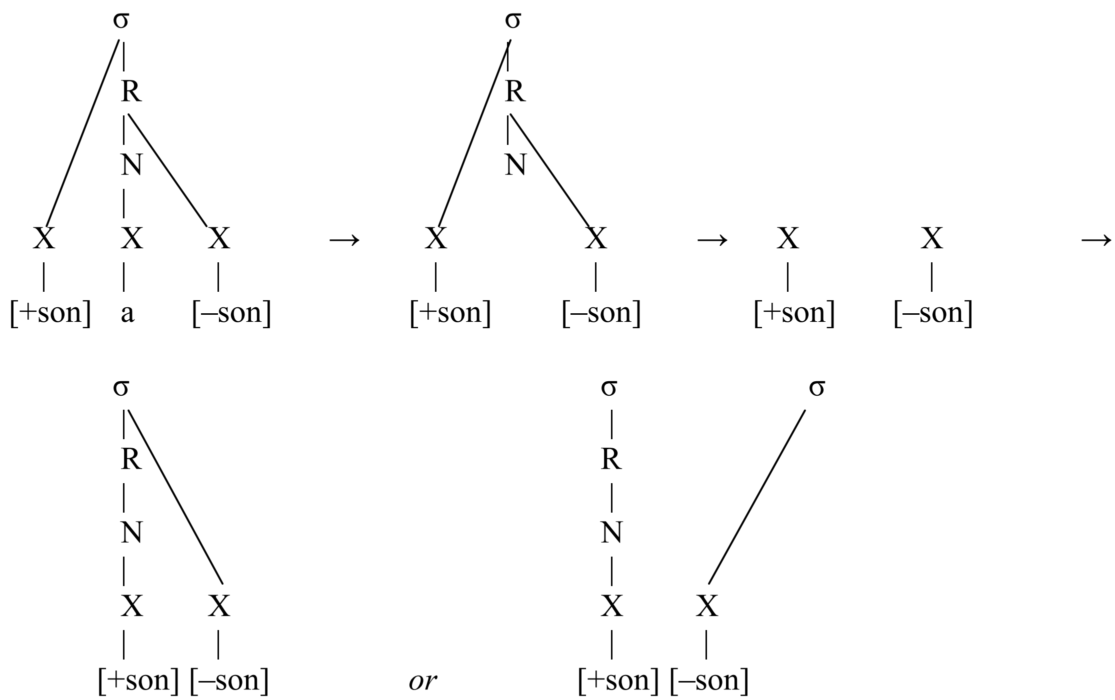


(his (56))

By Calabrese's account, deletion of the nucleus head triggers automatic restructuring, by which the formerly postvocalic sonorant becomes the leftmost nuclear constituent, and therefore, the nucleus head.

Cases in which a prevocalic sonorant vocalizes are defined by the absence of a postvocalic sonorant. In the absence of such a sonorant – i.e., in the absence of a nuclear constituent – Calabrese proposes that the syllable structure is deleted. A consequent process of resyllabification occurs, which assigns nuclear status to the onset sonorant (8).

(8) *Resyllabification*[7]



In the absence of any sonorant – i.e., when vowel /a/ occurs between two obstruents – one of two possible outcomes may hold. If the root syllable is word-initial, Calabrese argues that syncope cannot take place: "if the resyllabification module cannot assign a well-formed representation to the output of a given rule, then the application of this rule is blocked" (699). On the other hand, if the root syllable is not initial, resyllabification can occur, heterosyllabifying the two obstruents into a coda + onset sequence.

5.2.3 Comments

The accounts reviewed in the previous two subsections would seem to provide some theoretical groundwork for the analysis of Proto-Indo-European, developed along similar morphophonological lines, which we sketched descriptively in 5.2. Before formally constructing

[7] Note we assume the initial sonorant is not preceded by a vowel, in which case its vocalization would be blocked.

this analysis in part in 5.4 and in earnest in 5.5, we comment briefly first on two distinctions we must draw, which differentiate the approach we take from that of Steriade and Calabrese.

The first distinction we make is empirical in nature, and concerns Steriade's analysis. Again, she characterizes the syncope rule eliminating the vowel of the full-grade as occurring when said vowel is unstressed. While this may be a valid generalization for Sanskrit (we have reason to think it is not, based on Calabrese's characterization of the environment for the same rule), it cannot be so for Proto-Indo-European, as reconstructed. At at least one stage in this language, it is not the case that lack of accent always triggers zero-grade, as forms such as **septḿ̥* 'seven' (Gk. *heptá*, Ved. *saptá*; possibly contaminated with **oḱtṓ* 'eight') and **u̯ĺ̥k^{w}os* 'wolf' (Ved. *vŕ̥ka-*), which feature accented syllabic sonorants, would suggest. (On the other hand, nothing precludes such a rule's general application at an earlier stage of the language; as Bell 1978 argues, non-prominent vowel reduction is one synchronic source of syllabic consonants.) While Calabrese's "certain morphological environments" is vague to a perhaps undesirable extent, it nonetheless would seem to provide the better description for the environments in which full-grade syncope occurs, at least in the period of Proto-Indo-European under examination.

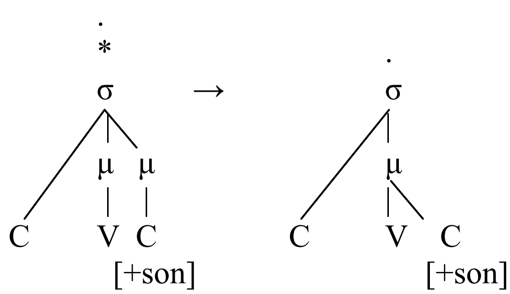
The second distinction we make is formal, and concerns Calabrese's account. Calabrese employs a hyper-articulated conception of syllable structure for the purposes of distinguishing a righthand sonorant from a lefthand one; the former is part of the syllable rime, and more specifically, is incorporated into the nucleus. But the status of such constituents has been a topic of intense scrutiny in the literature (Clements and Keyser 1983, etc.), and current approaches to the syllable in the framework of moraic phonology have seen fit to formally (if not descriptively) do away with them. In this vein Steriade's casting of her analysis in terms of moras is more relevant to the approach we develop.

5.3 Nature of the Zero-Grade in Proto-Indo-European

Before developing a formal analysis of the Proto-Indo-European data using Optimality-Theory, we first pay some attention to the issue of zero-grade ablaut, and how we conceive of it in terms of moraic theory.

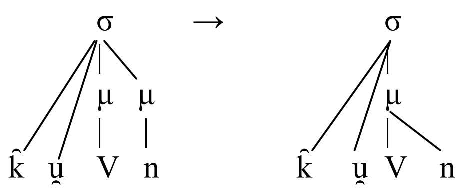
We begin with consideration of a claim by Kager (1989: 166), who presents the description by Liberman and Prince (1977: 299) of a process of coalescence by vowel and tautosyllabic sonorant in English, as a type of destressing by deweighting: compare the second vowel in *transform* versus that in *transformation*, which can be pronounced as a syllabic rhotic in the latter. He analyzes this phenomenon in moraic theory as the "occasional deletion of the second mora linked to a sonorant consonant, and subsequent linking of the segmental melody to the first mora," and schematizes as follows (his (180)):

(9)



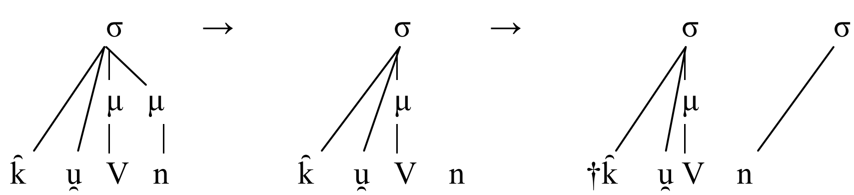
This conception of sonorant coalescence can be adapted to explain vocalization in for example _*k̑u̯n̥b^{h}ís_; we would simply identify zero-grade ablaut as involving deletion of the postvocalic tautosyllabic sonorant's mora. It then links to the mora associated with the vowel, and so is realized as syllabic.

(10)



This case, however, is about as far as Kager's approach can go for the Proto-Indo-European data. To show as much, we next consider the example of **k̂unós*. Here the second sonorant is prevocalic, and as such serves as the onset to the syllable headed by that vowel. As it is occupied in this way, *u̯* has the opportunity to vocalize. But this is not the result predicted, if zero-grade involves loss of a postvocalic mora and – not relevant here – subsequent linking of the sonorant to the preceding one. Rather, we expect that the vowel should surface:

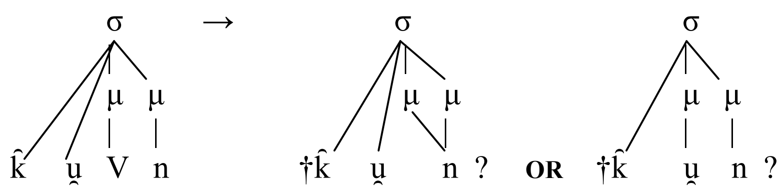
(11)



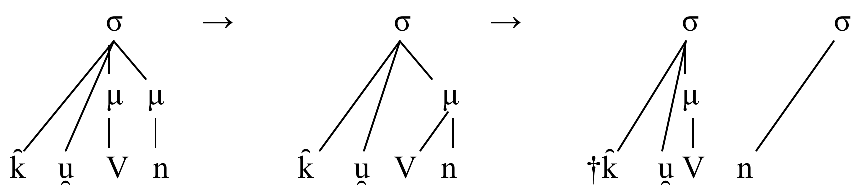
As we can see, if we conceive of zero-grade ablaut in such a way, then the prediction is that any time both conditions are not or cannot be met, the full-grade vowel should surface instead. But this is not what happens.

If we would like to promote an analysis using moraic theory, then it must be the vowel itself which is deleted, its segmental melody together with its mora; of course this is already more in line with the traditional conception of the zero-grade. Note that we cannot simply posit deletion of one or the other – deletion of the vowel's segmental content in a form like **k̂u̯n̥b*^{h}*ís*, with preservation of its mora, would presumably result in a long (bimoraic) syllabic nasal, or perhaps vocalization of *u̯* (12); while deletion of the vocalic mora would predict a full-grade outcome in place of actual **k̂unós* (13).

(12)

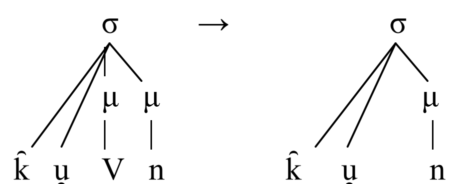


(13)

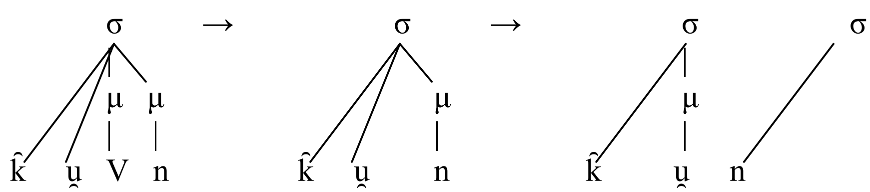


Rather, we conceive of the process of vocalization in a case like **k̂u̯n̥b^{h}ís* to proceed as in (14), and in a case like **k̂unós*, as in (15).

(14)



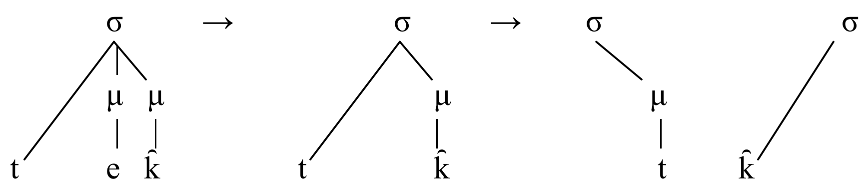
(15)



As the only moraic segment remaining in a sequence lacking a vocalic element, the nasal is favored for syllabic status over the glide in (14); this is in line with the claim by Steriade that the role of syllable nucleus in this phenomenon is filled by the leftmost rimal segment, or in moraic theory, the leftmost segment dominated by a mora. On the other hand, the scenario in (15) is a bit more complicated; we must assume that given the strong preference for onsetful syllables, the nasal delinks from its mora, and this mora subsequently links to the glide, a viable candidate for syllabicity given its status as a sonorant. (Alternatively, in the spirit of Calabrese, we can assume a process of resyllabification eliminates the mora, and a new one is subsequently introduced, associated with the glide.)

Before formalizing this analysis using Optimality Theory, we schematize the treatment of two more types of environment. First, there are cases in which two obstruents flank the full-grade vowel. Obstruents never vocalize, regardless of moraicity. When such a sequence occurs word-medially, the vowel is lost with no subsequent vocalization; the obstruents are accommodated across two syllables. This process is shown in (16) for the root component of the present stem *ti-tk̂-e-.

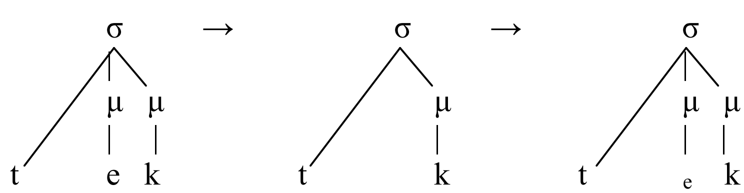
(16)



As the coronal functions as a coda consonant, we assume it must be moraic; likewise, as the palatovelar functions as an onset, the mora associated with it is lost. We may conceive of this outcome as perhaps the result of mora transfer, or as two unconnected processes of mora deletion and epenthesis; in any case we note that moraic quantity is maintained (apart from the loss of the root vowel).

When the sequence of two obstruents occurs word-initially, on the other hand, such recourse to heterosyllabification is unavailable. As such the full-grade vowel is not lost entirely, but rather is retained as a schwa-like element. This is schematized in (17), for the present stem *t$_e$k-i̯é-.

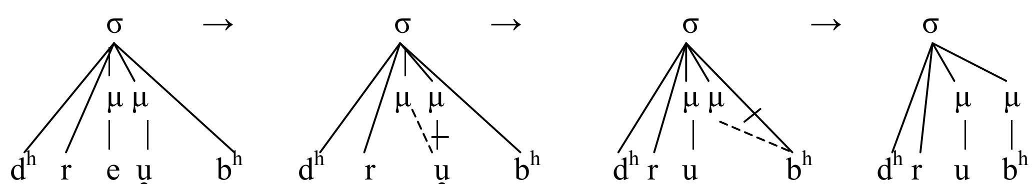
(17)



We see that because an obstruent cannot be a syllable nucleus, the sequence is reconciled by maintaining a vocalic element intervening between the two obstruents. We may conceptualize it as either a (partial) blocking of zero-grade transition, or the usual zero-grade deletion followed by a minimal operation of epenthesis.

We acknowledge that had we started our analysis in consideration of a form like present stem _*d^{h}rub^{h}i̯é-_ (> Gk. _t^{h}ruptǭ_), built to _*d^{h}reu̯b^h-_ 'break' (_LIV_ 156; _IEW_ 275), we might have concluded that both the segmental melody and the mora of the vowel need not be deleted, but only the former. Its mora could then be linked to the following sonorant, and in turn that sonorant's mora could be linked to the following obstruent (18).

(18)



Under this approach, we would need to account for the deletion of the mora in a form like _*k̂unós_, a requirement which parallels our need to explain the insertion of a mora in _*d^{h}rub^{h}i̯é-_ now. We assume the process as developed in view of _*k̂unós_, as we believe it easier to motivate the insertion of a mora in _*d^{h}rub^{h}i̯é-_ rather than its deletion in _*k̂unós_: the former process falls in line with the general behavior of coda consonants to be moraic, while the latter, if to be captured by e.g. a drive to avoid bimoraic syllables, would not find independent support in the language.

5.4 Optimality-Theoretic Formalization

Having sketched the basics of the account descriptively in 5.1 and in terms of moraic theory in 5.3, we turn now to a formal implementation in Optimality Theory (Prince and Smolensky 1993 [2004]).[8]

For a morphophonological approach which is sensitive to full-grade syllable structure, we must assume inputs with moraic content beyond that of a vowel or geminate consonant.

[8] We note that another way of capturing analogy would be to introduce Output-Output constraints (Benua 2000).

Specifically, consonants which find themselves in postvocalic position in full-grade forms maintain the moraicity associated with this position in the zero-grade. Thus we will proceed operating with forms such as k̂u̯n$_{\mu}$-b^{h}is as inputs to the evaluation, as opposed to k̂u̯n-b^{h}is, which featured in the strictly phonological account developed in Chapters 3 and 4. The derivational nature of the account as laid out above presents a problem for classic Optimality Theory, which being concerned with a direct mapping from phonological input to output, leaves no space for intermediate stages of development, or derivation. The vocalization process as conceived here is opaque, in that it is contingent on there being certain information in the input – the moraic status of relevant sonorants – which itself should form part of the output. Nevertheless, for the time being we abstract away from this issue, as ‘derived’ input moraicity would seem to be a necessary element of a morphophonological analysis; we will revisit it to some extent in the next chapter.

In the following discussion, we tackle the relevant data in three main parts: cases in which a moraic sonorant vocalizes (5.4.1), cases in which a non-moraic sonorant vocalizes (5.4.2), and cases in which no sonorant vocalizes – i.e., the environment consists of obstruents (5.4.4). We also examine a special case involving zero-grades of morphemes ending in RO- before a consonant, in which the moraicity of the obstruent, or lack thereof, is a relevant factor (5.4.3).

5.4.1 Moraic Sonorant Vocalizes

In the absence of a full vowel, a moraic sonorant is preferentially vocalized over a non-moraic one, regardless of relative sonority. We account for this outcome with the constraints in (19), with the (preliminary) ranking in (20).

(19) a. SONORITY-SEQUENCING (adapted from Zec 2007: 187)

For every pair of segments *s* and *z* in a syllable, *s* is as or less sonorous than *z* if

(a) (i) $s < z < Nucleus$

or (ii) $Nucleus > z > s$

or (b) (i) $s < z$ and z is the nucleus

or (ii) $z > s$ and z is the nucleus

b. DEP-μ-IO

Output moras should have input correspondents (no mora insertion).

c. *PEAK/X

No syllable peaks of segment class X.

(20) SONORITY-SEQUENCING, DEP-μ-IO » *PEAK/X

As we conceive of the preference for righthand sonorant vocalization to tie directly to the moraic status of that segment, at first blush the analysis might simply and crucially hinge on faithfulness to input moraic structure – in other words, satisfaction of the constraint MAX-μ-IO, omitted here. Alternatively, we conceive of this righthand vocalization as driven by a limited allowance for derived moras, that is, moras that are inserted and lack correspondents in the input form, a situation calling for inclusion of the constraint DEP-μ-IO, as done here. The decision in favor of introducing DEP-μ-IO, and not, at least for the time being, MAX-μ-IO, will become clear in consideration of the first case we consider below, in (21). On another note, our use here of the fixed family of PEAK constraints, as opposed to stringent counterparts, is not intended to be a statement of the superiority of such an approach in this context (the data are amenable to a stringency approach, as well); rather, the interaction of these constraints with DEP-μ-IO simply better illustrates the effect of this faithfulness constraint on the ranking.

We will first apply this ranking to the case of **k̂u̯n̥b*^{h}*ís*, which exemplifies the environment #CReR-C, where *e* marks the position of the full vowel in the full grade of the root. The relavant tableau is given in (21).

(21)

k̂u̯n$_\mu$-b^{h}is	SON-SEQ	DEP-μ-IO	*PK/NAS	*PK/GLI	*PK/V
a. k̂u̯n$_\mu$b^{h}is	*!				
☞ b. k̂u̯n̥$_\mu$b^{h}is			*		
c. k̂u$_\mu$n$_\mu$.b^{h}is		*!		*	
d. k̂u̯V$_\mu$n$_\mu$.b^{h}is		*!			*
e. k̂u̯nb^{h}is	*!				

We have included five candidates for evaluation. In addition to the winning candidate (21)b., which features a syllabic nasal, there are also the candidates (21)a., which reproduces the input exactly, with no change in vocalism; (21)c., which features a syllabic glide (high vowel *u*); (21)d., which features an epenthetic vowel; and (21)e., which reproduces the input, save for deletion of the nasal's mora. Under the constraint ranking in (20), candidates (21)a. and (21)e. are eliminated because they incur sonority-sequencing violations: doing nothing or deleting an input mora results in an unsyllabifiable sequence of segments. Likewise, vocalizing *u* or vowel epenthesis (as in (21)c.-d.) are dispreferred strategies as well, as they each involve mora insertion, and hence violate DEP-μ-IO. We are left with (21)b., which violates neither of the higher-ranked constraints, but only *PK/NASAL. As this constraint, given the fixed ranking of PEAK constraints we choose to operate with, ought to outrank *PK/GLIDE, the presence of DEP-μ-IO crucially prevents the selection of the otherwise preferred †*k̂u*$_\mu$*n*$_\mu$*.b*^{h}*is* (and, for that matter, †*k̂u̯V*$_\mu$*n*$_\mu$*.b*^{h}*is*).[9] Finally, this case demonstrates the limited influence of the aforementioned constraint MAX-μ-IO, which militates against the deletion of input moras. None of the three most viable candidates, (21)b.-d., violate this constraint, as the moraic content of the nasal is

[9] This same result would be generated with stringent constraints as well – any stringent PEAK constraint which *u* would violate, *n̥* would necessarily violate as well.

consistently preserved, if not as a component of the syllable nucleus, then as a component of a coda. Indeed, if we were to include candidates identical to (21)c.-d. save for the moraicity of *n*, we would sooner analyze their elimination as the result of violating relatively highly-ranked *APPENDIX, rather than due to violation of MAX-μ-IO, seeing as how the former is presumably required anyway, as part of a means of accounting for the more general phenomenon of consonantal weight in coda position.

The same preliminary ranking in (20) is also able to generate the correct results in the tableaux in (22) and (23), in which a moraic sonorant again precedes a consonant. The only difference here is that the segment preceding the sonorant happens to be word-initial.

(22) #OR$_{\mu}$RV: **g^{w}m̥-i̯é-* pres. > Gk. *baínǭ* ‘go’ (*LIV* 209-210; *IEW* 464-465)

g^{w}m$_{\mu}$-i̯e-	SON-SEQ	DEP-μ-IO	*PK/OBS	*PK/NAS	*PK/V
a. g^{w}m$_{\mu}$i̯e-	*!				
☞ b. g^{w}m̥$_{\mu}$i̯e-				*	
c. g̥^{w}$_{\mu}$m$_{\mu}$i̯e-		*!	*		
d. g^{w}V$_{\mu}$m$_{\mu}$i̯e-		*!			*
e. g^{w}mi̯e-	*!				

(23) #RR$_{\mu}$RV: **mn̥-i̯é-* pres. > Ved. *mányate* ‘thinks’ (*LIV* 435-436; *IEW* 726-728)

mn$_{\mu}$-i̯e-	SON-SEQ	DEP-μ-IO	*PK/NAS	*PK/V
a. mn$_{\mu}$i̯e-	*!			
☞ b. mn̥$_{\mu}$i̯e-			*	
c. m̥$_{\mu}$n$_{\mu}$i̯e-		*!	*	
d. mV$_{\mu}$n$_{\mu}$i̯e-		*!		*
e. mni̯e-	*!			

Once again, making no change to the input, or deleting an underlying mora, results in a sonority sequencing violation ((22)-(23)a., (22)-(23)e.), while vocalizing a non-moraic segment or epenthesizing a vowel constitutes an unnecessary insertion of a mora ((22)-(23)c.-d.). The winning candidates (22)-(23)b. simply vocalize the moraic sonorant. Note that in the case of (22), we see the candidate in c., featuring a syllabic obstruent, is also militated against due to violation of *PK/OBSTRUENT, which outranks *PK/NASAL under the fixed-ranking approach to these constraints. Furthermore, both it and candidate (23)c. feature onsetless syllables, a result which might conceivably be ruled out by an appropriately-ranked ONSET. In fact we will find it necessary to explicitly introduce each of these constraints below, in consideration of forms undesirably evaluated by the ranking in (20). For now we have simply wished to show what this ranking alone can successfully account for.

5.4.2 Non-Moraic Sonorant Vocalizes

Save for some cases requiring special comment, which will be treated separately in 5.5.3 below, we have exhaustively covered the situations in which a moraic sonorant vocalizes. As such we turn in this section to cases in which a non-moraic sonorant vocalizes. There are two circumstances under which this outcome arises: when a moraic sonorant must fill the role of onset, and when the moraic segment is an obstruent.

A form such as **k̂unós* shows that a segment which would be moraic in a full grade, here the nasal, can be appropriated to satisfy the onset position of a syllable headed by a following vowel – otherwise we expect †*k̂u̯n̥os*, predicted by the analysis as developed thus far:

(24) #ORR$_\mu$V: **k̂un-ós* > Gk. *kunós* gen. sg. 'dog' (*NIL* 436-440)

k̂u̯n$_\mu$-os	SON-SEQ	DEP-μ-IO	*PK/NAS	*PK/GLI	*PK/V
a. k̂u̯n$_\mu$os	*!				
☞ b. k̂u̯n̥$_\mu$.os			*		
c. k̂u$_\mu$n$_\mu$.os		*!		*	
☹ d. k̂u$_\mu$.nos		*!		*	
e. k̂u̯V$_\mu$.nos		*!			*
f. k̂u̯nos	*!				

We assume that the desired winner in (24)d. should lose because of a violation of DEP-μ-IO, incurred by the insertion of the mora associated with *u*. On the other hand, one might interpret this constraint to be satisfied by **k̂unós*, if it is taken as significant that the loss of the nasal mora and the gain of the glide mora balance each other out to a net effect of zero. Under this view, candidate (24)e., with epenthetic vowel, should likewise also satisfy DEP-μ-IO, and indeed, would presumably go on to win the evaluation, since a full (non-high) vowel is a more preferable syllable peak than a syllabic nasal or glide (*PK/VOWEL ranks below both *PK/NASAL and *PK/GLIDE). It is true, though, that without this candidate, **k̂unós* would win, since it features a vocalized glide over a vocalized nasal, but this result is only locally successful, as it would also predict that if in the opposite order – i.e., C*nu̯*V – the glide would still be preferably vocalized, even though it would be expected to be an onset.

Clearly, the ranking requires adjustment, under any view of the nature of DEP-μ-IO. Specifically, we introduce the following two constraints in (25), incorporating them into the updated ranking in (26).

(25) a. DEP-V-IO

Output vowels should have input correspondents (no vowel insertion).

b. ONSET

Syllables have onsets.

(26) SONORITY-SEQUENCING, DEP-V-IO, ONSET » DEP-μ-IO » *PK/X

For now we crucially rank these two additional constraints only with respect to DEP-μ-IO (and by extension, *PK/X); further case studies will require some revision.

The updated tableau for **k̂unós* is given in (27); the influence of the added constraints should be clear.

(27)

k̂u̯n$_\mu$-os	SON-SEQ	DEP-V-IO	ONS	DEP-μ-IO	*PK/NAS	*PK/GLI	*PK/V
a. k̂u̯n$_\mu$os	*!						
b. k̂u̯n̥$_\mu$.os			*!		*		
c. k̂u$_\mu$n$_\mu$.os			*!	*		*	
☞ d. k̂u$_\mu$.nos				*		*	
e. k̂u̯V$_\mu$.nos		*!		*			*
f. k̂u̯nos	*!						

Focusing on the more viable candidates, those in (27)b.-e., we see that any attempt to maintain the moraicity of the nasal, either as a nucleus (27)b. or a coda (27)c., necessarily involves a violation of ONSET, the domain of which we understand to involve militation against *moraic* onsets as much as lack of onset. Of the candidates in (27)d.-e., violation of DEP-V-IO crucially rules out the latter, as it features epenthesis of a full vowel rather than simply vocalization of a segment already present in the input. We are left then with candidate (27)d., **k̂unós*.

As this tableau demonstrates, we must employ a variant of DEP-IO in the hierarchy, rather than the general version itself. In any ranking, DEP-IO would essentially replicate the effect of DEP-μ-IO, as every violation of the latter entails a violation of the former. But important here is the notion that the system prefers to insert the minimum amount of material to render a string syllabifiable: inserting a full vowel is worse than inserting just a mora, or rather, inserting whatever content is needed to make the non-moraic sonorant vocalic is an operation preferred over (and presumably involving less material than) inserting a full-blown independent vowel. It is this preferential hierarchy which we have sought to encode in the introduction and use of the constraints DEP-V-IO and DEP-μ-IO.

With respect to the second scenario by which a non-moraic sonorant vocalizes, namely, when the moraic consonant is an obstruent, additional revision of the constraint ranking is required. As it is the ranking would select candidates which feature a syllabic obstruent:

(28) #RO$_\mu$: *n̥s- aor. (weak) > Gk. *ásmenos* 'saved' (*LIV* 454-455; *IEW* 766-767)

ns$_\mu$-	Son-Seq	Dep-V-IO	Ons	Dep-μ-IO	*Pk/Obs	*Pk/Liq
a. ns$_\mu$-	*!					
b. ns̥$_\mu$-					*	
☹ c. n̥$_\mu$s̥$_\mu$-			*!	*		*
d. nV$_\mu$s$_\mu$-		*!		*		

As Proto-Indo-European does not allow for syllabic obstruents (the issue of laryngeals aside), this is clearly an undesirable result. It is to be avoided by the crucial re-ranking in (29).

(29) Sonority-Sequencing, *Pk/Obs, Dep-V-IO » Onset » Dep-μ-IO » *Pk/C[+son]

The highest fixed Peak constraint, *Pk/Obstruent – which would also be the core Peak constraint under the stringency approach – must rank over both Onset and Dep-μ-IO, as the desired output here, candidate (28)c., violates both of these constraints. The revised tableau is thus as in (30); we omit low-ranked *Pk/Liquid, which the winner also violates, in the interests of space.

(30)

ns$_\mu$-	Son-Seq	*Pk/Obs	Dep-V-IO	Onset	Dep-μ-IO
a. ns$_\mu$-	*!				
b. ns̥$_\mu$-		*!			
☞ c. n̥$_\mu$s̥$_\mu$-				*	*
d. nV$_\mu$s$_\mu$-			*!		*

A further note about the ranking: while the case of **k̑unós* demonstrates the importance of ranking Onset over Dep-μ-IO, it does not actually show that this constraint should also be outranked by Dep-V-IO. Indeed, since every violation of Dep-V-IO entails a violation of Dep-μ-IO, the same result will obtain regardless of their ranking. Rather, the position of Dep-V-IO in the hierarchy in (29) vis-à-vis Dep-μ-IO is made clear in consideration of forms such as the weak aorist stem *$n̥s$-: DEP-V-IO must outrank ONSET (else we expect †*n*V*s*-, with epenthesis), and thus by transitivity also outranks DEP-μ-IO.

The revised ranking in (29) accounts for other cases in which a non-moraic sonorant vocalizes over a moraic obstruent, as shown by the tableaux in (31)-(33); again, relevant low-ranked PEAK constraints are omitted.

(31) #ORO$_{\mu}$: **pr̥k̂-sk̂e-* pres. > Ved. *pr̥ccháti* 'ask' (*LIV* 490-491, *IEW* 821-822)

prk̂$_{\mu}$-sk̂e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. prk̂$_{\mu}$sk̂e-	*!				
b. prk̥̂$_{\mu}$sk̂e-		*!			
☞ c. pr̥$_{\mu}$k̂$_{\mu}$sk̂e-					*
d. prV$_{\mu}$k̂$_{\mu}$sk̂e-			*!		*
e. prk̂sk̂e-	*!				

(32) #RRO$_{\mu}$: **u̯r̥g-éi̯e-* pres. >> Lat. *urgeō*, *-ēre* 'press' (*LIV* 697, *IEW* 1181)

u̯rg$_{\mu}$-ei̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. u̯rg$_{\mu}$ei̯e-	*!				
b. u̯rg̥$_{\mu}$ei̯e-		*!		*	
c. u̯r̥$_{\mu}$g$_{\mu}$ei̯e-				*!	*
☞ d. u̯r̥$_{\mu}$gei̯e-					*
e. u̯rV$_{\mu}$gei̯e-			*!		*
f. u̯rgei̯e-	*!				

(33) #ORRO$_{\mu}$: **h_2u̯id^h-i̯é-* > Ved. *vídhyati* 'injure' (*LIV* 294-295; *IEW* 1127-1128)

h_2u̯i̯d$^h_{\mu}$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. h_2u̯i̯d$^h_{\mu}$i̯e-	*!				
b. h_2u̯i̯d̥$^h_{\mu}$i̯e-		*!			
☞c. h_2u̯i$_{\mu}$d$^h_{\mu}$i̯e-					*
d. h_2u̯i̯V$_{\mu}$d$^h_{\mu}$i̯e-			*!		*
e. h_2u̯i̯d^{h}i̯e-	*!				

The cases presented in (31) and (33) are similar to that of **n̥s-*, save for the fact that the sonorant which vocalizes is not word-initial; the winning candidates do not violate ONSET. Again, the evaluation comes down to candidates which vocalize a preceding sonorant ((31)c. and (33)c.) versus those which insert a full vowel ((31)d. and (33)d.), and results ultimately in selection of the former as most optimal. In (32), ONSET does play a role, as it is the only constraint capable of negotiating between the two most viable candidates in (32)c.-d., which differ only in the treatment of the input moraic obstruent: violation of ONSET rules out (32)c., in which the mora is preserved at the cost of an onsetless syllable.

Note that in all three of these tableaux it is the sonorant which immediately precedes the moraic obstruent which vocalizes, regardless of sonority vis-à-vis any sonorants which may precede it. This is again a reflection of the influence of DEP-μ-IO: vocalizing a sonorant in pre-pre-moraic position will necessarily involve adding more moras than simply vocalizing one in pre-moraic position will, since coda segments are moraic in this language. Additionally, while highly-ranked *PK/OBSTRUENT could now be considered to be decisive in the case of the aforementioned *g^wm̥i̯é-* (22), likewise ONSET in the case of **mn̥i̯é-* (23), and consequently the importance of DEP-μ-IO in the analysis is arguably reduced, recall that this constraint is still nevertheless active, in the evaluation of forms such as **ḱu̯n̥b^hís* (21). Its inclusion in the ranking thus continues to be integral to the viability of the overall analysis.

5.4.3 Special Case: Zero-Grades of …eRO- morphemes before C

Before moving on to sonorant-less zero-grade environments in 5.4.4, we consider in this subsection a particular variant of the scenario discussed in 5.4.1 above, in which the moraic sonorant vocalizes. Relevant forms are distinguished by the fact that they feature a morpheme (typically a root), the full grade form of which features two consonants postvocalically, one sonorant, one obstruent, rather than just a single sonorant. As developed thus far, the analysis is unable to converge on a single most optimal candidate in many such cases, as we will see shortly. In fact, in order to ascertain how the analysis should operate at all, we must explicitly address one issue in particular: namely, the nature of the obstruent here – should it too be treated as moraic, and if so, should this moraicity also be an aspect of the input? Note that we are not suggesting there is a question of whether postvocalic obstruents are moraic at all – rather, the question is whether an obstruent in the more specific environment of VC_. is moraic or not. The answer to this question bears directly on the shape of the input in relevant forms: if a VC_. obstruent is moraic, then it follows that its moraicity should also be in the zero-grade input, just as we have treated the moraicity of a V_. consonant, as shown in the following tableau analyzing an input with an associated full-grade of shape #CeRC.

(34) #OR$_\mu$O$_{(\mu)}$: *b^h*ug-i̯é-* pres. > Lat. *fugiō*, *-ere* 'flee' (*LIV* 84; *IEW* 152)

b^hu̯$_\mu$g$_\mu$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO	*PK/GL
a. b^hu̯$_\mu$g$_\mu$i̯e	*!					
☞ b. b^hu$_\mu$.gi̯e						*
☞ c. b^hu$_\mu$g.i̯e						*
☞ d. b^hu$_\mu$g$_\mu$.i̯e						*
e. b^hV$_\mu$u̯$_\mu$g$_\mu$i̯e			*!		*	
f. b^hu̯gi̯e	*!					

On the other hand, if the obstruent is not moraic, then of course it should not be in the input, and would only be so in an optimal output if in the position V_.; the form in (34) would instead be evaluated as in (35):

(35)

b^hu̯$_\mu$g-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO	*PK/GL
a. b^hu̯$_\mu$g$_\mu$i̯e	*!					
☞ b. b^hu$_\mu$.gi̯e						*
☞ c. b^hu$_\mu$g.i̯e						*
☹ d. b^hu$_\mu$g$_\mu$.i̯e					*!	*
e. b^hV$_\mu$u̯$_\mu$g$_\mu$i̯e			*!		*	
f. b^hu̯gi̯e	*!					

In (34), the constraint ranking equally prefers any of the candidates in b.-d., as none of these violate sonority-sequencing, as (34)a.,f. do, nor do they feature an epenthetic vowel, as (34)e. does. In (35), the constraint ranking as is actually eliminates from contention the desired winner, candidate d., because it features a mora analyzed as inserted.

To be fair, though, there are forms featuring morpheme-final VRO whose treatment does not actually depend on the moraicity of the obstruents, or lack thereof, as shown in (36) and (37).

(36) #RR$_\mu$O$_{(\mu)}$: **lm̥b^h-é-* pres. > Ved. *rábhate* 'take' (*LIV* 411-412; *IEW* 652)

lm$_\mu$b$^h{}_{(\mu)}$-e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. lm$_\mu$b$^h{}_{(\mu)}$e-	*!				
☞ b. lm̥$_\mu$.b^{h}e-					
c. lm̥$_\mu$b^h.e-				*!	
d. lm̥$_\mu$b$^h{}_\mu$.e-				*!	
e. l̥$_\mu$m$_\mu$.b^{h}e-				*!	*
f. l̥$_\mu$m$_\mu$b^h.e-				*!*	*
g. l̥$_\mu$m$_\mu$b$^h{}_\mu$.e-				*!*	*
h. lV$_\mu$m$_\mu$b^{h}e-			*!		*
i. lmb^{h}e-	*!				

(37) #RR$_{\mu}$O$_{(\mu)}$: **d^{h}u̯n̥s-éi̯e-* pres. > Ved. *dhvasáyati* ‘scatter’ (*LIV* 159; *IEW* 268-269)

d^{h}u̯n$_{\mu}$s$_{(\mu)}$-ei̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. d^{h}u̯n$_{\mu}$s$_{(\mu)}$ei̯e-	*!				
☞ b. d^{h}u̯n̥$_{\mu}$.sei̯e-					
c. d^{h}u̯n̥$_{\mu}$s.ei̯e-				*!	
d. d^{h}u̯n̥$_{\mu}$s$_{\mu}$.ei̯e-				*!	
e. d^{h}u$_{\mu}$n$_{\mu}$.sei̯e-					*!
f. d^{h}u$_{\mu}$n$_{\mu}$s.ei̯e-				*!	*
g. d^{h}u$_{\mu}$n$_{\mu}$s$_{\mu}$.ei̯e-				*!	*
h. d^h u̯V$_{\mu}$n$_{\mu}$sei̯e-			*!		*
i. d^{h}u̯nsei̯e-	*!				

In both of these cases satisfaction of ONSET plays a crucial role in the evaluation, as the obstruents in question precede vowel-initial morphemes. In (36), the most optimal output is candidate b., which unlike its chief competition, features no onsetless syllables. Similarly, in (37) four candidates are eliminated because of a violation of ONSET, albeit in this case evaluation comes down to satisfaction of the constraint DEP-μ-IO, given that the word is obstruent-initial (thus blocking the possibility of the initial syllable being onsetless, due to high-ranking *PK/OBSTRUENT). Candidate (37)b. wins because it features no inserted moras, while its opponent (37)e. features one.

Still, apart from these cases, forms such as that presented in (34)-(35) above do clearly demonstrate that the analysis requires adjustment in order to reach a definitive result, regardless of the view one takes concerning the moraicity of VC_. obstruents. Isolating the simplest and most elegant means of doing so, however, will indeed hinge on how one treats these segments, as we will now show.

5.4.3.1 VC_. Obstruents are Moraic

Assuming first that obstruents are indeed moraic in VC_., we require a means of differentiating the disfavored candidates in (34)b.-c. from the desired winner, (34)d. To do so, and thus to ensure a definitive evaluation, we propose to introduce the aforementioned constraint MAX-μ-IO, which, though claimed to be of limited influence for other data in the system, turns out to be well-suited to the matter at hand, as the desired winner (34)d. can be distinguished from the pack due to its preservation of the mora associated with the obstruent *g*. We rank this constraint above the low-ranking, consistently inactive *PK/C[+SON] constraints and on par with DEP-μ-IO, the lowest-ranked, yet still active constraint (recall its importance for the correct evaluation of **k̑u̯n̥b^{h}is*). The revised tableau looks as follows:

(38)

b^{h}u̯$_{\mu}$g$_{\mu}$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO	MAX-μ-IO
a. b^{h}u̯$_{\mu}$g$_{\mu}$i̯e-	*!					
b. b^{h}u$_{\mu}$.gi̯e-						*!
c. b^{h}u$_{\mu}$g.i̯e-						*!
☞ d. b^{h}u$_{\mu}$g$_{\mu}$.i̯e-						
e. b^{h}V$_{\mu}$u̯$_{\mu}$g$_{\mu}$i̯e-			*!		*	
f. b^{h}u̯gi̯e-	*!					**

Candidate (38)d. is selected as most optimal, as it faithfully preserves all input moraic content.

The tableaux in (39)-(40) present further environments for which the most optimal outputs feature VC_. obstruents, a position obtained by virtue of faithfulness to input moraicity.

(39) #RR$_\mu$O$_\mu$: **lip-i̯é-* pres. > Gk. *liptǭ* ‘desire’ (*LIV* 409; *IEW* 671)

li̯$_\mu$p$_\mu$-i̯e-	Son-Seq	*Pk/Obs	Dep-V-IO	Onset	Dep-μ-IO	Max-μ-IO
a. li̯$_\mu$p$_\mu$i̯e-	*!					
b. li$_\mu$.pi̯e-						*!
c. li$_\mu$p.i̯e-						*!
☞d. li$_\mu$p$_\mu$.i̯e-						
e. l̥$_\mu$i̯$_\mu$.pi̯e-				*!	*	*
f. l̥$_\mu$i̯$_\mu$p.i̯e-				*!	*	*
g. l̥$_\mu$i̯$_\mu$p$_\mu$.i̯e-				*!	*	
h. lV$_\mu$i̯$_\mu$pi̯e-			*!		*	
i. li̯pi̯e-	*!					**

(40) #RRR$_\mu$O$_\mu$: **u̯rik̂-i̯é-* pres. > Y. Avestan *uruuisiieiti* ‘turn’ (*LIV* 699; *IEW* 1158-1159)

u̯ri̯$_\mu$k̂$_\mu$-i̯e-	Son-Seq	*Pk/Obs	Dep-V-IO	Onset	Dep-μ-IO	Max-μ-IO
a. u̯ri̯$_\mu$k̂$_\mu$i̯e-	*!					
b. u̯ri$_\mu$.k̂i̯e-						*!
c. u̯ri$_\mu$k̂.i̯e-						*!
☞ d. u̯ri$_\mu$k̂$_\mu$.i̯e						
e. u̯r̥$_\mu$i̯$_\mu$.k̂i̯e					*!	*
f. u̯r̥$_\mu$i̯$_\mu$k̂.i̯e					*!	*
g. u̯r̥$_\mu$i̯$_\mu$k̂$_\mu$.i̯e					*!	
h. u̯rV$_\mu$i̯$_\mu$k̂i̯e-			*!		*	
i. u̯rik̂i̯e-	*!					**

(41) #ORR$_\mu$O$_\mu$: *d^{h}rub^h-i̯é-* pres. > Gk. *t^{h}ruptǭ* ‘break’ (*LIV* 156; *IEW* 275)

d^{h}ru̯$_\mu$b^h$_\mu$-i̯e-	Son-Seq	*Pk/Obs	Dep-V-IO	Onset	Dep-μ-IO	Max-μ-IO
a. d^{h}ru̯$_\mu$b^h$_\mu$i̯e-	*!					
b. d^{h}ru$_\mu$.b^{h}i̯e-						*!
c. d^{h}ru$_\mu$b^h.i̯e-						*!
☞ d. d^{h}ru$_\mu$b^h$_\mu$.i̯e-						
e. d^{h}r̥$_\mu$u̯$_\mu$.b^{h}i̯e-					*!	*
f. d^{h}r̥$_\mu$u̯$_\mu$b^h.i̯e-					*!	*
g. d^{h}r̥$_\mu$u̯$_\mu$b^h$_\mu$.i̯e-					*!	
h. d^{h}rV$_\mu$u̯$_\mu$.b^{h}i̯e-			*!		*	*
i. d^{h}ru̯b^{h}i̯e-	*!					**

With the inclusion of MAX-μ-IO in the ranking, the desired result in each case is generated. The expanded candidate set in these three tableaux is a reflection of the presence of two sonorants in sequence, which in principle means two viable targets of vocalization (as opposed to the case of of *b^hugi̯é- in (38) above). In fact, because of the dispreference for onsetless syllables, which eliminates all of the candiates in (39) featuring vocalic *l*, only the winning forms in (40)-(41) face any serious competition from candidates with a lefthand vocalic sonorant.

To summarize, we have seen that assuming obstruent moraicity in the position VC_. allows for a relatively simple analysis of the relevant data. Introducing MAX-μ-IO into the constraint ranking results in a formal preference for the faithful realization of input moraic content, leading to a stricter state-of-affairs than that which held previously, when we included only DEP-μ-IO to minimize derived moraic content. Furthermore, assuming obstruent moraicity in this position straightforwardly, if not explicitly, accounts for at least some cases of consonant sequence heterosyllabification, specifically the variety in which the two consonants are heteromorphemic.

At this point we acknowledge the preference, mentioned in the discussion of *ḱu̯n̥b^hís above, for capturing coda moraicity through crucial ranking of the constraint *APPENDIX, as opposed to MAX-μ-IO. We note, however, that introducing *APPENDIX alone will not work for these cases: as can be seen, it would only be capable of evaluating the candidates in e.g. (38)c.-d. above; the candidate in (38)b., with complex onset, lacks the relevant structure of a postvocalic, tautosyllabic segment. Rather, relying on *APPENDIX necessitates the introduction of an additional constraint, one by whose violation (38)b. can be eliminated; the most obvious candidate is a constraint militating against complex onsets. The point here is that given the assumption that obstruents are moraic in VC_. position, and thus underlyingly moraic for the purposes of this phenomenon (as it is currently being considered), an account using MAX-μ-IO appears at this point to be the simpler approach, as it requires a single additional constraint over at least two.

5.4.3.2 VC_. Obstruents are not Moraic

We now entertain the alternative hypothesis, which holds that, while obstruents in immediate postvocalic position are moraic, in a position one step removed from the vowel, they are not. For ease of reference, we repeat in (42) the relevant tableau found in (35) above, which again shows how the analysis as is makes the wrong prediction, if we operate with this assumption.

(42)

b^{h}u̯$_\mu$g-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO	*PK/G
a. b^{h}u̯$_\mu$gi̯e-	*!					
☞ b. b^{h}u$_\mu$.gi̯e-						*
☞ c. b^{h}u$_\mu$g.i̯e-						*
☹ d. b^{h}u$_\mu$g$_\mu$.i̯e-					*!	*
e. b^{h}V$_\mu$u̯$_\mu$g$_\mu$i̯e-			*!		*	
f. b^{h}u̯gi̯e-	*!					

Candidate (42)d., which is the desired winner, loses because of its violation of DEP-μ-IO, incurred by the mora of the coda consonant *g*. The evaluation then fails to converge on a single candidate, as (42)b.-c. share identical violation profiles.

We require a means of differentiating these three most viable candidates, ultimately in favor of (42)d. Whereas in the previous subsection we were able to set *b^{h}u$_\mu$g$_\mu$.i̯e-* apart from its competition by virtue of its faithful moraic content – it did not violate MAX-μ-IO while *b^{h}u$_\mu$.gi̯e-* and *b^{h}u$_\mu$g.i̯e-* did – no such recourse is available here; under the current view there is no single parameter in which (42)d. can be distinguished from (42)b.-c. Rather, we must distinguish pairwise between (42)d. and (42)b., and (42)d. and (42)c., and introduce into the constraint ranking two additional constraints. Each of these constraints must outrank DEP-μ-IO; one of them must be violated by (42)b., the other by (42)c.

Comparing first (42)d. and (42)b., we note that the latter features a complex onset, while the former does not. Anticipating the issue posed by forms such as *d^hrub^{h}i̯é-, we opt not to simply introduce the constraint *COMPLEX$_{\text{ONSET}}$ to negotiate this distinction, but rather appeal to the Positional Markedness constraint COINCIDE. This constraint is defined in (43), after Zoll (1998).[10]

(43) 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

As for (42)d. and (42)c., both of which position *g* in the coda, this obstruent is moraic in the former, but not in the latter. We propose, then, to introduce the constraint sub-ranking *APPENDIX » *μ/CONSONANT into the hierarchy, to capture this distinction. The definitions in (44) are also repeated from Chapter 4.

(44) a. *APPENDIX (after Sherer 1994)

 No appendix segments.

 b. *μ/CONSONANT

 Consonants must not be moraic.[11]

As we have noted, both COINCIDE and *APPENDIX should outrank DEP-μ-IO, to prevent elimination of the favored candidate, which violates it. We thus propose the ranking in (45).[12]

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[10] This constraint will also feature later in Chapter 10.

[11] In the following discussion, we conceive of *APPENDIX as applicable only to segments in *immediate* postvocalic position. We readily acknowledge, though, that left unrestrained this constraint has the implication of disfavoring *any* non-moraic postvocalic segment, immediate or otherwise, a fact that complicates the non-moraic view of VC_. obstruents we are examining in the first place.

[12] While this ranking is, as will be seen shortly, capable of generating the correct results, it is nonetheless provisional, in that more work is required to clarify all crucial ranking relationships.

(45) SONORITY-SEQUENCING, *PK/OBSTRUENT » DEP-V-IO » ONSET »

COINCIDE, *APPENDIX » DEP-μ-IO, *μ/CONSONANT

The effect of this revised ranking plays out in the case of input *b^{h}u̯$_μ$g-i̯é-* as follows:

(46)

b^{h}u̯$_μ$g-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APP	DEP-μ-IO	*μ/C
a. b^{h}u̯$_μ$gi̯e-	*!							*
b. b^{h}u$_μ$.gi̯e-					*!			
c. b^{h}u$_μ$g.i̯e-						*!		
☞ d. b^{h}u$_μ$g$_μ$.i̯e-							*	*
e. b^{h}V$_μ$u̯$_μ$gi̯e-			*!				*	*
f. b^{h}u̯gi̯e-	*!							

With appropriately-ranked COINCIDE and *APPENDIX, the candidate in (46)d. is able to emerge as the winner, as it violates neither of these constraints.

The ranking in (45) is also able to account for the treatment of forms like **lipi̯e-*, as shown by the tableau in (47).

(47)

li$_μ$p-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APP	DEP-μ-IO
a. li̯$_μ$p$_μ$i̯e-	*!						
b. li$_μ$.pi̯e-					*!		
c. li$_μ$p.i̯e-						*!	
☞d. li$_μ$p$_μ$.i̯e-							*
e. l̥$_μ$i̯$_μ$.pi̯e-				*!	*		*
f. l̥$_μ$i̯$_μ$p.i̯e-				*!		*?	*
g. l̥$_μ$i̯$_μ$p$_μ$.i̯e-				*!			**
h. lV$_μ$i̯$_μ$pi̯e-			*!				
i. li̯pi̯e-	*!						**

While this form does contain a sequence of sonorants not adjacent to a vowel, given that this sequence is word-initial, any viable candidate in which the lefthand sonorant *l* vocalizes – i.e., (47)e.-g. – will feature an onsetless syllable, and thus incur a violation of ONSET. Remaining candidates are eliminated due to violation of COINCIDE and *APPENDIX, without which the correct result, selection of candidate (47)d., could not be obtained. On the hesitation associated with the violation of *APPENDIX incurred by candidate (47)f., as indicated by the question mark, see fn. 11; in any case, given higher-ranking ONSET, the issue is moot for this form.

When we consider forms featuring a word-internal sequence of sonorants not adjacent to a vowel, we see that the ranking in (45) requires adjustment. Consider the tableau in (48).

(48)

u̯ri̯$_{\mu}$k̂$_{\mu}$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APP	DEP-μ-IO
a. u̯ri̯$_{\mu}$k̂$_{\mu}$i̯e-	*!						
b. u̯ri$_{\mu}$.k̂i̯e-					*!		
c. u̯ri$_{\mu}$k̂.i̯e-						*!	
☞ d. u̯ri$_{\mu}$k̂$_{\mu}$.i̯e							*
e. u̯r̥$_{\mu}$i̯$_{\mu}$.k̂i̯e					*!		*
☞ f. u̯r̥$_{\mu}$i̯$_{\mu}$k̂.i̯e						*?	*
g. u̯r̥$_{\mu}$i̯$_{\mu}$k̂$_{\mu}$.i̯e							**!
h. u̯rV$_{\mu}$i̯$_{\mu}$k̂i̯e-			*!				
i. u̯ri̯k̂i̯e-	*!						**

The problem with the ranking so far lies in the nature of the constraint *APPENDIX: if we understand it to *not* be violated by a non-moraic obstruent in the position VC_., as it seems we must given the overarching assumption we are for the moment operating with, then we have no way of differentiating between the candidate (48)f., in which the obstruent *k̂* occurs in this position, and the desired winner, candidate (48)d. Absent a violation of *APPENDIX, these two forms share an identical violation profile, incurring one violation each of DEP-μ-IO: in (48)f., a mora is added to the vocalized lefthand sonorant *r*, while in (48)d., one is added to coda *k̂*.

To eliminate (48)f. from contention, we must introduce a constraint which it violates, but which (48)d. satisfies. We propose the relevant constraint to be *COMPLEX$_{\text{CODA}}$, defined in (49).

(49) *COMPLEX$_{\text{CODA}}$

Syllables do not have complex codas.

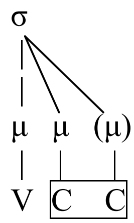
As discernible from the matter at hand, this constraint need only be freely ranked with DEP-μ-IO to generate the desired result; but in consideration of the expected syllabification of the sequence VR.ORV (which will be discussed in more detail in Chapters 9 and 10) we instead crucially rank it over COINCIDE, and on par with ONSET. The tableau in (48) is revised accordingly in (50).

(50)

u̯ri̯$_{\mu}$k̂$_{\mu}$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	*COMP CODA	COINC	*APP	DEP-μ-IO
a. u̯ri̯$_{\mu}$k̂$_{\mu}$i̯e-	*!							
b. u̯ri$_{\mu}$.k̂i̯e-						*!		
c. u̯ri$_{\mu}$k̂.i̯e-							*!	
☞ d. u̯ri$_{\mu}$k̂$_{\mu}$.i̯e								*
e. u̯r̥$_{\mu}$i̯$_{\mu}$.k̂i̯e						*!		*
f. u̯r̥$_{\mu}$i̯$_{\mu}$k̂.i̯e					*!		*?	*
g. u̯r̥$_{\mu}$i̯$_{\mu}$k̂$_{\mu}$.i̯e					*!			**
h. u̯rV$_{\mu}$i̯$_{\mu}$k̂i̯e-			*!					
i. u̯ri̯k̂i̯e-	*!							**

The candidates in (50)f.-g. are disfavored because they both feature complex codas, regardless of the moraic character of the syllable-final obstruent. With the form in (50)f. in particular now so eliminated ((50)f. also being disfavored for insertion of two moras), the evaluation selects (50)d. as most optimal. We note that the viability of this revision rests on the way in which we conceive of the constraint *COMPLEX$_{\text{CODA}}$; specifically we must assume that it has domain over both postvocalic moraic segments (true 'codas') and postvocalic non-moraic segments ('appendices'). In other words, we understand this constraint to govern content strictly at the segmental level of the syllable, and to be unconcerned with any intervening moraic structure; it is minimally violated by the syllable structure in (51).

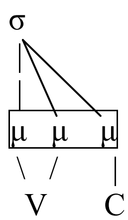
(51) *Minimal Violation of *C**omplex*$_{\textit{CODA}}$



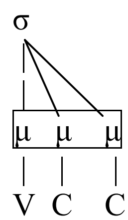
For a comparable constraint which is sensitive moraic structure, we point to the superficially similar *3μ, militating against superheavy syllables; its schema of minimal violation is as in (52).

(52) *Minimal Violation of *3μ*

a.



b.



While the domains of these two constraints can largely overlap in languages with heavy CVC syllables, the data here suggest they are not always interchangeable.

Given the appropriate assumptions, a ranking including *COMPLEX$_{\text{CODA}}$ also works in the final case we examine, the form **d^{h}rub^{h}i̯é-*, similar in shape to **u̯rik̑i̯é-* save for being obstruent-initial. The relevant tableau is given in (53).

(53)

d^{h}ru̯$_\mu$b^h-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	*COMP CODA	COINC	*APP	DEP-μ-IO
a. d^{h}ru̯$_\mu$b^h$_\mu$i̯e-	*!							
b. d^{h}ru$_\mu$.b^{h}i̯e-						*!		
c. d^{h}ru$_\mu$b^h.i̯e-							*!	
☞ d. d^{h}ru$_\mu$b^h$_\mu$.i̯e-								*
e. d^{h}r̥$_\mu$u̯$_\mu$.b^{h}i̯e-						*!		*
f. d^{h}r̥$_\mu$u̯$_\mu$b^h.i̯e-					*!		*?	*
g. d^{h}r̥$_\mu$u̯$_\mu$b^h$_\mu$.i̯e-					*!			**
h. d^{h}rV$_\mu$u̯$_\mu$.b^{h}i̯e-			*!					
i. d^{h}ru̯b^{h}i̯e-	*!							**

Once again, competitors with a complex coda, medial complex onset, or non-moraic segment immediately following a tautosyllabic vowel are all eliminated, and the candidate (53)d. is selected as most optimal, despite its inserted mora and consequent violation of DEP-μ-IO.

5.4.3.3 Which Approach to Take?

In the preceding two subsections we have seen that the simplest way to adjust the analysis to account for the syllabification of morphemes ending in -VRO depends on whether we treat the obstruents in such sequences as moraic. If we assume they are, then the most straightforward revision involves inclusion of MAX-μ-IO in the ranking; but if we assume they are not, then we have seen it necessary to introduce the three active constraints COINCIDE, *APPENDIX, and *COMPLEX$_{CODA}$ (as well as a fourth, low-ranking *μ/CONSONANT).

On the face of it, the more elegant analysis would seem to be the former, since it requires the addition of fewer constraints into the ranking, at the cost of an assumption which is essentially only the logical extension of the one overarching this section as a whole. In fact, though, there are a variety of indications suggesting instead that the alternative hypothesis, that obstruents are indeed not moraic in the position VC_., or at least, the analysis it has entailed, is the way to proceed. On the one hand, as regards the validity of the hypothesis, there is the evidence offered by the operation of Osthoff's Law vowel shortening in the development of Greek; if one posits a syllabification VVO.CV (and by extension, VRO.CV), then one is compelled to conclude that obstruents in such a sequence are non-moraic, since they do not trigger shortening. But of arguably greater import is the fact that the associated analysis, involving the constraints COINCIDE, *APPENDIX, and *COMPLEX$_{CODA}$, is independently justified. Recall that assuming obstruent moraicity in the position VC_. allowed for an account of *some* cases of consonant sequence heterosyllabification – again, the variety in which the two consonants are heteromorphemic. But this leaves other types of consonant sequence heterosyllabification – such as tautomorphemic CC syllabified as C.C[13] – unaccounted for. The treatment of such sequences, as we show in the next subsection, would seem to require the introduction of COINCIDE and *APPENDIX. As for *COMPLEX$_{\text{CODA}}$, as will be shown in Chapter 10, this constraint is needed, given inclusion of COINCIDE in the ranking, to allow for the syllabification VR.ORV. In view of these facts, adding MAX-μ-IO into the system on top of these three appears superfluous by comparison.

5.4.4 No Sonorant Vocalizes

The final situation we will seek to analyze is that in which no sonorant vocalizes. Typically this outcome is an effect of the absence of any sonorants in the sequences in question.[14]

On the subject of zero-grade and obstruents, we now provide a formal analysis for the two outcomes described earlier, which again we differentiated based on position in the word. First, we examine the situation word-initially. In this position, evidence along the lines of forms such as **$t_e$ki̯e-* suggests the presence of a vowel intervening between two obstruents in zero-grade, which precede another consonant. This result is also captured straightforwardly enough regardless of how we adjust the ranking in view of the moraicity of VC_. obstruents; the one integral adjustment we must make, however, is the crucial ranking of *PK/OBSTRUENT over DEP-

[13] Specifically, tautomorphemic -CC after a vowel, or tautomorphemic CC- after a vowel and before a consonant. Before a vowel, tautomorphemic CC- syllabified as C.C is already predicted by a drive to avoid an onsetless syllable (a violation of ONSET), while before a vowel and after a consonant tautomorphemic -CC is expected to be tautosyllabic.

[14] There may be at least one environment featuring sonorants, in which neither a moraic nor non-moraic one vocalizes. Strong forms of stative stems feature a suffix *-eh_1-* with zero-grade of the root. For a root such as 1.**u̯el-* 'include, cover' (*LIV* 674; *IEW* 1138), the associated stative stem is **u̯leh_1-*, suggesting that despite its moraicity in the associated full grade of the root, the sonorant *l* does not vocalize, so as to avoid an onsetless syllable. In addition, the initial glide does not vocalize either; this can also be analyzed as a result of avoiding an onsetless syllable, though we must conceive of the sonority-sequencing principle as allowing a complex onset of shape **u̯l-*.

V-IO, where previously these two constraints were unranked with respect to each other. The importance of this modification is shown in (54).

(54) #OO$_{\mu}$RV: **t$_{e}$k-i̯é-* pres. > Old English *ðicgan* 'receive' (*LIV* 618-619, *IEW* 1057-1058)

tk$_{\mu}$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. tk$_{\mu}$i̯e-	*!				
b. tk̥$_{\mu}$i̯e-		*!			
c. t̥$_{\mu}$k$_{\mu}$i̯e-		*!		*	*
☞ d. tV$_{\mu}$k$_{\mu}$i̯e-			*		*
e. tki̯e-	*!				

It is now the case that insertion of a full vowel as a strategy for resolving sequences with poor sonority profiles is more preferable than one involving vocalization of an obstruent; hence neither candidate in (54)b.-c. fares better than the ultimate winner, (54)d. If the ranking were free or reversed, then candidate (54)b. would be the expected winner, since it does not incur a violation of ONSET (or, for that matter, DEP-μ-IO), as (54)c. does.

When a zero-grade obstruent-only sequence occurs word-internally before a vowel, neither vocalization nor vowel epenthesis occurs, as we observed above: the sequence is able to be accommodated in the syllable structure without recourse to either of these strategies. Specifically, we analyze their treatment as a sequence of coda + onset, meaning the mora associated with onset *k̂* is lost, while one is inserted for coda *t*. However, given the ranking used in (54), this result is not obtained:

(55) #OVOO$_{\mu}$V: **ti-tk̂-é-* pres. > Gk. *tíktō̧* (with metathesis) ‘give birth’ (*LIV* 618; *IEW* 1057)

ti-tk̂$_{\mu}$-e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO
a. titk̂$_{\mu}$e-	*!				
b. ti.tk̥̂$_{\mu}$.e-		*!			
☞ c. ti.tk̂e					
☞ d. tit.k̂e-					
☹ e. tit$_{\mu}$.k̂e-					*!
f. ti.tV$_{\mu}$.k̂e-			*!		*

Under this ranking, while the evaluation does not converge on a single candidate, it nonetheless does eliminate the desired winner, 0e., due to the inserted mora associated with *t*. Candidates 0c.-d. violate none of these constraints, and so are judged equally optimal in the absence of any modification to the ranking.

The point made at the conclusion of the previous subsection about the independent justification for inclusion of the constraints COINCIDE and *APPENDIX should now become clear. We have in this case a tautomorphemic consonant sequence, which we analyze as being heterosyllabified into a coda + onset. Of the two variants of the analysis, only the one involving the pair COINCIDE, *APPENDIX is capable of generating this result (56); introducing only MAX-μ-IO instead would gain us nothing, as neither the desired winning candidate, nor the undesired pair in c.-d., are faithful to the input mora (57).

(56)

ti-tk̂$_{\mu}$-e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APPENDIX	DEP-μ-IO
a. titk̂$_{\mu}$e-	*!						
b. titk̥̂$_{\mu}$.e-		*!		*			
c. ti.tk̂e					*!		
d. titk̂e-						*!	
☞ e. tit$_{\mu}$.k̂e-							*
f. titV$_{\mu}$k̂e-			*!				*

(57)

ti-t͡k$_\mu$-e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONSET	DEP-μ-IO	MAX-μ-IO
a. tit͡k$_\mu$e-	*!					
b. tit͡k̥$_\mu$.e-		*!		*		
☞ c. ti.t͡ke						*
☞ d. tit͡ke-						*
☹ e. tit$_\mu$.͡ke-					*!	*
f. titV$_\mu$͡ke-			*!			(*)

To summarize, in view of the evidence of zero-grade obstruent sequences, we posit the ranking in (58), which incorporates into the hierarchy aspects of the analysis developed under the assumption that VC_. obstruents are not moraic, namely, again, the constraints *COMPLEX$_{\text{CODA}}$, *APPENDIX, and COINCIDE.

(58) SONORITY-SEQUENCING, *PK/OBSTRUENT » DEP-V-IO » ONSET, *COMPLEX$_{\text{CODA}}$ » COINCIDE, *APPENDIX » DEP-μ-IO, *μ/CONSONANT

It is in fact the case, as perhaps has been noticed by this point in the discussion, that the ranking in (58) is compatible with *either* view of VC_. obstruent moraicity. Of course we have already seen how the analysis works without positing such moraicity, and so without including it in the input; the tableau in (59) demonstrates how, if we maintain the alternative view, the analysis is still capable of generating the correct outcome.

(59)

b^{h}u̯$_\mu$g$_\mu$-i̯e-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APPENDIX	DEP-μ-IO
a. b^{h}u̯$_\mu$g$_\mu$i̯e	*!						
b. b^{h}u$_\mu$.gi̯e					*!		*
c. b^{h}u$_\mu$g.i̯e						*!	*
☞ d. b^{h}u$_\mu$g$_\mu$.i̯e							
e. b^{h}V$_\mu$u̯$_\mu$g$_\mu$i̯e			*!			*	*
f. b^{h}u̯gi̯e	*!						

Candidate (59)d. is the winner, violating no constraints in the hierarchy. But the input moraic content associated with the obstruent *g* is ultimately preserved in the interests not of an explicit preference to do so (as the constraint MAX-μ-IO would involve), but rather of a dispreference for a segment in *g*'s position to be a syllable appendix.

The fact that by virtue of the interactions of the constraints in the ranking, the same result is generated despite the shape of the input in this respect, is a desirable result, and one expected to hold under the notion of Richness of the Base. The implications of this outcome are raised at the conclusion of the next subsection, and will be addressed in detail in 5.5.

5.4.5 Sonorant Vocalization in Non-Zero-Grade Environments

Although we have so far developed the account of sonorant vocalization treating the phenomenon as exclusively an effect of the morphologically-conditioned transition to zero-grade ablaut, as already noted above in 5.2 there are also forms which can be analyzed as featuring syllabic sonorants, albeit outside of a zero-grade context. The aforementioned instrumental plural ending *-b^{h}is*, for instance, is reconstructed entirely as is, without an associated full-grade.

On the face of it, the traditional account, being purely phonological in nature, is to be preferred to the morphophonological alternative, seeing as how it can easily accommodate forms such as *-b^{h}is*. It might seem as though incorporating explanation of *-b^{h}is* et al. within the boundaries of the latter's explanatory breadth would require us to posit a series of associated full-grades, the members of which so far as we know are not actually reflected in any of the daughter languages. This step turns out not to be necessary, however, once we subject a form like the instrumental plural ending *-b^{h}is* to evaluation by the finalized constraint ranking in (59), as demonstrated by the tableau in (60); only the relevant constraints are included.

(60)

/-b^{h}i̯s/	Son-Seq	*Pk/Obs	Dep-V-IO	Dep-μ-IO
a. -b^{h}i̯s	*!			
☞ b. -b^{h}i$_μ$s$_μ$				**
c. -b^{h}i̯s̥$_μ$		*!		*
d. -b^{h}V$_μ$i̯$_μ$s			*!	**
e. -b^{h}i̯V$_μ$s$_μ$			*!	**

Given the high-ranking drive to abide by the sonority-sequencing principle, whereby here a coda featuring a sonority reversal would be disfavored (60)a., vocalizing the glide *i̯* is the preferred strategy, despite the consequent violations of Dep-μ-IO incurred by insertion of two moras, one for the nucleus, the second for coda *s* (60)b. Minimizing mora insertion by vocalizing *s* incurs a violation of high-ranking *Pk/Obstruent (60)c., while inserting a full vowel runs afoul of Dep-V-IO (60)d.-e.

5.4.6 Nucleus Selection in Full-Grade

Before concluding our discussion of the morphophonological approach to sonorant vocalization, we examine one final type of environment to ensure the viability of the analysis as developed, namely, those in which sonorants occur in full-grade forms. It is expected that in such cases, sonorants will have no need to vocalize, assuming they are adjacent to a full vowel, as they would occur in a sequence perfectly syllabifiable. This is exactly the result predicted by the analysis, as shown by the tableau in (61).

(61) #OV$_μ$RO: **b^{h}éi̯d-e-* pres. > Lat. *fīdō*, *-ere* 'trust' (*LIV* 71-72; *IEW* 117)

/b^{h}e$_μ$i̯d-e-/	Ons	Coinc	*App	Dep-μ-IO	*Pk/N	*Pk/L	*Pk/G	*Pk/V
a. b^{h}e$_μ$i̯.de-			*!					*
☞ b. b^{h}e$_μ$i̯$_μ$.de-				*				*
c. b^{h}e̯i$_μ$.de-				*			*!	
d. b^{h}e$_μ$.i$_μ$.de-	*!			*			*	

Given the constraint ranking, the evaluation comes down to the candidates in (61)b.-c., with the candidate in (61)b. ultimately selected as most optimal because it features the non-high vowel as syllabic, rather than the glide / high vowel, as in (61)c. Unlike the analysis developed in Chapter 3, we need not introduce constraints of the MARGIN family to force this outcome, simply because we have been using fixed PEAK constraints; the constraint DEP-μ-IO crucially differs from the proposed constraint $\mathbb{C}$ (later identified with ALIGN-L(μ, PrWd)), in being equally violated whether or not a non-high vowel before a sonorant is a syllabic peak.

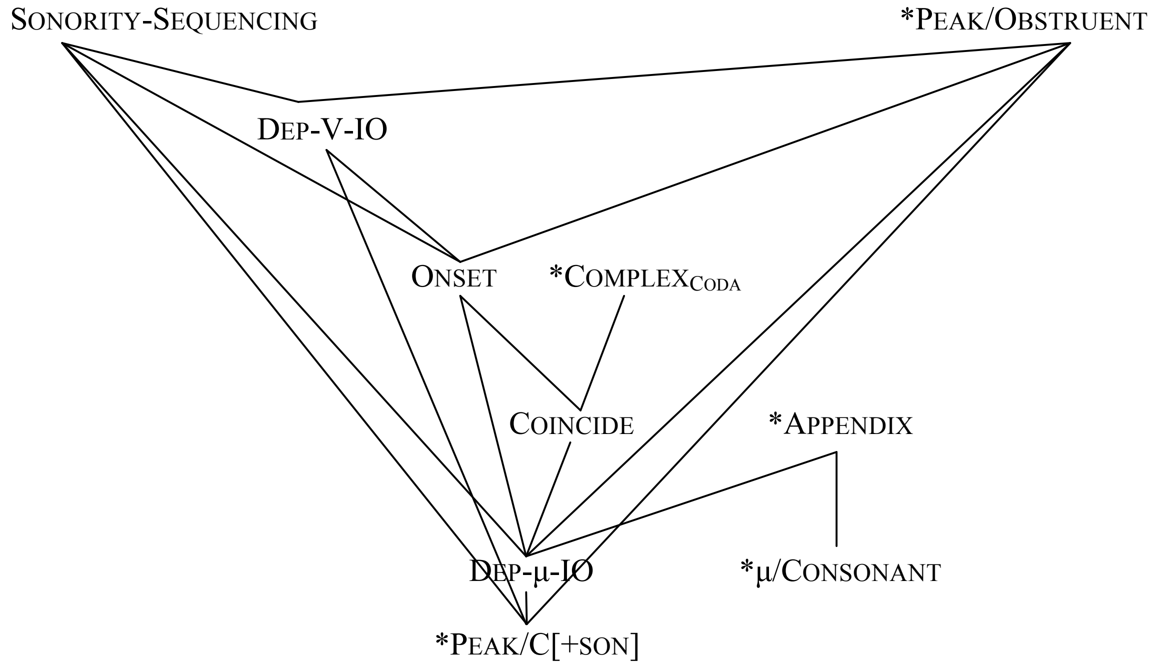
Note the absence of a mora associated with the glide in the input (and, relatedly, the use of slashes); we assume that, as per the standard approach in current phonological theory, all moraicity in full-grade forms, save for that associated with non-high vowels, is derived. In fact the issue is moot, in the sense that regardless of whether the glide is moraic in the input or not, (61)b. will be the winner: whatever its violation profile for DEP-μ-IO, its rival (61)c. matches it.

5.4.7 Conclusion

In this section we have sought to construct an alternative approach to sonorant vocalization in Proto-Indo-European, in the interests of overcoming its typologically unusual (but not unattested) insensitivity to general sonority distinctions. Inspired by work on Sanskrit by Steriade (1988) and Calabrese (1999), we have centered the analysis around the observations that, first, sonorants vocalize most often in zero-grade environments, and second, a syllabic sonorant in such an environment typically is the one following a vowel in an associated full-grade form.

Conceptualized in the framework of moraic theory, and formalized in the framework of Optimality Theory, we have analyzed the phenomenon as motivated crucially by a drive to minimize the insertion of moraic content. The data have been successfully captured by the constraint ranking in (62).

(62)



While we have proceeded in this section assuming the importance of input moraic structure to the success of the analysis, we have in fact shown in the previous three subsections that the presence or absence of input moraicity in at least three situations does not actually matter in the selection of optimal outputs. In these cases, rather, it has been the interactions of the constraints in the assembled ranking which have led to the correct results. This state-of-affairs raises a broader question about the nature of the input within the morphophonological approach to Proto-Indo-European sonorant vocalization we have been pursuing in this section: as we have rendered the issue of e.g. input VC_. obstruent moraicity moot, can we do likewise for *all* input coda moraicity? That is, do we even need to make a morphological appeal to the relationship between full- and zero-grade, if the burden of the analysis lies squarely on the constraint ranking? This matter is taken up in earnest in the next section.

5.5 Discussion

5.5.1 The Alternatives Reviewed

When all is said and done, the rankings for the traditional, phonological account of sonorant vocalization in Proto-Indo-European, and the morphological alternative, are not remarkably different. We present these rankings in (63).

(63) a. <u>Phonological Ranking</u>

SONORITY-SEQUENCING, *PK/OBSTRUENT, *MAR/VOWEL » DEP-IO » ALIGN-L(μ, PrWd), ONSET » *PK/NASAL » *PK/LIQUID » *PK/GLIDE

b. <u>Morphophonological Ranking</u>

SONORITY-SEQUENCING, *PK/OBSTRUENT » DEP-V-IO » ONSET » *COMPLEX$_{\text{CODA}}$ » COINCIDE, *APPENDIX » DEP-μ-IO, *μ/CONSONANT » *PK/NASAL » *PK/LIQUID » *PK/GLIDE

These rankings basically share in common a set of highest-ranked constraints, and a set of lowest-ranked constraints. Intervening are sets of constraints differing somewhat in their make-up and ordering. Even here, though, we note that there should not be much difference: once we factor in the need to generate moraic codas, *APPENDIX » *μ/CONSONANT becomes a crucial part of the ranking in (63)a. Furthermore, while we did not introduce the constraints *COMPLEX$_{\text{CODA}}$ and COINCIDE into the phonological ranking as it was developed in Chapter 3 and refined in Chapter 4, nonetheless we will find need to do so, once we consider how to extend the account to cover the heterosyllabic treatment of medial consonants (see Chapter 10). So despite coming at the issue from two distinct perspectives, we are left with rankings that are not that different.

One crucial distinction between our Optimality-Theoretic formalization of the traditional, phonological approach to Proto-Indo-European sonorant vocalization, and our formalization of the morphophonological alternative, is the fact that the morphophonological approach requires a derivational component to take place prior to the evaluation of relevant data, such that ostensibly derived moraicity is part of the input to said evaluation. As the inclusion of a predictable phenomenon already in the input to evaluation goes against the classic conception of Optimality Theory, its absence in the traditional approach is arguably to this account's benefit. We address this matter more fully in the next section.

5.5.2 A Need for Input Moraicity?

As may perhaps have been noticed, indeed for none of the data considered in 5.4 were we compelled to rely on the constraint MAX-μ-IO. Even where this constraint seemed to provide for a relatively elegant account – assuming VC_. obstruents are moraic – it was shown that MAX-μ-IO in such a case would have to be introduced on top of the already independently-motivated constraints COINCIDE, *APPENDIX, and *COMPLEX$_{CODA}$, thereby rendering any semblance of elegance specious at best. As MAX-μ-IO is the only constraint concerned with input moraicity, requiring faithful realization thereof, if we do not need it for a successful analysis, the obvious question is, do we actually need input moraicity of the sort we have assumed at all?

We have already shown above that an analysis consisting of the trio COINCIDE, *APPENDIX, and *COMPLEX$_{CODA}$, but not MAX-μ-IO, is compatible with either view of VC_. obstruent moraicity, a result in accordance with Richness of the Base. In fact such an analysis will also work regardless of whether we assume V_. moras to be present in the input, as in (64), or not, as in (65).

(64)

k̂u̯n$_{\mu}$-b^{h}is	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APP	DEP-μ-IO	*PK/NAS
a. k̂u̯n$_{\mu}$b^{h}is	*!							
☞ b. k̂u̯n̥$_{\mu}$.b^{h}is								*
c. k̂u$_{\mu}$n.b^{h}is						*!	*	
d. k̂u$_{\mu}$n$_{\mu}$.b^{h}is							*!	
e. k̂u̯V$_{\mu}$n$_{\mu}$.b^{h}is			*!				*	
f. k̂u̯nb^{h}is	*!							

(65)

k̂u̯n$_{\mu}$-b^{h}is	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	COINCIDE	*APP	DEP-μ-IO	*PK/NAS
a. k̂u̯n$_{\mu}$b^{h}is	*!							
☞ b. k̂u̯n̥$_{\mu}$.b^{h}is							*	*
c. k̂u$_{\mu}$n.b^{h}is						*!	*	
d. k̂u$_{\mu}$n$_{\mu}$.b^{h}is							**!	
e. k̂u̯V$_{\mu}$n$_{\mu}$.b^{h}is			*!				**	
f. k̂u̯nb^{h}is	*!							

The evaluations presented in these two tableaux proceed along similar lines. Candidates (64)-(65)a.,e.,f. are all eliminated fairly early on, due to violations of high-ranking SONORITY-SEQUENCING and DEP-V-IO. The remaining viable candidates are then (64)-(65)b.-d., with (64)-(65)c. eliminated due to their featuring a syllable appendix in the form of *n*. Of (64)-(65)b.,d., the selection of (64)-(65)b. comes down to these candidates' featuring one fewer violation of DEP-μ-IO, whether none compared to one in (64), or one compared to two in (65). With respect to the slight difference in the ranking between (64) and (65), again, assuming the moraicity of nasal *n* to be absent from the input allows for a non-crucial ranking of the low constraints DEP-μ-IO and *PK/NASAL (more generally, all PEAK constraints making reference to sonorants).

Given this finding, moraic structure is apparently not required to be present in the input for the phenomenon of sonorant vocalization in Proto-Indo-European. And if moraic structure is not necessary, the consequent need to recognize a derivationally opaque flavor to the phenomenon – involving, namely, the persistence of moraicity in the transition from full-grade to zero-grade ablaut – and more generally, the motivation to craft a morphophonological account in the first place, also become moot. If we do away with this requirement, the overall effect, then, is an analysis that adheres more closely to the traditional conception of Optimality Theory, and is arguably more elegant as a result. So should we proceed accordingly?

For now we believe so, despite the fact that in some sense we have come back to the concern motivating the substance of this chapter in the first place, namely the ostensible rarity of the phenomenon from a cross-linguistic standpoint (the Shuswap data to be presented in the next chapter notwithstanding). On this point we make the following comment. Over the course of this discussion, we have come to demonstrate that the phenomenon of righthand sonorant vocalization is in and of itself straightforwardly analyzed in the current theoretical framework of Optimality Theory. We need introduce no additional machinery, but rather the data, as interpreted, are amenable to approaches using formalisms already proposed in the literature and shown to be crucial in accounting for the behavior of one language or another. For example, the stringency approach to constraint families like PEAK and MARGIN which we entertained in Chapter 3 was key to a successful account of vowel conflation in the stress assignment of Nganasan, as investigated by de Lacy (2004) (although he used constraints from the more basic families *H(EA)D and *NON-H(EA)D). How many other languages display the same type of conflation that this language does? While a valid concern, more important than whether multiple languages can be shown to behave in the same way is de Lacy's broader claim, that conflation should target only adjacent members of a hierarchy, a criterion which Proto-Indo-European nucleus selection satisfies. More generally, the generation of typologies by alternative constraint rankings is a core predictive asset of Optimality Theory; that an analysis can be so elegantly achieved using established means, but an idiosyncratic ranking, is a result which arguably itself speaks to the plausibility of the phenomenon under consideration.

Doing away with input moraicity of sonorants, the constraint ranking should thus be as in (66).

(66) SONORITY-SEQUENCING, *PK/OBSTRUENT, *MAR/VOWEL »
(*COMPLEX$_{CODA}$ » COINCIDE,) DEP-IO » ALIGN-L(μ, PrWd), ONSET »
*PK/NASAL » *PK/LIQUID » *PK/GLIDE

CHAPTER 6

DISCUSSION

6.0 Introduction

In this chapter we discuss a number of issues related to the account developed in Chapters 3 and 4. First, in 6.1 we deploy the analysis, applying it to a host of environments to demonstrate its ability to select the desired sonorant for vocalization. We then proceed in 6.2 to reconsider the exceptional cases identified by Schindler (1977b), and examine how they may be accounted for under our approach. In 6.3 we introduce data from multiple unrelated languages which also feature syllabic consonants, in the interests of situating the Proto-Indo-European phenomenon within a more explicit typology. We conclude in 6.4.

6.1 Deploying the Analysis

The fixed PEAK / MARGIN analysis initially developed in Chapter 3 and revised in Chapter 4 is repeated below in (1). Relying on this constraint ranking, we will now seek to exhaustively account for the behavior of sonorants in all of the environments in which they may occur.

(1) *PK/OBSTRUENT, *MAR/VOWEL » DEP-IO » ALIGN-L(μ, PrWd), ONSET »
*PK/NASAL » *PK/LIQUID » *PK/GLIDE

We will begin in 6.1.1 with environments containing a single sonorant, then proceed to those containing two sonorants in 6.1.2 and three sonorants in 6.1.3. In general we will abstract away from consideration of output candidates violating high-ranking *PK/OBSTRUENT and *MAR/VOWEL, since obstruents are never syllabic and vowels are never marginal; in some cases, though, inclusion of such forms will prove useful for purposes of comparison.

We also note at the outset that, while ALIGN-L(μ, PrWd) is concerned with the location of syllable boundaries, we will not consistently consider exhaustively-parsed output candidate sets, as our main interest lies in capturing the behavior of sonorants. Rather, candidates will be syllabified only in so far as either the constraints evaluated against warrant them, or our understanding of syllable structure demands: for instance, given a sequence of two vocalic elements, we will explicitly include an intervening syllable boundary V.V, as we assume such units cannot be tautosyllabic; similarly, given a sequence of sonorant + obstruent, we will syllabify R.O, as such a sonority reversal is not permitted syllable-initially.[1]

6.1.1 Single Sonorant Environments

We first consider cases in which the single sonorant is consonantal (6.1.1.1), followed by cases in which it is syllabic (6.1.1.2). Environments are further differentiated by the sonorant's ultimate position in the word: word-initial syllable (onset or nucleus), word-medial position (i.e., following at least one vocalic environment), and word-final syllable.

Note that for the current purposes we will simply assert the syllabifications VC.CV, VC.CCV where relevant; on the issue of medial consonant sequence heterosyllabicity, see Part II, and, in particular, Chapter 10, where we extend the account to generate this result. We also understand an active ranking of *APPENDIX over *μ/CONSONANT, to compel the moraicity of coda consonants.

6.1.1.1 Sonorants are Consonantal

All of the environments in which a single sonorant is consonantal are straightforwardly accounted for by the fixed PEAK / MARGIN analysis. Syllabic sonorants in such sequences,

[1] Eventually this will be forced through explicit introduction of the constraint SONORITY-SEQUENCING; see below.

featured in the second candidates in each of the following tableaux, incur an unnecessary violation either of ALIGN-L(μ, PrWd), as in (2)b., or a relevant PEAK constraint, as in (2)a. Note that we omit the constraint ONSET here, although we have seen fit to introduce it in the discussion in Chapter 4, since its inclusion is not justified by these forms, whose evaluations proceed successfully regardless. Again, violations of ALIGN-L(μ, PrWd) equal the sum of the distance of each mora from the left edge of the prosodic word, calculated in terms of segments; so for example in (2)b., the candidate in i. has six violations, two for the mora associated with the first *e*, four for the mora associated with the second *e*, while the candidate in ii. has seven violations, one for the mora associated with vocalized *i*, two for the mora associated with the first *e*, and four for the mora associated with the second *e*.

(2) *Single Sonorants: Word-Initial Syllable, Consonantal*

a. #_V: **léĝ-e-* pres. > Gk. *légō̜* 'gather' (*LIV* 397; *IEW* 658)

/leĝ-e/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. le.ĝe-	****			
ii. l̥.e.ĝe-	****		*!	

b. #O_V: **ti̯égʷ-e-* pres. > Gk. *sébomai* 'feel shame before' (*LIV* 643; *IEW* 1086)

/ti̯egʷ-e-/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. ti̯e.gʷe-	******			
ii. ti.e.gʷe-	*******!			*

(3) *Single Sonorants: Word-Medial, Consonantal*

a. O_V: **té-tm-e-* aor. > Gk. ep. *étetme* 'met at, reached' (*LIV* 624; *IEW* --)[2]

/te-tm-e-/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. tet.me-	*******			
ii. te.tm̥.e-	********!	*		
iii. te.tV.me	********!*			

[2] A Homeric hapax.

b. V_O: *b^héi̯d-e- pres. > Lat. *fīdō*, *-ere* ‘trust’ (*LIV* 71-72; *IEW* 117)

/b^hei̯d-e-/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. b^hei̯.de-	*******			
ii. b^he.i.de-	*******			*!

c. V_V: *b^hér-e- pres. > Ved. *bhárati* ‘bears’ (*LIV* 76-77; *IEW* 128-132)

/b^her-e-/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. b^he.re-	****			
ii. b^he.r̥.e-	*****!*		*	

(4) *Single Sonorants: Word-Final Syllable, Consonantal*

V_#: *h_1éḱu̯-o-m* > Gk. *híppon* acc. sg. ‘horse’ (*NIL* 230-233)

/h_1eḱu̯-o-m/	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. h_1eḱ.u̯om	***********			
b. h_1eḱ.u̯o.m̥	***********	*!		

6.1.1.2 Sonorants are Syllabic

Sonorants become syllabic in the absence of an established syllable nucleus. We can thus conceive of their permissibility in such cases as a means of resolving violations of the sonority sequencing principle; in an Optimality-Theoretic analysis, this is reflected in a high-ranking (if not undominated) position for the constraint SONORITY-SEQUENCING, defined in (5):

(5) SONORITY-SEQUENCING (adapted from Zec 2007: 187)

For every pair of segments *s* and *z* in a syllable, *s* is as or less sonorous than *z* if

(a) (i) $s < z < Nucleus$

or (ii) $Nucleus > z > s$

or (b) (i) $s < z$ and z is the nucleus

or (ii) $z > s$ and z is the nucleus

Importantly, we posit for Proto-Indo-European a relatively weak notion of sonority sequencing, which tolerates sonority plateaus at least in the position preceding the nucleus, if not following it as well, but does not abide sonority reversals.

In each of the following tableaux, the first candidate features a disfavored sonority reversal, and so is eliminated from consideration by SONORITY-SEQUENCING, while the third candidate features an epenthetic vowel, and as such is eliminated due to violation of DEP- IO. Ultimately the second candidate is then able to emerge as the most optimal one.

(6) *Single Sonorants: Word-Initial Syllable, Syllabic*

a. #_O: *n̥s- aor. (weak) > Gk. *ásmenos* 'saved' (*LIV* 454-455; *IEW* 766-767)

/ns-/	SON-SEQ	*PK/OBS	DEP-IO	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. ns-	*!						
☞ ii. n̥s-					*		
iii. ns̥-		*!		*			
iv. nVs-			*!	*(*)			

b. #O_O: *b^hug-i̯é- pres. > Lat. *fugiō*, *-ere* 'flee' (*LIV* 84; *IEW* 152)

/b^{h}u̯g-i̯e-/	SON-SEQ	DEP-IO	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. b^{h}u̯gi̯e-	*!					
☞ ii. b^{h}ug.i̯e-			*******			*
iii. b^{h}Vu̯.gi̯e-		*!	********			

(7) *Single Sonorants: Word-Final Syllable, Syllabic*

O_#: *pó/ed-m̥* > Gk. *póda* acc. sg. 'foot' (*NIL* 526-540)

/pod-m/	SON-SEQ	DEP-IO	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
a. podm	*!					
☞ b. po.dm̥			****			*
c. po.dVm		*!	********			

6.1.2 Two Sonorant Sequences

Sequences of two sonorants in absolute word-initial position differ in their treatment depending on the nature of the following segment: if it is a vowel, both sonorants are usually consonantal; if it is a consonant, the first is consonantal, the second, vocalic.

Only one of these scenarios fall out of the ranking established thus far (including high-ranking SONORITY-SEQUENCING), the first, which is illustrated by the tableau in (8)a. As stated above, the appropriate conception of the sonority sequencing principle holding here must allow for complex onsets of flat sonority (i.e., .RRV in (8)a.), or at least, complex onsets of the particular shape *ml-*, in initial position.

(8) *Two Sonorants: Absolute Word-Initial*

a. #_ _V: **mléu̯h₂-* pres. > Ved. *brāvīti* 'says' (*LIV* 446-447; *IEW* --)

/mleu̯h₂-/	SON-SEQ	DEP-IO	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ i. mleu̯h₂-			*****			
ii. ml̥.eu̯h₂-			******!		*	
iii. m̥.leu̯h₂-			*****	*!		
iv. m̥.l̥.eu̯h₂-			******!	*	*	
v. mV.leu̯h₂-		*!	********			

b. #_ _O: **lip-i̯é-* pres. > Gk. *líptō̧* 'desire' (*LIV* 409; *IEW* 671)

/li̯p-i̯e-/	SON-SEQ	DEP-IO	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. li̯pi̯e-	*!			****			
☞ ii. lip.i̯e-				*******			*
iii. l̥i.pi̯e-			*!	*****	*		
iv. l̥.ip.i̯e-			*!*	*******		*	*
v. lVi̯.pi̯e-		*!		********			

On the other hand, without the explicit inclusion of the constraint ONSET in the tableau in (8)b., which has been absent in our discussion thus far because no forms had required its presence, we are unable to generate the correct output. Absent ONSET, the preferred candidate would be that in

(8)b.iii., since it minimizes violations of the Alignment constraint. Crucially, observe that not only must we include ONSET here, we must also crucially rank it with respect to the Alignment constraint (something we did not do in the discussion in Chapter 4), or else obtain the wrong result.

Moving beyond absolute word-initial position, we can consider sequences of two sonorants in-between two segments. First, in (9) we see that intervocalically, neither sonorant is vocalized, as predicted by the established ranking. The candidate in (9)a. does not violate SONORITY-SEQUENCING, nor does it incur any violations of *PK/NASAL, *PK/LIQUID, or *PK/GLIDE; thus it is most optimal.

(9) *Two Sonorants: Intervocalic*

V_ _V: **b^h^éru̯-e-* pres. > Lat. *feruō*, *-ere* 'boil' (*LIV* 81; *IEW* 143-145)

/b^h^eru̯-e-/	SON-SEQ	DEP	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
☞ a. b^h^er.u̯e-				*******			
b. b^h^e.ru.e-			*!	********			*
c. b^h^e.r̥.u̯e-			*!	*******		*	
d. b^h^e.r̥.u.e-			*!**	**********		*	*
e. b^h^e.rV.u̯e-		*!		*********			

When the sonorant + sonorant sequence is flanked by two consonants, we have the outcome for which the analysis was specifically designed to account for: namely, the vocalization of the second sonorant, regardless of its relative sonority vis-à-vis the preceding one. In (10) we present three tableaux illustrating this outcome for three types of sonorant + sonorant sequences: one in which the first sonorant is (by traditional conception) lower in sonority than the second (10)a.; one in which the first sonorant is higher in sonority than the second (10)b.; and one in which the first sonorant is equally sonorous as the second (10)c. Note that SONORITY-SEQUENCING is required to rule out the candidates in i., in which neither sonorant is vocalic – the strategy which would incur no violations of *PK/NASAL, *PK/LIQUID, or *PK/GLIDE.[3]

(10) *Two Sonorants: Interconsonantal*

a. Sonority Rise

#O_ _O: **k̂lu-tó-* > Ved. *śrutá-* ‘heard’ (*NIL* 425-432)

/klu̯-to-/	SON-SEQ	DEP	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. klu̯to-	*!			****			
☞ ii. klu.to-				******			*
iii. kl̥u̯.to-				*******!		*	
iv. kl̥.u.to-			*!	*******		*	*
v. klVu̯.to-		*!		**********			

b. Sonority Fall

#O_ _O: **k̂un-b^{h}is* > Ved. *śvábhiḥ* inst. pl. ‘dog’ (*NIL* 436-440)[4]

/k̂u̯n-b^{h}is/	SON-SEQ	DEP	ONS	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. k̂u̯nb^{h}is	*!			****			
☞ ii. k̂u̯n̥.b^{h}is				***********			*
iii. k̂un.b^{h}is				************!	*		
iv. k̂u.n̥.b^{h}is			*!	************	*		*
v. k̂u̯Vn.b^{h}is		*!		****************			

c. Sonority Plateau

O_ _H: **spti̯uH-é-* pres. > Ved. *ní ṣṭhīvati* ‘spit out’ (*LIV* 583-584; *IEW* 999-1000)

/spti̯u̯H-e-/	SON-SEQ	DEP	ONS	ALIGN-L	*PK/N	*PK/L	*PK/G
i. spti̯u̯He-	*!			******			
☞ ii. spti̯u.He-				**********			*
iii. sptiu̯.He-				***********!**			*
iv. spti.u.He-			*!	*************			**
v. spti̯Vu̯.He-		*!		****************			

[3] For situations in which CRRC sequences interact with the heterosyllabification of medial consonants, as in the present stem form *d^hrub^h-i̯é-* > Gk. *t^hrúptō̜* ‘break’ (*LIV* 156; *IEW* 275), see Chapter 10.

[4] Candidates featuring *i̯* in the second syllable are omitted here for the sake of clarity; they would be excluded from consideration due to violations of SONORITY-SEQUENCING.

As we have seen in Chapter 4, a mixed environment, in which the two sonorants are preceded by a consonant and followed by a vowel, does not pose a problem for the analysis as it has been developed thus far:

(11) *Two Sonorants: V/C combinations, first pass*

#O_ _V: **k̂un-ós* > Gk. *kunós* gen. sg. 'dog' (*NIL* 436-440)

/k̂u̯n-os/	SON-SEQ	DEP	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
a. k̂u̯nos	*!			*******			
b. k̂u̯n̥.os			*!	*********	*		
c. k̂un.os			*!	**********			*
☞ d. k̂u.nos				********			
e. k̂u.n̥.os			*!*	**********	*		*
f. k̂u̯V.nos		*!		***********			

Although using the ranking we ultimately proposed gives the constraint ONSET the bulk of the influence in the evaluation, nonetheless we again point out that even in the absence of this constraint, the desired result would nonetheless still be obtained, because of the nature of the moraic Alignment constraint (recall that an approach built on syllable-based Alignment requires ONSET in this case).

Note we use SONORITY-SEQUENCING here to militate against complex onsets of shape .ORRV, despite their lacking a sonority reversal; still, this does not seem an invalid extension of the constraint's influence, given the length of the sequence in question (but see also 6.1.4 for another view). Also, although the crucial ranking of SONORITY-SEQUENCING and DEP-IO (as well as *PK/OBSTRUENT, not relevant in this particular case) over ONSET is not clearly demonstrated here, nevertheless it must hold, as evidenced in consideration of a form such as the aorist stem **n̥s*-, which satisfies the first three constraints (†*ns*-, †*ns̥*-, †*nVs* -) at the expense of violating the last one.

Finally, we conclude discussion of the behavior of sequences of two sonorants by considering their occurrence word-finally. Both environments in the tableaux in (12), CRR# (familiar already from the discussion in Chapters 3 and 4) and VRR#, require the constraint SONORITY-SEQUENCING in the evaluation process, which here disfavors complex codas of shape .VRR(R).

(12) *Two Sonorants: Word-Final*

a. C_ _#: **per-u̯r̥* > Gk. *pȇrar* nom. acc. sg. 'end, boundary'

/per-u̯r/	SON-SEQ	DEP-IO	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. peru̯r	*!						
☞ ii. per.u̯r̥				*******		*	
iii. pe.rur				********!			*
iv. pe.ru.r̥			*!	********		*	*
v. per.u̯Vr		*!		************			

b. V_ _#: **di̯éu̯i* > Ved. *dyávi* loc. sg. 'sky-god' (*NIL* 69-81)[5]

/di̯eu̯-i̯/	SON-SEQ	DEP-IO	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. di̯eu̯i̯	*!						
☞ ii. di̯e.u̯i				******			*
iii. di̯e.ui̯			*!	*********			*
iv. di̯e.u.i			*!*	*********			**
v. di̯e.u̯Vi̯		*!		***********			

6.1.3 Three Sonorant Sequences

As was observed in the case of two sonorant sequences, sequences of three sonorants also differ in their treatment in absolute word-initial position, depending on whether they precede a vowel or a consonant. Before a vowel, the middle sonorant vocalizes, while the two segments flanking it do not. Before a consonant, the third sonorant vocalizes, while the first two constitute a

[5] On the nature of the locative singular ending *-i* in Proto-Indo-European, see most recently Jasanoff (2009).

complex onset. These outcomes are exactly those predicted by the analysis, as enhanced with high-ranking SONORITY-SEQUENCING and ONSET; the two tableaux in (13) demonstrate as much.

(13) a. #_ _ _V: **mn̥-i̯é-* pres. > Ved. *mányate* ‘thinks’ (*LIV* 435-436; *IEW* 726-728)

/mn-i̯e-/	SON-SEQ	DEP-IO	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. mni̯e-	*!			***			
ii. mni.e-			*!	*****			*
☞ iii. mn̥.i̯e-				****	*		
iv. m̥n.i̯e-			*!	****	*		
v. mn̥.i.e-			*!*	******	*		*
vi. m̥.ni.e-			*!*	*****	*		*
vii. m̥.n̥i̯e-			*!*	****	**		
viii. m̥.n̥.i.e-			*!***	******	**		*
ix. mVn.i̯e-		*!		*******			

b. #_ _ _H: **mluh₂-* pres. > Ved. *bruvánti* ‘say’ (*LIV* 446-447; *IEW* --)

/mlu̯h_2-/	SON-SEQ	DEP-IO	ONSET	ALIGN-L	*PK/NAS	*PK/LIQ	*PK/GLI
i. mlu̯h_2-	*!						
☞ ii. mlu.h_2-				**			*
iii. ml̥u̯.h_2-				***!		*	*
iv. m̥lu̯.h_2-			*!	*(**)			*
v. ml̥.u.h_2-			*!	***		*	*
vi. m̥.lu.h_2-			*!	**			**
vii. m̥.l̥u̯.h_2-			*!*	***		*	*
viii. m̥.l̥.u.h_2-			*!**	***		*	**
ix. mlVu̯.h_2-		*!		*****			

In (13)a.-b., the majority of candidates are eliminated due to violations of ONSET, a constraint which the winners, (13)a.iii. and (13)b.ii., satisfy. The evaluation process effectively ends here when the sonorant sequence precedes a vowel, but when it precedes a consonant, selection comes down to ALIGN-L(μ, PrWd); this constraint rules against the candidate in (13)b.iii., because it is the lefthand sonorant which vocalizes, not the righthand one, thereby creating a coda consonant, and an additional mora to assess. Note we also assume that SONORITY-SEQUENCING militates against complex onsets of shape .RRRV and .RRROV, hence the elimination of candidates (13)a.i. and (13)b.i. from consideration.

6.1.4 The Revised Ranking

In order to account for all of the environments surveyed in the previous sections, we have seen fit to enhance the constraint ranking posited in Chapter 3 and refined in Chapter 4. Specifically, we have explicitly included when relevant the constraint SONORITY-SEQUENCING and crucially adjusted the ranking of the constraint ONSET, yielding the revised ranking shown in (14); justification for components of this ranking are also included here.

(14) SONORITY-SEQUENCING, *PK/OBSTRUENT, *MAR/VOWEL » DEP-IO » ONSET » ALIGN-L(μ, PrWd) » *PK/NASAL » *PK/LIQUID » *PK/GLIDE

a. SONORITY-SEQUENCING » ONSET (**n̥s*- not †*ns*-)

b. SONORITY-SEQUENCING » *PK/NAS » *PK/LIQ » *PK/GLI "

c. *PK/OBS » ONSET (**n̥s*- not †*ns̥*-)

d. DEP-IO » ONSET (**n̥s*- not †*n*V*s*-)

e. DEP-IO » *PK/NAS » *PK/LIQ » *PK/GLI (**n̥s*- not †*n*V*s*-)

f. *PK/OBS » ALIGN-L(μ, PrWd) (**k̂u̯n̥bʰis* not †*k̂u̯n̥bʰi̯s̥*)

g. *MAR/V » ALIGN-L(μ, PrWd) (**peru̯r̥* not †*pe̯r̥u̯r̥*)

h. ONSET » ALIGN-L(μ, PrWd) (**lipi̯é*- not **l̥i̯.pi̯é*-)

i. ALIGN-L(μ, PrWd) » *PK/NAS (» *PK/LIQ » *PK/GLI) (**k̂u̯n̥bʰis* not †*k̂unbʰis*)

With respect to the three highest-ranked constraints, SONORITY-SEQUENCING, *PK/OBSTRUENT, and *MAR/VOWEL, there appears to be no evidence to suggest a ranking relationship holds between these; they appear to be undominated in Proto-Indo-European. For the ranking of

*PK/OBSTRUENT over DEP-IO, while none of the data considered over the past few subsections suggest a crucial ranking, as noted earlier, if we expand our focus to consider cases in which sequences of obstruents are rendered syllabifiable in the absence of a sonorant to vocalize, we see that the preference is for vowel epenthesis over vocalization of an obstruent: e.g. present stem *$t_e$ki̯é-* ‘extend the hand’ (*LIV* 618-619; *IEW* 1057-1058).

Under this conception of the phenomenon of sonorant vocalization in Proto-Indo-European, syllabic sonorants are countenanced only when the alternative would violate the sonority sequencing principle. That being said, when faced with this situation, a string of segments containing multiple sonorants will be syllabified in such a way as to incur the fewest violations of ONSET. Furthermore, in such a string, all else being equal, it is the righthand sonorant which is preferentially syllabic, an outcome of the influence of the constraint ALIGN-L(μ, PrWd).

Before moving on, a note about SONORITY-SEQUENCING. Over the course of extending the analysis to all the environments considered, we have been compelled to understand this constraint as militating against the following structures: sequences featuring a sonority reversal, and hence difficult to syllabify otherwise (#RO, #RRO, #RRRO, ORO, ORRO, OR#), but also sequences which would otherwise surface as complex onsets of shape .ORRV, .RRRV, or complex codas of shape VRR., VRRR. Of such sequences, the interpretation of SONORITY-SEQUENCING associated with those of the former type is relatively non-controversial, as even the weakest versions of the sonority sequencing principle militate against tautosyllabic pre- and/or post-vocalic sonority reversals. On the other hand, the understanding of the constraint required for the latter type of sequence is perhaps a bit more problematic, as the matter is more so one of sequence length, not sonority: longer onsets and codas, though lacking sonority reversals, are disfavored. Indeed such illicit sequences would seem to suggest the need to introduce the constraints *COMPLEX$_{\text{ONSET}}$ and *COMPLEX$_{\text{CODA}}$, but such a strategy would face complications of its own: the interaction of at least the former constraint with ALIGN-L(μ, PrWd) could lead to undesirable results such as †CR̥RC over CRR̥C, to avoid a complex onset. Furthermore, under the required conception of SONORITY-SEQUENCING there would seem to be an asymmetry in allowable sequences in coda position versus onset position: RR constitutes an unacceptable complex coda, but is permitted as a complex onset (at least word-initially). Given this, we may be compelled to introduce two variants of SONORITY-SEQUENCING, one governing syllable-initial phonotactics, the other governing syllable-final phonotactics.[6]

In light of all these issues, one may consider as an alternative positing an account using stringent MARGIN constraints instead of fixed PEAK / MARGIN ones, since this approach would not generally rely on potential sonority sequencing violations as a trigger of sonorant vocalization. Rather, it would be the case that sonorants would be realized as consonants so as to avoid violations of ONSET. (One environment requiring SONORITY-SEQUENCING under this approach would be #RO, which otherwise would be realized with a consonantal sonorant; but as this case involves a sonority reversal, the conception of the constraint would presumably not be such an issue.) Again, though, any potential benefit of adopting the stringent MARGIN approach would have to be weighed against its perceived detriments, an issue we have already considered briefly earlier in Chapter 3.

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[6] In fact, this is exactly what we do in our analysis of Vedic medial consonants in Chapter 8, which makes use specifically of SONORITY-SEQUENCING$_{\text{CODA}}$.

6.2 Schindler's Exceptions Revisited

Having more or less settled on an analysis – effectively the ranking in (14), combined with the traditional assumption (both for Proto-Indo-European and Optimality Theory) that inputs are purely phonological objects – we return now to the exceptional cases noted by Schindler (1977b), and assess their treatment within this framework. These five cases are repeated in (15) for convenience.

(15) *Schindler's Exceptions* (1977b: 56-57)

a. Root- and word-initial groups /u̯r-, u̯l-, u̯i̯-/ and /mr-, ml-, mn-/ (and /mi̯-/, if already PIE) are unchanged before a vowel.

b. In the weak forms of nasal-infix presents *n* is non-syllabic, i.e. /n/ then is not subject to the principle, when it is a verbal infix (e.g. PIE */i̯u̯ng-/ → **i̯ung*- instead of †*iu̯n̥g*-.

c. In the accusative of acrostatic and proterokinetic *i*-, *u*- and *r*-stems /m/ remains non-syllabic (PIE -*im*, -*um*, -*r̥m*).

d. In *men*-stems /m/ was not syllabic in the sequence /CmnV/, but rather disappeared (type Ved. *áśman*- : *áśnaḥ*).

e. Sonorant groups between *C* and *V* (/$\mathrm{CR_1R_2V}$/), in which the syllabification $C\underset{\circ}{R}_1R_2V$ would be expected, were then frequently realized as $CR_1\underset{\circ}{R}_2V$, when in the same paradigm /$\mathrm{CR_1R_2C}$/ → $CR_1\underset{\circ}{R}_2C$ also appears.

The fact that a word-initial sonorant does not vocalize before another sonorant which is consonantal has been analyzed, already by Kobayashi and Keydana, as a means of avoiding an onsetless syllable, in Optimality-Theoretic terms, a violation of the constraint ONSET; more importantly, such sequences must also not run afoul of the higher-ranked (if not undominated)

SONORITY-SEQUENCING. Of the remaining four cases, none feature results generated by the analysis, in its current state; if we are to account for them, then, some alternative explanation must be invoked. Indeed explanation via analogical pressure seems most viable in the final class of exceptions, and for now this is precisely the position we take on the matter. As for the remaining exceptions in (15)b.-d., we explore each in turn in the following two subsections, the nasal-infix presents stems (15)b. in 6.2.1, and the unexpected non-syllabicity of *m* (15)c.-d. in 6.2.2.

6.2.1 Nasal-Infix Presents: Evidence for Input Moraicity?

While we have concluded that there is no demonstrable need to posit input moraicity for sonorants, there is at least one set of data to be considered, the nasal-infix presents, which is ostensibly amenable to such a strategy. However, as we will show in this subsection, maintaining input moraicity in view of these data is a problematic enterprise, requiring a complicated theoretical apparatus and, perhaps more importantly, not satisfactorily accounting for all the relevant data.

The strong form of the nasal-infix present stems has zero-grade of the root and full-grade of the infix (schematically CC-*ne*-C- or C-*ne*-C-); the weak form has zero-grade of both (schematically CC-*n*-C- or C-*n*-C-). As Schindler noted, the behavior of these stems runs counter to the expectations of the traditional account: given its prevocalic position, the nasal of the infix is never a candidate for vocalization in the strong form of the stem; but Schindler's phonological rule predicts that in the weak form, built to roots containing sonorants, it should come out as syllabic. And indeed, this is what we see in sequences of three sonorants, such as the present stem **u̯rik̂-i̯é-* 'turn' (> YAv. *uruuisiieiti*; *LIV* 699; *IEW* 1158-1159) – although granted, the actual sonorants in question are different[7] – and it is also the result predicted by an Optimality-Theoretic account using the ranking in (14) above – augmented with the constraint *COMPLEX$_{\text{CODA}}$, the justification for which in the ranking is addressed in Chapter 10 – as shown in (16). Yet in these forms it is consistently a preceding sonorant which vocalizes instead of the nasal of the infix: e.g. **i̯ung-*, not †*i̯u̯n̥g-* (or †*i̯un̥g-*, if we disallow the sequence *-i̯u̯-* from constituting a possible initial onset), as indicated by the ☹ icon accompanying the desired winner.

(16)

/i̯u̯-n-g-/	SON-SEQ	*PK/OBS	DEP-IO	*COMP$_{\text{CODA}}$	ONSET	ALIGN-L
a. i̯u̯ng-	*!					
☞ b. i̯u̯n̥$_{\mu}$g$_{\mu}$-	(*!)					*****
☹ c. i̯u$_{\mu}$n$_{\mu}$g$_{(\mu)}$-				*!		***(***)
d. i$_{\mu}$u̯$_{\mu}$n$_{\mu}$g$_{(\mu)}$-				*!	*	***(***)
(☞) e. i$_{\mu}$u̯n̥$_{\mu}$g$_{\mu}$-					*!	*****
f. i̯V$_{\mu}$u̯$_{\mu}$n$_{\mu}$g$_{(\mu)}$-			*!	*		******(****)
g. i̯V$_{\mu}$u̯$_{\mu}$nV$_{\mu}$g$_{\mu}$-			*!*			***********

Note that violations included in parentheses are meant to be associated with the parenthetical mora attached in some cases to *g*; the presence or absence of this mora is contingent on whether obstruents in the relevant position are moraic or not.[8]

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[7] This present stem, along with **mléu̯h$_1$- / *mluh$_2$-* (Ved. *bráv́īti*, *bruvánti* 'say, speak') built to **mleu̯h$_2$-* 'speak' (*LIV* 446-447; see the previous section), would seem to provide the strongest evidence for a general (and expected) treatment RRR̥ (at least, when the first sonorant is a labial). A consultation of *LIV* reveals a total of five verb roots with nine stem forms featuring a sequence of three sonorants, all of which, save for **u̯rik̂-i̯é-* and **mluh$_2$-*, constitute less than ideal examples in some way or another. The other seven stem forms are the following (page numbers are given in parentheses): present stems **mi̯éu̯h$_1$- / *mih$_1$u̯-* (with metathesis, reflected in [Ved. (AV+) *mī́vati* 'pushes' and [YAv. *auua.miuuamahi* 'eliminate') and **mi̯uh$_1$-ské/ó-* (with loss of *i̯* > Tocharian A, B *musk-* 'disappear') built to **mi̯eu̯h$_1$-* 'head for' (445-446); present stems **u̯léi̯k^w- / *u̯lik^w-* (Tocharian A *lyīktsi* 'wash') and ?**u̯li-né/n-k^w-* ([Lat. *pol-lingo* 'wash a corpse', with secondary *g* for †*qu* after e.g. *lingō*), and essive stem **u̯lik^w-h$_1$ié-* ([Lat. *liqueo*, *-ēre* 'be liquid'), built to **u̯lei̯k^w-* 'wet' (696-697; the reconstruction of initial *u̯* in view of Old Irish *fliuch* 'moist', Welsh *gwlith* 'dew'); present stem ?**u̯rei̯k̂- / *u̯rik̂-* ([Old English (+) *wrīon* 'envelop') built to **u̯rei̯k̂-* 'turn; cover' (699); and present stem **u̯Ri-né/n-H-* (Ved. (MS) *vlinati* 'pressuring down', Younger Avestan *uruuīnaitī-* 'compression') built to ?**u̯Rei̯H-* 'compress' (699; only Indo-Iranian).

[8] It might be pointed out that consideration should be of full verbal forms, not simply the stem, and further, that those forms completed with vowel-initial personal endings would render the issue of obstruent moraicity moot, as *g* would constitute the onset of the syllable headed by the following vowel. Even if we were to evaluate outputs to an

On the other hand, at first blush the crucial feature of the morphophonological approach, positing for a zero-grade input sonorant its moraic content in an associated full-grade, would seem to offer us a means of bringing these ostensibly recalcitrant data into the fold of a uniform analysis. If we assume such moraic content in the input, the candidates in (16) could instead be evaluated against a form i̯u̯$_{\mu}$-n-g- (based on a full-grade root **i̯eu̯g-*), meaning that vocalization of glide *u̯* can be preferred over the nasal, given its already being moraic. However, we have already determined that regardless of approach, the constraint ranking is essentially the same; whatever constraints need not be invoked for the data at hand assuming input moras – namely *APPENDIX, COINCIDE, and *COMPLEX$_{\text{CODA}}$ – should be included for independent reasons. We therefore need to not only posit moraic *u̯* in the input, but also adjust the ranking in (16) to favor the candidate in which it vocalizes; in other words, we need to introduce MAX-μ-IO.

When we entertained in Chapter 5 an analysis involving MAX-μ-IO, we saw no compelling reason to crucially position it in the ranking, so we placed it on par with DEP-μ-IO. In view of (16) we see that this stance would no longer tenable, as MAX-μ-IO in this position would be incapable of exerting active influence on the evaluation. Rather, we must precisely locate MAX-μ-IO in the hierarchy such that it outranks *COMPLEX$_{\text{CODA}}$; in view of a form such as **k̂unós*, the constraint must also rank below ONSET. The revised ranking is operative in the tableau in (17).

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input such as 3 pl. /i̯u̯-n-g-ént-i/, the analogous candidate to that in (16)b. would still be selected as most optimal, because of its parsimonious set of moras.

(17)

i̯u̯$_\mu$-n-g-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	MAX-μ-IO	*COMP CODA	COINC	*APP	DEP-μ-IO
a. i̯u̯ng-	*!				*				
b. i̯u̯n̥$_\mu$g$_\mu$-					*!				**
☞ c. i̯u$_\mu$n$_\mu$g-						*			*
d. i̯u$_\mu$n$_\mu$g$_\mu$-						*			**!
e. i$_\mu$u̯$_\mu$n$_\mu$g-				*!		*			**
f. i$_\mu$u̯n̥$_\mu$g$_\mu$-				*!	*				***
g. i̯V$_\mu$u̯$_\mu$n$_\mu$g-			*!			*			**
h. i̯V$_\mu$u̯$_\mu$nV$_\mu$g$_\mu$-			*!*						***

The evaluation comes down to the candidates in (17)b.-d., with (17)c. selected as most optimal due to not only its preservation of the input mora, at the cost of featuring a complex coda, but also its minimal insertion of moras.

There are more than a few wrinkles with this approach, however, which together ultimately conspire against its successful implementation; we address a few of these now. The first is the familiar matter of obstruent moraicity in the position VC_. Note that we have assumed for the purposes of (17) that only an immediately postvocalic tautosyllabic obstruent is moraic, a position which ultimately has no impact on many of the relevant candidates – i.e., (17)b.,e.-h. – since given the ranking, they will indeed be eliminated regardless. As for (17)c.-d., the absence of a mora attached to *g* in the input directly affects the selection of one over the other; an input mora would favor (17)d. over (17)c., given MAX-μ-IO.

The question of whether we should include a mora for *g* in the input is not a simple parametric issue of the sort we have considered thus far, i.e., if VC_. obstruents are moraic, then yes, if not, then no. Rather, the more complex morphological structure of the nasal-infix present stem complicates the picture, as it raises additional questions about the derivational process necessarily feeding the input under the morphophonological account. The first question is when does zero-grade of root occur, and when does zero-grade of the stem (for the weak form) occur? We can imagine two scenarios, sketched in (18).

(18) a. *i̯eu̯g- → *i̯u̯g- → *i̯u̯-ne-g- → *i̯u̯-n-g-

b. *i̯eu̯g- → *i̯eu̯-ne-g- → *i̯u̯-n-g-

The derivational chain in (18)a. is a three stage process, whereby the root undergoes zero-grade, is infixed, and then the infix undergoes zero-grade. In the chain in (18)b., the root in its full-grade form is infixed, and then both the root and stem undergo zero-grade in a single pass. Of these two alternatives, we may be inclined to posit the former, as it arguably more elegantly reflects the fact that nasal-infix presents feature consistent zero-grade of the stem, versus conditioned zero-grade of the infix (in the weak forms). But in fact either of these approaches ends up being compatible with the data, once we factor in the more operative matter of just what moraic content is assigned to the input – that of the root, or that of the root and stem. The derivations in (19)-(20) offer an elaborated take on the schemata in (18)a.-b., by presenting for each one two possible scenarios: in the lefthand column of each pair of derivations, it is the moraic content of the root alone which is relevant for the eventual shape of the input (hence only one application of the process labeled 'μ-Assignment'), while in the righthand column, it is the moraic content of both the root and the stem (hence two such applications). Parenthetical moraic content is contingent on the moraicity of obstruents in VC_. position.

(19) *Successive Zero-Grade Derivation*

	μ-structure sensitive to Root alone	**μ-structure sensitive to Root+Infix**
Root	*i̯eu̯g-	*i̯eu̯g-
a. μ-Assignment	*i̯eu̯$_{\mu}$g$_{(\mu)}$-	*i̯eu̯$_{\mu}$g$_{(\mu)}$-
b. ø-Grade	*i̯u̯$_{\mu}$g$_{(\mu)}$-	*i̯u̯$_{\mu}$g$_{(\mu)}$-
c. Infixation	*i̯u̯$_{\mu}$-ne-g$_{(\mu)}$-	*i̯u̯$_{\mu}$-ne-g$_{(\mu)}$-
d. μ-Assignment	n/a	*i̯u̯$_{\mu}$-ne-g$_{\mu}$-
e. ø -Grade	*i̯u̯$_{\mu}$-n-g$_{(\mu)}$-	*i̯u̯$_{\mu}$-n-g$_{\mu}$-
OT Input	***i̯u̯$_{\mu}$-n-g$_{(\mu)}$-**	***i̯u̯$_{\mu}$-n-g$_{\mu}$-**

(20) *Single-Stage Zero-Grade Derivation*

	μ-structure sensitive to Root alone	**μ-structure sensitive to Root+Infix**
Root	*i̯eu̯g-	*i̯eu̯g-
a. μ-Assignment	*i̯eu̯$_{\mu}$g$_{(\mu)}$-	*i̯eu̯$_{\mu}$g$_{(\mu)}$-
b. Infixation	*i̯eu̯$_{\mu}$-ne-g$_{(\mu)}$-	*i̯eu̯$_{\mu}$-ne-g$_{(\mu)}$-
c. μ-Assignment	n/a	*i̯u̯$_{\mu}$-ne-g$_{\mu}$-
d. ø-Grade	*i̯u̯$_{\mu}$-n-g$_{(\mu)}$-	*i̯u̯$_{\mu}$-n-g$_{\mu}$-
OT Input	***i̯u̯$_{\mu}$-n-g$_{(\mu)}$-**	***i̯u̯$_{\mu}$-n-g$_{\mu}$-**

A third theoretically-possible pair of scenarios, in which only the moraic content of the full root + infix present stem is relevant, we exclude from consideration, since this approach would deprive us of the crucial component for a regular analysis of sonorant vocalization in this stem-type – namely, the moraicity of the sonorant in pre-infix position (in the case of **i̯ung-*, *u̯*). In other words, the moraicity of the root is obligatorily a factor, if the analysis is intended to go through.

We see that each of the four derivations illustrated in (19)-(20) result in one of two input shapes, depending only on what stage(s) of mora-assignment are relevant: if only the root's, the input is *i̯u̯$_{\mu}$-n-g$_{(\mu)}$-, but if both the root's and the stem's, the input is *i̯u̯$_{\mu}$-n-g$_{\mu}$-. More specifically, with respect to the former, the input will be *i̯u̯$_{\mu}$-n-g$_{\mu}$- if obstruents are moraic in

VC_. position, but *i̯u̯$_{\mu}$-n-g- if they are not. In other words, as long as at some stage in the process, *g* is assigned a mora, this mora will be in the input; *only* if both VC_. obstruents are not moraic, nor is moraic assignment sensitive to the infix, will it be the case that the obstruent is not moraic in the input, as captured in (21).

(21)

	VC_. Obstruents are Moraic	**μ-structure sensitive to (Root+)Infix**	**Result**
a.	✓	✓	i̯u$_{\mu}$n$_{\mu}$g$_{\mu}$-
b.	✓	✗	
c.	✗	✓	
d.	✗	✗	i̯u$_{\mu}$n$_{\mu}$g-

Given these two possible inputs, we have two possible evaluations to consider. We present in (22) the evaluation based on input i̯u$_{\mu}$n$_{\mu}$g$_{\mu}$- (as in (21)a.-c.), and in (23) the evaluation based on input i̯u$_{\mu}$n$_{\mu}$g- (as in (21)d.), which is actually identical to the initial tableau in (17) above.

(22)

i̯u̯$_{\mu}$-n-g$_{\mu}$-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	MAX-μ-IO	*COMP CODA	COINC	*APP	DEP-μ-IO
a. i̯u̯ng-	*!				**				
b. i̯u̯n̥$_{\mu}$g$_{\mu}$-					*!				*
c. i̯u$_{\mu}$n$_{\mu}$g-					*!	*			*
☞ d. i̯u$_{\mu}$n$_{\mu}$g$_{\mu}$-						*			*
e. i$_{\mu}$u̯$_{\mu}$n$_{\mu}$g-				*!	*	*			**
f. i$_{\mu}$u̯n̥$_{\mu}$g$_{\mu}$-				*!	*				**
g. i̯V$_{\mu}$u̯$_{\mu}$n$_{\mu}$g-			*!		*	*			**
h. i̯V$_{\mu}$u̯$_{\mu}$nV$_{\mu}$g$_{\mu}$-			*!*						**

(23)

i̯u̯$_{\mu}$-n-g-	SON-SEQ	*PK/OBS	DEP-V-IO	ONS	MAX-μ-IO	*COMP CODA	COINC	*APP	DEP-μ-IO
a. i̯u̯ng-	*!				*				
b. i̯u̯n̥$_{\mu}$g$_{\mu}$-					*!				**
☞ c. i̯u$_{\mu}$n$_{\mu}$g-						*			*
d. i̯u$_{\mu}$n$_{\mu}$g$_{\mu}$-						*			**!
e. i$_{\mu}$u̯$_{\mu}$n$_{\mu}$g-				*!		*			**
f. i$_{\mu}$u̯n̥$_{\mu}$g$_{\mu}$-				*!	*				***
g. i̯V$_{\mu}$u̯$_{\mu}$n$_{\mu}$g-			*!			*			**
h. i̯V$_{\mu}$u̯$_{\mu}$nV$_{\mu}$g$_{\mu}$-			*!*						***

Each of these tableaux selects its own distinct candidate as most optimal, (22)d. and (23)c., which differ only in the moraicity of the obstruent *g*. When *g* is moraic in the input, MAX-μ-IO favors its moraicity in the output, but when *g* is not moraic in the input, DEP-μ-IO disfavors its being so in the output.

In some sense the difference between these two results may appear inconsequential, as crucially the right vocalization is selected (that of the glide *u̯* over the nasal). But there is reason to be hesitant about the outcome of (22). For one thing, given its result, even if we assume that VC_. obstruents are not moraic, this generalization must break down on the surface, as the winning candidate features such supposedly-banned structure. Assuming instead obstruent moraicity in VC_. position in conjunction with (22) makes for a more coherent account – but this is perhaps problematic in view of the aforementioned Greek Osthoff's Law data, if we choose to treat such data as evidence relevant for Proto-Indo-European. Additionally, the scenarios captured in (22)-(23) make different predictions once we consider nasal-infix present forms that are actually inflected. Given the ranking, it is predicted that the final consonants of the stem in (22) will only be heterosyllabic before a vowel-initial ending (of which there are few, if any); but before a consonant-initial ending, while we would have earlier predicted VC.CCV in spite of the morphological structure, the position of MAX-μ-IO precludes this syllabification from being most optimal, since it is unfaithful to the moraicity of *g* (onsets cannot be moraic). If instead we choose to go with the analysis operational in (23), we can maintain a view of obstruents more compatible with that suggested by the available evidence. But the fact that we must concurrently hold that only the full-grade of the *root* is significant in the determination of the moraic content crucially feeding sonorant vocalization, would seem to require an explicit reformulation of our conception of the phenomenon. Indeed in all the data considered in Chapter 5, the zero-grade morpheme in question was a root; we see now that this cannot be coincidental, if we seek to explain the behavior of nasal-infix presents as regular. Regardless, with MAX-μ-IO ranked as such in the hierarchy, Proto-Indo-European is predicted to have a rather strong preference for realizing input moras, whether truly underlying (as for non-high vowels) or the result of preceding derivation (as for other segments, in e.g. transition to zero-grade ablaut). The sole exception would be cases in which this realization would result in an onsetless syllable: thus **ḱunos*, not †*ḱu̯n̥os*.

Despite the ostensible promise of the account as captured in (23) – if we make the appropriate assumptions that neither were VC_. obstruents moraic, nor is moraic structure assigned on the basis of the infix – nevertheless there are also complications stemming from the data themselves. The weak nasal-infix stem **i̯ung-* exemplifies the case in which a sonorant in a zero-grade morpheme vocalizes, that is post-vocalic in the associated full-grade. This allows for a nice comparison with the nasal of the infix, which is prevocalic in the associated full-grade; the fact that the sonorant of the root vocalizes thus finds straightforward explanation.[9]

[9] Assuming syllabicity to be preferentially associated with pre-determined moraicity would also predict vocalization of the final sonorant in the nasal-infix present of roots of shape CReR (as would Schindler's rule as well). This is not an unreasonable expectation, but one which is difficult to corroborate with actual data – of the 168 secure cases of nasal-infix presents in *LIV*, only five are built to sonorant-final roots: **deh₂u̯-* 'catch fire' (*LIV* 104-105; *IEW* 179-

There are also, however, nasal-infix presents in which a root sonorant vocalizes, which is actually prevocalic in an associated full-grade. Given our current hypothesis, there should be no reason why this sonorant would be preferentially vocalized over the nasal of the infix. The nasal-infix present built to the root **u̯eb*^{h}- 'wrap, weave' (*LIV* 658; *IEW* 1114) provides a particularly interesting example in this regard: the strong form is reconstructed as **u-né-b*^{h}- (Ved. *unap*), the weak form as **u-n-b*^{h}- (Ved. *aumbhan*). In both cases it is the root-initial glide which vocalizes, over the nasal of the infix. In the strong form this is understandable, given that *n* precedes a vowel; we only have to assume that *u̯n-* is not a licit complex onset (as opposed to other *u̯*-initial sonorant sequences considered earlier) to account for why the glide is syllabic.[10] But in the weak form, we expect a perfect opportunity for *n* to emerge as syllabic, since it occurs between an initial sonorant and an obstruent; compare **lm̥b*^{h}*-é-* (Ved. *rábhate*), present stem of **lemb*^{h}- 'take' (*LIV* 411-412; *IEW* 652). (This same form also shows that the lower sonority of *n* relative to *u̯* should not be a factor.)

The fact that we do not see †*u-n̥-b*^{h}- suggests the privileged status of root over infix for the purposes of sonorant vocalization in weak nasal-infix present forms, as opposed to a sensitivity to purported input moraicity, as entertained above. We might interpret such status simply as the result of analogical pressure: vocalization in the weak stem proceeds according to that of the strong stem, as has been suggested in the literature by e.g. Fortson (2004: 65). A more formal approach along these lines might involve introducing another constraint into the ranking. Two possible approaches come to mind at this time: we can either explicitly favor vocalization in

181), **du-né/n-h*$_2$- ([Ved. (AV) *dunóti*); **ĝ*^{h}*eh*$_1$*i̯*- 'gape' (*LIV* 173-174; *IEW* 419-420), *ĝ*^{h}*i-né/n-h*$_1$- ([Old High German (+) *ginēn*);**g/ĝeh*$_2$*u̯*- 'rejoice' (*LIV* 184; *IEW* 353), **g/ĝh*$_2$*-né/n-u̯*- (Gk. *ganutai*); **k̂lei̯*- 'lean' (*LIV* 332-333; *IEW* 601-602), **k̂l̥-né/n-i̯*- ([Y. Avestan *-sirinaoiti*); and **k̂leu̯*- 'hear' (*LIV* 334-335; *IEW* 605-607), **k̂l̥-né/n-u̯*- (Ved. *śṛṇóti*). The stems built to the first and second of these features metathesis of the sonorant and laryngeal, so that it is the laryngeal which is thought to follow zero-grade infix *n*; for the remaining three, the evidence is made murky by apparent paradigmatic leveling in favor of the singular active.

[10] In the Optimality-Theoretic analysis as conceived thus far, initial *u̯n-*, unlike, say, initial *u̯r-*, would constitute a violation of SONORITY-SEQUENCING, a more serious offense than the violation of ONSET incurred by initial *un-*.

the root, in the form of a constraint of the COINCIDE class basically calling for moras to 'coincide with' (here 'occur in') roots; or we can explicitly disfavor vocalization in the nasal infix, in the form of a variant of *PK/NASAL relativized to (or co-indexed with) this morpheme and outranking its general counterpart.[11] It may be the case that the domain of such constraints extends beyond the specific circumstance of the nasal infix present, and that using them can capture generalizations holding of the data in general; the extent to which this holds remains to be evaluated.

In sum, while on the surface the distinctive pattern of sonorant vocalization in the weak forms of nasal-infix presents would appear to provide some impetus for a general approach involving input moraicity of sonorants, as we have seen, maintaining such an account is a complicated affair. In view of the data, the operative factor for this phenomenon would instead appear to be the fact that, given a root sonorant and the nasal of the infix, it is the former rather than the latter which is consistently syllabic, despite our expectations of righthand vocalization. How exactly this generalization is to be treated vis-à-vis the more general phenomenon of sonorant vocalization in Proto-Indo-European remains a topic for future work.[12]

6.2.2 The Nature of **m**

While appeal to analogy might also conceivably be at work in the case of the accusative singular of *i*-, *u*-, and *r*-stems as well, we choose to pursue an alternative path to accounting for these data. We consider it non-coincidental that both this case, and the fourth one as well, involve the

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[11] Note introducing a relativized version of DEP-μ-IO should not work, since presumably the nasal is moraic in coda position following the vocalized root sonorant.

[12] Also of relevance here are those roots ending in two obstruents (most often stop + laryngeal), the weak form of the nasal infix presents of which are expected to show, according to Schindler's rule, vocalization of the nasal: C(C)C-n-O-. Twenty-six roots of such a shape are presented in *LIV*, of which twenty are reconstructed relatively securely.

labial nasal, a commonality suggesting that their exceptionality may have something to do with the nature of this segment. Relevant to this discussion may be the aforementioned case of Latin _dormiō_, _-īre_ 'sleep', which is said to reflect a Proto-Indo-European _i̯é/ó_-present _*dr̥m-i̯é-_ built to the root 2._*drem_ (_LIV_ 128; _IEW_ 226); it would be difficult to trace the Latin form to the otherwise expected _*drm̥-i̯é-_ (cf. _veniō_ < _*g_^{w}_m̥-i̯ó_ 'come'). There is also the fact that _m_ does not seem to trigger Osthoff's Law, at least in the history of Greek, as well as the fact that in Celtic _*r̥_ and _*l̥_ become _*ri_ and _*li_ before stops and _*m_, but otherwise become _*ar_ and _*al_ (Schumacher 2004: 125-126).

In view of the evidence, we propose a revised version of the sonority hierarchy for Proto-Indo-European, one in which not every sonorant is equally sonorous. Rather, in this conception _m_ is less sonorous than its peers, occupying a position intervening between them and the obstruents:

(24) _a_, _e_, _o_ » _i̯_, _u̯_, _r_, _l_, _n_ » _m_ » obstruents

This revised hierarchy has the following implications for the analysis of nucleus selection. The 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. Hence _veniō_ < _*g_^{w}_m̥-i̯ó_, but also _dormiō_ < _*dr̥m-i̯é-_. Indeed a similar view of _m_ is maintained for Sanskrit by Steriade (1988: 98).

So as to better reflect this revised conception of the Proto-Indo-European state-of-affairs, instead of the sub-ranking *PK/OBSTRUENT » DEP-IO » ONSET » ALIGN-L » *PK/NASAL » *PK/LIQUID » *PK/GLIDE, we propose the modification *PK/OBSTRUENT » DEP-IO » ONSET » *PK/_m_ » ALIGN-L » *PK/_n_ » *PK/LIQUID » *PK/GLIDE (using fixed constraints; the analogous stringent constraint would be *PK/OBSTRUENT;*m*). With respect to the accusative singular data, the revised ranking operates as in (25) (we omit the remaining inactive PEAK constraints in the interests of space).

(25)

/-i̯-m/	*PK/OBS	DEP-IO	*PK/*m*	ALIGN-L
☞ a. -im.				
b. -i̯m̥.			*!	

In the accusative singular of *i*-stems, for example, the outcome in (25)a. is now preferred over that in (25)b., because the latter features a syllabic *m*. It is now worse to vocalize this nasal, than it is to have a coda consonant; we also note that, while neither of these candidates violates ALIGN-R, due to the monosyllabicity of the sequence in question, the sequence in (25)a. will, as part of a larger form, result in more violations of this constraint than the sequence in (25)b.

We now illustrate the effect of the revised ranking in consideration of a few additional forms. With respect to the behavior of *m* amidst other sonorants, we first demonstrate the crucial ranking of *PK/*m* below both ONSET and DEP-IO, as shown by evaluation of the input in (26).

(26)

/lmb^h-e-/	DEP-IO	ONSET	*PK/*m*
☞ a. lm̥b^{h}e-			*
b. l̥mb^{h}e-		*!	
c. lVmb^{h}e-	*!		

The nasal *m* is permitted to vocalize in the context of other sonorants when the alternatives would either result in an onsetless syllable, as in the candidate in (26)b., or involve epenthesis, as in the candidate in (26)c. Crucially, we have in these data evidence for a higher position in the ranking for the constraint ONSET than that which was determined previously in chapter 3, although it cannot rank on par or higher than DEP-IO, since epenthesis is still more heavily disfavored, even if it means an onsetless syllable: recall weak aorist stem **n̥s*-, and compare also the following, for the present stem *m̥s-i̯é- (>> Gk. *maíomai*, with reintroduction of *m*), built to the root **mes*- ‘stretch out the arm’ (*LIV* 441; *IEW* 693):

(27)

/ms-i̯e-/	Son-Seq	*Pk/obs	Dep-IO	Onset	*Pk/*m*
a. msi̯e-	*!				
b. ms̥i̯e-		*!			
☞ c. m̥si̯e-				*	*
d. mVsi̯e-			*!		

Outside of the context in (26), lefthand sonorants will be preferentially vocalized over a righthand *m*, provided the result is not an onsetless syllable or epenthetic nucleus, as **dr̥m-i̯é-* is thought to show:

(28)

/drm-i̯e-/	Dep-IO	Onset	*Pk/*m*
a. drm̥$_{\mu}$i̯e-			*
☞ b. dr̥$_{\mu}$m$_{\mu}$i̯e-		*!	
c. drVmi̯e-	*!		

In environments in which *m* is the sole sonorant amidst obstruents, the data show that it behaves as any other sonorant would, indeed as we have seen already in (27) above. This tableau shows the importance of ranking *Pk/Obstruent over *Pk/*m*; while this ranking ought to hold by transitivity anyway, given the position of Onset, it is nonetheless worth explicitly pointing out. Note also how Onset can be violated by a winning candidate, if the alternatives are full vowel epenthesis, vocalization of an obstruent, or violation of the sonority sequencing principle.[13]

In view of our hypothesis about the nature of *m*, we thus propose the revised constraint ranking in (29) to account for nucleus selection and sonorant vocalization in Proto-Indo-European.

(29) Sonority-Sequencing, *Pk/obstruent, *Mar/Vowel » Dep-IO » Onset » *Pk/*m* » Align-L(μ, PrWd) » *Pk/*n* » *Pk/Liquid » *Pk/Glide

[13] But cf. **m$_{a}$sd-i̯é-* pres. > Ved. *médyati* ‘become fat’ (*LIV* 422; *IEW* [694]).

Admittedly, an explanation of Schindler's fourth type of exception does not immediately fall out of this revised analysis. But given it, we can more easily conceive of one: the failure of *m* to vocalize (and persist) in an environment such as /CmnV/ could presumably be due to its relatively lower sonority, which may have been especially noticeable in a position adjacent to a coronal nasal.

Finally, we note that accepting this revised view of the sonorants in Proto-Indo-European invites us to reconsider a detail of the first case of exceptions noted by Schindler. It is now no longer the case that all sonorant + sonorant sequences feature a sonority plateau; rather, instances of *m*R rise in sonority.[14, 15]

6.3 Typology

In this section we take steps towards more explicitly situating the Proto-Indo-European phenomenon of sonorant vocalization within a cross-linguistic typology. Indeed while there are at least three components to the Proto-Indo-European phenomenon the status of which can be considered from this perspective – the existence of syllabic consonants in the first place; the ostensibly leftward directional character of the vocalization phenomenon; the co-existence of this

[14] An additional wrinkle: given that the PEAK and MARGIN constraint families are built to the sonority hierarchy, and that the major manner classes are usually the basic categories in this hierarchy, is it actually, formally possible to separate out *m* from *n*? It seems like the closest we could get, with a stringency approach, would be the constraint *PK/OBS;NAS, but this would of course include *n* as well. Perhaps we might posit a language-specific sonority hierarchy for Proto-Indo-European, in which *m* intervenes between the sonorants and obstruents. But if we are compelled to posit a special ranking anyway, why not make it also show conflation of the sonorants (save for *m*), i.e. rank non-high vowels » *i̯*, *u̯*, *r*, *l*, *n* » *m* » obstruents? This approach would seem to render superfluous the generation of sonorant conflation via the constraint ranking, though; the ranking would presumably only duplicate what the language-specific hierarchy would already be telling us.

[15] Additionally, on the subject of the bilabial nasal *m*, one must also not lose sight of the process known as Stang's Law, whereby a laryngeal or glide was lost with compensatory lengthening between a vowel and final nasal: e.g. ***di̯eu̯m* acc. sg. 'sky(-god)' > **d(i)i̯ēm* (Ved. *dyā́m*). One might interpret the operation of this phenomenon as privileging the nasal over the glide – counter to the evidence of the other accusative forms we have seen, which seem to do the opposite, at least as far as vocalization is concerned – in which case one must consider if and how this might be related to the feature [sonority], and further, to the language-specific sonority hierarchy we tentatively posit here.

phenomenon with a heterosyllabic treatment of consonants (see Chapter 10) – we will be most concerned here with the second of these.

In the remainder of this section will review the behavior of syllabic consonants in three languages: Micmac (6.3.1), Shuswap (6.3.2), and Imdlawn Tashlhiyt Berber (6.3.3). While only Shuswap and Imdlawn Tashlhiyt Berber have been claimed to show directionality in the vocalization of consonants, we include Micmac in this discussion simply because it has already been linked to Proto-Indo-European on the basis of its vocalization of sonorants; the second two are so far as we know new to such consideration.

6.3.1 Micmac

Hewson (1985) draws a comparison between Proto-Indo-European and the Algonquian language Micmac. In this language, as in Proto-Indo-European, the class of sonorants /m, n, l, i, u/ has syllabic and non-syllabic allophones, as exemplified in (30).

(30) *Sonorant allophony in Micmac* (Hewson 1985: 444)

a.	***l ~ l̩***	*kelpilatl*	[kelˀpiladl̩]	'he ties him up'
		klpil	[kl̩bil]	'tie him up!' impv.
b.	***m ~ m̩***	*temsək*	[temˀsək]	'he cuts it off'
		tmse·n	[tm̩ze·n]	'cut it off!' impv.
c.	***n ~ n̩***	*entu*	[enˀtu]	'I lose it'
		ntutes	[n̩dudes]	'I will lose it'
d.	***w ~ u***	*kewčit*	[kewˀčit]	'he is cold'
		ku·čitew	[ku·ǰidew]	'he will be cold'

e.	***j ~ i***	*eykik*	[eyˀkik]	'they are'
		eyk	[eyˀk]	'he is'
		i·tew	[i·dew]	'he will be'

Syllabic sonorants generally arise under morphological conditioning, typically in future or imperative forms, where vocalic reduction eliminates the vowel heading the initial syllable of the word (445).[16] On the other hand, the position of stress may be a factor, as initial vowels are deleted in Micmac when there is stress on the second syllable (Hewson 1973: 160); however, as Hewson does not note stress in the forms reproduced here, it is difficult to determine if this is so.

Comparing Micmac and Proto-Indo-European, we note, as Hewson does, that a syllabic sonorant is in the coda of a full vowel form in Micmac, much as it usually is in Proto-Indo-European as well (see Chapter 5). On the other hand, so far as we have been able to identify, there are no instances in Micmac in which multiple sonorants can conceivably vocalize, but only one does so. Indeed the absence of this feature serves to lessen the force of Hewson's claim that Micmac "is a living exemplar of the situation reconstructed for the class of sonorants in PIE" (446).

6.3.2 Shuswap

Rather, a better candidate for such a distinction would appear to be Shuswap, the northernmost of the Interior Salish languages. As analyzed by Kuipers (1974), Shuswap provides a striking parallel to the Proto-Indo-European phenomenon of righthand sonorant vocalization. While this language has already been cited as a typological parallel for the Proto-Indo-European

[16] But note word-final [l̥] in *kelpilatl* [kelˀpiladl̥], requiring further consideration.

phonological system, specifically, its laryngeal inventory (Beekes 1989, but cf. Hopper 1989, Swiggers 1989), to my knowledge its similarity in this regard has gone unrecognized.[17]

Kuipers presentation of the complete phonemic inventory of the Shuswap western dialects (1974: 20), consisting of thirty-seven consonants and six vowels, is reproduced in (31); the portion containing the fifteen sonorants, relevant for our discussion, is enclosed in double-lines.

(31) *Phonemic Inventory of Shuswap*

a. Consonants

<table>
<tr><td colspan="2" rowspan="3"></td><td colspan="3">OBSTRUENTS</td><td colspan="2">RESONANTS (R)</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">Plos.</td><td rowspan="2">Fric.</td><td rowspan="2">plain</td><td rowspan="2">glott.</td></tr>
<tr><td>plain</td><td>glott.</td></tr>
<tr><td colspan="2">labial</td><td>p</td><td>p̓</td><td></td><td>m</td><td>m̓</td><td colspan="3">labial</td><td rowspan="2">NASALS and LIQUIDS</td></tr>
<tr><td colspan="2">dent.-lateral</td><td>t</td><td>t̓</td><td>λ</td><td>n l</td><td>n̓ l̓</td><td colspan="3">dental</td></tr>
<tr><td colspan="2">dent.-palatal</td><td>c</td><td>c̓</td><td>s</td><td>y</td><td>y̓</td><td colspan="2">plain</td><td rowspan="3">palatal-velar</td><td rowspan="7">GLIDES</td></tr>
<tr><td rowspan="2">velar</td><td>plain</td><td>k</td><td>k̓</td><td>x</td><td>ɣ</td><td>ɣ̓[18]</td><td colspan="2" rowspan="2">velarized</td></tr>
<tr><td>round.</td><td>k°</td><td>k̓°</td><td>x°</td><td></td><td></td></tr>
<tr><td rowspan="2">uvular</td><td>plain</td><td>q</td><td>q̓</td><td>x̌</td><td>ʕ[19]</td><td>[ʕ̓][20]</td><td>plain</td><td rowspan="2">uvular-ized</td><td rowspan="3">laryngeal-uvular</td></tr>
<tr><td>round.</td><td>q°</td><td>q̓°</td><td>x̌°</td><td>ʕ°[21]</td><td>ʕ̓°</td><td>round.</td></tr>
<tr><td rowspan="2">laryng.</td><td>plain</td><td></td><td>ʔ</td><td>h</td><td></td><td></td><td rowspan="2">-- round.</td><td rowspan="2">plain</td></tr>
<tr><td>--</td><td></td><td></td><td></td><td>w</td><td>w̓</td></tr>
</table>

[17] It should perhaps also be noted that Kuipers himself has a place in the annals of Proto-Indo-European reconstruction, having worked extensively on the Northwest Caucasian language Kabardian. Indeed, in reviewing his 1960 book *Phoneme and Morpheme in Kabardian (Eastern Adyghe)*, Paul Friedrich stresses how Kuipers' work has "important historical implications" (208), as his conception of Kabardian parallels the Proto-Indo-European phonological system; thereby, Friedrich claims, suggesting a phylogenetic relationship between Proto-Indo-European and Proto-Caucasian (1964: 208-209).

[18] "The glides ɣ, ɣ̓ are comparable to voiced prevelar fricatives but are pronounced with a very wide aperture" (24).

[19] "ʕ is close to a voiced uvular fricative or to a weak uvular trill, again with a wide aperture; it sounds somewhat like a pharyngealized back [a], except in the surroundings é-C, é-# (# = word-end), where the combination eʕ sounds as long [a:]" (24).

[20] [ʕ̓] coincides with /ʔ/ (20).

[21] "ʕ° sounds like a pharyngealized [ɔ], except in the surroundings ú-C, ú-#, where [ɔ:] results" (24).

b. Vowels

	Front	Central	Back-Rounded
Open		a	
Mid	e	(ʌ)[22] ə[23]	o
Close	i[24]		u[24]

In his discussion of the resonants (1974: 24-26), Kuipers devotes the most space to analyzing their realization as either consonantal or vocalic, depending on position in the word. First of all, all resonants are consonantal when immediately adjacent to a vowel, i.e. V_ or _V. As to be expected, then, resonants are vocalic when occurring in the positions C_C (between two consonants, obstruent or resonant), and C_# (between a consonant and word-final position). Additionally, in initial position before a consonant (either an obstruent or a prevocalic resonant), resonants have the variant [#RəC] (but Kuipers does not explicitly classify resonants in this position as vocalic).

Before we move on to consider vocalization in strings of multiple non-vowel-adjacent resonants, we first note Kuipers' phonetic description of a subset of Shuswap vocalic resonants. In particular, vocalic /m, m̓, n, n̓, l, l̓/ are generally pronounced as [əR],[25] unless they follow a homorganic consonant, in which case they have the variant [R̥], "characterized by close contact between consonant and vocalic resonant, i.e. by absence of an automatic vowel before the closure of the resonant" (1974: 25). A selection of his examples illustrating as much are given in (32); in a., c., and e. the resonant follows a homorganic consonant, while in b., d., and f. it follows a heterorganic one.

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[22] Very rare (20).
[23] In unstressed syllables only (20).
[24] In stressed syllables only (20).
[25] The actual pronunciation of *ə* can vary depending on its consonantal environment; pronunciations include [ĕ, æ̆, ʌ̆], [ɔ̆] near rounded consonants, [ə, ŭ], or zero (26).

(32) a. *t̓upm* [ƛ̓’úPm̥][26] ‘to twist’

b. *qit̓m* [qɛ́iƛ̓’ɛm] ‘to angle’

c. *tntes* [Tn̥tɛ́s] ‘he places it’

d. *kntes* [kɛntɛ́s] ‘he touches it’

e. *pλeλlq°*[27] [pλɛ́Λl̥q°] ‘thick board’

f. *st̓uplq°* [sƛ̓’úpʌlq°] ‘twisted (of rope)’

With respect to the remaining resonants, Kuipers presents the following tabulation of all resonant variants by environment (1974: 25):

(33)

Con. pos.	m	m̓	n	n̓	l	l̓	w	w̓	y	y̓	ɣ	ɣ̓	ʕ	ʕ°	ʕ̓°
Voc. pos.	əm	əm̓	ən	ən̓	əl	əl̓	u(:)	uʔ	i(:)	iʔ	ə̂(:)[28]	--	â(:)	ɔ̂(:)	ɔ̂ʔ
	m̥	m̥̓	n̥	n̥̓	l̥	l̥̓									
Init.	mə-	[29]	nə-		lə-		wu-		yi-		ɣə-		ʕa-	ʕ°ɔ-	

We now consider vocalization in resonant sequences, in which none of the segments are adjacent to a vowel. Regarding this environment, Kuipers states the following: “Of two consecutive resonants neither of which adjoins a vowel the first is consonantal and the second vocalic” (1974: 24) – i.e. CRR̥C, CRR̥#, #RR̥C. Kuipers’ data are given in (34); we organize them according to word-position (initial in a., medial in b., final in c.), and underline the relevant sequences.[30]

[26] Two notes: first, *t̓* is commonly pronounced as a lateral affricate; second, in phonetic notation a capital letter indicates a consonant with one of two types of release: velic before a nasal, lateral before a lateral.
[27] *λ* represents a dental-lateral fricative.
[28] The diacritic ˆ is used to indicate a slight velarization or pharyngealization.
[29] Glottalized resonants occur only after vowels or in vocalic position (21).
[30] In addition to these forms, Kuipers also cites *pwntes* ‘he beats the drum’, featuring a sequence of glide + nasal, with two phonetic transcriptions: [pwəntɛ́s] and [pəwəntɛ́s]. The former is the expected outcome, given his rule; the latter shows vocalization of both resonants, perhaps to avoid a labial consonant cluster.

(34) *Two resonant sequences in Shuswap*

a. #RRC-

i.	*wlmin*	[wəlmín]	‘a fungus’		(G+L)
ii.	*ylqínm*	[yəlqέinəm]	‘coil up’		(G+L)
iii.	*wycín*	[wi(:)cín]	‘loud’ DC[31]		(G+G)
iv.	*ywyuwt*	[yu(:)yú:t]	‘slow in acting’		(G+G)
v.	*yʕ°yuʕ°t*	[yɔ̂(:)yɔ́ʕ°t, -ɔ̂:t]	‘intensive’		(G+G)

b. -CRRC-

i.	*ptínəsmns*	[ptínəsməns]	‘he thinks of it’		(N+N)
ii.	*swekmn̓st*	[swέkmən̓st]	‘lightning’ DC[31]		(N+N)
iii.	*xpln̓tes*	[xpLn̥̓tέs]	‘he puts rocks in the sweathouse’		(L+N)
iv.	*t̓kxely-nke*	[t̓(ə)kxέlyənkε]	‘over there, apparently’		(G+N)
v.	*cq°eq°ym̓x*	[cq°áq°yəm̓x]	‘red pigment’		(G+N)
vi.	*pʕ°nwen̓s*	[pʕ°ənwέns]	‘he manages to revive him’		(G+N)
vii.	*λʕ°ntes*	[λʕ°əntέs]	‘he loses it’		(G+N)
viii.	*pepɣlxwn*	[pépɣəlxwən]	‘I cool off’		(G+L)
ix.	*swlmin̓k*	[swəlmín̓k]	‘rifle’		(G+L)
x.	*k̓°əλlɣʔép*	[k̓°əλlə̂:ʔép]	‘waterfall’		(L+G)
xi.	*xlɣmin̓*	[xlə̂mín̓]	‘stretching-board’		(L+G)
xii.	*syʕ°yeʕ̓tn*	[syɔ̂:yáʕ̓°Tn̥]	‘belt’		(G+G)
xiii.	*l-pətpényws*	[l(ə)pətpέnyus]	‘last year’ DC[31]		(G+G)

c. -CRR#

i.	*momln*	[mɔ́mLn̥]	‘I put them down’		(L+N)

[31] The form is from the Deadman’s Creek dialect.

ii. *pepɣlxwn* [pépɣəlxwən] ‘I cool off’ (G+N)

iii. *cipwn* [čipwən] ‘cellar’ (G+N)

As for sequences of more than two non-vowel-adjacent resonants, Kuipers states the following: “Of three consecutive resonants (first and third not adjoining a vowel) the second is consonantal, the others vocalic (if the first is word-initial, it is consonantal and the second and third are vocalic” (25) – i.e. CR̥RR̥C, CR̥RR̥# and #RR̥R̥C. Kuipers’ data are given in (35); once again, we organize them according to word-position (initial in a., medial in b., final in c.), and underline the relevant sequences.

(35) *Three resonant sequences in Shuswap*

a. #RRRC-

i. *lɣntes* [ləɣəntɛ́s, lə̂n̥tɛ́s] ‘he sticks it on’ (L+G+N)

ii. *wlntes* [wəLn̥tɛ́s] ‘he burns it’ (G+L+N)

iii. *nmntwex˚* [nəməntwɛ́x˚] ‘accuse each other’ (N+N+N)

iv. *llʕtúpeʔ* [Ll̥â:túpɛʔ] ‘tips of pine branches’ DC[31] (L+L+G)

b. -CRRRC-

i. *lelwyn-kn* [lɛ́luyən-kən] ‘I catch something in a trap’ (G+G+N)

ii. *stwlnsmátk˚eʔ* [stuLn̥smátk˚ɛʔ] ‘algae’ (G+L+N)

iii. *snɣlɣalts* [sənɣəlɣálts] ‘the strongest’ (N+G+L)

c. -CRRR#

i. *ʔəx̌˚ʔéx̌˚mnm* [ʔəx̌˚ʔǽx̌˚əmnəm] ‘horseshoe-pitching game’ (N+N+N)

The word-initial treatment #RR̥R̥C is at first blush unusual; not only does it ostensibly involve hiatus, but it is also a departure from the way in which other sequences are handled. If we combine the predictions of both Kuipers’ rule for RR sequences, and his rule for initial #RC sequences, we expect instead #RəRR̥C. In fact, given the data he presents to exemplify the behavior of #RRRC sequences, this interpretation does not seem impossible. Of the four forms in (35)a., three have transcriptions which are, as far as I can see, compatible outright with this view. The fourth, *llʕtúpeʔ* 'tips of pine branches', is transcribed as [Ll̥â:túpɛʔ]; but as it features a resonant preceding a homorganic consonant, an intervening vowel will be absent in any case, as dictated by the special rule applying to such sequences. So it is not convincing that one must necessarily posit the special treatment #RR̥R̥C over #RəRR̥C; the surface realizations seem equally compatible with an interpretation governed by the rules concerning RR and #RC as well. In fact, in his recapitulation of this phenomenon in his work focusing on the eastern dialects of Shuswap, Kuipers seems to recognize as much, characterizing the syllabic positions of sonorants as follows: "if T is any obstruent, any resonant adjacent to a vowel (a nonsyllabic, i.e., consonantal position), or word-final pause, then we have TR̥T, TRR̥T, TR̥RR̥T, word-initially RəT, RR̥T, RəRR̥T" (1989: 12-13).

Kuiper's statements about sonorant syllabicity in Shuswap could just as easily describe the same phenomenon in Proto-Indo-European. Yet we acknowledge that the generalization about sonorant vocalization in Shuswap is posited by Kuipers in view of its particular set of resonant phonemes, as he analyzes them; this set differs from that of Proto-Indo-European in lacking a rhotic, featuring an expansive set of velars and uvulars, and also apparently distinguishing between true high vowels and syllabic glides – the former unconditionally stressed (22), the latter not (compare *pəp̓íʔse* 'snake' versus *sxylap* [sxiláp] 'hour'). Still, if we assume that what have been identified as nasals, liquids, and glides do not depart significantly from the cross-linguistic 'norm' (admittedly illusory as such a notion may be), then comparison of Shuswap and Proto-Indo-European is arguably valid.

6.3.3 Imdlawn Tashlhiyt Berber

Finally, in this subsection we examine a language which has been shown to display descriptively rightward vocalization, a phenomenon naturally expected given our use of the direction-oriented Alignment constraint schema.

In their continuing work on the Imdlawn Tashlhiyt dialect of Berber, Dell and Elmedlaoui (1985, 1988, 2002) have extensively examined the idiosyncratic process of syllabification in this language. What has made this language so distinctive is the claim that any segment can serve as a syllable peak, from non-high-vowels to voiceless obstruents, under the appropriate circumstances.

In their early work on this topic, cast in derivational terms, Dell and Elmedlaoui analyze the process of syllable nucleus selection in Imdlawn Tashlhiyt Berber as a negotiation between drives to maximize nucleus sonority, yet maintain onsetful syllables (at least in non-initial positions).[32] Based on the sonority scale in (36) (their (11), 1985: 109), multiple passes of CV-type "Core syllabification" are made, targeting progressively less and less sonorous segments for selection as syllable nuclei, until the entire phonological string is exhaustively assigned syllable structure.

(36) voiceless stop « voiced stop « voiceless fricative « voiced fricative « nasal « liquid « HV [high vowels] « *a*

As an example, Dell and Elmedlaoui derive the syllabification of the sequence /t-!IzrUal-In/ 'those (f.) from Tazrwalt', ultimately realized as [!tizRwalin], as follows (their (23)):[33]

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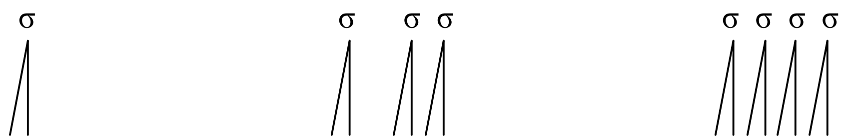
[32] For Optimality-Theoretic approaches, see Prince and Smolensky (1993 [2004]), Clements (1997), and Dell and Elmedlaoui (2002).

[33] On some conventions of representation: prefixed ! in the phonological representation indicates that one or more of the segments in the following morpheme are emphatic, while in the phonetic representation it indicates that all the segments of the word have emphatic articulation at the phonetic level; further, use of capitals in phonetic transcription indicates consonant syllabicity (1985: 126 n.1) – not to be confused with the use of capital *U* and *I* in the phonological representation.

(37) a. CS(*a*) b. CS(HV) c. CS(L)



t-!IzrUal-In t-!IzrUal-In t-!IzrUal-In etc.

In (37)a., the first pass of Core syllabification, targeting instances of the low vowel *a*, identifies the *a* present in the string as the nucleus of a syllable, and assigns the preceding segment as onset to that syllable, i.e., *.wa*. On the second pass of the syllabification process in (37)b., targeting high vowels, the two instances of *I* are selected as nuclei, with *t* and *l* selected as onsets of the resulting syllables, i.e. *.ti.* and *.li.* On the third and final pass represented in (37)c., targeting liquids, *r* is selected as a nucleus, and *z* as an onset, to the syllable *.zR*. (A last step, which Dell and Elmedlaoui do not explicitly include in this example, is the assignment of the lingering final *n* as coda to the syllable headed by the preceding *I*.)[34]

All told, the result of the considerations operative here is a system in which, under the right conditions, a syllable of shape GR̥, in which a (high vowel /) glide is not vocalic and another sonorant is, can be licit: e.g. /t-IUn-t-a-s/ → *ti.wN.tas* 'you climbed on him'. While ostensibly similar to the Proto-Indo-European facts, note it is not this aspect of the Imdlawn Tashlhiyt Berber system which we can draw a significant comparison to: syllabifications like *ti.wN.tas* occur only when the alternative would involve hiatus (i.e. †*ti.un.tas*). This obviously cannot be the motivation behind **k̂u̯n̥bʰis* over †*k̂unbʰis* (but it would disfavor †*k̂u.n̥.bʰis*). Rather, the system mirrors that of Proto-Indo-European in consideration of what happens when a sequence of like-manner sounds occurs in an environment in which either could conceivably vocalize: in such cases it is the *lefthand* segment which does so. Consider the data in (38).

[34] On the phonetics of syllabic consonants in Imdlawn Tashlhiyt Berber, see recently Ridouane (2008) – who, contra Coleman (1996, 1999, 2001) and others, demonstrates their lack of an epenthetic schwa – and Fougeron and Ridouane (2008).

(38) *Like-manner vocalization in Imdlawn Tashlhiyt Berber* (Dell and Elmedlaoui 1985)

	Manner	Input	Syllabification	Alternative	Gloss
a.	**Stop-Stop**	/t-ftk-t/	*tF.tKt*	(†*tFt.kT*)[35]	'you suffered a sprain'
b.	**Fric-Fric**	/rks-x/	*R.kSx*	†*Rk.sX*	'I hid'
c.	**Nasal-Nasal**	/baIn-n/	*ba.yNn*	†*bay.nN*	'they (m.) appear'
d.	**Glide-Glide**	/I-sUfU-IIt/	*isufuyyt*	†*isufwiyt*	'let him illuminate'
		/ldI-III/	*Ldiyyi*	†*Ldyiyi*	'pull me!'

In each of these cases, of two segments of like sonority, it is the lefthand one which serves as syllable nucleus, while the righthand one is a syllable coda. In view of these data Dell and Elmedlaoui characterize syllabification as a process operating iteratively from left to right (1985: 114), though they go on to state their belief that the process is not concerned with left-to-right ordering *per se*, but rather in maximizing the sonority distance in the onset – nucleus sequence (1985: 127n.22). This latter claim is somewhat difficult to accept, however, in view of the fact that it does not seem to matter what the nature of said distance between onset and nucleus actually is – sonority can rise, as in (38)b. *R.kSx*, in which the onset is *k* and the nucleus *S*, or it can fall, as in (38)c. *ba.yNn*, in which the onset is *y* and the nucleus *N*.[36]

While Imdlawn Tashlhiyt Berber would seem to provide a welcome typological parallel to the Proto-Indo-European (and Shuswap) vocalization phenomenon, we should nevertheless emphasize, as Clements (1997) has done, the paucity of relevant data in support of lefthand vocalization. In fact both Dell and Elmedlaoui (1985: 114) and Clements (1997: 308) cite a handful of counterexamples, repeated in (39) (adapted from Clements' (30)b.).

[35] Dell and Elmedlaoui do not include this form in their discussion of the phenomenon in question, but present it elsewhere in the paper. As such the alternative syllabification is our conjecture, based on the syllabification pairings in (38)b.-d.
[36] This assumes that syllabic consonants and their non-syllabic counterparts are of like sonority.

(39) *Syllabification of sonority plateaux supporting right-to-left syllabification*

		I	II	
a.	/wgm-n/	*u.g*$\underline{m}$*n*	*ug.m*$\underline{n}$	'they (m.) drew (water)'
b.	/y t-!bdry-n/	†*i.t*$\underline{b}$*d.rin*	*it.b*$\underline{d}$*.rin*	'for the cockroaches'
c.	/tt-bddal/	?	*ttb*$\underline{d}$*.dal*	'exchange'
d.	/y-ftk baba-s/	?	*if.t*$\underline{k}$*.ba.bas*	'his father suffered a sprain'

In view of these data any parallelism between Imdlawn Tashlhiyt Berber and Proto-Indo-European must remain tentative for now. Clearly more work on the Imdlawn Tashlhiyt Berber system is required to better understand *all* of its pockets of consistency.

6.4 Conclusion

In this chapter we have covered a variety of issues in relation to the phenomenon of sonorant vocalization in Proto-Indo-European. We first of all successfully extended the analysis developed over the course of Chapters 3 and 4 to a number of additional environments, thereby demonstrating its greater empirical coverage as compared to previous Optimality-Theoretic accounts. We then revisted the exceptional cases identified by Schindler (1977b), and explored in greater detail two issues in particular, the nasal-infix presents, whose idiosyncratic behavior we have shown to be most amenable to an analogical explanation, and the nature of *m*, for which we proposed a revision in our conception of the PEAK family of constraints. Finally, we also took steps to situate the Proto-Indo-European phenomenon within a typological framework, showing that its descriptively right-to-left nature is matched by at least one language, Shuswap, and tentatively paralleled by another, Imdlawn Tashlhiyt Berber.

PART II:

MARGINS:

CONSONANT HETEROSYLLABICITY IN INDO-EUROPEAN

CHAPTER 7

SYLLABIFICATION OF MEDIAL CONSONANT CLUSTERS IN VEDIC SANSKRIT

7.0 Introduction

Various scholars have explored syllabification in Vedic Sanskrit – including the Sanskrit grammarians themselves. As is to be expected, the resulting accounts agree on some points but differ on others. In the word-internal domain, a single intervocalic consonant, for instance, is uncontroversially associated with the syllable headed by the following vowel, functioning as its onset; evidence for this position is discussed below in section 7.2.3, on meter.[1]

On the other hand, the treatment of an intervocalic sequence of two (or more) consonants is a matter of disagreement. Two distinct accounts have been maintained. The traditional approach (Hermann 1923, Kuryłowicz 1948), based largely on the evidence of Vedic meter (again, see subsection 7.2.3 below), but bolstered by various phonological phenomena such as the distribution of the perfect union vowel, treats two intervocalic consonants as heterosyllabic, regardless of their sonority profile. The alternative, treating a sequence of consonants of rising sonority as an onset, has been advocated for as well (Steriade 1982, Rice 1990, Cho 1999), based on another set of phonological criteria, including word-initial and word-medial consonant sequence overlap, the reduplicated perfect stem and the facts of obstruent neutralization.

There have also been attempts to reconcile the evidence supporting these two competing analyses. Vaux's (1992) account assigns the different syllabifications to different periods of the language: heterosyllabic treatment in Vedic Sanskrit, tautosyllabic treatment in Classical Sanskrit. Kessler (1998) rejects this account, as well as any based on resyllabification as developed by Selkirk (1982), arguing instead that the first of two intervocalic consonants is

[1] But see section 7.2.2 for the differing perspective of Varma (1929).

actually ambisyllabic, belonging to both the coda of one syllable and the onset of the next, and so immune from processes thought to target segments wholly contained in one position or the other. In this solution he is joined by Calabrese (1999). However, Calabrese (2009) argues for a resyllabification approach, with biconsonantal sequences treated tautosyllabically at one level (or "pass"), heterosyllabically at a later one; he does not seem to address the concerns with resyllabification laid out by Kessler (1998), though.

In this section I argue that Vedic Sanskrit is in fact best characterized as a language in which intervocalic biconsonantal sequences are treated heterosyllabically. I begin in 7.1 by reviewing the purported evidence to the contrary, and show how these facts and phenomena – initial / medial cluster overlap, the reduplicated perfect stem, *-vy-* sequences and obstruent neutralization – are an unreliable indication of the existence of word-internal complex onsets. I next evaluate in 7.2 the evidence cited in support of the heterosyllabic approach – pre-Indo-Iranian Brugmann's Law, writings of the Sanskrit grammarians, meter, the reduplicated aorist and intensive, and the perfect union vowel – and discuss the critical aspects of Vedic syllabification which it reveals.

7.1 The Tautosyllabic Approach

7.1.1 Initial and Medial Clusters

The first array of evidence Kessler (1998) presents in favor of the tautosyllabic[2] treatment ("onset maximization") of intervocalic biconsonantal sequences, before ultimately promoting ambisyllabicity, involves the relationship of such sequences with those found word-initially (9ff.). This position boasts many consonant clusters which, given the fact that they generally rise

[2] Unless explicitly noted otherwise, I use the term 'tautosyllabic' to refer to syllabification of an internal consonant sequence as a complex onset.

in sonority (e.g. *kl-*, *jm-*, *bhr-*, *śn-*, etc.), Kessler considers to be complex onsets; invoking syllable appendices or extrasyllabic segments, given the sonority profile involved, would seem unjustified.[3] Assuming that complex onsets exist word-initially creates, Kessler claims, "a certain presumption against the CS [Consonant Splitting, i.e. heterosyllabic treatment of medial CC sequences] theory. All things being equal, one would expect word-internal onsets and word-initial onsets to follow the same rules; strict CS is normally associated with a language lacking word-initial clusters" (9). In other words, the claim is that, since Vedic possesses complex onsets word-initially, those same sequences ought to be treated in the same way word-internally as well; if Vedic did not possess word-initial complex onsets, then the heterosyllabic approach in internal position would be more plausible. Kessler proceeds to argue (13f.) that the case for tautosyllabifying internal CC sequences of rising sonority as complex onsets is bolstered by the significant overlap shared between these sequences and those in initial position: in other words, that many of the sequences found word-internally also happen to show up initially, where they arguably constitute legal complex onsets. So, again, if these sequence are onsets initially, why not also medially?

Yet the implication at the heart of Kessler's claim, which he notes (after Allen 1953) is at least as old as the Greek grammarian Herodian (ca. 170-240 CE),[4] and more recently has been

[3] Sequences of a sibilant followed by a stop, such as *śc-*, *sk-*, *st-*, etc., occur word-initially as well. While these could also be considered complex onsets, they do feature a reversal in sonority (assuming the appropriate sonority hierarchy); thus in this case, if nowhere else, something like extrasyllabicity may be relevant. Due to this complication we focus only on rising-sonority clusters.

[4] Herodian's statements on the matter include the following; translations are taken from Woodard (1997: 35):

(i) Τὰ σύμφωνα τὰ ἐν ἀρχῇ λέξεως εὑρισκόμενα, καὶ ἐν τῷ μέσῳ ἐὰν εὑρεθῶσιν, ἐν συλλήψει εὑρίσκονται, οἷον ἐν τῷ κτῆμα τὸ κ̅τ̅ ἐν ἀρχῇ λέξεως ἐστίν, ἀλλὰ καὶ ἐν τῷ ἔτικτον εὑρεθέντα ἐν τῷ μέσῳ τὸ κ̅ καὶ τὸ τ̅ ὁμοῦ ἐστιν· (Lentz 1870, p. 393, 33-36)
The consonants which are found at the beginning of a word are found in conjunction [i.e. are not divided] when they occur word-medially. For example, in [kte:ma] the [kt] is at the beginning of the word, and in [étikton], where they occur in the middle of the word, the consonants stand together.

(ii) ὅσα σύμφωνα μὴ δύναται ἐν ἀρχῇ λέξεων ἐκφωνεῖσθαι, ταῦτα καὶ ἐν μέσῃ λέξει εὑρεθέντα χωρισθήσεται ἀλλήλων· οἷον ἄνθος, ἔργον. (Lentz 1870, p. 396, 1-2) espoused in for instance the work of Kahn (1976) for English,[5] cannot be fully maintained in the face of cross-linguistic scrutiny. There are languages in which the same sequence of two consonants is treated as a complex onset word-initially, yet is heterosyllabified word-internally. True, often when this is the case – such as in Icelandic or Munster Irish – the heterosyllabic treatment is not across the board, but rather a restricted set of medial complex onsets does exist. But there are cases in which it is apparently across the board, as in Klamath, which has a wide array of possible initial complex onsets but consistently splits internal CC sequences across syllables. Let us now consider these three languages more closely.[6]

In Icelandic (Green 2003, Gouskova 2004, et al.) the set of possible word-internal complex onsets is confined to a sequence of {p, t, k, s} plus {r, j, v}. All other combinations of two consonants are split up across syllables, regardless of whether or not they occur word-initially (Table 7.1; data in the third column collected from the authors cited).

Table 7.1 Onsets in Icelandic

CC	#__V	V__V
a. kn	.knaiva ‘to project’	ek.na ‘to bait’
b. sn	.s(t)nɪða ‘to slice’	vɪs.a ‘to wither’
c. k(h)v	.k(h)vikna ‘to come to life’	vœ:.k(h)va ‘to water’
d. t(h)j	.t(h)ja ‘to show’	vɪ:.t(h)ja ‘to visit’
e. p(h)r	.p(h)rent(h)a ‘to print’	skɔ:.p(h)ra ‘to roll’

Such consonants as are unable to be pronounced at the beginning of a word are to be separated from one another when they occur word-medially: for example, [ánthos], [érgon].

Interestingly, the implication is not recognized, apparently, by the Sanksrit grammarians, at least the authors of the Prātiśākhyas; see below section 7.2.2.

5 “Thus I will accept as a safe working hypothesis that the set of possible syllable-initial (-final) clusters in English is identical to the set of possible word-initial (-final) clusters” (41).

6 There are also languages in which the mismatch concerns not clusters of rising sonority, but those of falling or flat sonority. Italian, for instance, has been traditionally analyzed (but see recently Kambourakis 2007 for an opposing view) as heterosyllabifying sequences of *s* + consonant, consonant + *s* and consonant + stop in medial position, while allowing them in initial position (only complex onsets consisting of either consonant + liquid or consonant + nasal are permitted internally). However, as noted earlier, the sonority profile of such sequences presents a complication for onset syllabification – one which devices such as extrasyllabicity or syllable appendices have sought to remedy – and as such I opt not include languages like Italian in the discussion.

The diagnostic for word-internal syllabification is as follows. The vowel preceding a word-internal consonant sequence is typically the nucleus of a stressed syllable, which apparently must be minimally bimoraic. Following Gouskova (2004), when the sonority distance between the two consonants is great enough, they constitute a complex onset; consequently, to satisfy the minimality requirement, the stressed vowel is lengthened (c.-e.). However, when the distance is below the threshold, the two consonants are treated heterosyllabically; the first closes the syllable headed by the preceding vowel, thus achieving the required weight, and the vowel remains short (a.-b.). The lack of a long vowel in cases of the former is indicative of a sequence coda + onset, not of a complex onset. Assuming, as Green (2003) does, that identical sequences of consonants word-initially are in fact complex onsets, and extrasyllabicity is not a factor, there clearly is a mismatch in Icelandic between the set of word-initial and word-medial complex onsets.[7]

Green (2003) also discusses the case of onset mismatch in Munster Irish (246-250). This language possesses a three-way distinction in onset domains, stress being a relevant factor for word-internal syllables. Thus the number of consonant clusters found in initial position is greatest, and includes stop + liquid, m + coronal sonorant, fricative + liquid, and obstruent + nasal sequences; as these all rise in sonority, it is again not unreasonable to characterize them as complex onsets. Word-internally, only stop + liquid sequences are possible onsets for stressed syllables, while other clusters are broken up by epenthesis; as for unstressed syllables, they do not allow any complex onsets at all, with epenthesis occurring in all clusters. Examples for all positions are given below in Table 7.2 (collected from Green's (14)-(17)).

[7] See e.g. Berg (2001) for a summary of the various discussions of Icelandic syllabification.

Table 7.2 Onsets in Munster Irish

CC	#__V	V__V (stressed)	V__V (unstressed)
a. stop + liquid	.glan ‘clean’	ə.bra:n ‘April’	agələ ‘fear’ (†a.glə, †ag.lə)
b. *m* + cor. son.	.m^{j}r^{j}i: ‘strength’	am^{j}əl^{j}i:xt ‘wretchedness’ (†a.m^{j}l^{j}i:xt, am^j.l^{j}i:xt)	ʃaumərə ‘room’ (†ʃau.mrə, †ʃaum.rə)
c. fricative + liquid	.sra:d^j ‘street’	*no example*	lasərəx ‘flames’ (†la.srəx, †las.rəx)
d. obstruent + nasal	.g^{j}n^{j}i:v ‘deed’	*no example*	ag^{j}ən^{j}ə ‘mind’ (†a.g^{j}n^{j}ə, †ag^j.n^{j}ə)

Finally, Klamath (Blevins 1993) exhibits the greatest degree of mismatch between onsets in initial and medial positions: whereas complex onsets are permitted word-initially, all internal biconsonantal sequences are treated heterosyllabically. While arguing against a syllable-based account of obstruent neutralization in this language (256-259; see section 7.1.4 below), Blevins cites three (morpho)phonological phenomena, all of which point to a general word-internal syllabification -VC.CV-: stress assignment (1), closed-syllable laxing (2), and vowel reduction/deletion under prefixation (3).

(1) a. *kepkápli* ‘comes back’

b. *saqpáq’wis* ‘a single braid’

(2) a. [ki] ‘is, does’

b. [čɪkmɪn] ‘iron, nail’

(3) a. *wečli* ‘lisps’

b. *wew’ačli* ‘lisp (distributive)’

In all of these cases, consonant clusters of rising sonority must be treated heterosyllabically, as the crucial condition of a closed syllable is satisfied. With respect to stress assignment, absent a long vowel, primary stress in Klamath is assigned on a heavy penultimate syllable, which by circumstances must be closed; thus penultimate stress in *kepkápli* and *saqpáq’wis* is indicative of the syllabification *-p.l-*, *-q'.w-*. As for vowel laxing, certain vowel allophones occur in closed syllables, such as the [I] of [čıkmın] ,which is an allophone of /i/ as in [ki]; so *-km-* must be split across syllables, with *k* functioning as a coda. Finally, when following a prefix a short vowel in the first syllable of the stem is deleted in open syllables or reduced to schwa (a lax allophone of /a/) in closed syllables; that we have schwa (*a*) in the prefixed form *wew'ačli* suggests that, again, the following consonant sequence *-č.l-* is heterosyllabified.

Yet while these consonant clusters of rising sonority function as sequences of coda + onset word-internally, they are all found in initial position as well (see Blevins' inventory on 254-255, unfortunately lacking a full set of examples), where they arguably constitute onsets. Compare, for instance, the cluster *q'w* in *q'wanq'a* 'limps, is lame' with the aforementioned *saqpáq'wis*. Thus Klamath seems to constitute a counterexample to Kessler's generalization associating "strict consonant splitting" with languages lacking word-initial clusters.[8]

To summarize, from a typological perspective we are not compelled to conclude that the overlap of biconsonantal sequences in initial and medial positions in Vedic is significant to the extent that onset maximization is operational in this language. Languages such as Icelandic, Munster Irish and Klamath all possess certain consonant clusters of rising sonority that are syllabified as complex onsets word-initially but as a sequence of coda + onset word-internally. Klamath is particularly restrictive, in that all medial biconsonantal sequences appear to be heterosyllabified, regardless of sonority profile; in this way it most closely resembles what we will conclude to be the case in Vedic.[9] Indeed this implicational argument based on distributional

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[8] "Seems" in the absence of a fuller set of data.

[9] The mismatches seen in these languages do not preclude the plausible implication that any word-medial sequence of consonants syllabified into onset position must also constitute a licit word-inital onset (Vennemann's "Law of Initials" (1988:32): "Word-medial syllable heads [i.e., onsets] are the more preferred, the less they differ from possible word-initial syllable heads of the language system."). Such a claim can indeed co-exist with a heterosyllabic treatment of intervocalic consonants.

facts is probably the weakest piece of evidence cited in support of onset maximization; we move on in the next sections to consideration of phonological phenomena, which ostensibly should possess more substance.

7.1.2 The Reduplicated Perfect

Steriade (1982, 1988) presents the details of the formation of the perfect stem in Classical Sanskrit as evidence of the relevance of onset maximization in the language's system of syllabification: true onsets rise in sonority. Many of the forms she cites are attested already in Vedic, and indeed her generalizations about stem shape generally hold for this period of the language as well. The data in Table 7.3 come from Steriade (1982: 313-314); they are modified only in formatting.[10]

Table 7.3 Vedic perfect reduplication

Initial Sequence	Root	Perfect Stem	Gloss
CV	a. *tod-*	*tu-tód-*	'push'
ORV	b. *prach-*	*pa-prácch- / pa-pracch-*	'ask'
sRV	c. *smay-*	*si-ṣmiy-*	'laugh'
OsV	d. *kṣam*^{i}*-*	*ca-kṣam-*	'tolerate'
RRV	e. *myakṣ-*	*mi-myakṣ- / mi-mikṣ-*	'join'
GGV	f. *vyac-*	*vi-vyác- / vi-vic-*	'extend'
sOV	g. *skand-*	*ca-skánd-*	'leap'
	h. *stav-*	*tu-ṣṭáv- / tu-ṣṭu(v)-*	'praise'

The perfect stem is formed by prefixed reduplication built on the root. The prefix is of shape CV-; our focus is the principle behind the selection of the consonant. For roots beginning with a single consonant (a.), it is this consonant which appears in the prefix. For roots beginning with two consonants, though, there are two distinct patterns of reduplication, targeting either the

[10] Steriade also cites the stem *cu-kṣnu-*, from the root *kṣnu-* 'whet', but this verb is not found in Vedic, to my knowledge.

initial consonant (b.-f.), or the following one (h.-i.). Based on these data Steriade argues that the reduplication process is associated with syllable-structure, specifically, the shape of acceptable onsets as dictated by the sonority-sequencing principle, prescribing onsets of rising sonority. She claims that reduplication consistently involves the initial segment of a true onset in the root, whether simple or complex. Thus, *pa-prácch-* and *si-ṣmiy-* show reduplication of *p* and *s*, respectively, because these segments are of lower sonority than their neighbors, which are sonorants, and thus form licit complex onsets with them. On the other hand, the *s* that is root-initial in forms such as *skand-* and *stav-* does not appear in the reduplicated prefix because it is not the first segment of an onset. Operating with a sonority hierarchy fine-grained enough to draw a distinction between stops and fricatives (with the latter being more sonorous than the former), the root-initial consonant sequences fall in sonority. In such cases Steriade identifies the onset as the following stop, and considers s extrasyllabic. She thus accounts for the shape of *ca-skánd-* and *tu-ṣṭáv-*; the prefixes continue to show reduplication of the initial segment of the onset.

Steriade's work is later cited by Calabrese (2009) as evidence for the general existence of complex onsets in Vedic. However, as was the case with initial and medial sequence overlap, what can only be explicitly demonstrated by these patterns of reduplication is the existence of complex onsets in an initial position, in this case not truly word-initial, but root-initial (which begs the question, of course, of the existence of syllabification at nonsurface levels). Such patterns are irrelevant for the treatment of true internal consonantal sequences: indeed, the fact that, according to Vedic metrical practice, the initial syllable of *pa-prácch-* counts as heavy, suggests that root-initial *p* should be treated as a coda. Thus once again we lack evidence for medial complex onsets, a fact which Steriade (1999b) herself later comes to acknowledge: the argument for tautosyllabic treatment of stop + sonorant sequences in initial position, as laid out in Steriade (1982), "does not establish that stop-sonorant clusters are onsets in all contexts" (n. 12).

Furthermore, we need not adhere to Steriade's analysis of the process of reduplication, either. An alternative way of capturing the facts could be as follows: reduplicate the less sonorous member of a root-initial consonant sequence. So Kessler (1993) has argued. Such an approach reflects Vennemann's generalization that less sonorous consonants make better onsets (1988: 13).

7.1.3 -vy- Sequences

The first set of data Calabrese (1999) presents as evidence for complex onsets in Vedic, before promoting ambisyllabicity, is the treatment in certain cases of intervocalic *-vy-* (705). Based upon the usual behavior of the first segment of this sequence following *a* and before a consonant, we expect *v* to diphthongize with the preceding vowel. However, before *y*, *v* can sometimes remain unchanged. Calabrese's data are presented, with some adjustment, in Table 7.4.

Table 7.4 Special treatment of *-vy-* sequences in Vedic

Form (__y)	Gloss		Form (__C)	Gloss
a. *gávya-*	'relating to cows'		f. *góbhiḥ*	'cow' inst. pl.
b. *návya-*	'praise' gerund.		g. *ánūnot*	'praise' aor.
c. *plāvya-* [Skt.]	'float' gerund.	vs.	h. *ploṣyáti*	'float' fut.
d. *bhávya-*	'be' gerund.		i. *bodhí*	'be' aor. impv.
e. *divyá-*	'heavenly'			

We should note, as indeed Calabrese does (744 n. 30), that these forms are found in the Rig Veda not only with a disyllabic scansion, but with a trisyllabic scansion as well (e.g., *gavi(y)a*, *bhavi(y)a*). The actual counts, according to van Nooten and Holland (1994)'s metrically-restored text, are given in Table 7.5. While there is much more that can be said about these numbers, for now it is sufficient to confirm that disyllabic scansion is not a strict rule for these forms (even if a significant tendency for some). We might therefore approach Calabrese's characterization of this phenomenon as evidence for complex onsets with some skepticism.

Table 7.5 Trisyllabic vs. disyllabic scansion of select Rig Vedic -*vy*- sequences

Form	*(i)y*	*y*
a. *gávya-*	3	26
b. *návya-*	2	42
c. *bhávya-*	2	2
d. *divyá-*	72	28

Indeed such skepticism is bolstered on two further fronts. First and perhaps more important is the fact that examples actually do exist of monophthongization in -*avy*- sequences in the Rig Veda. Three forms built to the root *yu*- 'separate' show just this outcome: *áyoyavīt* 3 sg. impf., *yóyuvatīnãm* gen. pl. intens. part., and *yoyuve* 1 sg. mid. intens. Given these data, the lack of monophthongization observed in forms such as *gávya*- and *návya*- would appear to be exceptional – even for -*avy*- sequences, let alone -*avC*- sequences. Second and more generally, even if we allow consideration of the data in Table 7.4, one gets the feeling that the idiosyncratic behavior exemplified by *gávya*-, *návya*-, etc. is just that: characteristic only of the sequences *vy*, and not necessarily emblematic of the operation of any general principle of syllabification. As such it is difficult to maintain that we have in these forms evidence for a general tautosyllabic treatment of intervocalic consonant clusters, although, to be sure, the existence of a complex onset of uncharacteristic shape *vy* might be said to imply the existence of complex onsets of more typical form (such as obstruent plus sonorant). Yet in the face of the evidence reviewed in

§2 for heterosyllabic treatment, relying on mere implication in support of the onset maximization account is a rather weak strategy.[11]

7.1.4 Obstruent Neutralization

The facts concerning the neutralization of stops in certain positions in Sanskrit (both Classical and Vedic) – particularly the environments where such neutralization occurs and does not occur – have been invoked as support for several claims of the tautosyllabic treatment of medial biconsonantal sequences (Rice 1990; Kessler 1998; Calabrese 1999; Cho 1999). However, as I will show here, the underlying assumption common to all these accounts of the phenomenon in Sanskrit, that neutralization occurs in coda position, need not be adhered to; a comparably-satisfactory alternative can be posited, one which is compatible with a heterosyllabic treatment of the sequences in question. The details of stop neutralization are as follows. Sanskrit has a four-way stop contrast in laryngeal features, distinguishing between voiceless unaspirated, voiceless aspirated, voiced unaspirated and voiced aspirated stops. However, the full range of contrast is only realized in a certain number of positions in a word; in others the contrast is reduced (usually along the dimension of aspiration) by neutralization. Examples for Vedic (selected from Calabrese 1999: 707) are given in Table 7.6.[12]

[11] To be fair to Calabrese, he is not arguing for onset maximization per se so much as the existence, anywhere at all, of complex onsets in Vedic. His motivation is to discount the analysis of Sievers' Law developed by Murray (1988), which relies on a constraint against complex onsets. By showing that there is evidence for complex onsets in Vedic – evidence, it should be pointed out, that this work ultimately disputes – Calabrese aims to prove that such a structure was not restricted, and consequently, that Murray's account ought to be invalidated outright. I am hesitant to conclude as quickly as he does that this should be the case, especially based on so idiosyncratic a set of data.

[12] Neutralization of palatal obstruents occurs as well, in the same environments: *yunájat*, *yunájmi* versus *yunakṣi*, all built to the root *yuj-* 'yoke'.

Table 7.6 Obstruent neutralization in Vedic

Root	__##	__O	__R	__V
a. *prach- / pṛch-* 'ask'		*á-prāt* (< *á-prāch-s-t*; *ch* → *t*)	*pṛch-áti*	*pṛch-yá-te*
b. *vaid- / vid-* 'find'	*vit-tá*		*vi-n-dá-ti*	*vid-yá-te*
c. *bhaid- / bhid-* 'split'	*bhi-ná-t-ti*	*á-bhet*	*bhédati*	*bhíd-ya*

Full differentiation is maintained in only two of the four environments shown, before a sonorant consonant or before a vowel; these two environments can of course be collapsed into, simply, before a sonorant. Elsewhere – before an obstruent consonant or in word-final position – neutralization occurs, limiting the range of stops to just voiceless unaspirated.

Such distribution of environments for contrast and neutralization of stops in Vedic understandably lends itself to an analysis of the phenomenon based on syllable structure: neutralization can be associated with coda position. A word-final stop is syllable-final (at the level of the word), and the sonority sequencing principle can be invoked in the word-internal domain to treat a stop as a coda, when it precedes another obstruent consonant. On the other hand, a stop before a vowel would be an onset, and a stop before a sonorant consonant, again by sonority sequencing, could reasonably form a complex onset. So argue Rice (1990), Kessler (1998), Calabrese (1999), and Cho (1999).

Yet we need not proceed so far as invoking syllable structure to capture these data. We can, alternatively, rely simply on the segmental environment of neutralization, without necessarily connecting this environment to syllable position. So argues Steriade (1999a,b), who claims that laryngeal neutralization is better captured in Vedic and elsewhere in segmental terms, rather than through appeal to syllable structure. With respect to Vedic, her main argument is that the facts of neutralization remain constant in Sanskrit, whereas syllable structure may vary by dialect and time period (see Kobayashi 2004 for discussion of the former, Vaux 1992 for discussion of the latter). Further, from a cross-linguistic standpoint we can note the similar case of Klamath, as Steriade does (1999b: 94): neutralization of obstruents in this language, which does not occur before sonorants, cannot be restricted to coda position because, as Blevins (1993) shows, intervocalic CC sequences are consistently treated heterosyllabically (see section 7.1.1).

That there is a plausible alternative analysis for the conditioning environment of neutralization is enough to cast doubt on its ability to serve as an indication of where syllable boundaries lie in Vedic. Thus this phenomenon does not provide conclusive evidence for onset maximization, nor does it supplement any other evidence. Indeed in the face of evidence to the contrary, a syllable-based account of neutralization in Sanskrit requiring the tautosyllabic treatment of medial consonant clusters is ultimately untenable.

7.1.5 Conclusion

None of the supposed evidence for word-internal onset maximization and complex onsets in Vedic has been shown to be conclusive. The overlap between initial and medial sequences and the formation of the perfect stem, for example, support the existence of complex onsets only in initial position (be it in the word or the root). We cannot reasonably extend this claim to apply to medial consonantal sequences of rising sonority as well, since there need not be a correlation between possible onsets in initial position versus those in medial position (though the reverse correlation seems appropriate). Similarly, we cannot conclude, based on examples of apparent onsets of shape -*vy*-, that onset maximization operated to any robust extent in the language. Finally, while the facts of obstruent neutralization are valid, the analysis restricting the phenomenon to coda position is less convincing; neutralization can arguably be better (or at least, no worse) captured by appealing to linear ordering at the segmental level (an obstruent does not neutralize before a sonorant). Given these determinations, we can only conclude that the tautosyllabic treatment in Vedic of medial consonantal sequences lacks satisfactory argumentation. We therefore lay it aside and proceed in the next section to review the evidence for the heterosyllabic syllabification of these sequences.

7.2 The Heterosyllabic Approach

The purported evidence reviewed in the previous section for tautosyllabification of medial clusters in Vedic was shown to be inconclusive, as none of the facts or phenomena considered there were shown to crucially necessitate this treatment. On the other hand, of the (morpho)phonological processes that we will now consider, nearly all are intimately connected to a phenomenon which in modern phonological theory is critically linked to syllable structure: weight. We will encounter multiple cases calling for a syllable headed by a short vowel to be considered heavy, a feat that is consistently achieved by treating the initial segment of a following consonant cluster as a coda. Such evidence will be difficult to refute or reconcile with tautosyllabification of said clusters.

7.2.1 Brugmann's Law: Pre-Vedic Evidence for -VC.CV- Syllabification

As a prelude to the discussion of Vedic-internal evidence for the heterosyllabic treatment of intervocalic consonant sequences, we can first review the sound change known as Brugmann's Law, which occurred in the development from Proto-Indo-European to Indo-Iranian. The formulation of this sound change suggests that internal consonant sequences were uniformly split up across syllables, but the nature of the data makes this claim difficult to assess.

First articulated by Brugmann (1876), the law in its most basic form states that PIE **o* (Brugmann's **a₂*) lengthens in open syllables to **ō*, and, following the merger of long vowels, becomes *ā*. So we have cognate pairs such as Vedic *jā́nu* ~ Greek *gónu* 'knee' (< PIE **ĝónu*), *dā́ru* ~ *dóru* 'tree' (< **dóru*). Brugmann later clarified that the law did not apply to instances of non-ablauting *o*, many of which can be explained as the result of laryngeal coloring (i.e., h_3e; see Lubotsky 1990). In the face of criticism and apparent counterexamples such as those compiled by Hirt (1913), the law fell out of favor, but was revived by the efforts of Kuryłowicz (1927), who factored laryngeals into its operation; he was thereby able to account for several (though not all) of these apparent counterexamples. In his reformulation we have an explanation for the distinction between Vedic first and third person singular forms such as *cakā́ra* and *cakára*, from *car-* 'do': the former reflects PIE $*k^wek^w$*óre*, with open syllable, while the latter reflects $*k^wek^w\acute{o}rh_2e$, with closed syllable.[13] While Kuryłowicz himself would later come to alter his view of the law, seeking to analyze it as morphologically governed (Kuryłowicz 1956), nevertheless whatever consensus there seems to be today among those who acknowledge Brugmann's Law is focused on his earlier approach.[14] More recently, for example, Volkart (1994), reviewing Hirt's counterexamples, as well as work by Lubotsky (1990) and Jamison

[13] The *ā* for expected *ă* in third person forms built to set roots such as *jajā́na* 3 sg. perf. 'born' ($*\hat{g}e\text{-}\hat{g}\acute{o}nh_1\text{-}e$; cf. the expected, but unattested, first person *jajána* < $*\hat{g}e\text{-}\hat{g}\acute{o}nh_1\text{-}h_2e$) is the result of analogy. Sihler (1987: 369) suggests syllable weight, not vowel length, to be the salient trait defining the third person, in light of forms such as *dadárśa* 'saw' 1/3 sg. perf., which were unchanged. See fn. 29 for a similar case of prosodic analogy.
[14] See Collinge (1985: 13-21) for a more detailed overview of the history of Brugmann's Law. Another account worth mentioning is that of Burrow (1975), who argues that all instances of PIE **o* surface as *ā* in Sanskrit, even those before consonant clusters. As far as I can tell this view has not been thoroughly engaged.

(1983), ultimately concludes that Brugmann's Law and Kuryłowicz's interpretation are valid,[15] though the restriction to ablauting **o* lacks conclusive evidence.[16]

We might also in the context of syllable structure mention the adjustment of Kleinhans, as reported in Pedersen (1900), which restricted operation of the law only to instances in which the vowel was followed by a liquid or nasal (i.e., *l*, *r*, *m* or *n*).[17] For a phenomenon thought to be conditioned by syllable structure, it is ostensibly peculiar that the length of a vowel should be conditioned by the quality of a following consonant, which is the onset of a different syllable (though vowels do tend to be phonetically longer before voiced sounds, including sonorants);[18] and in any case the Kleinhans formulation has been rebutted by e.g. Burrow (1975), Hajnal (1994) and Volkart (1994), the last of whom cites forms such as *uṣā́sam* 'dawn' acc. sg. < PIE *$h_2$éus-os-m̥*, and perhaps also *pā́dam* 'foot' acc. sg. and *vā́cam* 'speech' acc. sg, with a following obstruent (64).[19]

Given Kuryłowicz' earlier interpretation, a primary revelation of the phenomenon of Brugmann's Law is its demonstration of laryngeal 'substance' – that is, it shows that laryngeals were phonetically substantial enough to constitute the onset of a syllable. With respect to syllabification, though, examples like those above, and others that are cited, such as *-áya-* causatives *mānáyati* 'causes to think' (< **monéi̯eti*) versus *janáyati* 'causes to be born' (< **ĝonh$_1$éi̯eti*), are not particularly revealing, in that by certain conceptions of the sonority

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[15] "Brugmanns Gesetz ist...somit allerWahrscheinlichkeit nach gültig" (63); "Kuryłowicz' Interpretation zu BG ist...somit aller Wahrscheinlichkeit nach gültig" (64).

[16] "Ohne zusätzliches Material ist eine definitive Entscheidung in dieser Frage wohl nicht möglich" (64). See Lubotsky (1990: 57-58) for discussion of one of the possible counterexamples Volkart cites, *styā́yate* 'to become solid, stiff', which he claims to be a nonce form.

[17] As Burrow notes (1975: 77), the set has been expanded to include glides *i̯* and *u̯* by for example Lehmann (1955: 13).

[18] In fact such a development is apparently to be found in the Algic language Yurok, which lengthened o in an initial open syllable before a resonant in some words (Berman 1982: 416-417): compare Yurok *ho·leʔm*(-) 'to go, to travel, to be around, to fare (plural verb)', cognate with the related language Wiyot's *hol-* 'to go, to walk'. The fact that it is *o* in particular which lengthens (Yurok has a typical five-vowel system, with contrastive length for all members save *e*) is a similarity worth investigating further.

[19] Although we cannot exclude analogical explanations for any of these, however.

sequencing principle, a medial sequence sonorant + laryngeal (whether considered a sonorant or obstruent), could easily be treated heterosyllabically anyway. Indeed a survey of the typical types of data introduced in favor of the Law's relevance reveals few forms in which a consonant cluster of rising sonority must necessarily be treated heterosyllabically in order to achieve the right result. In this respect morphology certainly comes into play, as the shapes of morphemes, which generally abide by sonority sequencing, constrain the set of possible consonant combinations which may occur in the usual Brugmann's Law environments.

As an example to illustrate this point, let us consider the case of the oft-cited *-áya-* formation. Brugmann's Law operates in those forms built to roots ending in a single consonant: *cātáyate* 'makes hide', *nāśáyati* 'makes disappear', etc. Jamison (1983) cites 50 such forms which obey the rule, 12 which do not (205-206); her analysis does not incorporate Kuryłowicz' laryngeal-related adjustment, an insight which would account for at least one of her exceptions (*janáyati*, 'causes to be born'). On the other hand, in forms built to roots ending in two consonants, the law should not operate; and indeed, Jamison (1983) cites 62 forms derived from PIE **o*, which is not lengthened, including *krandayati* 'makes roar' and *nartáyati* 'makes dance' (203-204).

The issue should (hopefully) be clear: the chances of observing a sequence of rising sonority, such as stop + liquid, preceding *-áya-* are practically nil, as are those, consequently, of being able to test whether such a sequence would satisfy the Brugmann's Law open syllable environment. Necessarily occurring root-finally, any such sequence would violate the morphophonotactic conditions on Sanskrit (and Proto-Indo-European) verbal roots, which are monosyllabic in shape and generally abide by sonority sequencing. Instead, all of the root-final consonant clusters in Jamison's data are of falling sonority, a profile expected of a coda sequence, or, given a following vowel, a sequence of coda + onset – the result of heterosyllabic treatment.

The nature of the data makes this issue relevant for the perfect as well, the other area of the Vedic verbal system chiefly providing evidence for Brugmann's Law. In this domain Brugmann's Law operates to lengthen original **o* in forms of the third person singular, across the morpheme boundary between stem and ending *-a* < **-e*. In contrast stand, again, forms of the first person singular,[20] in which the ending is *-a* < *-h_2e and the syllable headed by the root vowel is analyzed as closed; this would be an expected syllabification whether the stem ends in an obstruent or sonorant.

While the verbal evidence for Brugmann's Law would appear to be unhelpful for demonstrating the heterosyllabic syllabification of rising sonority consonant clusters, nevertheless there are a handful of Vedic nominal forms that may prove illuminating in this regard. Chief among these is *ájma-* 'course, path', from PIE *h_2*oĝ-mo-*; the *o*-grade is confirmed by Gk. *ógmos* 'furrow, swathe' (cf. Lat. *agmen* 'driving' from *e*-grade *h_2*eĝ-men-*). The absence of a long vowel indicates that the medial sequence *-jm-* is split up across syllables, such that *j* closes the syllable headed by the root vowel. Other forms are less conclusive but still worth mentioning; one such form is *áśri-* 'sharp edge' if from *h_2*ok̂ri-* (Gk. *ókris* 'sharp edge', Lat. *ocris* 'rocky mountain'), but note the *e*-grade indicated by Gk. *ákris*, which means an origin in *h_2*ek̂ri-* cannot be excluded. There is also the athematic neuter *śákṛt* 'dung', genitive *śáknaḥ*, if from an *o*-grade **kok*^{w}- of the root **kek*^{w}- 'defecate' (*IEW* 544; cf. Lith. *šikù*, *šìkti* 'defecate'). Gk. *kópros* 'dung' may provide confirmation of the original *o*-grade, but as a thematic masculine cannot be directly compared.[21]

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[20] Also the second person singular, in which the ending is *-tha* < -*th*$_2$*e*.
[21] The form *patni-* 'mistress' from **pot-n-ih*$_2$ (Gk. *potnia*) can be included here as well.

Taking such forms into account, then, we can reasonably argue that Brugmann's Law provides evidence that an intervocalic consonant cluster – even one of rising sonority – was treated heterosyllabically at the time of its operation, somewhere in the development from Proto-Indo-European to Indo-Iranian. As we will see, this is a treatment which continued into Vedic.[22]

7.2.2 The Sanskrit Grammarians

Before moving on to the (morpho)phonological phenomena internal to Vedic indicative of the heterosyllabic treatment of consonant medial clusters, we pause to acknowledge statements on the matter made by the ancient Sanskrit grammarians themselves (summarized in e.g. Varma 1929: 61-83, Allen 1953: 81-83, Chakrabati 1996: 131-145 and Kobayashi 2001: 96-99), which more or less endorse the position argued for here, albeit with some wrinkles.

The four treatises known as Prātiśākhyas deal with various phonetic aspects of Vedic Sanskrit; these are the Rik-Prātiśākhya (covering the Rig Veda), the Taittirīya-Prātiśākhya and Vājasaneyi-Prātiśākhya (covering the Yajur Veda) and the Śaunakīya-Caturādhyāyiā (covering the Atharva Veda). The discussion of syllable structure – or rather, the structure of what the grammarians termed *akṣara*, the 'imperishable'[23] – found in these works consists of a series of brief statements, in which consonants in various positions and of varying natures are assigned to either a preceding or following vowel. Relevant passages from the Rik-Prātiśākhya (RP), the Taittirīya-Prātiśākhya (TP) and the Śaunakīya-Caturādhyāyiā (ŚC) are given below in (4)-(6).

[22] In a way, for the study of Proto-Indo-European syllable structure, the evidence of Brugmann's Law might be viewed as superior to that provided by processes and phenomena internal to Vedic, by virtue of its chronological precedence. While providing further support for the overall claims made, I would argue that the discussion of syllabification in Vedic undertaken here is also important in its own right, as it provides a fresh perspective on the true probative value of the evidence typically put forth.

[23] As Allen notes (1953: 81), the meaning is not certain. An alternative is 'that which does not move subordinate to another', i.e. that which stands alone. Either would be derived from negative prefix *a-* + *kṣar-* 'flow, perish'.

(4) **RP** (Müller 1869)

a. 1.23-25 (15):

svarāntare vyañjanānyuttarasya (23)

pūrvasyānusvāravisarganīyau (24) *saṃyogādirvā* (25)

'Between vowels consonants [belong] to the following [vowel] (23); to the preceding [vowel belong] anusvāra and visarga (24); the first consonant of a group [belongs to either (?) vowel] optionally (25)'

b. 18.33-35 (147-148):

vyañjanānyuttarasyaiva svarasyāntyam tu pūrvabhāk (33)

visarganīyānusvārau bhajete pūrvamaksaram (34) *samyogāadiśca vaivamca* (35)

'Consonants [belong] to a following vowel, but a final [consonant belongs] to the preceding [vowel] (33); visarga and anusvāra belong to the preceding syllable (34); the first consonant of a group, one [vowel] or another (35)'

(5) **TP** 21.1-9 (Whitney 1871: 375-386):

vyañjanaṁ svarāṅgam (1) *tatparasvaram* (2)

śavasitaṃ pūrvasya (3) *samyogādi* (4)

parena cāsaṁhitam (5)

'The consonant is adjunct of a vowel (1); it [belongs] to the following vowel (2); a consonant in pausa [belongs] to the preceding vowel (3); also the first consonant of a group (4); and one that is not combined with the following vowel (5)'

(6) **ŚC** 1.55-56 (Whitney 1860-1863: 374-375):

parasya svarasya vyañjanāni (55) *samyogādihpūrvasya* (56)

'Consonants [belong] to the following vowel (55); the first consonant of a group [belongs] to the preceding vowel (56)'

As can be seen, with respect to a single intervocalic consonant, all of these texts agree that it is to be assigned to the syllable headed by the following vowel.[24] The situation is more complicated for consonant clusters: while all three texts associate the initial consonant with the syllable headed by the preceding vowel – abstracting away from the exceptions noted in the TP[25] – in the RP this practice is apparently only optional, as suggested by use of *vā* 'either'.[26] Based on this particle, line 25 has been interpreted to mean (by accounts such as those cited above) that the heterosyllabic treatment is considered optional; the first consonant could alternatively be grouped with the following syllable. However, as Kessler (1998) points out, it is not entirely clear what it means in this case to be 'optional' – does it mean that for any and all combinations of consonants, either syllabification is valid? Or that both types of syllabification are *possible* for the general sequence -VCCV-, but that, based on the particular consonants involved (or perhaps some other factor(s)) only one is actually appropriate? It is difficult to draw any conclusion, one way or the other, and indeed Kessler cites this issue to justify his hesitation in relying on the native grammarians as a source of evidence for Vedic phonology; in my own judgment, I can appreciate his hesitation.[27]

[24] Cf. Varma (1929: 61-62) (repeated, practically verbatim, by Mishra 1972: 200-201), who considers such treatment "purely conventional," arguing instead that the segment is ambisyllabic ("divided between two vowels"). The claim is similar to those made for English by Kahn (1976) and for Danish by Borowsky et al. (1984).

[25] See lines 21.6-9; tautosyllabic treatment is advocated for consonant + semivowel and stop + fricative sequences.

[26] The meaning of this particle in the grammatical tradition of Pāṇini has been identified by Kiparsky (1979) as 'usually, preferably' (1) – i.e., the particle features in rules whose application to a particular set of forms creates a 'normal' outcome. (In contrast is the form *vibhāṣā* 'or rather not, rarely, preferably not, marginally', which Kiparsky analyzes as indicating the opposite.) It is difficult to see how this definition would apply here.

[27] Further complicating matters, Whitney (1860-1863, 1871), in his editions of the Taittirīya-Prātiśākhya and the Śaunakīya-Caturādhyāyiā, argues that the rule for the initial consonant of the cluster must be understood in conjunction with rules of consonant doubling, and that as such its application is not as straightforward as it may seem.

7.2.3 Meter

Perhaps the method most relied upon for determining in Vedic where the syllable boundary lies for an intervocalic consonantal sequence is meter; the following discussion is drawn primarily from Arnold (1905). Vedic meter is principally based on syllable counting, with each verse (*pāda*) usually consisting of either eight syllables (as in *gāyatrī* or *anuṣṭubh* stanzas), eleven syllables (as in *triṣṭubh* stanzas) or twelve syllables (as in *jagatī* stanzas). The rhythm within each verse consists of a sequence of light (*laghu*) and heavy (*guru*) syllables: a light syllable is headed by a short vowel and open – i.e., followed by a single consonant – and a heavy syllable is headed by a long vowel and/or closed – i.e., followed by two or more consonants.[28] While there are distinct tendencies in the initial portion of the *pāda* for the distribution of light and heavy syllables, it is in the cadence, comprising the last four (or five, in the case of dodecasyllables) syllables, where the regularity is strongest: iambic in octosyllables and dodecasyllables, trochaic (predominantly) in hendecasyllables.

The following sample lines are taken from van Nooten and Holland (1994)'s metrically-restored text of the Rig Veda. While syllable weight is indicated throughout (‿ marks a light syllable, – a heavy syllable, | the beginning of the cadence), we will focus on the rhythm within the cadence.

(7) – – – – | ‿ – ‿ x

ágne dhármāṇi puṣyasi (5.26.6)

'Agni, you cherish the laws'

(8) – – ‿ – – ‿ ‿ | – ‿ – ‿ x

trír adyá yajñám mádhunā mimikṣatam (1.34.3)

[28] For discussion of 'superheavy' syllables, syllables meeting both of these criteria, see section 7.2.6. These syllables also count as heavy for metrical purposes, but are more restricted than plain heavy syllables in their deployment.

‘three times today you two sprinkle the sacrifice with honey’

(9) – – ‿ – ‿ – ‿ | – ‿ – x

mádhvaḥ punanti dhā́rayā pavítraiḥ (3.36.7)

‘they cleanse [it] with a stream of mead [and] filters’

Examination of the cadence in these three lines confirms the defining criteria for light and heavy syllables in Vedic. The penultimate syllables in the octosyllabic (7) and dodecasyllabic (8) lines and the antepenultimate syllable in the hendecasyllabic line (9) must all be light, to meet the required metrical structure. The sequences associated with these positions, *-ya-*, *-ṣa-*, and *pa-*, respectively, must therefore constitute light syllables, with the following consonant (*s*, *t*, *v*) part of the following syllable. Similarly, the first syllable within the cadence in (9) must be heavy, and with its long vowel, the sequence *-yā* fulfills this role. The antepenultimate syllables in (7) and (8) and the penultimate syllable in (9) must also be heavy; in the absence of a long vowel, though, this requirement is clearly satisfied by the heterosyllabic treatment of the following consonant sequence, yielding heavy syllables of shape *puṣ-*, *-mik-*, and *-vít-*, respectively. This is apparently so despite the fact that in at least two of these cases, (7) and (9), the resulting coda consonant precedes another consonant of higher sonority (*y*, *r*), with which it can comprise a theoretically viable complex onset. Thus metrical practice would seem to provide clear confirmation of two points about Vedic syllabification: that 1) a single intervocalic consonant is an onset, in that it does not make a preceding syllable heavy, and 2) the first of two intervocalic consonants belongs to the syllable headed by the preceding vowel, regardless of its relative sonority. Further, all consonants can be weight-bearing by position, since even a postvocalic, preconsonantal obstruent makes the syllable headed by the preceding vowel heavy.

7.2.4 The Reduplicated Aorist

Some verbs form their aorist stem by prefixed reduplication (Whitney 1896, Macdonell 1910: 373-375). The reduplication process involves the prefixing of a sequence CV to the stem, where C generally corresponds to the initial consonant of the root, and V is most often *i*. Examples are presented in Table 7.7 (Macdonell 1910: 374).

Table 7.7 Vedic aorist stems

Root	Aorist Stem	Gloss
a. *jan^{i}-*	*á-j**ī**-jan-a-*	'beget'
b. *vāś-*	*á-v**ī**-vaś-a-*	'bellow'
c. *vṛdh-*	*á-v**ī**-vṛdh-a-*	'grow'
d. *krand-*	*a-c**i**-krad-a-*	'cry out'
e. *kṣip-*	*c**i**-kṣip-a-*	'throw'
f. *syand-*	*á-s**i**-ṣyad-a-*	'flow'

The reduplicated aorist is often associated with causative meaning and the *-áya-* secondary conjugation, and indeed the origin of the reduplicated formation's shape may lay in this connection. According to Jamison (1983: 217ff.), the heavy syllable concluding the prefix followed by the light syllable of the root arose out of an effort to make reduplicated aorist forms metrically equivalent to most *-áya-* transitives, which are also dactylic: compare *trāsayati* 'makes tremble', *pātáyati* 'flies' with heavy syllable via long vowel; *arpáyati* 'fits in', *jambháyati* 'crushes' with heavy syllable via coda consonant (but note also forms such as *janáyati* 'begets', *namáyati* 'makes bow', with light syllable). The heavy syllable of the prefix would have been original, by virtue of the root-initial consonant cluster, or introduced later via lengthening of the reduplicated vowel and/or zero grade of the root.[29]

[29] Such analogical extension of a prosodic pattern may find company in the lengthening observed in Old Norse *ō*-stem datives (Þórhallsdóttir 2007: 335ff.).

Descriptively speaking, the reduplicated prefix is of the form $C\bar{V}\breve{}$. In cases where the root begins with a single consonant, the vowel is long (*á*-***jī***-*jan*-*a*-); in cases where the root begins with two consonants, it is short (***ci***-*kṣip*-*a*-). We can thus analyze the process of reduplication as follows: the template for aorist stem reduplication is a heavy syllable, a shape Jamison (1988: 217) links to metrical considerations. For roots beginning with two consonants, appropriate weight is achieved by linking the first consonant to the prefixed syllable, with the second acting as onset for the root syllable. For roots beginning with a single consonant, since this consonant satisfies the onset requirement of the root syllable, it cannot also close the preceding one. In order to satisfy the template's size requirement, then, the vowel of the prefixed syllable is lengthened. These facts have been cited as evidence for heterosyllabic treatment of intervocalic biconsonantal clusters (Vaux 1992; Kessler 1998; Calabrese 1999).

7.2.5 The Reduplicated Intensive

The characterization of the reduplicated aorist can be extended to the reduplicated intensive, though the shape of the template differs. Whitney (1896: 363-365) and Macdonell (1910: 390-391) identify three possible shapes of the reduplicated syllable portion of the intensive stem: $C_1\bar{V}$-, C_1VC_2- and $C_1VC_2\breve{\bar{i}}$-. Generally speaking, C_1 corresponds to the first consonant of the root, C_2 corresponds to the consonant in the root following the vowel, and V corresponds to the root vowel.[30] Schaefer (1994)'s more recent classification falls along more or less the same lines, although she distinguishes between prefixes of shape K*ā*- (Typ(e) I) and K*e/o*- (Typ(e) II); the Typ(e) III shape is K*a*R-, the Typ(e) IV shape is K*a*R*ī̆*-. While our interest lies in forms

[30] Some further details: in the shape $C_1\bar{V}$-, the vowel is *ā* if the root vowel is *a* or *ṛ*; *e* if the root vowel is *ī̆*; and *o* if the root vowel is *ū̆*. In the shape C_1VC_2-, the second consonant is *r* if the root vowel is *ṛ*; otherwise it is always *a* (by virtue of a root vowel *a*). Finally, in the shape C_1VC_2 *ī̆*-, the vowel is *a* in all cases, and C_2 is *r* when the root vowel is *r*, *v* when the root vowel is *u*. The examples in Table 7.8 should make the patterns clearer.

exhibiting disyllabic reduplication, examples of intensive stems of all of these shapes are given in Table 7.8; the reduplicated prefix is in bold.

Table 7.8 Vedic intensive stems

	Root	Intensive Stem	Gloss
$C_1\bar{V}$	a. *dṛ-*	***dā**-dṛ-*	'split'
	b. *nī-*	***ne**-nī-*	'lead'
	c. *pruth^i-*	***po**-pruth-*	'snort'
	d. *vad^i-*	***vā**-vad-*	'speak'
C_1VC_2-	e. *jambh-*	***jañ**-jabh-*	'chew up'
	f. *sṛ-*	***sar**-sṛ-*	'flow'
$C_1VC_2\breve{\bar{\imath}}$-	g. *krand-*	***kani**-krand-*	'cry out'
	h. *gam-*	***ganī**-gam-*	'go'
	i. *dyot-*	***davi**-dyut-*	'shine'
	j. *vṛj-*	***varī**-vrj-*	'turn'

The generalization which comes through in consideration of these data is that the reduplicated portion of the intensive stem must end in a heavy syllable. This condition is clear enough in the data for the first two (or three, following Schaefer) reduplication types, where the reduplicated portion ends in a long vowel, as in *vā-vad-*, or a vowel plus a consonant of higher sonority than the immediately following (root-initial) one, as in *sar-sṛ-*. Extending the generalization to the data for the third reduplication type, we see here too that the examples featuring *ī*, *varī-vṛj-* and *ganī-gam-*, clearly have a reduplicated portion ending in a heavy syllable as well.

We must now consider the case of the final two intensive stem forms in the data, *davi-dyut-* and *kani-krand-*. If we choose to extend the generalization about a heavy syllable to forms such as these, it is straightforward enough to do so: we must simply posit a syllabification whereby the root-initial consonant is in the coda of the second syllable of the reduplicated portion, thereby closing it and making it heavy: *david.yut-*, *kanik.rand-*.[31] This would suggest, then, a heterosyllabic treatment of intervocalic consonant sequences, even when the consonants concerned rise in sonority (Kessler 1998; Steriade 1999b).[32]

At this point we might mention that the origin of the disyllabic reduplication with *i* has been the subject of some debate. Prefix-final *i* has been associated with the *i* sometimes found stem-finally in intensive forms; Beekes (1981), discounting a number of other possibilities (root-final laryngeals, for example), sought to identify the vowel as originating in the reduplicated intensive forms of laryngeal-initial roots: a root of shape HCeR(C)- would have had an intensive of shape HC*e*R-HC*e*R(C), and while the initial laryngeal would have been lost,[33] the word-internal one would have become *i*. Similarly, roots of shape HC*e*T- would have reduplicated HC*e*-HC*e*T-, resulting in the vowel length observed in forms such as those in a.-d. in Table 7.8 above (Schaefer's Typ(e) I and Typ(e) II). Unfortunately Beekes can cite no laryngeal-initial root with intensive forms in support of his claim, a gap in the evidence acknowledged to exist by Jamison (1988). More recently, however, Schaefer (1994) taking up Beekes' theory, cites the root *vṛj-* 'turn', with intensive stem *várīvṛj-* (cited above), if derived from PIE *h_2u̯erg-*.[34] Still, questions remain for this theory, for instance why some roots with confidently-reconstructed

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[31] The interaction of the intensive weight condition with syllable structure is further illustrated in view of participial forms such as *gani-gm-at-*, *pani-pn-at*. The absence of the root vowel is accompanied by a shortening of prefix-final *i*, an expected result given a heterosyllabic treatment of the sequences *-gm-*, *-pn-*: *g* and *p* function as codas and make the syllable with nucleus *i* heavy. Thus the weight condition is satisfied without resorting to vowel lengthening.

[32] Proponents of the idea that ambisyllabicity plays a role in syllabification in Sanskrit – a position articulated by Kessler (1998) and Calabrese (1999) – might argue that the root-initial consonant which also closes the last syllable of the reduplicated prefix is ambisyllabic. This would make it immune from neutralization seen in other coda positions, as it is not fully within the coda. However, as discussed already in section 7.1.4, the facts of neutralization need not be expressed in terms of syllable structure, and so we need not invoke ambisyllabicity. Absent independent motivation, invoking it in general would seem to be an unnecessary complication.

[33] Based on the pattern of reduplication with respect to initial consonants observed in the data in Table 7.8, I am not certain that the laryngeal would have been reduplicated in the first place. Of course the generalization may only apply synchronically.

[34] Lubotsky (1997a), reviewing Schaefer, proposes also the root *yudh-* 'fight' with intensive stem *yavīyúdh-*; evidence for an initial laryngeal comes from vowel lengthening in compounds such as *amitrā-yúdh-* 'fighting with the enemies' (561).

initial laryngeals (such as *mṛj-* ‘wipe’ from PIE **H₃mṛǵ-*[35]) do not feature prefix-final *i*; Lubotsky (1997a) is unconvinced by Schaefer’s account relying on Saussure-Hirt’s Law on laryngeal loss in the environment of *o*-vocalism. Writing earlier, Jamison (1983) is skeptical of any attempt to explain a situation in which “it is quite clear that there is no rhyme or reason for the attested forms” (42), adding that many roots build multiple intensive forms of different shape, or intensive forms counter to historical expectations. Her own view on the matter, articulated in Jamison (1988: 218), is that intensive prefix *i* is a vocalized laryngeal originally found in a set of seṭ roots (e.g. “perhaps” **navH-nuH-* ~ **-navH* ‘praise’, **sanH-snh-* ‘gain’) which spread “out of sheer phonological exuberance”, remaining short before two consonants (*saniṣṇata*), but lengthening before a single consonant (*návīnot*), for identical metrical shape. But this view necessitates that the entire root syllable reduplicate, including final consonant cluster – a pattern, as Beekes points out, not found in Indo-European languages (20-21). Still, it is not inconceivable that under the combined influence of laryngeal-initial and laryngeal-final root intensive stem formation, a generalized intensive *i* was introduced.

Finally, with respect to syllable structure, In a more restrictive sense, reduplicated aorist and intensive stem formation shows us that surface syllabification can be C.C to satisfy a template in Vedic. From this perspective, these phenomena identify Vedic as a language preferring first to use material already present in an input or underlying form for such purposes, prior to resorting to mechanisms such as epenthesis. If we want to posit a ‘default’ syllabification for Vedic, these cases do not in and of themselves provide crucial evidence for it; yet in the greater context of phenomena explored here which all point to a heterosyllabic treatment of intervocalic consonant sequences, their existence serves to bolster our conclusions.

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[35] Lubotsky’s stated formulation; **h₂merĝ-* in *LIV* (280-281; *IEW* 738).

7.2.6 The Perfect Union Vowel

Certain verbs in Vedic have forms of the perfect indicative featuring a vowel i, ostensibly belonging to neither the stem nor the ending.[36] The distribution of this 'perfect union vowel' is yet another phenomenon in the phonology of the language conditioned by syllable structure. Crucially, the syllabification involved in the analysis of the perfect union vowel necessitates that intervocalic consonant sequences be treated heterosyllabically.

We will begin the discussion with a brief word about the formation of the perfect, starting with the perfect stem. We have already seen in section 7.1.2 that the formation of the perfect stem involves a process of reduplication, much like certain aorist and intensive stems. However, while the discussion above focused on the form of the reduplicated prefix, our concern here is with the end of the stem, as it is this portion which comes into direct contact with the perfect endings. With this in mind, let us consider the verbal roots and associated perfect stems in Table 7.9; note that where alternative stems are included, the distinction is between strong (active singular) and weak (elsewhere) variants.

[36] Though the discussion here will focus on *i* in the perfect indicative, the principles underlying its distribution will be applicable to its appearance in the perfect participle as well. The perfect subjunctive and optative, by virtue of the process of their formation (see Macdonell 1910: 360-361) do not generally provide the relevant environment (though Macdonell does note the optative form *jakṣ-ī-yat*, from *ghas-* 'eat', although this form may be better analyzed as an activized aorist middle). In the perfect imperative, *i* does not occur either, though there is at least one form with the appropriate environment: *mumoktu*, third singular active of *moc-* 'release'; perhaps a limited frequency contributes to its resistance to add *i*, or perhaps we have an instance of the 'peremptory shortening' of the kind seen in Latin *dīc* 'speak!'. In any case, its absence will play a role in the development of the analysis in the next subsection. The perfect union vowel, as the name suggests, does not apply outside of the perfect conjugation; see below and Chapter 8 for more about this point.

Table 7.9 Vedic perfect stems

Root	Perfect Stem	Gloss
a. *as-*	*ās-* (= *a-as-*)	'be'
b. *vac-*	*u-vác- / ūc-* (= *u-uc-*)	'speak'
c. *gam-*	*ja-gám- / ja-gm-*	'go'
d. *jan^{i}-*	*ja-ján- / ja-jñ-*	'beget'
e. *pat$^{(i)}$-*	*pa-pát- / pa-pt-* (*pet-*)	'fall'
f. *sac-*	*sa-śc-*	'follow'
g. *grabh^{i}-*	*ja-grábh- / ja-gṛbh-*	'grab'
h. *yoj-*	*yu-yuj-*	'yoke'

Based on these forms (intended to be representative of Vedic perfect stems in general), the perfect stem of a verb can end in either a sequence -V̄C- (a., b.); -VC- (b.-e., g., h.); or -VCC- (c.-f.). These stem-final sequences immediately precede the perfect endings, a combination of vowel-initial and consonant-initial suffixes presented in Table 7.10.[37] We can predict, taking into account the shape of the stem-ending and the beginning of the perfect endings, the occurrence of sequences of segments problematic for the simple syllabification of coda followed by onset. This is indeed the case, as demonstrated by the attested perfect paradigms presented in Table 7.11, of the roots in Table 7.9.

Table 7.10 Vedic perfect endings (Macdonell 1910: 355)

	Active			**Middle**		
	Sg.	**Du.**	**Pl.**	**Sg.**	**Du.**	**Pl.**
1	*-a*	[*-vá*]	*-má*	*-é*	[*-váhe*]	*-máhe*
2	*-tha*	*-áthur*	*-á*	*-sé*	*-ā́the*	*-dhvé*
3	*-a*	*-átur*	*-úr*	*-é*	*-ā́te*	*-ré*

[37] Endings of the dual number are included for the sake of completeness but will not factor into the discussion.

Table 7.11 Vedic perfect indicatives

			as-	*vac-*	*gam-*	*jan*^{i}*-*
Active	Sg.	1	*āsa*	--	*jagama*	--
		2	*ā́sitha*	--	*jagántha*	--
		3	*ā́sa*	*uvā́ca*	*jagā́ma*	*jajā́na*
	Pl.	1	*āsimá* (AV)	*ūcimá*	*jaganma*	--
		2	--	--	*jagmá* (AV,TS,VS)	--
		3	*āsúr*	*ūcúr*	*jagmúr*	*jajñúr / jajanúr*
Middle	Sg.	1	--	--	--	--
		2	--	*ūciṣé*	--	*jajñiṣé*
		3	--	--	*jagmé*	*jajñé*
	Pl.	1	--	--	--	--
		2	--	--	--	--
		3	--	*ūciré* (AV)	*jagmire*	*jajñiré*

			pat$^{(i)}$*-*	*sac-*	*grabh*^{i}*-*	*yoj-*
Active	Sg.	1	--	--	*jagrábha*	--
		2	--	--	--	--
		3	*papā́ta* (AV)	--	--	*yuyója* (AV)
	Pl.	1	*paptima*	*saścima*	*jagṛbhmá*	*yuyujma*
		2	--	--	--	--
		3	*paptúr*	*saścúr*	*jagṛbhúr*	--
Middle	Sg.	1	--	*saśce*	--	--
		2	--	--	--	*yuyukṣé* (AV)
		3	--	--	--	*yuyujé*
	Pl.	1	--	--	--	--
		2	--	--	--	--
		3	--	*saściré / secire* (AV)	*jagṛbhré*	*yuyujré*

The vowel *i* occurs in forms such as *āsimá* and *jajñiṣé*, but not *āsa* or *jajñé*; it is nowhere to be found in the paradigms of *gam-* or *yoj-*. From a purely descriptive standpoint, at the level of the segment the distribution of *i* can be captured as follows – it occurs in perfect forms specifically 1) after a stem ending in either a long vowel followed by a single consonant ($\bar{V}C$), or a short vowel followed by two consonants (V̆CC);[38] and 2) before an ending beginning with a consonant. Otherwise, it is not present.

Historically, the distinction in behavior observed here originates in the distinction between Sanskrit seṭ and aniṭ roots, literally roots "with *i*" and "without *i*," respectively (Seebold 1972: 37, Kümmel 2000: 50). The concept of seṭ and aniṭ is original to the Sanskrit grammarians, to distinguish suffixes which show a linking vowel *-i-*, from those which do not, but it has assumed relevance in modern scholarship as well; this is in large part due to Saussure's groundbreaking work on ablaut, which anticipated Proto-Indo-European laryngeal theory (Meier-Brügger 2002: 107ff.). By the modern conception, seṭ roots are reflexes of laryngeal-final roots in Proto-Indo-European, while aniṭ roots descend from roots which do not end in a laryngeal. The *i* which sometimes appears is, then, related to the original root-final laryngeal in Sanskrit, but it appears only in a particular environment: namely, between consonants, when the laryngeal developed an epenthetic vowel;[39] in a vowel-adjacent position the laryngeals were lost. (Hence the representation of seṭ roots by superscript *i*, as in jan^{i}-, $grabh^{i}$- and $pat^{(i)}$- in Tables 7.9 and 7.11; the proposed Proto-Indo-European forebears of these roots are reconstructed as $*\hat{g}enh_1$- [*LIV* 163-165; *IEW* 373-375], $*g^{h}reb^{h}h_2$- [*LIV* 201; *IEW* 455] and $*peth_1$- [*LIV* 477-478; *IEW* 825-826].) The forms of set roots showing *i*, then, must contain an environment in which the original root-final laryngeal is syllabic. With respect to the perfect, such an environment presents itself in forms featuring consonant-initial endings. In these cases the laryngeal is between two consonants, and so would be vocalized. Preceding a vowel-initial ending, the laryngeal would

[38] It is expected that the environment V̄CC is applicable here as well, but by the nature of Vedic morphophonotactics stems ending in such a configuration do not seem to exist.

[39] The interconsonantal treatment of the laryngeals is a complicated issue. While the outcome is clearly vocalic, the process by which this is reached has been the subject of debate. In addition to those advocating the epenthesis approach stated in the text (Meier-Brügger 2002: 114), there are those who claim the laryngeals were themselves vocalic (Reynolds et al. 2000). Regardless, it is a not uncommon shorthand to refer to laryngeals in relevant positions (between consonants or initially before a consonant) as being 'vocalic' or 'syllabic'.

not vocalize, and hence would not surface. So we have an explanation for the appearance of *i* in certain perfects.

Or, at least, a starting point for one: in point of fact such an analysis can only account for the origin of the perfect union vowel, as Kümmel (2000), and, to some extent, Seebold (1972), point out. The distribution of the perfect union vowel in Vedic does not exactly coincide with the set of relevant forms of established seṭ roots; rather, it is broader. Before a consonant-initial ending, the vowel *i* is found following the perfect stems of aniṭ roots as well, specifically those ending in an obstruent, as in *saściré* from *sac-* (Table 7.11), from PIE 1.**sek^{w}-* (*LIV* 525-526; *IEW* 896-897). It is also found in perfect forms of vowel- and glide-initial roots, the perfect stems of which, as already stated, show reduplication of the initial vowel or associated high vowel and subsequent contraction; for example, *ās-* from *a-as-* (*as-*), *ūc-* from *u-uc-* (*vac-*). Neither of these stems belong to seṭ roots, either: *as-* comes from Proto-Indo-European 1.**$h_1$es-* (*LIV* 241-242; *IEW* 340-341), *vac-* from **u̯ek^{w}-* (*LIV* 673-674; *IEW* 1135-1136).

The wider distribution of the perfect union vowel suggests that, if indeed its origin lay in the original laryngeal of seṭ roots, its appearance has since then been reanalyzed as a function of some other principles, such that appeal to the distinction between seṭ and aniṭ roots is untenable as a means of synchronic explanation. The question, then, is what principle or principles actually do govern the distribution of the perfect union vowel; the most straightforward answer involves syllable structure.

The relevance of syllable structure in accounting for the distribution of the perfect union vowel has already been noted descriptively (Delbrück 1874, Whitney 1896, Macdonell 1910, Kümmel 2000), and as the basis of an analysis of its historical development (Osthoff 1884). The potential implications of a syllable-based account of the phenomenon for general rules of Vedic syllabification have been noted as well (Kessler 1998). Whitney (1896) characterizes the conditioning environment for the appearance of *i* as following a perfect stem-final heavy syllable ("In the RV., the union-vowel **i** is taken by roots ending in consonants provided the last syllable of the stem is a heavy one, but not otherwise" (287)); Delbrück (1874) and Macdonell (1910) identify essentially the same environment, though they refer to the stem-final syllable as necessarily being "long" ("Wenn die Stammsilbe kurz ist, so tritt die Endung unvermittelt an, wenn die Stammsilbe lang ist, tritt ein verbindendes i zwischen sie und die Endung" (119); "Roots with final consonant add *-tha*, *-ma*; *-se*, *-re* direct if the last syllable of the stem is prosodically short, but with the connecting vowel *-i-* if that syllable is long" (356)).[40] This view is later maintained by Kümmel (2000: 50-51).

Osthoff (1884: 391-476)'s explanation for the perfect union vowel (reiterated by Horowitz 1974: 15-16) centers on the endings *-má*, *-sé*, *-ré*. He argues that the vowel arises out of an epenthesis targeting the tautosyllabic environment .C_1__C_2V, where C_1 is the final consonant of a heavy stem-end (V̄**C**- or V̆C**C**-), syllabified into the onset position of the syllable built on the ending which follows, and C_2 is the initial consonant of that ending (that is, sequences V̄C#CV, V̆CC#CV must be syllabified V̄.CCV, V̆C.CCV). The fact that *m*, *s* and *r* are all sonorants or sibilants is crucial to his claim, and allows him to distinguish what he views as a substantive difference between *i* in forms with these endings, and *i* in forms with *-tha*; he views instances of the latter as a later development, the earlier situation exemplified by *véttha*, second person singular active perfect of *ved*$^{(i)}$- 'know'. So, for instance, Osthoff posits developments **pep|trái̯* > **pep|tr̥rái̯* > *paptiré*[41] and (**ū|k*^{2}*sái̯* >) **ū|k*^{2}*əsái̯* > *ūciṣé* [*ûcishé*] (396). Under this account, it

[40] Macdonell (1910) points to the rhythm rule "that the stem may not have two prosodically short vowels in successive syllables" (356, n.1) to motivate the appearance of *i*. As Seebold (1972: 37) notes, however, this rule cannot explain why *viveditha* (from *ved-* 'find') should be better than unattested **vivettha*, without *i*.

[41] This form is not actually attested in Vedic, if Avery (1872-1880) is accurate.

is not clear why epenthesis should occur in-between what would otherwise be, by sonority sequencing, an acceptable complex onset such as *tr-*, when it does not occur to break up a less preferable sequence of two obstruents such as *tth-*; this assumes syllabifications **pep|ttha*, **ū|k²tha*. Further, as discussed above, given laryngeal theory, the presence of *i* finds more plausible historical explanation elsewhere. Still, considering the relevant environment, one can see how Osthoff's conception of this process of epenthesis leads him (477), and later Hirt (1921: 199), to consider its inclusion among the evidence for a broader version of Sievers' Law.[42]

Returning to the more descriptive statements of Delbrück (1874), Whitney (1896) and Macdonell (1910), these accounts, while certainly a step in the right direction, nevertheless are inadequate in their explicit formulation, from the perspective of current phonological theory. To characterize the stem as ending in a "heavy" or "long" syllable is clearly an insufficient delimiter, as the perfect stems of *gam-* and *yoj-*, *jagan-* and *yuyuj-*, taken alone (or before a consonant-initial ending, assuming heterosyllabic treatment) possess such a structure; yet their perfect forms do not feature *i*. A better way to capture the general environment necessary for the appearance of *i* must exclude these cases; introducing the notion of the superheavy syllable will allow us to begin to do so, though, as will be shown, invoking it alone proves insufficient as well.

Thus a superior characterization of the syllable-structural unit preceding *i* in many cases is a superheavy syllable. That superheavy syllables exist in Vedic is difficult to address empirically; from the metrical perspective, there is no practical distinction in weight, when a short vowel is followed by a simple coda (single consonant) or a complex one (two or more consonants), or a long vowel is followed by no coda, or a simple one: all four of these cases

[42] Wholly dismissive of this idea, however, is Seebold (1972: 37), among others, who maintains instead the stricter conception of the rule generally accepted today.

count as ‘heavy’. Indeed, the unit has been tacitly conflated with a syllable featuring a complex coda (as in, e.g., Calabrese 1999: 704), where the assumption would seem to be that if the first consonant of the coda contributes to weight (as suggested by the meter), then by extension all of them do. Often lacking in such discussions is explicit justification for such a position.

Yet, the possibility of superheavy syllables in Vedic has been suggested through indirect evidence: namely, that the relevant environments (-V̄CCV-, -V̆CCCV-) are the targets of various phonological processes, which alter their shape away from superheavy syllables, to the extent that superheavy syllables are apparently avoided in Rig Vedic cadences (see section 7.2.3). Hoenigswald (1989: 559) cites four examples of such processes, including, in fact, the phenomenon currently under discussion; the others are Sievers’ Law, hiatus over *praśliṣṭa* contraction when the second vowel precedes a consonant cluster (as in *sá ít* C..., but *séd* V...; Wackernagel 1896: 315) and distraction (Renou 1952: 31). He also notes that the Rig Veda avoids non-thematic *guṇa* forms of *TERT- roots (e.g., *dógdhi*) and other categories with “overlength” (559). Further, to analyze the impact of these various phenomena on limiting superheavy syllables in the Rig Veda, Hoenigswald conducts a study of the cadences (‿ – ‿ x |, – ‿ – (‿) x|) in the second book and the first sixty-four hymns of the tenth book, for a total of 107 hymns. Based on the lower frequency of presumed superheavy syllables in this domain, as compared to outside it (that is, in the rest of the *pāda*), he tentatively concludes that overlength is actively avoided. Kobayashi (2004: 29-31), citing Hoenigswald, reiterates the processes but also conducts a more extensive version of the study, examining all ten books of two different editions of the Rig Veda; his results provide further confirmation that, if hypothesized to exist, superheavy syllables are avoided in the Rig Veda as “a general tendency” (31).

So, following Hoenigswald (1989) and Kobayashi (2004), we understand superheavy syllables to be a unit of prosodic structure that can be legitimately introduced in a discussion of Vedic syllabification, if for no other reason than that there is a calculated effort to avoid them in Rig Vedic cadences. Using this unit, we now take a first pass at developing a synchronic account of the distribution of the perfect union vowel. We will evaluate the extent to which invoking it allows us to differentiate between, on the one hand, the sequences -V̄C- and -VCC-, after which *i* occurs, and, on the other hand, the sequence -V̆C-, after which it does not. A couple of assumptions accompany our discussion, such as the idea that each coda consonant – sonorant or obstruent – is weight-bearing by virtue of its position (or at least, the two coda consonants closest to the nucleus are), and as such that the syllable is not maximally bimoraic, but rather can be trimoraic. Let us begin this exercise by looking at the environment -V̄CCV-. We can first of all make clear that the only reasonable motivation for epenthesis here is tied to weight, in consideration of perfect forms such as those in (10) and (11).

(10)	a.	*cak**ártha***	*kṛ-*	'make'
	b.	*ā́ritha* (< **ār#tha**)	*ṛ-*	'go'
(11)	a.	*ān**aśma***	*aṁś-*	'attain'
	b.	*dadāśimá* (< dad**āś#ma**)	*dāś-*	'wait on'

The forms in a.-b. share an identical sequence of segments (pre-epenthesis), differing only in the length of the vowel heading that sequence. Yet epenthesis of perfect union vowel *i* occurs only in the b. forms. What else might straightforwardly condition this distinction in behavior, if not syllable weight, specifically, a dispreference for superheavy syllables? (Improved syllable contact, for example, is excluded by the forms in (11).)

The structure required for a superheavy syllable can only arise as a result of a heterosyllabic treatment of the consonant sequence following the long vowel; even if the initial consonant can be part of a theoretically-viable onset (that is, one of rising sonority), nonetheless it is not: the syllabification of dadāś#ma must be, absent epenthesis, †*dadāś.ma*, even though the sequence *-śm-* rises in sonority. This treatment becomes clearer still in comparing †*dadāś.ma* with third person singular *dadāśa*; the latter form is unproblematic but the former is not, suggesting that *ś* is in the onset in one, but the coda in the other.

How can the superheavy syllable concept help us in the case of V̆CC sequences? Here the matter is more complicated, by virtue of the types of consonantal sequences involved. We can better appreciate as much by examining the actual attested instances of such CC sequences in Vedic; these are presented in Table 7.12 (as usual, *O* = obstruent, *R* = sonorant).

Table 7.12 Attested perfect stem-final CC sequences (from Avery 1872-1880: 249-251)

Type	Sequence	Sample Form	Gloss
OO	a. *-kṣ-*	*vavákṣ-i-tha*	2 sg. act. *vakṣ-* 'increase'
	b. *-pt-*	*papt-i-ma*	1 pl. act. *pat*$^{(i)}$- 'fall'
	c. *-śc-*	*saśc-i-ré*	3 pl. mid. *sac-* 'follow'
OR	d. *-kr-*	*cakr-i-ré*	3 pl. mid. *kṛ-* 'make'
	e. *-gm-*	*jagm-i-re*	3 pl. mid. *gam-* 'go'
	f. *-ghn-*	*jaghn-i-má* (AV)	1 pl. act. *han-* 'strike'
	g. *-jñ-*	*jajñ-i-ṣé*	2 sg. mid. *jan*^{i}- 'beget'
	h. *-tn-*	*tatn-i-ṣe*	2 sg. mid. *tan-* 'stretch'
	i. *-dhr-*	*dadhr-i-re*	3pl. mid. *dhṛ-* 'fix'
	j. *-bhr-*	*jabhr-i-ṣe*	2 sg. mid. *bhṛ-* 'bear'
RO	k. *-nd-*	*vavand-i-ma*	1 pl. act. *vand-* 'praise'
	l. *-ṃs-*	*jihiṁs-i-má* (AV, TS)	1 pl. act. *hiṁs-* 'injure'
	m. *-rt-*	*cakart-i-tha*	2 sg. act. *kṛt-* 'cut'
	n. *-rd-*	*tatard-i-tha*	2 sg. act. *tṛd-* 'split'
	o. *-rh-*	*arh-i-re*	3 pl. mid. *arh-* 'earn'
RR	p. *-nv-*	*dadhanv-i-ré*	3 pl. mid. *dhanv-* 'run'

With the exception of -*kṣ*-, which occurs in perfects of four roots (*vakṣ*-, plus *cakṣ*- 'see', *takṣ*- 'fashion', and *myakṣ*- 'be situated'[43]), and -*nd*-, which occurs in those of two (*nind*- and *vand*- 'praise'), each of these sequences occurs in the perfects of only one root, that given in the table. Further, it is also worth noting that, by virtue of the shape of the perfect endings, each of the CC sequences can theoretically occur before an obstruent or a sonorant, so that we have in total eight types of extended consonantal sequences (all but one of which – RRO – are actually attested, as shown in the table).

Examining the four types of CC sequences, we can see that at least some of them are amenable to analysis as a complex coda – certainly the RO sequences, which fall in sonority, a canonical profile for a complex coda. Of the rest, the OO and RR sequences could also be analyzed as complex codas, operating under a version of sonority sequencing that allows for segments of equal sonority to occupy coda (or onset) position. On the other hand, if we were to invoke a stricter version of sonority sequencing requiring only rising and falling sonority profiles, then these sequences would prove problematic, as does the final and – likely not coincidentally[44] – most populous sequence type, OR, under any version, as it features a sonority reversal. As there is little motivation for a sonority sequencing principle of the former type in Vedic, outside perhaps these cases, we will operate hereon with the more standard version, meaning that further explanation is required to account for the epenthesis' motivation.

First, in the case of OR sequences, we would be hard-pressed to identify the epenthesis of *i* as a means of resolving a superheavy syllable. Nor can we necessarily treat the second consonant (the sonorant) as part of a following syllable. Before an obstruent-initial ending like -

[43] Macdonell (1910: 360) connects the form *mimikśire* to both *myakṣ*- and *mikṣ*- 'mix', but Kümmel (2000: 386) associates its two occurrences in the Rig Veda solely with the former root.

[44] In the sense that these segments constitute the initial and final consonants of the full root, which, being syllabic in shape, is likely to have obstruents in the onset and sonorants in the coda, following e.g. Vennemann (1988).

tha or *-ṣe*, this would create a sonority reversal, meaning a complex onset just as bad as the avoided complex coda. Before the sonorant-initial endings *-ma* or *-re*, we could have an onset of flat sonority, but we would need to account for the acceptability of such a complex onset, when -*sm*-, of rising sonority, is bad (cf. †*āsma*); recall also our reliance on a stricter version of sonority sequencing, which would not work with this approach.

Yet while the fact that the intermediate sonorant in these cases cannot be reasonably treated as part of the previous syllable may preclude the superheavy syllable-based analysis of the epenthesis of *i*, it is not difficult, to be sure, to develop a principled account of why it should occur. We have already seen the difficulty in treating this segment as either part of a coda or an onset: unepenthesized †*jajñ.ṣé* and †*jaj.ñṣé* are both improbable, from the perspective of sonority sequencing. Thus the epenthesis of *i*, which yields the form *jajñiṣé*, creates a sequence capable of being syllabified, out of one which would otherwise be unsyllabifiable.

Factoring into consideration the OO and RR sequences, this same process of epenthesis could be analyzed as operating on all instances of the latter, regardless of whether the following segment is an obstruent or sonorant. (Note though that the only instance of this sequence attested is *-nv-* in *dadhanviré*; there are no RRO forms to be found.[45]) In order to address OO sequences, however, we must examine each subtype, OOO and OOR, individually. OOO sequences present as poor a sonority profile as any for straightforward syllabification, and so can be grouped with OR and RR sequences in requiring epenthesis to this end. On the other hand, OOR sequences can indeed be syllabified as a theoretically-viable sequence of coda + complex onset; epenthesis cannot be motivated in quite the same way in this case. The simplest explanation for why epenthesis does occur in forms such as paptima, then, is that the dispreference for complex onsets, which is manifested in general in Vedic by the splitting of internal consonant clusters, is

[45] Though we could imagine what they would look like based on *dadhanviré*: *dadhanviṣe* etc.

even stronger in the domain of the perfect, to the extent that such sequences are broken up by insertion of *i*.

Thus we might conceptualize the phenomenon of the perfect union vowel as comprised of three distinct processes of epenthesis, one to resolve superheavy syllables (*āsima*, *vavandima*), a second to resolve complex onsets (*paptima*), and a third to render syllabifiable a sequence of consonants with a complex sonority profile (*cakriré*). In all of these cases, the epenthesized segment is *i*, and its location is at the boundary between the perfect stem and ending. The three triggers of perfect union vowel epenthesis differ in their relevance in the realm of general Vedic morphophonology. The fact that unsyllabifiable sequences such as those observed here never surface anywhere in Vedic suggests their avoidance (and resolution) is due to general principles of syllabification, as instantiated by sonority sequencing. On the other hand, the dispreference for superheavy syllables exhibited in the conjugation of the perfect is not necessarily to be extended to Vedic in general with quite the same strength. The regular epenthesis of *i* is a phenomenon confined to the perfect,[46] and even within this realm it is not fully deployed (on this point see fn. 36). More generally, as already noted, Hoenigswald (1989) and Kobayashi (2004) have

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[46] Macdonell (1910)'s presentation of the intensive suggests that a similar process of epenthesis might be analyzed as taking place here as well. He describes the distribution of a vowel *ī* in intensive forms as follows: "*ī* may be inserted between the root and terminations beginning with consonants; it is common in the 1. and 3.sing.ind.act., and is also sometimes found to occur in the 2. 3.du.ind. and the 2. 3.sing. imperative and imperfect active" (391). As a sample paradigm he presents forms of the verb *nij-* 'wash' – "forms actually found, if made from the intensive of *nij-* 'wash', would be the following in the indicative" (391) – which show variation along these lines: so, e.g., *nénej-mi* and *nenéj-ī-mi*, *nének-ti* and *nenéj-ī-ti*, are given for the first and third persons singular active indicative, respectively, but only *nének-si* is given for the second person.

One might conclude, based on these forms, that the perfect union vowel has perhaps spread, or is in the process of spreading, into the realm of the intensive (difference in vowel quantity notwithstanding), or, at least, that the intensive shares a similar lack of tolerance for superheavy syllables, which it resolves through its own form of epenthesis. However, the forms Macdonell presents appear to be hypothetical, as they are not actually attested in the Rig Veda (according to Avery 1872-1880), and further, his description of where *ī* occurs is inaccurate. Looking at attested forms with *ī* as collected by Avery (1872-1880: 270), we see that the vowel occurs only following a stem ending in a sequence V̆C; there are no instances of it following V̄C. Without direct evidence that *ī* occurs after both types of superheavy syllables, we cannot conclude that its appearance is a result of process similar to that of *i*-epenthesis in the perfect (although its origin may be similar, as the reflex of a vocalized laryngeal; all the forms in which it occurs belong to seṭ roots). As such, we will continue to maintain that only in the perfect does the intolerance of superheavy syllables lead to their resolution by epenthesis.

demonstrated that superheavy syllables are avoided in the Rig Veda. However, as Calabrese (1999) points out in arguing against Murray (1988)'s account of Sievers' Law, examples of superheavy syllables do exist; consider the data in Table 7.13 (his (76)).[47]

Table 7.13 Sample superheavy syllables in Vedic

Type	Form		Gloss
V̄C(C).	a.	*kārtsnya-*	'in full, entirely'
	b.	*ūrjani-*	'strength' loc.sg.
	c.	*ūrdhváthā*	'upwards'
	d.	*mārṣṭu*	'wipe' 3 sg. act. impv.
V̆CC	e.	*yunkté*	'join' 3 sg. mid. pres.
	f.	*yungdhvam*	'join' 2 pl. mid. aor.
	g.	*bhinttá*	'split' 2 pl. mid. impv.
	h.	*bhunkté*	'enjoy' 3 sg. mid. pres.

Both types of superheavy syllables are attested: that in which a long vowel is followed by at least one consonant (a.-d.), and that in which a short vowel is followed by at least two consonants (e.-h.); this assumes a syllabification in which complex onsets are disfavored more strongly than complex codas. The existence of superheavy syllables in the Rig Veda can be entirely consistent with the results of Hoenigswald's and Kobayashi's studies; to claim, as Calabrese does, that "there is no problem in having superheavy syllables" in Vedic (704), would seem to be too simplistic a characterization, especially in light of the behavior of the perfect union vowel. Still, the fact that superheavy syllables do exist in Vedic begs the question of how we might address the distinctive treatment they receive within the perfect conjugation, versus elsewhere.[48]

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[47] The first form cited, *kārtsnya*-, does not actually appear to occur in the Rig Veda, according to Lubotsky (1997b)'s concordance. We might include instead the similarly shaped *viśvápsnya*- 'having all forms', though the fact that in three of its four appearances the sequence -*psny*- is treated -*psniy*-, according to van Nooten and Holland (1994), makes its syllable structure significantly less dramatic.

[48] One might wonder, given the fact that epenthetic *i* resolution of superheavy syllables is confined to the perfect, if the dispreference for complex onsets stated in the text ought to be considered similarly limited, and thus not a feature of Vedic in general. Apart from the fact that the perfect union vowel phenomenon is only one piece of evidence arguing for the associated syllabification -VC.CV-, it is, furthermore, more plausible that the same principles of syllabification hold throughout Vedic, regardless of verbal conjugation, and that within the perfect, a

Further, we have in this phenomenon demonstration once again of the fact that complex onsets are disfavored in Vedic, else we would expect forms such as †*ā.sma* to surface. Thus we have additional evidence that the language treats intervocalic consonants heterosyllabically, as complex onsets do not occur, even where theoretically possible. This last observation is made also by Kessler (1998), who, while remaining agnostic about the details of the process (whether i is epenthesized in relevant forms, or syncopated from non-relevant ones), nevertheless includes the phenomenon of the perfect union vowel in his array of evidence suggesting heterosyllabic treatment of intervocalic consonants ("consonant splitting" (7)) in Vedic.[49]

Finally, this discussion has proceeded under the assumption that the perfect union vowel is synchronically the result of epenthesis (epentheses). One might attempt to analyze the vowel operating from the opposite perspective, i.e. that its absence is the result of syncope. In this case we would posit that consonant-initial endings are in fact underlyingly *i*-initial, and that this *i* is lost following a perfect stem ending in a single consonant or vowel. While the fact that such an

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different level of tolerance holds for superheavy syllables, such that epenthesis occurs to lighten them, as opposed to the idea that perfect forms are actually syllabified differently to begin with.

[49] Given the distinction between the diachronic and synchronic explanations of the perfect union vowel, one might wonder what would happen when there is a mismatch in their predictions. A locus for such a mismatch could be the second person singular active, for which the ending is consonant-initial *-tha*. Diachronically, perfect forms built to seṭ roots should exhibit *i*, given that the original laryngeal would have been between consonants. On the other hand, synchronically the conditions for the presence of *i* would probably not be met: the second person singular active calls for the strong form of the perfect stem, with a full vowel (e.g. *jaján-*, *jagrábh-*), meaning many forms should not be superheavy, but rather just heavy. (While we might think of the influence of analogy based on Brugmann's Law forms, which has apparently led to third person forms with *ā* where we would expect *a*, as in *jajā́na* in Table 7.11 from PIE **ĝe-ĝónh*$_1$*-e*, more realistically we would probably expect the second person to follow the pattern of the first person, in which no such analogy is found: *jagrábha* from **g*^{h}*e-g*^{h}*róbh*$_2$*-h*$_2$*e* shows no lengthening.)

In fact the only second person singular forms built to seṭ roots attested in Vedic are *ninétha* (*nay*^{i}- 'lead'), *vāvántha* (*van*^{i}- 'grow fond of' – or *van-* 'gain'?), *babhū́vitha* (*bhav*^{i}- 'be(come)') and *ā́vitha* (*av*^{i}- 'help'). (Seebold, in his discussion of this phenomenon [1972: 37], cites the form *jajántha*, presumably the second person singular active perfect of *jan*^{i}-; such a form, however, is unattested in Vedic.) None of these roots provide conclusive evidence one way or the other. *Babhū́vitha* and *ā́vitha* meet the synchronic criteria for the perfect union vowel, since they would otherwise contain a sequence V̄C. (the other type of superheavy syllable); their *i* is thus expected (the form *babhū́tha*, without *i*, is also attested, and in fact is more common). *Ninétha* shows in *e* the reflex of the diphthong **oi*; the original laryngeal (**ne-nói**H**-th*$_2$*e*) is lost. As for *vāvántha*, if from *van*^{i}- we could theorize that synchronic pressures have eliminated the laryngeal *i*. But given the alternative, identification with *van-*, we would have a rather ordinary form in *vāvántha* (vowel length in the reduplicated prefix notwithstanding); so our theory would be on shaky ground (see Kümmel 2000: 447ff. for discussion of the relationship between these two roots).

analysis would not conform to our understanding of the historical developments involved is arguably not enough to discount it outright, it nevertheless does raise some doubt. Furthermore, it is unclear that analyzing *i* as underlying would lead to a more straightforward account of its occurrence, as the disjunction of environments observed in the epenthesis analysis would also be a factor in the syncope one (insert in -V̄CCV, -VCCCV versus delete in - V̆C*i*CV, -V*i*CV). As such we have little motivation to explore this alternative further.

7.2.6.1 On the Locus of Perfect Union Vowel Epenthesis

The insertion point for the perfect union vowel – between the second and third consonant of the triconsonantal sequence in the data above – merits some further discussion. The explanation for this location is clear enough from a diachronic standpoint: the vowel's origin lies in vocalized root-final laryngeals, so that *-VCCH#CV > -VCC*i*#CV. Of course, as laryngeals have generally been lost and i has spread to perfect forms built to anit roots as well, the process has been reanalyzed as an epenthesis -VCC#CV > -VCC#*i*#CV; the insertion point here is at the morpheme juncture between stem and ending.

It is worth pointing out, though, that this position is not the only one in which an epenthetic vowel would resolve the synchronic triggers of the phenomenon (superheavy syllables, complex onsets and generally unsyllabifiable sequences of consonants); forms such as †*vavanidma*, †*papitma*, †*jajinśé*, in which *i* is inserted between the first two consonants, are all equally acceptable alternatives to their attested counterparts in this regard. Furthermore, it is also important to acknowledge how the limits of the attested data affect the synchronic analysis. Indeed, the consistent co-occurrence in the data of *i* with the morpheme boundary may be significant, or it may simply be coincidental. The question is raised in consideration of sequences of shape -VC#CCV, which would occur given a perfect stem ending in a single consonant (VC-) and the second person plural middle ending *-dhvé* (-CCV); while the only form actually attested with this ending is *dadhidhvé*, from the root *dhā-* 'place' (in which *i* is part of the stem, alternating with *ā* in the paradigm), that relevant forms are even theoretically possible is enough to raise doubt. Still, absent explicit data to the contrary, we will assume that the morpheme boundary is significant; its role in attracting the epenthetic *i* will be formalized in the Optimality-Theoretic analysis by introduction of the constraint CONTIGUITY, which militates against breaking up a morpheme.[50]

Indeed, from a broader cross-linguistic perspective, either interpretation of the role of the morpheme boundary is plausible. For example, in Chukchi, according to Kenstowicz (1979: 407), word-medial triconsonantal sequences are broken up by schwa-epenthesis, and the target of this process consistently coincides with the location of any morpheme boundary that may be intervening. This practice is so consistent that the very same sequence can in fact be broken up differently, depending on where the morpheme boundary lies (12).

(12)	a.	*miml*<ins>*ə*</ins>*qacan*	<	/miml-qaca-n/	'place near the water '
	b.	*wejem*<ins>*ə*</ins>*lqən*	<	/wejem-lq-n/	'rivers'

In two instances of the same underlying sequence *mlq*, schwa is inserted between *l* and *q* in a., but between *m* and *l* in b., coinciding with the morpheme juncture. On the other hand, the position of the morpheme boundary appears to be irrelevant for triconsonantal cluster resolution in Lenakel; Lynch (1974) describes the process as follows:

[50] A relevant second plural middle form would be interpreted in one of two ways. The shape -C*idhvé* would argue for the significance of the morpheme boundary. On the other hand, if the form were of shape -C*dhivé* (more surprising, from the historical standpoint), then the simple linear order of consonants would appear to be the significant factor (always insert *i* between the second and third consonant), and the co-occurrence of *i* with the morpheme boundary observed in other forms would be coincidental. While straight CONTIGUITY would be sufficient to deal with the former scenario in the Optimality-Theoretic analysis, we might deal with the latter one by differentiating between $\text{CONTIGUITY}_{\text{STEM}}$ and $\text{CONTIGUITY}_{\text{AFFIX}}$, or, alternatively, appealing to Alignment constraints.

> Clusters of three non-syllabics are not permitted in Lenakel surface representations. When they do arise, generally at morpheme boundaries, schwa is obligatorily inserted between the second and third member of the cluster of non-syllabics . . . Now when the morphemes with an initial two-consonant cluster are immediately preceded by a consonant-final morpheme, schwa is inserted between the second and third consonants of the resultant cluster (89).

Examples are given in (13). We can see that despite the location of the morpheme boundary, schwa is always inserted immediately before the third consonant, though it may be tautomorphemic with the preceding consonant (b.-c.).

(13)	a.	[kam.nɨ̱.m̄a.nɨn]	<	/kam-n-m̄an-n/	‘for her brother ’
	b.	[əs.ɨd.bə̱.nan]	<	/əs-ət-pn-aan/	‘don’t go up there!’
	c.	[kar.bə̱.gɔm]	<	/k-ar-pkom/	‘they’re heavy’

One further case: Kenstowicz (1994: 13), citing Broselow (1982), notes the distinction in practice between Levantine and Egyptian Arabic – compare Levantine *ʔaki̱lna* to Egyptian *ʔakli̱na*, from /ʔakl+na/ ‘our food’, as well as Levantine *katabi̱tha* to Egyptian *katabta̱ha*, from /katab+t+ha/ ‘I wrote it’ (fem.).[51] Clearly, in Levantine Arabic the epenthetic vowel is consistently inserted after the first consonant of the triconsonantal cluster; the situation in Egyptian Arabic is admittedly a bit more vague, based on the data given here, but these forms suggest that epenthesis occurs at a morpheme boundary.[52]

Thus, regardless of whether or not we tie the morpheme boundary to the location of the epenthetic *i* in the perfect union vowel phenomenon, we can at least be assured that we are on solid typological ground, as demonstrated by the facts of triconsonantal cluster resolution in

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[51] As far as I can tell, Broselow does not actually mention this minimal pair in her paper.

[52] Alternatively, it could be before the last consonant; an underlying form of shape /-VC#CCV-/ would decisively resolve this question. Cf. the discussion in Chapter 4 on Iraqi and Cairene Arabic.

Chukchi and Lenakel, and Egyptian and Levantine Arabic.[53] It is important to note, though, that perfect union vowel epenthesis is an idiosyncratic process in Vedic, whereas the epentheses surveyed here are assumed to be generalized in their respective languages.

7.2.6.2 CCC Sequences and the Strength of Sonority Sequencing

By virtue of its disjunctive nature, the conclusion reached in the previous section, that the perfect union vowel phenomenon is best decomposed into a set of three processes of epenthesis, one targeting superheavy syllables, one targeting complex onsets, and a third targeting otherwise unsyllabifiable sequences of segments, naturally invites question as to whether a simpler, unitary alternative exists, such as one based solely on weight, or one cast purely in segmental terms. In this section I intend to demonstrate that despite its ostensible weakness in this respect, nevertheless the analysis as developed is the best means of capturing the facts.

To begin this discussion we will consider one sequence in particular: V̄RCV. Not only is this sequence found in the underlying representation of forms of the perfect (ār#tha > *āritha* 2 sg. perf. act. ind. 'move, rise'), it is found in non-perfect forms as well (*ārta* 3 sg. aor. mid. ind. 'move, rise'). While direct evidence for the syllabification V̄R.CV is lacking, all else being equal we would be hard-pressed to argue against it: it conforms with even the weakest versions of the sonority sequencing principle, as well as with the general practice of heterosyllabification we have seen in the case of V̆RCV sequences. We can thus posit it with a relatively high degree of confidence.

Assuming that the basic practice of syllabification does not vary between Vedic in general and the perfect, we can only conclude that V̄R. superheavy syllables are a nonnegotiable target

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[53] It would be interesting to assess the rules for epenthetic vowel placement in these languages from a historical context, to try to determine the extent to which they have been phonologized.

of perfect union vowel epenthesis. As the factor of weight necessarily has its foot in the door, we can crucially rule out the possibility of characterizing the perfect union vowel phenomenon as targeting only complex onsets. We can best proceed, then, by seeing how far weight will take us.

So, we must consider how to deal with the other sequences relevant here, namely V̄OCV and VCCCV. With respect to the former, we have no direct evidence (or any evidence at all, really) to indicate that V̄OCV sequences should be treated any differently than V̄RCV (and for that matter, V̆CCV) sequences, that is, with a tautosyllabic complex onset via onset maximization instead of a sequence coda + onset.[54] The simplest hypothesis is that this sequence too receives a heterosyllabic treatment, creating superheavy syllables of shape V̄O.; thus we can conclude that the epenthesis observed in perfect forms exhibiting the sequence is motivated by weight-reduction as well. This leaves VCCCV sequences to contend with. We enter into this portion of the discussion having already established that weight is at least one factor in the perfect union vowel phenomenon, so a natural initial step would be to continue to see how far it can take us. Are there any VCCCV sequences which can be analyzed as VCC.CV, with a superheavy syllable featuring a complex coda?[55] Let us consider the set of possible intervocalic triconsonantal sequences – operating with a sonority hierarchy distinguishing between obstruents and sonorants (i.e., O > R), there are eight logically possible types:

(14) *Possible VCCCV sequences*

a.	VOOOV	d.	VRRRV	g.	VRORV
b.	VOORV	e.	VROOV	h.	VOROV
c.	VORRV	f.	VRROV		

[54] It would be interesting to determine if there are any languages (apart from Proto-Indo-European, as it has been reconstructed by some – but see Chapter 9) which syllabify V̆C.CV, V̄R.CV, but V̄.OCV. Presumably in such a language long vowels would repel coda consonants, when sonority sequencing would allow it, to satisfy some sort of size requirement (or so as not to overly satisfy such a requirement).

[55] We assume that each coda consonant projects a mora.

How we syllabify these sequences depends, again, on how strict a sonority sequencing principle we employ. Specifically, we can either allow or disallow complex codas / onsets of flat sonority. (A third alternative would be to not invoke sonority sequencing at all, and claim that all VCCCV sequences are syllabified VCC.CV. While this would allow us to capture perfect union vowel epenthesis entirely in terms of superheavy syllable resolution, it would nonetheless be undesirable, in light of the general relevance of the principle.[56]) The implications of these two approaches for syllabification of VCCCV are presented below in Table 7.14; the assignments are guided by a principle of onset-filling (Berg and Niemi 2000) – as extrapolated from the evidence of basic VC.CV syllabification – whereby an onset is minimal (but not absent) and as many segments as are allowed by sonority sequencing are assigned to the preceding coda. (In other words, a complex onset will surface only when a complex coda is not possible.)

Table 7.14 Two approaches to VCCCV-syllabification

Son. Seq. Principle	VCC.CV	VC.CCV	Other
Sonority plateaux banned	VRO.OV VRO.RV	VO.ORV	VOOOV VORRV VRROV VOROV VRRRV
Sonority plateaux permitted	VOO.OV VOO.RV VRO.OV VRO.RV VRR.OV VRR.RV	VO.RRV	VOROV

As can be seen, if we disallow complex codas or onsets of flat sonority, then only two of the sequence types in (14) can be syllabified with a complex coda: VRO.OV, VRO.RV. These sequences can be subsumed under an account of the perfect union vowel which targets

[56] Then again, is it enough that the influence of sonority sequencing is observed in initial and final positions (the case of *s* notwithstanding), in words and in morphemes, given our hesitation to draw comparisons between what occurs at edges and internally?

superheavy syllables, but as epenthesis occurs in all VCCCV sequences, something still needs to be said about the remaining six types. The epenthesis observed in the five 'other' types, in which neither a complex coda nor complex onset is possible, can be characterized as a general process rendering syllabifiable what would otherwise be unsyllabifiable sequences of segments. As for the lone sequence VO.ORV, in order to account for the epenthesis that targets it, the simplest solution would be to analyze perfect union vowel epenthesis as targeting complex onsets as well. We are thus left with the analysis as developed earlier, in which the perfect union vowel phenomenon comprises three processes of epenthesis.

On the other hand, if we do allow complex codas or onsets of flat sonority, then the analysis changes – but only to a certain extent. To be sure, three times as many VCCCV sequences are capable of being analyzed as involving complex codas, and by extension, superheavy syllables; one sequence type is unsyllabifiable, if not for epenthesis. Operating with this looser version of sonority sequencing, the characterization of the perfect union vowel phenomenon as a process whose motivation is the resolution of superheavy syllables is thus strengthened. Crucially, however, we still cannot claim its motivation is *exclusively* that, in view of the single sequence VO.RRV, which, allowing complex onsets of flat sonority, would feature one consisting of two sonorants.

Restricting our consideration to the two approaches presented in Table 7.14, regardless of how strict a sonority sequencing principle we invoke, we are still left with the same result: namely that we would be hard-pressed to extend the weight-based account of perfect union vowel epenthesis to cover all eight types of VCCCV sequences. (Banning complex onsets outright – an ostensibly untenable approach, given at least their existence word- and root-initially – the two analyses would basically remain equivalent. The sequences featuring complex onsets would simply be reclassified as being unsyllabifiable absent epenthesis.) In either approach, there is one type which is an outlier; but while a VCC.CV syllabification is untenable in these exceptional cases, the sequences are not totally unsyllabifiable. Since we cannot appeal to either of the associated motivations for perfect union vowel epenthesis, then, appeal to a dispreference for complex onsets would seem to be necessary. Given the general dispreference for complex onsets observed Vedic – responsible for the heterosyllabic treatment of VCCV sequences – we are compelled to once again characterize the perfect conjugation as being particularly restrictive when it comes to disfavored syllabic structures, to the extent that it militates against them by means of epenthesis.

Though we have been able to further justify the tripartite analysis developed for the perfect union vowel, we must still attempt to determine which version of the sonority sequencing principle it is appropriate to invoke. The weaker version of the sonority sequencing principle might be seen as superior, in that it minimizes the number of 'other' sequence types and maximizes the number of superheavy syllable sequence types, thereby strengthening the superheavy-syllable-resolving aspect of the perfect union vowel phenomenon. On the other hand, the stricter version is closer to the canonical conception of the sonority sequencing principle; but this adherence to theoretical purity is not enough to justify its superiority. Ideally the argument either way should draw on data from Vedic, which we turn to now.

One good way to evaluate how strong a sonority sequencing principle is operational in Vedic is to consider the VCCCV sequences which actually do occur. Thus far the discussion has been confined to the perfect conjugation, in which all VCCCV sequences are expected to undergo epenthesis. In other words, what we have analyzed as complex codas and complex onsets do not actually surface as such, because they are broken up by *i*: these structures are simply *predicted* to occur, absent epenthesis; they are thus part of the syllabifications to be avoided. However, in non-perfect forms, at least some of these VCCCV sequences presumably ought to occur as is; determining which ones actually do could guide our search for the appropriate degree of strictness for the sonority sequencing principle.

According to Gotō (2005)'s inventory of attested Indo-Iranian VCCCV sequences, the sequence types below in (15) are the only ones of the eight possible types to actually occur:

(15)	a.	VROOV:	*chantsi*	2 sg. pres. act. ind.	'seem'
	b.	VRORV:	*vártma*	nom. acc. sg. neut.	'track'
	c.	VOORV:	*yóktram*	nom. acc. sg. neut.	'rope'

What can these sequences tell us about sonority sequencing in Vedic? Quite a bit, in fact. Their existence in general Vedic, to the exclusion of the five other theoretically possible types, is exhaustively predicted solely by a conception of the sonority sequencing principle recognizing only complex codas of falling sonority and complex onsets of rising sonority (thereby yielding VRO.OV, VR.ORV, VO.ORV). These sequences also happen to coincide exactly with those predicted to feature a complex coda or onset under the strict version of sonority sequencing presented above in Table 7.14. This overlap in distribution is highly suggestive of the relevance of strict sonority sequencing for Vedic: if weaker sonority sequencing were operational, allowing for complex codas and onsets of flat sonority, we would expect to see examples of general, unepenthesized Vedic forms with VOOOV, VORRV, VRROV, VRRRV (syllabified VOO.OV, VRR.OV, VRR.RV, VO.RRV). That such data is not found is compelling; I thus maintain the position stated above, that Vedic abides by strict sonority sequencing.

So we have seen that a unitary weight-based approach is untenable, given the expected syllabification of the relevant VCCCV sequences in Vedic. What about an approach which appeals to the linear order of segments, by positing a dispreference for medial triconsonantal sequences, which is resolved by epenthesis? While this approach would require a single motivation for epenthesis in these sequences, whereas the one established above requires two (complex codas / superheavy syllables on the one hand, complex onsets on the other), we would still have to account for V̄CCV sequences as well, in which weight (and hence syllable structure) must be relevant. The reality of disjunction permeates this approach as well; the real question which ought to be addressed, then, is how the disjunctive nature of the perfect union vowel phenomenon ought to best be treated. We can posit a hybrid approach that makes reference both to weight (for V̄CCV sequences) and segmental order (for VCCCV sequences), or an approach that makes reference exclusively to syllable structure, but crucially, not only superheavy syllables (a third alternative, a purely-segmental approach, is untenable in that it would fail to capture the obvious weight-based motivation of post- V̄C epenthesis). In short, which is superior: a wholly syllable-based account that is more complicated in its motivations for epenthesis, or a hybrid syllable-segmental account that is simpler in its motivations? The question is a challenge; for our purposes, though, we will proceed with the former approach, not merely because of its top-down simplicity, but more so because it better complements the general account of Vedic syllabification developed here. This 'economy of explanation' will translate into an economy of constraints introduced in the Optimality-Theoretic analysis discussed in the next section: as there is independent motivation for the constraint *COMPLEX$_{\text{ONSET}}$, for example – to account for the basic syllabification VC.CV – the more elegant analysis of the perfect union vowel would arguably make use of it, over, say, the constraint *CCC, which lacks analogous motivation.[57]

[57] Appeal to 'constraint economy' should probably be restricted to cases such as this, in which the two possible accounts are otherwise equivalent in their explanatory power.

7.2.7 On the Position of s

In our discussion of syllabification in Vedic we have operated with a sonority hierarchy distinguishing only sonorants from obstruents. There are few if any word-internal phenomena which might make us reevaluate this position. We will consider one here: the deletion of *s*. Relevant data are presented in (16)-(17).

(16) s *is lost*

a.	*ábhakta*	<	á-bhak-s-ta	3 sg. aor. mid. of *bhaj-* 'share'
b.	*árabdha*	<	á-rabh-s-ta	3 sg. aor. mid. of *rabh-* 'grasp'
c.	*babdhām*	<	bha-bhs-tām	3 du. pres. impv. of *bhas-* 'chew' [RV-Kh]

(17) s *is maintained*

a.	*ábhutsmahi*	1 pl. aor. mid. of *budh-* 'wake'
b.	*ásvārṣṭām*	2 du. aor. act. of *svar-* 'sound'
c.	*várṣma*	nom. sg. masc. 'height'

Between two obstruents, *s* is deleted; comparing a.-b. to c., the position of morpheme boundaries does not seem to have any bearing on this outcome. On the other hand, when *s* is immediately adjacent to a sonorant consonant, either preceding or following, it is retained; again, morphology does not play a role.

Our analysis of this phenomenon, if based on syllable structure (as plausible a starting point as any), depends on two distinct, but related factors: the strictness of the sonority sequencing principle, and the relative gradience of the sonority hierarchy. With respect to the former, we can either allow or disallow complex codas and onsets of flat sonority. As for the latter, we can maintain the hierarchy distinguishing only sonorants and obstruents, or introduce a more fine-grained version distinguishing between sonorants, stops, and *s* (i.e., O > *s* > R, where *O* represents only the non-sibilant obstruents).

Depending on our position vis-à-vis these two factors, the explanation for deletion of *s* will differ. We can sketch out four possible approaches, based on the sets of assumptions in (18).

(18) a. Sonority plateaux banned; hierarchy O > R

b. Sonority plateaux banned; hierarchy O > *s* > R

c. Sonority plateaux permitted; hierarchy O > R

d. Sonority plateaux permitted; hierarchy O > *s* > R

Operating under these assumptions, the corresponding explanations for loss of *s* are given in (19):

(19) a. *s* is deleted because flat sonority complex codas or onsets are disallowed.

b. *s* is deleted because complex codas cannot rise in sonority and complex onsets cannot fall in sonority.

c. There is no explanation for *s*-deletion.

d. *s* is deleted because complex codas cannot rise in sonority and complex onsets cannot fall in sonority.

As can be seen, the possible explanations really boil down to two. Assuming either a stronger version of sonority sequencing or a more fine-grained sonority hierarchy will enable us to capture the facts. Given that we already have independent motivation for the stronger version of the sonority sequencing principle (as discussed above), it is simpler to rely on it here, than introduce any new assumptions.[58, 59] As such, we can characterize the deletion of *s* as a response

[58] Independent support for the gradated sonority hierarchy might be drawn from sequences such as *kṣ*-, observed in the root *kṣip*- 'throw' and in *dhārayatkṣit*- 'sustaining creatures', attested twice in the Rig Veda (1.136.3, 10.132.2). If we do not consider such sequences exceptional, occurring in initial position and in a compound, respectively, then we could capture their permissibility by ranking sibilants higher in sonority than other obstruents; the sequences

to a poor sonority profile for syllabification: in-between two obstruents, the sibilant cannot be tautosyllabified with either segment, given their equal sonority. On the other hand, *s* is preserved next to a sonorant, as it can group with that segment into a complex syllabic constituent: a coda with a preceding sonorant (*ásvārṣṭām*), an onset with a following one (*ábhutsmahi*).[60]

We can conclude this discussion of the position of *s* by briefly remarking on the somewhat different approach taken by Kobayashi (2004) concerning sibilants (35ff.). Kobayashi distinguishes sibilants from other obstruents in Vedic in a number of ways. He points out that sibilants cannot occur in absolute final position (unless they precede an initial voiceless stop); while acknowledging that "distributional tendencies across a word boundary need not necessarily constrain medial strings" (41), he tentatively extends this restriction to all syllables, including word-internal ones. On the other hand, he speculates that a sibilant can be allowed in a coda, when it is geminated, in accordance with the Vājasaneyi-Prātiśākhya's statement that all consonants, including fricatives, are doubled after *r* and *h*. Finally, he also notes that sibilants can violate the sonority sequencing principle, by preceding stops in onset position, as they are higher in sonority according to the universal scale of sonority (but note their patterning with other obstruents in the less fine-grained version used above).

In order to account for such idiosyncratic behavior, Kobayashi analyzes sibilants occurring to the left of voiceless stops as extrasyllabic, that is, not part of a syllable proper, but

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would accordingly be of rising sonority, and thus constitute acceptable onsets.

Note that the form *dhārayatkṣit-* should not invalidate the argument for strict sonority sequencing made in the previous section, by virtue of its VOOOV sequence *-tkṣ-*: we can either consider it exceptional, citing its compound status and limited frequency, or allow for the more fine-grained sonority hierarchy, in which case its existence is predicted (syllabification VO.OSV).

[59] One might also reconsider the gradience on the sonorant end of the sonority hierarchy, but so far as I have been able to determine, there is little solid justification to do so, at least as concerns word-medial position. First, sequences of two sonorants intervocalically should be split up across syllables. Further, of the triconsonantal sequences featuring two sonorants listed by Kessler (1998: 13), all are glide-final, and, according to the metrically-restored text of van Nooten and Holland (1994), predominantly to be read as vocalic (i.e., *i(y)* / *u(w)*).

[60] In the case of *várṣma*, I propose the syllabification *várṣ.ma*, with complex coda over complex onset in accordance with the practices of syllabification I have attributed to Vedic.

rather licensed specifically by the following stop (sibilants occurring to the left of a sonorant behave as expected according to sonority sequencing). While for him this status applies word-internally as well, the evidence he adduces to bolster the claim – perfect stem reduplication, the inventory of possible word-final consonants as compared to other Indo-European languages, sandhi of final *s* before an initial *s*O cluster – is based only on facts and phenomena pertaining to word-initial or final positions. As we have already seen, however, what occurs initially (or finally) need not directly correspond to what occurs word-medially. As such it is difficult to be fully convinced by Kobayashi's position.[61]

To be sure, Kobayashi's extension of extrasyllabicity to word-internal syllable structure allows him to maintain a unified account of syllabification across the word, at edges and medially. However, this result comes at the cost of positing an additional layer in the syllabification process, to account for the behavior of sibilants with respect to weight-based phenomena such as meter. In order to allow for the contribution of sibilants to weight, when they occur following a sonorant and before a sequence of consonant + vowel – a fact which he notes is "puzzling" (42), given their extrasyllabicity – Kobayashi is constrained to identify multiple levels of syllabification: the underlying level, where sibilant extrasyllabicity is relevant, and the surface level, "where the 'metrical' syllable projects morae without reference to phonotactic templates" (43). But if we simply acknowledge the differing character of word-medial syllable structure versus word-initial or word-final syllable structure, as has been argued to be beneficial to understanding Vedic syllabification, then we can do away with Kobayashi's multiple levels of syllabification. The resulting account would seem to be the theoretically more elegant one: if

[61] It is perhaps worth noting that, while we have suggested earlier that the strict conception of Vennemann's LAW OF INITIALS may be applicable for Vedic, the corresponding LAW OF FINALS "Word-medial syllable codas are the more preferred, the less they differ from possible word-final syllable codas of the language system" (1988: 33), would not seem to be so. Rather the inventory of possible medial coda consonants, and consonant sequences, appears to be greater than that of analogous word-final structures.

these three domains have to differ at some level anyway (at least with respect to metrical practice), then why posit any level of syllabification other than that at which they do so.

7.2.8 Conclusion

In this section we have examined a variety of phenomena indicating that medial consonant clusters, regardless of their sonority profile, are split up across syllables in Vedic, a treatment recognized even by the authors of the ancient Prātiśākhyas. As weight plays a crucial role in nearly all of them, and weight by modern conceptions is to be located in the rhyme component of the syllable, the evidence is difficult to discount. This is especially so in consideration of the fact that the purported evidence for tautosyllabification has been shown to be inconclusive. We can thus conclude with some confidence that Vedic practiced heterosyllabification with respect to word-internal clusters.[62]

[62] Whether weight-based evidence for syllable structure should regularly be so prioritized is a question worthy of further empirical consideration.

CHAPTER 8

ANALYSIS OF VEDIC SYLLABIFICATION

8.0 Introduction; Defining the Constraints

The Optimality-Theoretic account of Vedic syllabification, in order to achieve explanatory adequacy, must account for the following generalizations established to hold for the language's word-internal syllable structure:

(1) a. Single intervocalic consonants are onsets.

b. A sequence of two intervocalic consonants is treated heterosyllabically, i.e. as a sequence of coda + onset.

c. A sequence of three or more intervocalic consonants is treated first in accordance with generalization (1)b.; the syllabic allegiance of the remaining intermediate consonant(s) is determined by the sonority sequencing principle and influenced by a dispreference for complex onsets which is stronger than that for complex codas.

d. Superheavy syllables are disfavored, but are actively prevented from surfacing only in the perfect conjugation.

e. Segments are neither inserted nor deleted to improve syllabification.

With respect to the final generalization, we must also account for the appearance of *i* peculiar to the perfect paradigm (referred to in d.), which breaks up potential superheavy syllables and complex onsets, and allows for the syllabification of what would otherwise be unsyllabifiable sequences of consonants.

The analysis will be developed as follows: in 8.1 I account for generalization (1)a., looking at -VCV- sequences; in 8.2 I account for (1)b., looking at -VCCV- sequences with both short and long initial vowels; and in 8.3 I account for generalization (1)c., looking at -VCCCV- sequences. Sequences of more than three consonants are examined in 8.4, and the incorporation of the perfect union vowel phenomenon into the general account is then addressed in 8.5.

Before moving on to 8.1, we will first briefly introduce the constraints which will play a role in the general analysis. We begin with the set of relevant markedness constraints, presented in (2); all pertain to syllable well-formedness.

(2) *Vedic Syllable Structure Markedness Constraints*

a. ONSET (after Prince and Smolensky 1993 [2004])

Syllables have onsets.

b. NOCODA (after Prince and Smolensky (1993))

Syllables may not have a coda.

c. *COMPLEX$_{\text{ONSET}}$

Syllables must not have more than one onset segment.

d. *COMPLEX$_{\text{CODA}}$

Syllables must not have more than one coda segment.

e. *3μ

No trimoraic syllables.

f. SYLLABLE-CONTACT (after Vennemann 1988)

A syllable contact A$^{\$}$B is the more preferred, the less the Consonantal Strength [i.e., the higher the sonority] of the offset A and the greater the Consonantal Strength [i.e., the lower the sonority] of the onset B.

g. SONORITY-SEQUENCING$_{\text{CODA}}$ (adapted from Zec 2007: 187)

For every pair of segments *s* and *z* in a syllable, *s* is less sonorous than *z* if

(a) *Nucleus* > *z* > *s*

or (b) *z* > *s* and *z* is the nucleus.

These constraints are all well-established in the literature; we will comment briefly on a few of them. First, we differentiate between two versions of *COMPLEX so as to formally encode the greater dispreference for complex onsets than for complex codas, an aspect of Vedic syllabification which in an Optimality-Theoretic account must be due to the influence of multiple distinctly-ranked constraints. Also, with respect to (2)g., we assume a general conception of SYLLABLE-CONTACT, defining it in such a way as to simply prefer a fall in sonority from coda to following onset; as we will see, however, such a preference is consistently unsatisfied in the syllabification of Vedic.[1] As for the sonority sequencing principle, it is defined here in such a way as to disallow complex codas of flat sonority, as has been argued to be the case in Vedic; note that the associated sonority hierarchy must at a minimum make a distinction between obstruents (O) and sonorants (R), with the latter of course being greater in sonority than the former. Further, we confine our focus to coda position, instead of offering a general SONORITY-SEQUENCING constraint covering both complex codas and complex onsets, as Vedic's dispreference for complex onsets is such that the structure only surfaces when the alternative, a complex coda, would violate sonority sequencing. As such we can consider the associated constraint SONORITY-SEQUENCING$_{\text{ONSET}}$ to be inert.

In addition to these markedness constraints, the usual faithfulness constraints DEP-IO and MAX-IO, defined in (3), are relevant as well.

[1] But see Gouskova (2004) for a more fine-grained approach to the issue of syllable contact, in which the phenomenon emerges out of the influence of a hierarchy of relational constraints.

(3) *Vedic Syllable Structure Faithfulness Constraints*

a. DEP-IO (McCarthy and Prince 1995)

An output segment has a correspondent in the input. ('No epenthesis')

b. MAX-IO (McCarthy and Prince 1995)

An input segment has a correspondent in the output. ('No deletion')

Generally, neither epenthesis nor deletion is resorted to as a means of improving syllable structure, suggesting that these two constraints hold a rather high position in the constraint ranking. They feature in the tableaux to follow only when their influence is the focus of discussion (for example, in the case of the perfect union vowel). Finally, we can note the importance of the constraint ranking *APPENDIX » *μ/CONSONANT (after Sherer 1994); even though these constraints will not feature explicitly in the following analysis, their activity in the overall Vedic constraint ranking is clear, given that syllables which end in -VC are counted as heavy by Vedic meter.[2]

Additional constraints that will prove relevant in various subcomponents of the analysis, such as the interaction of syllabification and reduplicated stem formation (8.2.1) and, more importantly, perfect union vowel epenthesis (8.5), will be introduced as required; again, the preceding constraint overview is meant to apply to the general process of syllabification in Vedic.

8.1 Syllabification of -VCV- Sequences

A single intervocalic consonant is always treated as the onset of the syllable headed by the following vowel, not as the coda of the syllable headed by the preceding one, as in (4): the

[2] Alternatively, one could also invoke high-ranking WEIGHT-BY-POSITION, after Hayes 1989.

syllabification *é.mi* is most optimal because it violates neither ONSET nor NOCODA, which are not crucially ranked with respect to one another.

(4) *émi*, 1 sg. pres. act. ind 'go'[3]

/e-mi/	ONSET	NOCODA
☞a. e.mi		
b. em.i	*!	*

This syllabification holds regardless of where a morpheme boundary may lie: thus the form *āsa* (ās-a) 1 sg. perf. act. ind 'be' is syllabified *ā.sa*, not †*ās.a*.

8.2 Syllabification of -VCCV- Sequences

8.2.1 Syllabification of -V̆CCV- Sequences

Intervocalic sequences of two consonants are treated heterosyllabically, as has been shown by, among other things, consideration of Vedic metrical practice. Such treatment holds for both sequences preceded by a short vowel, and those preceded by a long vowel (as addressed in the next subsection). Even if the consonants rise in sonority, thus forming a theoretically viable onset, they are still syllabified as coda + onset. The tableau in (6), for the form *pavítrais*, demonstrates as much: the obstruent-sonorant sequence *-tr-* can constitute a perfectly good onset, but because of the dispreference for complex onsets – instantiated by the crucial ranking in (5) – the sequence is broken up across syllables.

(5) *COMPLEX$_{\text{ONSET}}$ » NOCODA, SYLLABLE-CONTACT

[3] Two notes about the presentation of data in the Optimality-Theoretic tableaux: first, for every tableau, we generally restrict our focus only to the syllabification of the input sequence in question – any and all violations shown belong to this domain. Second, accentuation, when applicable, is indicated in the forms, but as it is a largely lexically-determined phenomenon, this practice is more for the sake of completeness of presentation than anything else.

(6) **-VORV-:** *pa.vít.rais*, inst. pl. 'filter'

/pavitrais/	*COMP$_{ONS}$	NOCODA	SYLL-CONT
☞a. pavit.rais		*	*
b. pavi.trais	*!		

The tableau also shows the lack of influence of the Syllable Contact Law; the optimal syllabification satisfies *COMPLEX$_{ONSET}$ at the cost of violating SYLLABLE-CONTACT, by positioning less sonorous *t* in a coda preceding more sonorous *r* in a following onset.

Given the ranking in (5), the heterosyllabic treatment of the three other types of medial biconsonantal sequences – -VOOV-, -VROV-, and -VRRV- – is easily accounted for as well. We can see as much in the tableaux in (7)-(9); in light of the sonority profiles involved, such treatment is to be expected.

(7) **-VOOV-:** *apaptan*, 3 pl. aor. act. ind. 'fall'

/a-papt-an/	*COMP$_{ONS}$	NOCODA
☞a. apap.tan		*
b. apa.ptan	*!	

(8) **-VROV-:** *jagántha*, 2 sg. perf. act. ind. 'go'

/ja-gan-tha/	*COMP$_{ONS}$	NOCODA
☞a. jagan.tha		*
b. jaga.ntha	*!	

(9) **-VRRV-:** *jaganma*, 1 pl. perf. act. ind. 'go'

/ja-gan-ma/	*COMP$_{ONS}$	NOCODA
☞a. jagan.ma		*
b. jaga.nma	*!	

Given high-ranking *COMPLEX$_{ONSET}$, complex onsets are consistently avoided, regardless of the sonority profile of the consonants in question. As an alternative take on the evaluation process, we might reason that the complex onsets (or codas) resulting from a tautosyllabic treatment of these consonantal sequences would be disfavored from the start, as they violate the sonority sequencing principle. While this intuitively makes sense, nonetheless the forms examined in (7)-(9) would not crucially justify inclusion of the constraint SONORITY-SEQUENCING in the rankings, as the correct optimal output in each of these cases is still attained, despite its absence, with the constraints and rankings established thus far. Note also that in the case of *jagántha*, the structure we might want to avoid more reasonably than the candidate †*jaga.ntha* would be, given sonority sequencing, †*jaganth.a*, with complex coda of falling sonority. The tableau including such a form, however, would be unenlightening for the purposes of constraint ranking, as the relevant constraints, *COMPLEX$_{\text{CODA}}$ and ONSET / NOCODA, are not crucially ranked with respect to each another.

Relevant in a discussion of intervocalic biconsonantal sequences is the fact that their heterosyllabic treatment establishes a syllabification that can play a role in the satisfaction of templatic size requirements. We can see this in the formation of certain aorist and intensive stems, requiring reduplicated prefixes of minimally bimoraic size (see Chapter 7). Typically, in the case of roots beginning with a single consonant, the final vowel of the reduplicated prefix must be lengthened to meet this requirement; this outcome is shown in the following two tableaux, for the stem forms *ájījana-* aor. 'beget' (10) and *ganīgam-* intens. 'go' (11).[4]

(10) *ájījana-* aor. 'beget'

/a-[Ci]-jan-a-/	$[\text{Ci}]_{2\mu}^{\text{Aor}}$	ONSET	NOCODA	DEP-μ-IO
a. aji.jana-	*!	*		
b. ajij.ana-		*!	*	
☞ c. ajī.jana-				*

[4] The nature of the general reduplication process involved in the formation of these stems is beyond the scope of the current discussion; I include in the inputs the template for the reduplicated prefix – [Ci] for the aorist, [CVCi] for the intensive – and its filled-in realization in the various output candidates (*-ji-* and *gani-*, respectively).

(11) *ganīgam-* intens. ‘go’

/[CVCi]-gam-/	$[CV[Ci]_{2\mu}]^{Intens}$	ONSET	NOCODA	DEP-μ-IO
a. gani.gam-	*!	*		
b. ganig.am-		*!	*	
☞ c. ganī.gam-				*

The cover symbols $[Ci]_{2\mu}^{Aor}$ and $[CV[Ci]_{2\mu}]^{Intens}$ are used here as a shorthand to represent the bimoraic size requirement for the syllable headed by prefix-final *i*, while the constraint Dep-μ-IO militates against processes such as vowel lengthening. The general principles of Vedic syllabification yield the candidates in a., where the root-initial consonant functions as an onset; yet the templatic size requirement is unmet, meaning the forms incur a fatal violation of highly-ranked $[Ci]_{2\mu}^{Aor}$ and $[CV[Ci]_{2\mu}]^{Intens}$ and are thus eliminated from consideration. Two alternatives are syllabifying the root-initial consonant as a coda (candidates b.), or lengthening the prefix-final *i* (candidates c.); given a higher ranking of Onset and NoCoda over Dep-μ-IO, the latter option is the more preferred.

For roots which begin with a sequence of two consonants, though, the heterosyllabic treatment of intervocalic CC sequences means that these two consonants will be split up, such that the first C will constitute the coda of the reduplicated prefix syllable. In this way, the bimoraic size requirement is satisfied; the tableaux in (12) and (13) demonstrate as much.

(12) *cikṣipa-* aor. ‘throw’

/[Ci]-kṣipa-/	$[Ci]_{2\mu}^{Aor}$	$*COMP_{ONS}$	NOCODA
☞ a. cik.ṣipa-			*
b. ci.kṣipa-	*!	*	
c. cī.kṣipa-		*!	

(13) *kanikrand-* intens. ‘cry out’

/[CVCi]-krand-/	$[\mathrm{Ci}]_{2\mu}^{\mathrm{Aor}}$	*COMP$_{\mathrm{ONS}}$	NOCODA
☞ a. kanik.rand-			*
b. kani.krand-	*!	*	
c. kanī.krand-		*!	

That the prefix-final syllable is heavy here is a natural outcome of the general principles of Vedic syllabification. Thus the lengthening process in these cases is unnecessary: the quantity of prefix-final *i* is not altered in either (12) or (13) because the syllable the vowel heads has already been made heavy. Incidentally, we see here also that, again, morpheme boundaries which may intervene in internal consonantal sequences do not necessarily have an effect on their syllabification.

8.2.2 Syllabification of -V̄CCV- Sequences

Given the relevance of superheavy syllables in Vedic (see the discussion in Chapter 7), we have no reason to believe that the syllabification of forms such as *śāsmi*, which feature a long vowel, should not follow the general heterosyllabic treatment of intervocalic biconsonantal sequences. So, based on the established constraint rankings, we see that the most optimal candidates in the tableaux in (14) and (15) break up the intervocalic consonant cluster across two syllables, the first of which is consequently superheavy. This fact suggests that *COMPLEX$_{\mathrm{ONSET}}$ must outrank *3μ. And, once again, we can see in (14) that the type of juncture preferred by the SYLLABLE-CONTACT constraint continues to be unrealized.

(14) **-V̄ORV-:** *śāsmi* (AV), 1 sg. pres. act. ind. ‘order’

/śās-mi/	*COMP$_{\mathrm{ONS}}$	*3μ	NOCODA
☞ a. śās.mi		*	*
b. śā.smi	*!		

(15) **-V̄ROV-:** *ārta*, 3 sg. aor. mid. ind. ‘move, rise’

/ār-ta/	*COMP$_{\text{ONS}}$	*3μ	NOCODA
☞ a. ār.ta		*	*
b. ā.rta	*!		

The general syllabification of sequences involving long vowels is one of the outcomes avoided in the perfect by the insertion of *i* (see 8.5 below).[5]

8.2.3 Summary: Intermediate Constraint Ranking 1

So far, in examining forms with internal sequences of one and two consonants, we have developed the following crucial rankings of constraints; as we move on to consider the syllabification of intervocalic sequences of three consonants, additional fixed rankings will be introduced.

(16) *COMPLEX$_{\text{ONSET}}$

NOCODA SYLLABLE-CONTACT *3μ

It is worse in Vedic to have a complex onset than either a syllable contact violation (tableau (6)), a coda consonant (tableaux (6)-(9)), or a superheavy syllable (tableaux (14)-(15)).

8.3 Syllabification of -VCCCV- Sequences

The syllabification of sequences of three consonants between vowels is understandably more complex than the cases reviewed above. Here sonority sequencing comes into play as an influential force weeding out non-optimal candidates: while the first and last consonants are

[5] Again, we might question the inclusion of the constraint *3μ in these tableaux, since the correct result can be achieved without it, given the effects of NOCODA. While this may be the case here, the importance of *3μ will prove crucially distinct from that of NOCODA in the discussion of the perfect union vowel.

treated heterosyllabically, the association of the intervening consonant depends on whether it can better comprise the final consonant of a complex coda or the initial consonant of a complex onset. If either position is theoretically possible, then the stronger restriction on complex onsets means that the consonant will be part of the coda.

Before moving on to individual cases, it is important to note that, as already observed in the previous chapter, of all possible combinations of consonants in a string -VCCCV-, only a subset are actually attested in Vedic. Operating with a sonority hierarchy making a distinction between only sonorants and obstruents, for instance, we posit the following eight logically possible shapes:

Table 8.1 Logically-possible Vedic -VCCCV- sequences

-VOORV-	-VRORV-	-VROOV-
-VOOOV-	-VOROV-	
-VORRV-	-VRRRV-	
	-VRROV	

These eight shapes are classified in the table above as follows. Starting with the three in the topmost box, these shapes actually appear in Vedic, with varying frequency. Moving outward, the seven shapes in the larger box are all found in the underlying structure of forms of the perfect; they fail to surface as a contiguous sequence because of the insertion of *i*. The four unique to the perfect will be addressed below in 8.5. Left remaining is the final potential sequence -VRROV-, which, following Gotō (2005)'s survey of internal triconsonantal groups in Indo-Iranian (205-206), does not occur at all in Vedic, lexically or by virtue of morpheme concatenation. As such it will not feature in the analysis developed here.

Indeed it may be no coincidence that the three sequences which do surface generally in Vedic are the only ones which can straightforwardly be syllabified in accordance with the sonority sequencing principle calling for complex codas to fall in sonority (and complex onsets to rise in sonority). The remaining five cannot be so treated, as is. It is interesting that a majority of them can be found in the perfect, where *i*-epenthesis significantly improves their ability to be syllabified.[6] With respect to unattested -VRROV-, while we would predict it not to surface as such, it is not unreasonable to think it possible in the underlying form of a perfect. In fact a potential candidate presents itself in the perfect stem *dadhanv-* 'run'; while its only attested indicative form is third plural middle *dadhanviré*, if inflected in either the second person singular active (*-tha*) or middle (*-sé*), or the second person plural middle (*-dhvé*), we would have an instance of the environment -VRROV-. So I would characterize the absence of this shape as more accidental than anything else, a consequence of the limits of our sources.

Returning to the generally attested sequences, let us begin with -VROOV-. Sequences of this shape are syllabified with a complex coda, that is, as -VRO.OV-. The constraint rankings established thus far are enough to guarantee this outcome, as the tableau in (17) shows, but we can also make reference to the constraint *COMPLEX$_{\text{CODA}}$, which clearly must rank below *COMPLEX$_{\text{ONSET}}$.[7]

(17) **-VROOV-:** *chantsi*, 2 sg. pres. act. ind. 'seem'[8]

/chant-si/	*COMP$_{\text{ONS}}$	*3μ	*COMP$_{\text{CODA}}$	NOCODA
☞ a. chant.si		*	*	**
b. chan.tsi	*!			*

[6] A question worth considering is whether the insertion of *i* in these particular cases should be considered a perfect-internal phenomenon, as epentheses to resolve superheavy syllables and complex onsets are, or as a more general process, given the all-around poor sonority profiles the sequences feature. I take up this issue at the end of 5.3.4 below.

[7] The need to invoke *COMPLEX$_{\text{CODA}}$ in addition to *3μ is worth considering further. Under the assumption that each coda consonant bears weight, every violation of *COMPLEX$_{\text{CODA}}$ necessarily means a violation of *3μ (assuming the latter militates against superheavy syllables of three moras *or more*). The reverse does not hold, however – consider long vowels in closed syllables – suggesting that while there is indeed some overlap between the two constraint's domains of influence, a distinction between superheavy syllables and complex codas is worth maintaining. See also the discussion in Chapter 5.

[8] It is perhaps worth noting that this is the only form featuring -VROOV- found in a cursory search of Macdonell (1910).

Note also that, although not explicitly included here, highly-ranked MAX-IO and DEP-IO militate against either epenthesis or deletion as a means of averting violations to *COMPLEX$_{ONSET}$, *3μ, or *COMPLEX$_{CODA}$.

Moving on to -VRORV-, there are ostensibly two possible syllabifications for forms containing such a sequence. Depending on the treatment of the intervening obstruent, we could have a complex onset (-VR.ORV-) or a complex coda (-VRO.RV-). Evaluated under the constraint rankings developed thus far, however, it is the former option which is selected as most optimal, as in (18).

(18) **-VRORV-:** *vártma*, nom. acc. sg. neut. 'track'

/vartma/	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$	NOCODA
☞ a. vart.ma		*	*	**
b. var.tma	*!			*

Again, given high-ranking MAX-IO and DEP-IO, either of these options is better than resorting to deletion or epenthesis. But *COMPLEX$_{ONSET}$ crucially outranks *3μ (see 8.1.4) and *COMPLEX$_{CODA}$ (see above), meaning it is worse to have a complex onset than a superheavy syllable or complex coda (note once again how it is also worse than violating syllable contact). Thus the winning candidate is (18)a., *várt.ma*.

Finally, with respect to the sequence -VOORV-, it is this case which provides crucial evidence of the importance of the sonority sequencing principle. The constraint SONORITY-SEQUENCING$_{CODA}$ has not played a role in the discussion thus far, as the constraint rankings which have been introduced have proven sufficient to account for the cases we have examined. Yet to maintain these rankings unchanged in the case of -VOORV- would result in the selection of an incorrect output, indicated by the pointing finger (the sad face marking the unselected, desired output):

(19) **-VOORV-:** *yóktram*, nom. acc. sg. neut. 'rope'

/yoktram/	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
☞ a. yokt.ram		*	*
☹ b. yok.tram	*!		

Failure to incorporate SONORITY-SEQUENCING$_{CODA}$ into the constraint hierarchy would result in candidate (19)a.'s selection as most optimal, given the established stronger dispreference for complex onsets than for complex codas or superheavy syllables. We must introduce the constraint, then, and crucially rank it higher than *COMPLEX$_{ONSET}$. Its influence is seen in the selection of the correct output in (20).

(20) **-VOORV-:** *yóktram*, nom. acc. sg. neut. 'rope'

/yoktram/	SON-SEQ$_{CODA}$	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
a. yokt.ram	*!		*	*
☞ b. yok.tram		*		

Sonority sequencing now makes candidate (20)a. untenable, even though in general complex codas are better than complex onsets: in other words, it is worse to violate this principle, than to surface with a complex onset. The departure of candidate (20)a. from consideration leaves candidate (20)b., *yók.tram*.

8.3.1 Summary: Intermediate Constraint Ranking 2

Building on the constraint rankings already established in the previous sections, we have found that the analysis of -VCCCV- syllabification requires the crucial ranking of SONORITY-SEQUENCING$_{CODA}$ over *COMPLEX$_{ONSET}$ (tableau (20)), and *COMPLEX$_{ONSET}$ over *COMPLEX$_{CODA}$ (tableaux (17)-(18)), schematically shown in (21).

(21) SONORITY-SEQUENCING$_{CODA}$
|
*COMPLEX$_{ONSET}$
|
*COMPLEX$_{CODA}$

As will be demonstrated in the following section, the overall array of constraint rankings will be incapable of accounting for the practice of *i*-epenthesis which takes place in the perfect conjugation; adjustment of some nature will be necessary.

8.4 -VCCCCV- Sequences and Beyond

Intervocalic sequences of more than three consonants are relatively infrequent, due to the possible shapes of Vedic morphemes and the greater chance of sonority sequencing violations. Still, the analysis as developed thus far is predicted to yield appropriate syllabifications for any such sequences which do occur. Abiding by sonority sequencing remains a priority, but there is greater leeway for the surfacing of *both* complex onsets and complex codas, as the example in (22) shows.

(22) *yungdhvam*, 2 pl. mid. aor. 'join'

/yung-dhvam/	SON-SEQ$_{CODA}$	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
a. yungdh.vam	*!		*	*
☞ b. yung.dhvam		*	*	*

The optimal syllabification of the form *yungdhvam* features both a complex onset and a complex coda, in the interest of satisfying undominated SONORITY-SEQUENCING$_{CODA}$. And again, neither epenthesis nor deletion occurs, satisfying omitted (but nonetheless influential) MAX-IO and DEP-IO.

8.5 Accounting for Perfect Union Vowel Epenthesis

So far we have developed an account of the general process of syllabification for Vedic Sanskrit. This process may disfavor complex onsets and superheavy syllables, but when no reasonable syllabification exists by which their surfacing could be avoided (neither epenthesis nor syncope being an option), they do surface.

Yet as we have seen, such tolerance, however limited, does not hold for forms of the perfect. In the perfect epenthesis occurs either to resolve a superheavy syllable, or to break up a complex onset (or, to render syllabifiable an otherwise unsyllabifiable sequence of segments). Given this starkly different treatment, where a phonological process is conditioned by the morphological identity of the form it occurs in, we must now equip our analysis with the means of accounting for the exceptional behavior of perfect union vowel epenthesis. In the analysis as developed thus far, candidates which feature no epenthesis would be selected in cases where the epenthesis of *i* should occur. Such an outcome is clearly illustrated in the comparative tableaux in (23)-(25); each pairing includes both a non-perfect and (underlying, though ultimately not surface-true) perfect form of similar shape.

(23) *-V̄CCV-*

a. *śā́smahe*, 1 pl. pres. mid. ind. 'order'

/śās-mahe/	DEP-IO	*COMP$_{ONS}$	*3μ
☞ i. śās.ma.he			*
ii. śā.sma.he		*!	
iii. śā.sV.ma.he	*!		

b. *dadāśimá*, 1 pl. perf. act. ind. 'wait on'

/da-dāś-ma/	DEP-IO	*COMP$_{ONS}$	*3μ
☞ i. dadāś.ma			*
ii. dadā.śma		*!	
☹ iii. dadā.śi.ma	*!		

(24) *-VRORV-*

a. *vártma*, nom. acc. sg. neut. 'track'

/vartma/	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
☞ i. vart.ma			*	*
ii. var.tma		*!		
iii. var.tV.ma	*!			

b. *vavandima*, 1 pl. perf. act. ind. 'praise'

/va-vand-ma/	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
☞ i. vavand.ma			*	*
ii. vavan.dma		*!		
☹ iii. vavan.di.ma	*!			

(25) *-VOORV-*

a. *yóktram*, nom. acc. sg. neut. 'rope'

/yoktram/	SON-SEQ$_{CODA}$	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
i. yokt.ram	*!			*	*
☞ ii. yok.tram			*		
iii. yok.tV.ram		*!			

b. *paptima*, 1 pl. perf. act. ind. 'fall'

/pa-pt-ma/	SON-SEQ$_{CODA}$	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
i. papt.ma	*!			*	*
☞ ii. pa.tma			*		
☹ iii. pap.ti.ma		*!			

Operating with the already established constraint rankings SONORITY-SEQUENCING$_{\text{CODA}}$, DEP-IO » *COMPLEX$_{\text{ONSET}}$ » *3μ, *COMPLEX$_{\text{CODA}}$, we predict the candidates †*ās.ma*, †*vavand.ma* and †*pap.tma* to be most optimal, as they avoid epenthesis in favor of syllabifying the word with a superheavy syllable (and complex coda) or complex onset, respectively. We are thus faced with a ranking paradox, as epenthesis indeed ought to occur. Additional attention is required, then, so as to formally account for the distinctive insertion of *i* attested in these and other perfect forms.[9]

The interaction of morphology and phonology in exceptionality has recently been accounted for in the literature in at least two different ways in the constraint-based framework of Optimality Theory: through the introduction of cophonologies attuned to different morphological categories (Anttila 2002, Inkelas and Zoll 2007), and through the lexical indexation of markedness and faithfulness constraints, such that they are relevant only to certain morphemes and not others (Pater 2006, 2009). A third approach, not necessarily confined to a constraint-based analysis, involves the subcategorization of allomorphs to different phonological environments (Paster 2005, 2006). In the subsections which follow I evaluate each of these approaches in light of the details of perfect union vowel epenthesis, beginning with cophonologies and concluding with constraint indexation. As will be shown, given the appropriate assumptions, both the cophonology and the constraint indexation approaches are able to satisfactorily account for the data, while invoking allomorphy subcategorization results in crucial generalizations being formally unacknowledged.[10]

Before moving on to the examination of the cophonology approach, I will first introduce a constraint which will prove relevant for both it and the constraint indexation analysis of the

[9] Perfect forms in which epenthesis does *not* occur – that is, forms which have neither superheavy syllable nor complex onset – are straightforwardly accounted for in the established analysis; see, for example, the tableaux in (8) and (9).
[10] Assessment of a fourth approach, involving Harmonic Serialism (McCarthy 2008, Wolf 2008), is a goal of future work on this issue.

perfect union vowel (both existing within the framework of Optimality Theory), CONTIGUITY$_{\text{STEM}}$. This constraint is defined in (26).

(26) CONTIGUITY$_{\text{STEM}}$ (McCarthy and Prince 1995)

The portion of S_2 standing in correspondence forms a contiguous string.

Range (*R*) is a single contiguous string in S_2. ('No intrusion')

The purpose of this constraint is to limit epenthesis to the morpheme juncture between perfect stem and ending, for as we will see below, there can typically be two viable points of insertion for *i*, either of which would resolve the disfavored syllable structure.[11,12]

8.5.1 Cophonologies

We will begin with the cophonology approach. Cophonologies are subgrammars of a language distinct from one another in some constraint ranking. Different constraint rankings mean different optimal outputs: ranking NOCODA over DEP-IO, for instance, would allow epenthesis as a means of avoiding a coda consonant; the reverse ranking would militate against such a strategy. While in principle one could posit an infinite number of cophonologies, thereby reducing the explanatory power of the mechanism, approaches such as that of Anttila (2002) seek to constrain the number of possible cophonologies of a language. Anttila defines the grammar of a language as a partial order, in which some constraint rankings hold, but not every constraint is ranked with respect to one another (20ff.). The set of possible cophonologies, or subgrammars, of that

[11] The constraint CONTIGUITY, as I understand it and invoke it here, is interested strictly in the linear order of a string of segments, and not any overarching prosodic structure. Indeed reference to the segmental level raises the question of whether the phenomenon of perfect union vowel epenthesis can appropriately be captured wholly in these terms (see, for example, Niepokuj 1997, and the discussion of subcategorization frames below in section 8.5.2). Ultimately, given the relevance of weight, as demonstrated by the inclusion of sequences -$\bar{V}$CCV- in the phenomenon, such an analysis would arguably be untenable.

[12] The fact that the perfect stem is a derived unit may be seen as problematic to the constraint as it is formulated here; perhaps it is better labeled as the more general CONTIGUITY$_{\text{MORPHEME}}$, though this might run into issues with the operation of Sievers' Law.

language include only those which build upon the initial partial order with further constraint rankings; the fixed rankings present in the grammar of the language must be maintained in each of its cophonologies. In turn, according to his Subregularity Interpretation (22), the set of possible cophonologies of a language defines its possible subregularities, such as declensions or lexical exceptions.

For Vedic, then, the partial order that is the grammar of the language must include, with respect to syllabification, the undominated constraint SONORITY-SEQUENCING$_{\text{CODA}}$. Regardless of whether a word is a perfect form or not, its internal syllable structure must abide by the sonority sequencing principle. The point of distinction between syllabification in the perfect versus elsewhere lies, again, in the degree of tolerance for complex onsets and superheavy syllables. For the general rules of Vedic syllabification, the ranking in (27) captured the fact that epenthesis is not relied upon as a means of avoiding a complex onset or superheavy syllable, but rather in the relevant forms such structures actually do surface.

(27) *General Vedic Constraint Ranking*

DEP-IO » *COMPLEX$_{\text{ONSET}}$ » *3μ, *COMPLEX$_{\text{CODA}}$

In the case of the perfect, epenthesis does occur. This can be reflected by the reversal in the following constraint ranking:

(28) *Perfect Conjugation Cophonology Constraint Ranking*[13]

*COMPLEX$_{\text{ONSET}}$, *3μ, *COMPLEX$_{\text{CODA}}$ » DEP-IO

Now, it is more optimal to avoid complex onsets and superheavy syllables from surfacing, even if doing so incurs a violation of DEP-IO. As a demonstration of the effect of this ranking reversal, consider the tableau in (29), for the perfect form *vavandima*, compared with the tableau in (30)

[13] Given the fact that superheavy syllables and complex onsets are equally disfavored in the perfect, we have no evidence to suggest *COMPLEX$_{\text{ONSET}}$ ought to maintain its ranking over *3μ in this domain.

(repeated from (24)a.) above, but with the fixed constraint ranking DEP-IO » *COMPLEX$_{ONSET}$) for the similar non-perfect form *vártma*.

(29) *vavandima*, 1 pl. perf. act. ind. 'praise'

/va-vand-ma/	*COMP$_{ONS}$	*3µ	*COMP$_{CODA}$	DEP-IO
a. vavand.ma		*!	*	
b. vavan.dma	*!			
☞ c. vavan.di.ma				*

(30) *vártma*, nom. acc. sg. neut. 'track'

/vartma/	DEP-IO	*COMP$_{ONS}$	*3µ	*COMP$_{CODA}$
☞ a. vart.ma			*	*
b. var.tma		*!		
c. var.tV.ma	*!			

With *COMPLEX$_{ONSET}$, *COMPLEX$_{CODA}$, and *3µ dominating DEP-IO, the most optimal output in (29) is *vavandima*, which features neither a complex onset nor a superheavy syllable. On the other hand, in the case of *vártma*, the reverse ranking means that the form surfaces with a complex coda and superheavy syllable, as epenthesis is a disfavored repair mechanism. Finally, the constraint CONTIGUITY$_{STEM}$, though explicitly excluded from the above tableaux, is influential in preferring the optimal output *vavan.di.ma* over potential rival †*vava.nid.ma*, which has no violations of *COMPLEX$_{ONSET}$, *COMPLEX$_{CODA}$, or *3µ either, but has an epenthetic segment which critically intrudes into the stem.

With respect to determining which constraints are relevant for the ranking reversal, note that we could not achieve the correct results if the constraint NOCODA were featured in the ranking reversal, in place of *3µ or *COMPLEX$_{CODA}$. As can be seen in the tableaux in (14) and (18), either constraint, interacting with *COMPLEX$_{ONSET}$, would yield the correct output in the case of general -$\bar{V}$ORV- and -VRORV- sequences. Here, however, ranking NOCODA over DEP-IO would result in epenthesis being favored to eliminate any and all coda consonants in a given perfect form, when in fact only a subset, those contributing to a superheavy syllable, are actually affected. This troublesome result is illustrated by the tableau in (31).

(31) *yuyujma*, 1 pl. perf. act. ind. 'yoke'

/yu-yuj-ma/	NoCoda	*Comp$_{ONS}$	Dep-IO
☹ a. yuyuj.ma	*!		
b. yuyu.jma		*!	
☞ c. yuyu.ji.ma			*

While the perfect ending *-ma*, being consonant-initial, is found in *i*-epenthesized forms, *yuyujma* is not one of them; it does not undergo epenthesis, but surfaces as such. The syllable structure of forms such as *yuyujma* is an outcome of the general rules of Vedic syllabification developed above. Unable to rely on NoCoda, then, we are compelled to introduce the constraints *3μ and *Complex$_{CODA}$ to capture the attested distribution of the perfect union vowel.

Having identified the crucial constraint reranking, we are left with a few issues to address in completing a cophonology-based account of the perfect union vowel. First, we must clarify how exactly the relevant forms are shunted into the perfect syllabification cophonology for evaluation. We posit that it is the perfect endings which are responsible for triggering this jump. The alternative option, making the perfect stem the responsible party, is problematic in a couple of ways. First, the perfect stem, as already stated, is a derived entity, and as such unamenable to the sort of lexical marking we expect to be indicative of cophonology membership. We might circumvent this issue by positing a generic perfect stem template, which itself is marked.

Still, we face a more important issue in making the stem the relevant unit, because doing so would predict a distribution of the perfect union vowel which is not borne out in the attested forms. The perfect imperative form *mumoktu* 3 sg. act. 'release' presents the expected environment for epenthesis of *i*, a superheavy syllable (*-mok.-* /-mōk-/), yet the vowel does not occur. We can explain its absence by appealing to the fact that the ending in this case, *-tu*, is common to Vedic in general, and not particular to the perfect conjugation. Forms which feature the perfect union vowel, also feature endings which *are* particular to the perfect, thus arguing that it is rather these morphemes which should trigger evaluation by the alternate perfect cophonology.

More broadly, one potential issue with the cophonology approach revolves around the claim that it possesses no mechanism for restricting the domain of its operation, here only to derived environment effects. An outright reranking of the relevant constraints could mean that for any word subject to this cophonology, epenthesis would be available as a means of avoiding superheavy syllables and complex onsets and codas *anywhere* they might occur, at the juncture between stem and ending – where it is actually attested – or elsewhere. However, this potential effect – of however much true concern it should be[14] – can be mitigated by the inclusion of the aforementioned CONTIGUITY constraint, militating against interruption of the linear order of segments within, but not across, morphemes. Such an approach would be akin to Anttila's (2009) use of FAITH_{root} versus FAITH_{affix}.

On the other hand, if we take the view of Inkelas and Zoll (2007), who argue that constraints within cophonologies must be strictly phonological in nature, the issue is dealt with

[14] In point of fact the evidence to justify our expectations is slim. Since the perfect endings do not themselves contain a superheavy syllable or complex onset, we must look to the set of perfect stems for possible examples. Based on a survey of Avery (1872-1880: 249-253), there is only a single root whose perfect stem might be said to contain a superheavy syllable or complex onset, in non-final position: *skambh*^{i}- 'prop', whose (strong variant) perfect stem is *cāskámbh-*. (The vowel length in the first syllable of *cāskambh-* is to my knowledge an anomaly; roots similar in shape to *skambh*^{i}-, such as *skand-* 'leap' and *stambh*^{i}- 'prop' have perfect stems *caskánd-* and *tastámbh- / tastabh-*, respectively, with short vowel in the initial syllable. The length may be analogical.) The form Avery cites is *cāskámbha* 3 sg. act. ind.; other perfect forms, built on either weak or unreduplicated variants of the stem, include *vicaṣkabhur* and *skambhur* 3 pl. act. ind. and *skambháthur* 2 du. act. ind. As epenthesis is not predicted in the third person singular anyway, given the vowel-initial ending, the question is in a way moot; on the other hand, it does raise the question of whether *all* endings particular to the perfect trigger evaluation by the perfect cophonology allowing epenthesis, or only the consonant-initial ones, where epenthesis is actually attested. We cannot really say, empirically.

in an even more straightforward, basic way. Inkelas and Zoll claim that the nature of the cophonology theory itself incorporates two important predictions about phonological processes which are sensitive to morphology, stem scope and locality, defined in (32) (their (15) on page 144).

(32) a. Stem scope: the scope of morphologically conditioned phonology is the stem formed by the word-formation construction in question.

b. Locality: the phonological pattern tied to a particular stem will never refer to morphological structure internal to the stem ("bracket erasure").

They go on to write: "Cophonologies are tied to word-formation constructions. As a direct consequence, cophonology theory correctly predicts that the special phonological effects associated with a particular affix will be felt only within the stem created by attachment of that affix, and nowhere else in the word" (145). Taken together with the idea that the perfect endings are what trigger the perfect cophonology, as already argued to be the case, under this view epenthesis of *i* anywhere in a perfect form other than at the juncture between stem and ending is automatically blocked.

To conclude this portion of the discussion, we have seen that the cophonology approach to morphology-sensitive phonology does indeed provide a means of incorporating the idiosyncratic facts of perfect union vowel epenthesis into the general account of Vedic syllabification. We next examine an approach which makes use of allomorphy subcategorization.

8.5.2 Allomorphy Subcategorization

Next, we will briefly explore this issue from the perspective of Paster (2005, 2006), who captures alternation in morpheme shape in terms of allomorph-based subcategorization frames, and seeks to do away with accounts which highlight such alternation in terms of some optimizing force on output forms. Under her approach, the distribution of the perfect union vowel would presumably be analyzed in one of two ways, depending on whether or not we would consider an alternation such as *-ma* ~ *-ima* to be suppletive (and hence allomorphic) or the result of a (relatively) regular morphophonological process. As Paster notes (2006: 27-31), while criteria have been posited by, for example, Kiparsky (1996) for distinguishing allomorphy from morphophonology, a considerable gray area remains, and many cases can be analyzed in either way. Indeed Paster does so for the Estonian genitive and partitive plural (2005: 331, 2006: 214-215), and we will do so for the current phenomenon.

First, assuming true suppletive allomorphy, we would analyze *i* as the initial segment of allomorphs of the consonant-initial perfect endings *-tha*, *-ma*, *-ṣe*, *-re*. Characterizing *i* as part of the ending, and not the perfect stem, agrees not only with the generalization that it is affixes which change shape, not stems (based on Paster's extensive cross-linguistic survey), but also with the fact that assigning *i* to the stem would be problematic, in much the same way that indexing the stem would have been in the constraint indexation analysis. The stem is a derived unit, and as such unamenable to allomorphic variation. Further, the idea of a perfect stem template, with two allomorphs, one of which ends in *i*, is possible but implausible, as there also happen to be perfect stems which end in *i* already, by virtue of the shape of the verbal root; distinguishing root-original from non-original (perfect union) *i* could be difficult. Most importantly, characterizing the stem as the allomorphic unit makes predictions about the distribution of *i*, which as we have seen, are not borne out; recall perfect imperative *mumoktu*, and the fact that *i* occurs only in cases where the ending is both consonant-initial and peculiar to the perfect paradigm.

So we would posit that it is the consonant-initial perfect endings which possess two allomorphs, one of which is indeed consonant-initial, the other of which begins with *i*. Again, Paster would capture the distribution of these allomorphs through distinctive subcategorization frames that show the particular environments in which they occur. Such frames could refer to segmental or prosodic structure, depending on the case. Here, taking first person plural *-ma* as a representative example, *-ma* ~ *-ima* allomorphy might be captured by any one of the following three sets of subcategorization frames:

(33) a. Segmental environment

Vedic perfect construction A — Vedic perfect construction B

$[[-\{\bar{V}C, VCC\}\#]_{\text{verb stem}}\ ima_{\text{perf ending}}]_{\text{perf verb}}$ — $[[\ ]_{\text{verb stem}}\ ma_{\text{perf ending}}]_{\text{perf verb}}$

b. Syllabic environment

Vedic perfect construction A — Vedic perfect construction B

$[[-\bar{\bar{\sigma}}\#]_{\text{verb stem}}\ ima_{\text{perf ending}}]_{\text{perf verb}}$ — $[[\ ]_{\text{verb stem}}\ ma_{\text{perf ending}}]_{\text{perf verb}}$

c. Segmental-syllabic environment

Vedic perfect construction A Vedic perfect construction B

$[[-\{\bar{\bar{\sigma}}, VCC\}\#]_{\text{verb stem}}\ ima_{\text{perf ending}}]_{\text{perf verb}}$ — $[[\ ]_{\text{verb stem}}\ ma_{\text{perf ending}}]_{\text{perf verb}}$

(33) presents three possible approaches to denoting the environment preceding *-ima*: in strict segmental terms (a.), in strict syllable-structural terms (b.), or in a hybrid approach combining the two (c.). In (33)a., the suffix *-ima* left-subcategorizes for a verb stem ending in either -$\bar{V}$C or -VCC; in (33)b., it left-subcategorizes for a verb stem ending in a superheavy syllable; and in (33)c., it left-subcategorizes for a verb stem ending in a superheavy syllable or a sequence -VCC. Absent the appropriate environment in each of these cases, the 'elsewhere' scenario takes hold and the consonant-initial allomorph is selected.

Before evaluating this framework, we will turn briefly to the alternative approach to accounting for the appearance of *i*, namely analyzing its distribution as the result of a phonological rule operating on a single underlying form. Again this option is available given the phonological similarity of the forms in question, which differ only in a single segment. Following Paster (2005: 331, ex. (17)a.), the rule of *i*-epenthesis could be schematized as follows:

(34) $\ldots-\{\bar{\sigma}, \mathrm{VCC}\}\#]_{\text{verb stem}}\ \mathrm{i}\,\mathrm{ma}]_{\text{perfect verb}}$

$$\begin{array}{c} \uparrow \\ \emptyset \end{array}$$

The vowel *i* is inserted into a perfect form between a stem ending in either a superheavy syllable or -VCC and an ending beginning with a consonant. There is perhaps some corroboration for the plausibility of this rule within the context of Vedic, since *i* is sometimes viewed as unmarked or default, being, among other things, the outcome of original Proto-Indo-European intervocalic laryngeals. Given the viability of this alternative analysis for the perfect union vowel within Paster's framework, the phenomenon would presumably fall at the 'optimizing' end of the optimization continuum which she constructs (2005: 332). The vowel *i* yields improved syllabic structure of the forms in which it occurs, by breaking up potential superheavy syllables or complex onsets.

Now, having developed the analysis, we can turn to evaluating Paster's approach to such issues. We can point to at least one advantage it has over both cophonologies and constraint indexation. As an outgrowth of the traditional, structuralist take on phonology, Paster's framework is able to make the environment in which *i* occurs explicit: the triggering structure (or segments) directly precedes the morpheme undergoing the change, and this restriction on locality is built right into the subcategorization frames (or the morphophonological rule). As we have seen, the cophonology approach has no standard means of limiting focus to a local domain, as the entire word is subject to the reversed constraint ranking. As for the constraint indexation approach, as developed by Pater, as we will see in the next subsection it must stipulate what it means to be local, in order to limit the domain of change.

Yet Paster's approach has its issues. First, with respect to the instantiation of the main component of the framework, subcategorization frames, problems exist with each of the pairs presented above in (33). The purely segmental and syllable-structural approaches each lack explicit reference to the domain of the other. Because of this fact, in (33)a. we lose out on the generalization of the relevance of superheavy syllables, the common link between segmental sequences -V̄C and -VCC. And to maintain (33)b.'s empirical adequacy, we are forced to admit into the realm of possible syllables those with complex codas of equal or falling sonority, such as *-pt-* in *paptima* or *-jñ-* in *jajñiṣe*. The only alternative to this unpalatable proposition lies in listing superheavy syllables and the non-superheavy syllable VCC sequences separately; hence the more cumbersome hybrid formulation in (33)c.

However, a greater issue with the use of subcategorization frames, and for that matter, rules such as that in (34), has to do with understanding *why* perfect ending allomorphy is motivated in the first place. Descriptively, we know that the perfect union vowel *i* occurs in forms which would otherwise have a superheavy syllable or complex onset (or an unsyllabifiable sequence of segments). As shown in (34), we can reference superheavy syllables in the subcategorization frames in so far as their existence (or the potential thereof) can be considered an underlying matter: as the segments which constitute superheavy syllables are confined always and only to the perfect stem – never the ending, in so far as the available data suggest[15] – we ought to be able, in turn, to legitimately characterize the shape of such stems with reference to these prosodic units.[16] On the other hand, the subcategorization frames cannot capture the resolution of complex onsets, as these structures are confined to output status, being formed across a morpheme boundary. In either case, we have no conception inherent in the subcategorization framework of why *i* should just happen to appear. Its motivation is apparent enough, though, in either Optimality-Theoretic approach. Through consideration of the constraints involved, *COMPLEX$_{\text{ONSET}}$, *COMPLEX$_{\text{CODA}}$, and *3μ, and the violations of them which the insertion of *i* clearly avoids, we can straightforwardly capture why this vowel appears.

Paster's work is admirable for seeking to develop a more general account of allomorphic alternation which acknowledges the existence of cases seemingly unmotivated by any interest in phonological optimization. However, in order to do so, she chooses to cede the ability to formally capture the motivating influence behind those cases that *would* occupy the optimizing end of her continuum – including the perfect union vowel – thereby depriving them of more satisfactory analysis.

8.5.3 Constraint Indexation

8.5.3.1 Introduction

Having surveyed and found issues with the two approaches to morphologically-sensitive phonology considered so far, we conclude our discussion with a more detailed examination of

[15] Recall the crucial test bed for this hypothesis would be the second person plural middle perfect, the ending of which is *-dhvé*, with two initial consonants. The first of these could in theory form part of a superheavy syllable, given a perfect stem ending in VR-. However, the only attested form so conjugated is, again, *dadhidhvé*, in which *i* belongs to the stem.

[16] Given the fact that many morphemes in Vedic exhibit conditions related to syllable structure anyway, this is not an issue unique to the matter at hand.

constraint indexation. As developed by Pater (2006, 2009), this approach involves the introduction of lexically-specified markedness and faithfulness constraints, the satisfaction of which yields the results of morphologically-conditioned phonological processes.

We begin by introducing the general schema of an indexed markedness constraint, which according to Pater (2009: 133) is as follows:

(35) $*X_L$

Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L

Pater furthermore states: "This formulation serves as a locality convention for indexed constraints: they apply if and only if the locus of violation contains some portion of the indexed morpheme" (133).

Pater's formulation of locality predicts two types of derived environment effects, distinguished by the nature of their phonological exponence. First, the disfavored structure penalized by the constraint of shape $*X_L$ can be heteromorphemic: both the indexed morpheme and the adjacent morpheme contribute phonological material to it (a typical morphological derived environment effect). As an example, consider Finnish /a+i/ allomorphy: sequences of [ai] arising through the addition of the past tense marker $/\text{-i-}/_L$ to *a*-final stems are disfavored by the associated indexed constraint $*[ai]_L$, as shown in the tableau in (36) (Pater 2009: 134, example (23)):

(36)

$/\text{taitta-i}_L/$ 'break (past)'	$*[ai]_L$	MAX	IDENT	*[ai]
a. taittai	*!			**
☞ b. taitti		*		*
☞ c. taittoi			*	*
d. titti		**!		
e. toitti			**!	

Illicit sequences of [ai] are resolved through either vowel deletion, as in (36)b., or mutation, as in (36)c.; but crucially, morpheme-internal [ai] is unaffected, as shown by the elimination of the candidates in (36)d.-e.

The second type of effect predicted by Pater's formulation is one in which the disfavored structure is monomorphemic, contained entirely within the bounds of the indexed morpheme. While Pater does not provide any examples of this type, he does not explicitly exclude them either (2006: fn.11). We leave the matter open for now, but note the possible issue of absolute neutralization.

There is also, however, a third potential scenario of phonological exponence: the disfavored structure is monomorphemic, but contained entirely within the bounds of the adjacent morpheme. While excluded outright by Pater's formulation, we will show that precisely such a case exists in the Vedic perfect union phenomenon; to my knowledge this type of phenomenon is new to such consideration.

8.5.3.2 Developing the Analysis

In advancing an approach to the perfect union vowel that makes use of constraint indexation, the first question we must address is whether the distribution of perfect union vowel *i* is determined by epenthesis or deletion (a matter already touched upon in the discussion in Chapter 7). Based on the clear prosodic motivation – avoiding superheavy syllables and complex onsets – I argue that the appearance of the perfect union vowel is the result of epenthesis. Alternatively, analyzing the vowel as 'latent' (after Zoll 1996), appearing only when necessary, does not appear justified, for a number of reasons: first, the vowel in question is straightforwardly non-alternating and always *i*; and second, there are no other such subsegments in Vedic (cf. Yawelmani, which features both latent consonants and vowels). Furthermore, introducing an exceptional segment to account for the idiosyncratic Vedic perfect would arguably only compound the exceptionality already associated with this morphological domain in the first place.[17]

The next issue we address concerns the nature of the indexed constraint: is it a faithfulness or markedness constraint?[18] As Pater (2009) notes, there are accounts in which only faithfulness constraints can be lexically indexed (e.g. Fukazawa 1999, Itô and Mester 1999, 2001). In this case, we would introduce a variant of DEP-IO linked to the perfect endings. As it is, high-ranking DEP-IO rules out epenthesis as a means of resolving superheavy syllables or complex onsets in general Vedic, as in (37).

(37) *śās.má.he*, 1 pl. pres. mid. ind. 'order'

/śās-máhe/	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$
☞ a. śās.máhe			*	
b. śā.smá.he		*!		
c. śā.sV.má.he	*!			

Instead of occupying the relatively high position of regular DEP-IO, especially in relation to *COMPLEX$_{ONSET}$, *3μ, and *COMPLEX$_{CODA}$, the proposed variant DEP-IO$_{PERF}$ would be ranked below these constraints. The consequent problem arises quite quickly, as the following tableau illustrates:

[17] Note that even if we allowed *i* to be latent, the situation in Vedic would differ from Yawelmani, or Tohono O'odham as analyzed by Yu (2000) (but see Fitzgerald 1997, 2002 for a non-latent analysis), in that the vowel's presence would be conditioned by a potential superheavy syllable, contained entirely within the preceding morpheme (i.e. with no exponence in the morpheme of which latent *i* would be part).
[18] Note local conjunction (Lubowicz 2002) will not work here – it is precisely the alignment of syllable and stem edges that creates the disfavored structure to begin with.

(38) *da.dā.śi.má*, 1 pl. perf. act. ind. 'wait on'

/da-dāś-ma/	DEP-IO	*COMP$_{ONS}$	*3μ	*COMP$_{CODA}$	DEP-IO$_{PERF}$
☞ a. dadāś.ma			*		
b. dadā.śma		*!			
☹ c. dadā.śi.ma	*!				*

The lower-ranked DEP-IO$_{PERF}$ has no power, being outranked by its more general analogue, and the wrong candidate is selected. Attempting to maintain faithfulness-only indexation, by alternatively indexing not the lower-ranked version of DEP-IO, but rather the higher-ranked one, would necessitate indexing all endings *other* than those of the perfect, essentially turning the notion of exceptionality on its head; as such it makes little sense, or at least, less sense than indexing the endings particular to the perfect. Using an indexed faithfulness constraint is thus an untenable approach to the issue; we must introduce indexed markedness constraints to effectively capture this phenomenon. In this respect we can agree with Pater's critique of faithfulness-only indexation approaches.[19]

The alternative to an indexed faithfulness constraint would be an indexed markedness constraint. We allow for an indexed markedness constraint of shape *X_L, as per the general schema in Pater (see above); specifically, we introduce three variants on the already established constraints *COMPLEX$_{ONSET}$, *3μ and *COMPLEX$_{CODA}$, linked exclusively to the perfect paradigm:

(39) a. *3μ$_{PERF}$

Assign a violation mark to any instance of a trimoraic (superheavy) syllable that contains a phonological exponent of a morpheme specified as PERF

[19] The issues arising out of the interaction of multiple constraint variants is avoided in the cophonology approach. In the reranking of the perfect cophonology, the one and only DEP-IO ranks low enough to allow epenthesis; there is no high-ranking DEP-IO blocking the process. This is an ostensible advantage of the approach, though one insufficient to warrant a reconsideration of its overall viability.

b. *COMPLEX$_{\text{ONSET-PERF}}$

Assign a violation mark to any instance of a complex onset that contains a phonological exponent of a morpheme specified as PERF

c. *COMPLEX$_{\text{CODA-PERF}}$

Assign a violation mark to any instance of a complex coda that contains a phonological exponent of a morpheme specified as PERF

These constraints have been defined somewhat tentatively, as only now do we turn to the final question we must address in developing the constraint indexation analysis of the Vedic perfect union vowel, namely, which morpheme, stem or ending, ought to be co-indexed with the constraint variants. The issue is perhaps obscured by the fact that epenthetic *i* occurs at the morpheme juncture: a non-original segment is inserted, and not within the bounds of any morpheme, but rather at the juncture between stem and ending: [dadāś]$_{\text{perf}}$*i*[ma] versus [dadāś]*i*[ma]$_{\text{perf}}$. As such, we are dealing with a case to be distinguished from any considered by Pater, where segments undergoing change are already present in underlying structure.

Yet, it must be the perfect endings that are indexed. As already discussed in 8.5.1, the perfect stem, a derived structure created by prefixed reduplication of the verbal root, is as such unamenable to lexical indexation. Even if we were to posit a perfect stem template, capable of indexation, a bigger concern remains: namely, that indexing the stem would incorrectly predict *i*-epenthesis throughout the perfect, when it does not occur in perfect forms such as the following, repeated from our discussion of cophonologies above:

(40) /mu-mok-tu/ → *mu.<u>mok</u>.tu* 3 sg. perf. act. impv. 'release' (†*mu.mo.ki.tu*)

(41) /cā-skambh-a/ → *<u>cās</u>.kám.bha* 3 sg. perf. act. ind. 'prop' (†*cā.si.kám.bha*)

Epenthesis occurs only at the morpheme juncture, as suggested by (40), and only with certain endings, as suggested by (41), in which the ending is the generally-distributed imperative *-tu*. This suggests that only the perfect endings should receive indexation.

Finally, as for ranking the indexed constraint variants, we propose the following:

(42) $*3\mu_{\text{PERF}}$, *COMPLEX$_{\text{ONSET-PERF}}$, *COMPLEX$_{\text{CODA-PERF}}$ » DEP-IO »
*COMPLEX$_{\text{ONSET}}$ » $*3\mu$, *COMPLEX$_{\text{CODA}}$

$*3\mu_{\text{PERF}}$, *COMPLEX$_{\text{ONSET-PERF}}$, and *COMPLEX$_{\text{CODA-PERF}}$ outrank DEP-IO, which in turn outranks the analogous general constraints, as established for general Vedic syllabification: thus their violation is worse than insertion of a segment.

The tableaux pairings in (43)-(46) illustrate this ranking. For the sake of comparison, in each pair the tableau in a. is for a non-perfect form, while that in b. is for a perfect form.

(43) *V̄C. Superheavy Syllables*

a. **Non-Perfect:** *śās.ma.he*, 1 pl. pres. mid. ind. 'order'

/śās-mahe/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	*COMP$_{\text{ONS}}$	$*3\mu$	*COMP$_{\text{CODA}}$
☞ i. śās.mahe						*	*
ii. śā.smahe					*!		
iii. śā.sV.mahe				*!			

b. **Perfect:** *da.dā.śi.má*, 1 pl. perf. act. ind. 'wait on'

/da-dāś-ma$_{\text{PERF}}$/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	*COMP$_{\text{ONS}}$	$*3\mu$	*COMP$_{\text{CODA}}$
i. da.dāś.ma	*!		*			*	*
ii. da.dā.śma		*!			*		
☞ iii. da.dā.śi.ma				*			

(44) *VRO. Superheavy Syllables before O*

a. **Non-Perfect:** *chant.si*, 2 sg. pres. act. ind. 'seem'

/chant-si/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	$*\text{COMP}_{\text{ONS}}$	$*3\mu$	$*\text{COMP}_{\text{CODA}}$
☞ i. chant.si						*	*
ii. chan.tsi					*!		
iii. chan.tV.si				*!			

b. **Perfect:** *ta.tar.di.tha*, 2 sg. perf. act. ind. 'split'

/ta-tard-tha$_{\text{PERF}}$/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	$*\text{COMP}_{\text{ONS}}$	$*3\mu$	$*\text{COMP}_{\text{CODA}}$
i. ta.tard.tha	*!		*			*	*
ii. ta.tar.dtha		*!			*		
☞ iii. ta.tar.di.tha				*			

(45) *VRO. Superheavy Syllables before R*

a. **Non-Perfect:** *várt.ma*, nom. acc. sg. neut. 'track'

/vartma/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	$*\text{COMP}_{\text{ONS}}$	$*3\mu$	$*\text{COMP}_{\text{CODA}}$
☞ i. vart.ma						*	*
ii. var.tma					*!		
iii. var.tV.ma				*!			

b. **Perfect:** *va.van.di.ma*, 1 pl. perf. act. ind. 'praise'

/va-vand-ma$_{\text{PERF}}$/	$*3\mu_{\text{PERF}}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP	$*\text{COMP}_{\text{ONS}}$	$*3\mu$	$*\text{COMP}_{\text{CODA}}$
i. va.vand.ma	*!		*			*	*
ii. va.van.dma		*!			*		
☞ iii. va.van.di.ma				*			

(46) *.ORV Complex Onsets after O*

a. **Non-Perfect:** *yók.tram* nom. acc. sg. neut. 'rope'

/yoktram/	SON-SEQ$_{CODA}$	*3μ$_{PERF}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	*COMP ONS	*3μ	*COMP CODA
i. yokt.ram	*!						*	*
☞ ii. yok.tram						*		
iii. yok.tV.ram					*!			

b. **Perfect:** *pap.ti.ma*, 1 pl. perf. act. ind. 'fall'

/pa-pt-ma$_{PERF}$/	SON-SEQ$_{CODA}$	*3μ$_{PERF}$	*COMP ONS-PERF	*COMP CODA-PERF	DEP-IO	*COMP ONS	*3μ	*COMP CODA
i. papt.ma	*!	*		*			*	*
ii. pap.tma			*!			*		
☞ iii. pap.ti.ma					*			

8.5.3.3 Locality Reconsidered

While the analysis ostensibly proceeds smoothly enough, crucially, indexation of the perfect ending particularly with the markedness constraints *3μ (and *COMPLEX$_{CODA}$) creates a direct challenge to Pater's conception of locality. In this subsection we will explore this issue in some detail and sketch the makings of a solution.

To begin, we repeat in (47) Pater's definition of the markedness constraint schema *X$_L$, introduced in (35) above:

(47) *X$_L$

Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L

For all three of the indexed constraints we have proposed, we can replace "a morpheme specified as L" with "an ending of the perfect tense," as it is only this set of morphemes which we have identified for indexation (as opposed to the perfect stem). While the condition that the structure penalized by the constraint of shape $*X_L$ must contain a phonological exponent of the perfect ending is satisfied in the case of $*\text{COMPLEX}_{\text{ONSET-PERF}}$, since the second member of a disfavored complex onset will be the initial consonant of the ending, it is not in the case of $*3\mu_{\text{PERF}}$ (and $*\text{COMPLEX}_{\text{CODA-PERF}}$). To be clear, under Pater's definition, we would have to understand the indexed constraint $*3\mu_{\text{PERF}}$ as follows:

(48) $*3\mu_{\text{PERF}}$

Assign a violation mark to any instance of a trimoraic (superheavy) syllable that contains a phonological exponent of a perfect ending.

But as we have seen, in forms in which the perfect union vowel resolves superheavy syllables, however, while the C-initial ending creates a context for the disfavored (input) structure, it is itself not part of, but rather adjacent to, it:

(49) da $\underbrace{\textit{dāś}}_{3\mu}$ - ma_{PERF} → *dadāśima*

Indeed, based on the evidence, the perfect ending can never itself, or any part of it, be included in a structure that violates the constraint $*3\mu$, by virtue of its shape and position in the word.

8.5.3.3.1 Indexing an Alignment Constraint?

One way we might attempt to obviate the issue of markedness locality is to revise the analysis, building it instead around an Alignment constraint. Indeed the focus on the context in which the indexed perfect ending appears connects the perfect union vowel phenomenon with cases like that of syncope in the Arawakan language Yine (formerly referred to as Piro), for which Pater introduces an indexed left-right alignment constraint $\text{ALIGN-SUF}_L\text{-C}$ (Align(Suffix, L, C, R)): in

Yine the left edge of an indexed suffix should align with the right edge of a consonant (2009: 129).

Using such a constraint here, we might indicate what sequence or structure should preferably occur at the left edge of the ending. But a single Alignment constraint cannot be so formulated: there is a mismatch between the environment in which *i* does not occur (50), versus the environment that insertion of *i* actually creates (51).

(50) *No epenthesis*[20]

a. ...V̌C- (*jagan.ma*)

b. ...V̄- (*dadātha*)

(51) *Epenthesis*

a. ...V̄C*i*- (*dadāśimá*)

b. ...VCC*i*- (*vavandima*)

The two cases in (50) and (51) each call for a separate alignment constraint: the no epenthesis case in (50) calls for the constraint in (52), while the epenthesis case in (51) calls for the constraint in (53).

(52) ALIGN-SUF$_{\text{PERF}}$-σ̄ (Align(Suffix, L, σ̄, R))

The left edge of a suffix coincides with the right edge of a heavy syllable.

(53) ALIGN-SUF$_{\text{PERF}}$-σ̆ (Align(Suffix, L, σ̆, R))

The left edge of a suffix coincides with the right edge of a light syllable.

If we apply the constraint in (53) to /yu-yuj-ma/, we expect †*yu.yu.ji.ma*:

[20] For these purposes I consider forms such as *cakr̥.ma* 1 pl. perf. act. ind. 'make' exceptional, featuring vocalization of underlyingly consonantal *r*.

(54) *yu.yuj.ma*, 1 pl. perf. act. ind. 'yoke'

/yu-yuj-ma$_{PERF}$/	ALIGN-SUF$_{PERF}$-$\breve{\sigma}$	DEP-IO
☹ a. yu.yuj.ma	*!	
☞ b. yu.yu.ji.ma		*

If we apply (52) to /da-dāś-ma/ or /va-vand-ma/, we might expect †*da.dā.śī.ma* or †*va.van.dī.ma*, with insertion of a long vowel to create a bimoraic syllable:

(55) *va.van.di.ma*, 1 pl. perf. act. ind. 'praise'

/va-vand-ma$_{PERF}$/	ALIGN-SUF$_{PERF}$-$\bar{\sigma}$	DEP-IO
☹ a. va.van.di.ma	*!	*
☞ b. va.van.dī.ma		*

If we posit some restriction on the limits of allowable epenthesis (i.e., *i* is better than *ī*), then why epenthesize in the first place? How is a light syllable any more like the preferred heavy syllable, than the original superheavy syllable that is avoided? If it is a matter of dispreferred structure (light and heavy syllables are less marked than superheavy syllables), then why bother with the Alignment constraint in the first place – why not directly invoke the associated markedness constraint?

We can also consider how an anti-Alignment constraint (Buckley 1998, Downing 1998) might fare here. The constraint in (56) can capture the superheavy syllable environment disfavored from preceding the perfect ending:

(56) *ALIGN-SUF$_{PERF}$-3μ (*Align (Suffix, L, 3μ, R)

The left edge of a suffix does not coincide with the right edge of a superheavy syllable.

But left-right alignment, when one of the arguments is simply the (indexed) morpheme, cannot capture generalizations about that morpheme's internal structure. Returning to the case of Finnish, for example, replacing *[ai]$_L$ with *ALIGN-SUF(L)-[a] means that in principle the indexed morphemes could begin with any segment, when in fact they are always *i*. In the Vedic case the fact that a superheavy syllable surfaces because the perfect ending is consonant-initial goes unacknowledged. More generally, consider the relative elegance of introducing variant(s) of constraints already introduced by independent motivation (*3μ, etc.), as compared to introducing a new (anti-)Alignment constraint indexed to the perfect, plus its general variant.[21]

8.5.3.3.2 Reformulating the Locality Domain: Take 1

If we are to proceed with constraint indexation via an indexed markedness constraint, then, we are compelled to redefine the bounds of the 'local' domain.

A possible solution would be to expand the local domain to include not only the indexed morpheme, but also the segments or structures immediately adjacent to it, directly across the morpheme juncture.[22] Under this approach the constraint $*3\mu_{\text{PERF}}$ would thus be redefined as in (57).

(57) $*3\mu_{\text{PERF}}$

Assign a violation mark to any instance of a trimoraic (superheavy) syllable that contains a phonological exponent of a perfect ending, or the immediately-adjacent segment of the perfect stem.

In the case of Vedic perfect union vowel epenthesis, "phonological exponence" in superheavy syllables would always be satisfied by the stem, never the ending.

[21] Indeed even if we were to posit $*\text{ALIGN-SUF}_{\text{P}}\text{-}3\mu$, doing so would in fact be insufficient, because we would still have to account for the appearance of *i* in cases where we would otherwise have a complex onset (i.e. in forms with the sequence VO.ORV) – meaning the introduction of at least two *more* alignment constraints into the hierarchy (one perfect, one general), or a high-ranking indexed $*\text{COMPLEX}_{\text{ONSET}}$. The account argued for here would make use of the latter.

[22] Such a reconsideration of locality is implicit in Padgett (2009)'s tentative analysis of depalatalization in Russian.

However, this reformulation could prove *too* permissive for capturing morphologically-sensitive phenomena outside of Vedic. Assume the following hypothetical scenario: a markedness constraint targeting intervocalic coronal stops for deletion (58) indexed to a suffix of shape -TV (*T* = a coronal stop).[23]

(58) $*VTV_L$

Assign a violation mark to any instance of an intervocalic coronal stop that contains a phonological exponent of a morpheme specified as L

With the ranking in (59), while VTV sequences would be permitted generally, in the case of this morpheme T would be lost following a stem ending in a vowel (60)a., but not after one ending in a consonant (60)b.

(59) $*VTV_L$ » MAX-IO » *VTV

(60) a. $-V\#TV_L \rightarrow -V\#V_L$

b. $-C\#TV_L \rightarrow -C\#TV_L$

But what would happen in (61)?

(61) $...VTV\#TV_L \rightarrow$ ...VVV *or* ...VTVV?

While the proposed expanded locality domain would point to the deletion of the stem-internal coronal stop (assuming the appropriate phonotactics), since the stem-final vowel immediately adjacent to the indexed morpheme forms with said coronal stop (and the preceding vowel) an instance of VTV (result: …VVV), we could just as easily imagine that the segment would *not* incur a violation of the indexed markedness constraint, as per Pater's original formulation (result:

[23] This scenario is inspired by, but crucially distinct from, intervocalic velar loss in Turkish (Inkelas 2000), in which stem-final velars delete (*bebek* 'baby' ~ *bebe-i* 'baby' acc.), but affix-initial ones apparently do not (*yedi-gen* 'heptagon'). In this case a high-ranking variant of MAX-IO could protect segments of the former type from being lost.

…VTVV). Accordingly we are hesitant to propose this first pass at a redefinition of locality, since in accommodating the Vedic data it may make undesirable predictions elsewhere.

8.5.3.3.3 Reformulating the Locality Domain: Take 2

The Vedic data, in which indexed C-initial perfect endings create the environment for, but are not actually part of, disfavored superheavy syllables, suggest the need to distinguish between two different factors in morphologically-conditioned phonological processes: phonological environment and phonological exponence. Within a constraint indexation framework, we must determine the status of the two morphemes involved – one indexed, one adjacent – with respect to each criterion:

(62) a. Phonological Exponence: Is there some portion of the (indexed, adjacent) morpheme contained within the disfavored structure?

b. Phonological Environment: Does the shape of the (indexed, adjacent) morpheme create an environment in which the disfavored structure can surface?

Phonological exponence entails phonological environment – if a morpheme contributes phonological material to a disfavored structure, it is by definition providing context for that structure to surface – though the converse does not hold.

Where Pater's formulation predicted two scenarios, based on these criteria, we predict three scenarios concerning the makeup of the disfavored structure, presented in Table 8.2 – the structure could involve either both morphemes (a.); the indexed morpheme only (c.); or the non-indexed morpheme only (b.).

Table 8.2 Three scenarios for the structure penalized by $*X_L$

Scenario	Morpheme		Phonological Exponence	Phonological Environment
a. **Heteromorphemic** (both morphemes)	*adjacent*	$\boxed{[\quad]}\#[\quad]_L$	**yes**	**yes**
	indexed	$[\quad]\#\boxed{[\quad]_L}$	**yes**	**yes**
b. **Monomorphemic** (adjacent morpheme)	*adjacent*	$\boxed{[\quad]}\#[\quad]_L$	**yes**	**yes**
	indexed	$[\quad]\#\boxed{[\quad]_L}$	no	yes
c. **Monomorphemic** (indexed morpheme)	*adjacent*	$\boxed{[\quad]}\#[\quad]_L$	no	yes
	indexed	$[\quad]\#\boxed{[\quad]_L}$	**yes**	**yes**

The new scenario in b., monomorphemic (adjacent morpheme) exponence, is exemplified by the case in Vedic: the disfavored structure resulting from the juxtaposition of two morphemes is contained entirely within the bounds of the one that is *not* indexed, while being immediately adjacent to the one that is. Crucially, however, by beginning with a consonant the indexed morpheme provides necessary context for the disfavored structure.

In light of this typology, how can we redefine the locality domain associated with Pater's indexed markedness constraint schema? In all three scenarios, the indexed morpheme consistently provides phonological environment. We propose to replace the requirement of phonological exponence with one of phonological environment; as such we redefine Pater's indexed markedness constraint schema as follows:

(63) $*X_L$

Assign a violation mark to any instance of X for which a morpheme specified as L provides phonological context.

Specifically for Vedic, the constraint $*3\mu_{PERF}$ is thus redefined as in (64):

(64) $*3\mu_{PERF}$

Assign a violation mark to any instance of a trimoraic (superheavy) syllable for which a perfect ending provides phonological context.

In order to satisfy the locality condition, the indexed morpheme must minimally contribute to the environment conditioning the surfacing of the disfavored structure. This may involve providing actual phonological material for that structure, but not necessarily so.

Returning to the monomorphemic (indexed morpheme) type, our prediction is that morpheme-internal structures would be targets of derived environment effects only when the adjacent morpheme provides phonological context. Otherwise we face the issue of absolute neutralization – if a change is entirely internal, why not incorporate it into the underlying form in the first place? More generally, how this reformulation fares cross-linguistically requires further consideration.

As we have seen, the nature of the Vedic perfect data suggest the need to loosen the conception of the local domain such that the indexed morpheme is minimally required to contribute to phonological environment, rather than full exponence. Many questions remain to guide further research, including the following. First, do the predictions of our proposed typology hold up –are there cases where the condition of phonological environment would be satisfied, but an expected change does *not* occur? Second, other than through syllable structure, what are the ways, if any, in which a morpheme can provide a phonological environment for a disfavored structure *without* being part of that structure? Finally, can we distinguish between phonological and *morphological* environment? Recall in this context syncope in Yine, in which (as per Pater's analysis) the nature of the indexed morpheme does not at all condition the satisfaction of the associated constraint, ALIGN-SUF$_{L}$-C.

8.5.3.4 Remaining Analysis

Using constraint indexation, we will now examine the syllabification of the remaining types of sequences triggering insertion of the perfect union vowel *i* – -VOOOV-, -VORRV-, -VOROV-, and -VRRRV-. We will also see how the analysis correctly predicts the absence of epenthesis in forms in which it does not occur.

As we have already noted in the discussion in Chapter 7, given restrictions on permitted syllable structure, all four of the sequences -VOOOV-, -VORRV-, -VOROV-, and -VRRRV- are simply unsyllabifiable; epenthesis of *i* resolves this issue. The tableaux in (65)-(68) demonstrate how forms exemplifying these sequences fare in the proposed analysis.

(65) **-VOOOV- > -VOOVOV-:** *vavákṣitha*, 2 sg. perf. act. ind. 'increase'

/va-vakṣ-tha$_{\text{PERF}}$/	*COMP$_{\text{ONS-PERF}}$	*3μ$_{\text{PERF}}$	*COMP$_{\text{CODA-PERF}}$	DEP-IO	CONTIG
a. vavakṣ.tha		*!	*		
b. vavak.ṣtha	*!				
☞ c. vavak.ṣi.tha				*	
d. vava.kiṣ.tha				*	*!

(66) **-VORRV- > -VORVRV-:** *jagmire*, 3 pl. perf. mid. ind. 'go'

/ja-gm-re$_{\text{PERF}}$/	*COMP$_{\text{ONS-PERF}}$	*3μ$_{\text{PERF}}$	*COMP$_{\text{CODA-PERF}}$	DEP-IO	CONTIG
a. jagm.re		*!	*		
b. jag.mre	*!				
☞ c. jag.mi.re				*	
d. ja.gim.re				*	*!

(67) **-VOROV- > -VORVOV-:** *jajñiṣé*, 2 sg. perf. mid. ind. 'beget'

/ja-jñ-ṣe$_{\text{PERF}}$/	*COMP$_{\text{ONS-PERF}}$	*3μ$_{\text{PERF}}$	*COMP$_{\text{CODA-PERF}}$	DEP-IO	CONTIG
a. jajñ.ṣe		*!	*		
b. jaj.ñṣe	*!				
☞ c. jaj.ñi.ṣe				*	
d. ja.jiñ.ṣe				*	*!

(68) **-VOROV- > -VORVOV-:** *dadhanviré*, 3 pl. perf. mid. ind. 'run'

/da-dhanv-re$_{\text{PERF}}$/	*COMP$_{\text{ONS-PERF}}$	*3μ$_{\text{PERF}}$	*COMP$_{\text{CODA-PERF}}$	DEP-IO	CONTIG
a. dadhanv.re		*!	*		
b. dadhan.vre	*!				
☞ c. dadhan.vi.re				*	
d. dadha.niv.re				*	*!

As can be seen, all four of these cases are satisfactorily accounted for under the constraint indexation analysis of the perfect union vowel we have developed. Epenthesis is once again permitted as a means of avoiding either a complex onset or a superheavy syllable, and preferably occurs at a position which does not interfere with the contiguity of the perfect stem; thus the candidates in c. are judged most optimal. Explicit reference to sonority sequencing could thus be considered unnecessary here, in that the correct output candidates are nonetheless still selected in the absence of SONORITY-SEQUENCING$_{\text{CODA}}$;[24] but of course the high-ranking (if not undominated) position of this constraint is justified in view of general Vedic *yóktram*, which we have argued is syllabified *yók.tram* over †*yókt.ram*.

Given the position of SONORITY-SEQUENCING$_{\text{CODA}}$ in the ranking, it is worth noting that for these four cases, we could just as easily consider *i*-epenthesis an aspect of general Vedic syllabification, rather than a part of the idiosyncratic perfect phenomenon. The forms in (65)-(68) differ from *dadāśima*, *paptima*, or *vavandima*, where inserted *i* breaks up a superheavy syllable or complex onset, in that they lack analogous forms outside of the perfect, in which epenthesis does *not* occur (cf. *śā̄smahe*, *yóktram*, and *vártma*, respectively). We have no indication, then, that the sequences -VOOOV-, -VORRV-, -VOROV- or -VRRRV- were generally possible in Vedic (as already noted above in 8.3). This is a point arguably in favor of

[24] This is all under the assumption that regardless of sonority profile, a syllable ending in two consonants has a complex coda, and one beginning with two consonants has a complex onset.

classifying their insertion of *i* as a more general phenomenon: epenthesis is predicted to occur in any and all cases where syllabification of the input sequence would violate sonority sequencing. Regardless, the analysis as we have developed it is compatible with either descriptive view of the phenomenon, as it concerns these environments.

We can also see how forms in which epenthesis does not occur are correctly handled by the analysis. These are the cases in which the sequence in question is only one or two consonants long, because the stem ends in a single consonant and / or the perfect ending is vowel-initial. As an example, consider the tableau in (69).

(69) **-VCCV-:** *yuyujma*, 1 pl. perf. act. ind. 'yoke'

/yu-yuj-ma$_{\text{PERF}}$/	*COMP$_{\text{ONS-PERF}}$	*3μ$_{\text{PERF}}$	*COMP$_{\text{CODA-PERF}}$	DEP-IO
☞ a. yuyuj.ma				
b. yuyu.jma	*!			
c. yuyujm.a		*!	*	
d. yuyu.ji.ma				*!

Because the candidate in (69)a. does not contain a complex onset, superheavy syllable, complex coda, or an epenthetic segment, against its featured competitors it is selected as most optimal.

8.6 Summary: Final Constraint Rankings

Factoring in the constraint indexation-based analysis of the perfect union vowel phenomenon, we have seen fit to develop an Optimality-Theoretic account of syllabification in Vedic Sanskrit built on the ranking in (70).

(70) SONORITY-SEQUENCING$_{\text{CODA}}$, MAX-IO, *COMPLEX$_{\text{ONSET-PERF}}$, *3μ$_{\text{PERF}}$, *COMPLEX$_{\text{ONSET-PERF}}$ »

DEP-IO, CONTIGUITY$_{\text{STEM}}$ »

*COMPLEX$_{\text{ONSET}}$ »

*3μ, *COMPLEX$_{\text{CODA}}$, ONSET, NOCODA, SYLLABLE-CONTACT

CHAPTER 9

ON MEDIAL CONSONANT TREATMENT IN PROTO-INDO-EUROPEAN

9.0 Introduction

In this chapter we dwell on the topic of medial consonants in Proto-Indo-European itself. Projecting our conclusions about syllabification in Vedic Sanskrit reached in the previous two chapters onto the proto-language (conclusions which are by no means unrecognized in the literature), we have a system in which medial consonants are generally heterosyllabified into sequences of coda + onset.

In the interests of refining this view of the Proto-Indo-European situation, as it concerns the treatment of triconsonantal sequences, we first consider in 9.1 evidence from the history of Greek, which bears on the treatment of the sequence VRORV. We then turn in 9.2 to assess how the traditional syllabifications of sequences VROOV and VOORV are handled in Optimality Theory. We conclude in 9.3.

9.1 VR.ORV: Evidence from the Development of **ti̯* in Greek

In this section we consider data from the history of Greek, which have been analyzed in an account requiring the syllabification VR.ORV. As we saw in the previous two chapters, there is no strong indication one way or the other about the status of such a syllabification in Vedic Sanskrit. In the general syllabification system of this language, we proposed the treatment VRO.RV, as it was simply the natural extension of the ranking we posited, $^*\textsc{Complex}_{\textsc{Onset}}$ » NoCoda. In the analysis of the perfect union vowel, on the other hand, in which epenthesis resolves both superheavy syllables / complex codas and complex onsets, either syllabification

VR.ORV or VRO.RV would be targeted for resolution. Thus the Greek data provide a welcome alternative source of evidence for the treatment of consonant clusters in Proto-Indo-European.

Before we move on to a more formal introduction to the phenomenon, we first provide a brief overview of consonant cluster syllabification in Ancient Greek, so as to better situate the discussion. As was the case with Vedic Sanskrit, there are two positions on the treatment of medial consonants in Ancient Greek. The traditional view (Hermann 1923, Meillet 1937, et al.) posits heterosyllabification of word-medial consonants into coda + onset sequences, regardless of the relative sonority of the consonants involved; it is based largely on the evidence of metrical practice, but also on other phenomena including the Rhythm Rule of adjectival comparison formation, Vendryes' Law, and Wheeler's Law (see e.g. the summary of evidence in Devine and Stephens 1994). On the other hand, Steriade (1982) develops the onset maximization view of Greek syllable structure, with particular focus on Attic, but also in consideration of evidence from Mycenaean, in which consonants of rising sonority are treated tautosyllabically as a complex onset, while only consonants of falling sonority are split up across syllables. The traditional evidence is deemed unreliable under this view, which is supported instead by evidence such as Linear B writing practice, perfect reduplication, and patterns of consonantal assimilation. Furthermore, Guion (1996) reconfirms Steriade's findings with evidence from the Cypriot syllabary, and this position is maintained as recently as Consani (2003).

While our immediate interests lie in reconstructing the Proto-Indo-European treatment of VRORV only by way of Ancient Greek data, nonetheless we choose to assert here our confidence in the traditional account of syllabification in this language, over the alternative. As was the case with Vedic, we expect that the evidence for tautosyllabicity in Ancient Greek can find alternative explanation: relevant for the facts of perfect reduplication, for example, may be the initial position of the root, and the facts of consonantal neutralization may be accounted for in segmental terms (see the relevant discussions in Chapter 7). As for the Linear B writing practice, despite the arguments that it reflects authentic Greek syllable structure (see also Beekes 1971), or even orthographic or 'analogical' syllabification, in reference to word-edge phonotactics (Ruijgh 1985, Morpurgo Davies 1987), in general we question the reliability of such a secondary type of evidence for accessing Ancient Greek phonology.[1]

9.1.1 Introduction; Data

The characterization, beginning with Allen (1958), of the development of Proto-Greek **ti̯* in terms of syllable structure would at first blush provide further confirmation that both Greek and the protolanguage heterosyllabified medial biconsonantal sequences. But is this necessarily so? Over the next few subsections we explore the question in some detail. We begin with the data, introduced in the remainder of this subsection. We move on in 9.1.2 to present the multiple views of **ti̯* development put forth in the literature, some invoking, others disregarding the role of syllable structure as a basis of analysis. We next address in 9.1.3 the matter of whether, assuming a syllable-based account, this approach is necessarily contingent on the specific syllabifications Allen identifies, or rather can be developed so as to accommodate alternative syllabifications, while still yielding the attested outcomes. In this way we evaluate the probative value of **ti̯* development for the determination of Greek, and by extension, Proto-Indo-Euorpean, syllable structure.

The development of Proto-Greek **ti̯* is but one component in a constellation of changes affecting sequences of consonant + glide in the language. As our chief concern here is the

[1] For a more detailed view of the various proposals for how the system works, and the associated issues, see Cooper (2010).

phonological environment conditioning this development, we abstract away from many of the complexities involved, to the extent possible.[2]

Sequences of *t + *i̯ arise in Proto-Greek in a number of contexts, though arguably the two most fruitful sources are morphologically complex forms featuring stem-final *t (or *t^{h} [3]) and either the present stem suffix *-*i̯e/o*- or the feminine suffix *-*i̯a*- (< PIE *-*ih_2*-). The outcome of Proto-Greek *ti̯ varies across and within dialects. Strictly at the segmental level, the distribution of reflexes is as presented below in (1)-(2); as morphological structure has been identified in all analyses as a relevant factor in the development of *ti̯, it is included here as a parameter.

(1) *Word-Initial*[4]

a. Tautomorphemic: *s* in all dialects

**ti̯eg*^{w}*etoi* > *sébetai* 'feels shame before'

b. Heteromorphemic: *no examples*

(2) *Word-Medial*

a. Postconsonantal

i. Tautomorphemic: *s* in all dialects (?)

**dik*^{h}*t*^{h}*i̯os* > Ionic *diksós* 'twice'[5]

ii. Heteromorphemic: *s* in all dialects (with subsequent developments)

**pant-i̯a* > *pansa* etc. 'all'

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[2] See most recently Hajnal (2009) for a detailed discussion of the various, sometimes overlapping, developments of Proto-Greek *Ci̯.

[3] Throughout this section unless otherwise specified *ti̯ is used as a cover term for both *ti̯ and *t^{h}i̯.

[4] Stem-initial in a form like Boeotian *á-sāma* 'without mark' ~ *sē̑ma* < *t^{h}*i̯āmn̥* 'sign'.

[5] Perhaps a more appropriate descriptor than *tautomorphemic*, especially in this case, is *simple* (as opposed to *complex*) morphological structure. Following Peters (1980: 287 n. 241), the morpheme boundary in *diksós*, *triksós* 'thrice', etc. is not 'present' in Proto-Greek, as the original suffix *-*i̯o*- was no longer productive. While the form *diksós* has been frequently noted in discussions of the development of *ti̯, it is usually as a counterexample to the troublesome form (*u̯*)*ánassa* 'queen, lady' (see below); nowhere to my knowledge has it been formally incorporated into an account of the phenomenon.

b. Postvocalic

i. Tautomorphemic: *tt* in Boeotian, Central Cretan; *ss* in Doric, Lesbian, Thessalian; *s* in Attic-Ionic, Arcado-Cypriot.

**met^h^i̯os* > *méttos*, *méssos*, *mésos* 'middle'

ii. Heteromorphemic: *tt* in Boeotian, Central Cretan, Attic, West Ionic; *ss* elsewhere.

**melit-i̯a* > *mélitta*, *mélissa* 'bee'

A more exhaustive data set is impossible to achieve on a number of fronts. This difficulty is primarily due to the nature of (Proto-)Greek morphophonology: the absence of **ti̯* word-finally, as well as word-initially in a heteromorphemic context, results from restrictions on morphophonological structure which preclude word-final glides and monoconsonantal stems or prefixes (as a word-initial heteromorphemic **t* would almost certainly have to be).[6] Perhaps most vexing, though, is the paucity of forms attested with shape (2)a.ii.: the majority of the oft-cited forms have nasal *n* as the preceding consonant, to the extent that Peters (1980: 287 n. 241) treats the associated development as contingent on its particular presence. The analysis of *érrǭ* 'go away' < **u̯ert-i̯ō* posited by Forssman (1980) would offer another case with a preceding sonorant, albeit one with an idiosyncratic assimilation to geminate *rr*.[7] If we take poetic *peîsa* 'obedience' < **peit^h^-i̯a*, then this form would provide additional support for a non-*n* specific change (and also suggest that postvocalic *i* / jod was considered consonantal[8]).[9] As for a

[6] But cf. the preposition *protí* 'alongside, toward' > **proti̯* [before a vowel-initial word] > *prós*.
[7] But Alan Nussbaum (p. c.) informs me of another possible etymology, linking *érrǭ* to the PIE root 1.**u̯ers-* 'wipe, sweep' (*LIV* 690-691; *IEW* 1169-1170), ultimate source of English *worse* < Germanic **wersizan* – and arguably a better match considering the negative connotation of this verb, which usually has the sense of 'get out of here' or 'proceed with difficulty'.
[8] On its own this form does not preclude an analysis of jod as the second part of a 'true' diphthong; but since the behavior of **ti̯* following a long vowel does not seem to match its development following a consonant, including the glide (see below), this suggests that jod is better treated as a sonorant consonant basically on par with the *n* of **pant-i̯a* et al.

preceding obstruent, the form (*u̯*)*ánassa* 'lady, queen', if indeed from **u̯anakt-i̯a*, would provide an example (the only one), though the shape of the protoform is hardly agreed upon.[10] In any case, even if it were of the relevant shape, its development disagrees with that of **pant-i̯a* – the analogous outcome would be †*anaksa* (< **u̯anaksa* < **u̯anakti̯a*) – so that one or the other would have to be explained as a special case not subject to the general rule; for those who do promote **u̯anakt-i̯a*, its development is the idiosyncratic one: so Lejeune (1972: 69, 103) posits an intermediate stage *u̯anatt-i̯a*, with assimilation of the velar.[11] Finally, with respect to shape (2)a.i., *diksos* provides the only example[12]; as this form has not been formally incorporated into analyses of **ti̯*, it will not feature in the discussion immediately following, where such accounts will be reviewed.

9.1.2 Analyses: Syllable vs. Morphological Structure

Given the data as encapsulated in (1)-(2), basically two types of analyses have been posited for the development of Proto-Greek **ti̯*, the distinction between which resides in the priority placed on syllable structure vis-à-vis morphological structure; these two approaches are schematized in (3), where . = a syllable boundary, + = a morpheme boundary.

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[9] The form *aîsa* 'lot, destiny', if from **aiti̯a*, would provide another post-glide example, pace Szemerényi (1987).

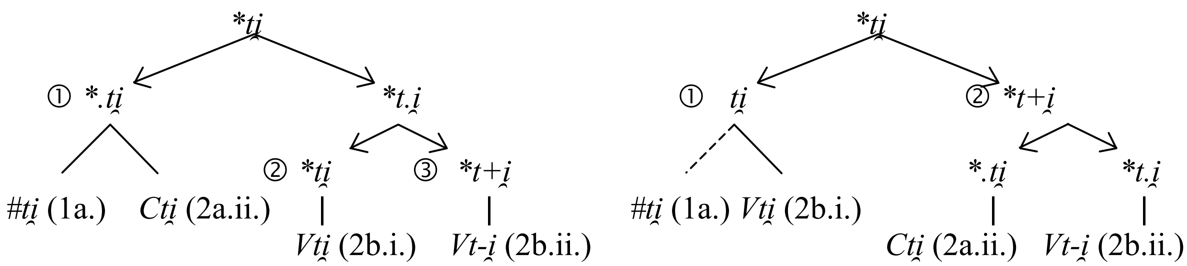
[10] Cf. Hart 1965, Wathelet 1970, Lejeune 1972, Heubeck 1979, Peters 1980, Forssman 1980, Crespo 1985, Brixhe 1996, Hajnal 2009, et al. The crux of the issue lies in one's conception of Mycenaean orthographic practice, specifically the interpretation of signs in the *s*- and *z*-series, as related to the representation of the outcomes of original **ki̯* and **ti̯*. If one believes, for instance, that there was a strict differentiation between the two (**ti̯* represented by *s*-signs, **ki̯* represented by *z*-signs), then attested *wa-na-sa-*, if to be connected to (*u̯*)*ánassa*, could not go back to **u̯anak-i̯a*. However, as noted in the text this position is not *communis opinio*.

[11] In principle, however, given the nature of the evidence one could presumably argue that the **wanakt-i̯a*-type development is the norm and **pant-i̯a*-type one is special, or that there is one development after obstruents, another after sonorants (but cf. *érrǭ*), or that there is just too little evidence to make any post-consonantal generalizations at all.

[12] There is also the form *éksǭ* 'outside', if from **ek-ti̯o* (but see Dunkel 1982), but as its outcome was very likely influenced by *eks*, its inclusion here for consideration would be less than confident.

(3) *Two Approaches to* *ti̯ *Development*

a. Syllable-first b. Morphology-first



Under the first view (3)a., the environments in (1)-(2) above are differentiated chiefly by syllable structure (tautosyllabic **.ti̯* versus heterosyllabic **t.i̯*), and secondarily, specifically in the case of (2)b., by the presence or absence of an intervening morpheme boundary (**t.i̯* versus **t+i̯*). Instances of **ti̯* occurring word-initially (1) and medially postconsonantally (2)a. are analyzed as complex onsets, while medial postvocalic instances of **ti̯* (2)b. are analyzed as a coda + onset. There are thus conceivably three distinct palatalizations in the development of Proto-Greek **ti̯*: first, a change affecting tautosyllabic **ti̯* resulting in *s* in all dialects (①); second, a change affecting heterosyllabic, tautomorphemic **ti̯* resulting in *tt* or *ss* (> *s*) (②); and third, a change affecting heterosyllabic, heteromorphemic **ti̯* resulting in *tt* (also in Attic) or *ss* (③).[13] Such is the series of developments proposed by Allen (1958: 124 n. 56); see also Forssman (1980: 194 n. 81), and, with grouping together of word-initial and word-medial postconsonantal positions, but no explicit reference to syllable structure, Sheets (1975 [1976]: 158, 166), Rix (1992: 90) (though Forssman, *loc. cit.*, characterizes these as syllable-based as well).[14]

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[13] This according to my understanding of Allen (1958)'s conception; in the note cited he describes these three palatalizations as "successive."

[14] Also worth mentioning in this context is Lejeune (1972): though he does differentiate outcomes based on syllable structure (109f.), he also states that the expected Attic outcome of **u̯anakt-i̯a* should be analogous to that of **melit-i̯a* (i.e., †*anatta*; 103 n. 2), which suggests a prioritization of the common morphological structure shared between the two. According to Allen's conception, however, †*anatta* should not be the expected reflex: **u̯anakt-i̯a* would presumably, like **pant-i̯a*, develop a singleton *s*, since *ti̯* is tautosyllabic (if *ti̯* is tautosyllabic following a nasal, then surely by sonority sequencing it ought to be so following *k*). On the other hand, perhaps for Lejeune **u̯anakt-i̯a*

Under the second view of *t̯i̯ development (3)b., however, morphological structure is the primary criterion for differentiation of development, so that the environments in (1)-(2) are classified chiefly by whether or not *ti̯ is heteromorphemic; syllable structure is secondary, if incorporated at all. So Risch (1979), Hajnal (2009: 237ff.) for instance see two waves of palatalization. The first affects tautomorphemic *ti̯ *only* in those dialects in which the outcome is singleton *s*, i.e., the southern dialects (the so-called "südgriechische Assibilation"; ①). The second palatalization is pan-dialectal, targeting all remaining sequences of *ti̯, including those unaffected by the earlier palatalization, i.e., heteromorphemic *ti̯ (the so-called "allgemeingriechische Palatalisation"; ②).

In Hajnal's account syllable structure plays a role only to differentiate the singleton versus geminate outcomes of *ti̯ (239 n. 427): following Brixhe (1996), gemination of *t* occurs when the sequence *ti̯ is split across syllables, to resolve a violation of the syllable contact law (Murray and Vennemann 1983); when *ti̯ occurs in a single syllable – as in word-initial and postconsonantal positions – no such violation exists, and a singleton outcome is observed. Note that while these two word positions are grouped together in terms of syllable structure, an account such as Hajnal's clearly departs from that of Allen (1958), since the shared syllable structure is not meant to translate into a shared, early process of palatalization. Indeed, it remains unclear at which stage word-initial *ti̯ is meant to have undergone its change for Hajnal; presumably, since its development was common across Greek, the change was part of the later palatalization, though it was necessarily tautomorphemic. A late development is the case at least for postconsonantal heteromorphemic *ti̯, as Hajnal posits an expected outcome †*-nt-* for **-nti̯-* in Attic and Boeotian feminine participles (249), in line with the outcome seen in e.g. **melit-i̯a*,

patterns with **melit-i̯a* to the exclusion of **pant-i̯a* because it is the preceding nasal which conditions the outcome in this last form; but this is only speculation on my part.

albeit singleton (because of syllable position). That †-*nt*- does not actually surface Hajnal explains as an avoidance of possible homonymy with the masculine/neuter.

However, not all who prioritize morphological structure necessarily see a role for syllable structure in the development of **ti̯*. Peters (1980: 287 n. 241) expects all -*i̯a*- formations to behave the same, postvocalic (**melit-i̯a*) or not (**pant-i̯a*); thus along similar lines as Hajnal, he predicts *-*nt-i̯a* should have resulted in Attic, Boeotian, and Cretan *-*Vntta*, Ion. etc. *-*Vnssa*, though with gemination. The singleton (sibilant) outcome he does not attribute to syllable structure, but rather, as noted above, to the singular qualities of the nasal. In fact he considers hardly probable ("wenig probabel") Allen's early Common Greek palatalization affecting tautosyllabic **ti̯*, precisely because the account does not acknowledge the morphological structure of the **-nt-i̯a* forms. In this vein Peters also rejects the hypothesis of Ruijgh (1967: 51 n. 28) that the morphological structure is somehow erased in the feminine participial forms. Brixhe (1996) also prioritizes morphological structure, only relying on syllable structure, as noted above, to account for the geminate outcome of intervocalic **ti̯*; he does not go so far as Allen in treating alike word-initial and medial postconsonantal **ti̯* – indeed he seems to voice skepticism on this approach (49 n. 38) – but prefers instead to account for the changes in these two environments independently. Like Peters does with Ruijgh, Brixhe rejects Risch (1979: 272, 274)'s similar proposal about reanalyzed morphological structure in the feminine participles.

Having reviewed the two types of approach to the development of **ti̯*, one 'syllable-first', the other 'morphology-first', how are we to evaluate them? We note first, that, to be sure, the case for Allen's syllable-based account is not as rock-solid as it could be. An even stronger indication of the role of syllable structure in the development of **ti̯* would be the patterning together of **ti̯* outcomes postconsonantally and after a long vowel, to the exclusion of the treatment after a short vowel. If this distribution held, syllable weight would clearly have to be a crucial factor at play – a geminate outcome would be disfavored in cases where it would create a superheavy syllable V̄C. or VCC. – and the role of syllable structure in general would be solidly confirmed. Yet this scenario would not seem to match the data. Identifying a relevant example, an instance of *t*i̯* following a Proto-Greek long vowel, is difficult.[15] Perhaps the securest form we can point to in this regard actually involves the velar aspirate k^h: for example, PGk. **glōk*^{h}*-i̯a* 'tongue' > Att. *glō̢tta* (cf. *glō̢̂ssa*, Ion. *glā́ssa*). Though this form lacks the dental, nevertheless its relevance holds if we assume that the outcome of *$k^{(h)}$*i̯* sequences was similarly conditioned across the same distribution of environments as were pertinent to the development of *t*i̯*. Operating with such an assumption, we cannot go so far as to invoke syllable weight in the account of *t*i̯* palatalization, as tempting as it might be. Indeed its elimination as a possible factor could then lead one to question any role for syllable structure in accounting for the phenomenon at all; as we will see, this position would seem to be too extreme.

Turning to the 'morphology-first' approach, we can comment on one alleged defect its proponents associate with the invocation of syllable structure as a distinguishing criterion, namely, the differing treatment of forms sharing morphological structure, such as, specifically, the feminine suffix *-i̯a*. If a morpheme boundary retards the development of *t*i̯* in **melit-i̯a*, then why not also in **pant-i̯a*? Again, Peters holds that Allen's account is "wenig probabel" basically because of this point. Operating so strictly within a 'morphology-first' framework presupposes that a single morpheme will behave identically in all contexts in which it occurs. But we can just as easily imagine a scenario in which the 'usual' or 'expected' behavior is thwarted by some condition or other, such as the phonological environment in which the morpheme finds itself. The forms **pant-i̯a* and **melit-i̯a* are quite similar, to be sure, but they differ crucially and

[15] The noun *nē̢̂ssa*, *nē̢̂tta* 'duck' requires further consideration.

obviously with respect to the environment to which the morpheme *-i̯a* attaches: stem-final …CC- in the former, …VC- in the latter. Of course this distinction is at the very heart of Allen's account of the development of **ti̯*, but proponents of the 'morphology-first' approach do not assign to it the same degree of importance. We can reconcile the disagreement here if we consider the importance of the morpheme boundary not to be *absolute*, but rather as one consideration in a hierarchy of considerations, whose influence, as such, is open to diminution. [16] In other words, the morpheme boundary is of importance, *but of comparatively less importance than some other morphophonological consideration*. This additional consideration would have to have been strong enough to derail the expected development of **pant-i̯a* vis-à-vis **melit-i̯a*, such that its similar morphological structure would not have mattered.[17]

We also note that while **pant-i̯a* and **melit-i̯a* are similar morphologically, not only do they differ with respect to phonological shape, their outcomes are distinct as well! Indeed if one wishes to espouse a 'morphology-first' account of **ti̯* development, one is then necessarily compelled to account for why a form like **pant-i̯a* does not retain the dental stop in Attic and Boeotian. Explanations for this wrinkle have so far proven less than satisfactory. As we noted above, for Peters (1980) the development to the sibilant is conditioned by the preceding nasal. He does not provide any phonetic grounding for this claim; nor does he take into account a form such as πεῖσα, which if from **pei̯t*^{h}*-i̯a* would suggest that his conditioning environment is too restrictive, and should be expanded to include at least jod, and more likely, sonorants in general

[16] Such a hierarchy is of course not unlike a ranking of constraints in Optimality Theory.

[17] One plausible candidate for such a consideration could be a dispreference for complex codas. This dispreference would favor a syllabification **pan.ti̯a* (just as Allen holds), which could have mitigated the influence of the morpheme boundary, as the syllable boundary does not coincide with it. See below for more on this restriction.

For a synchronic parallel we might consider consonant cluster simplification in Lenakel, as analyzed by Kager (1999), in which a preference for a morpheme boundary to be left-aligned with a syllable boundary is outranked by a higher-level preference for a word not to end in an epenthetic vowel: for the underlying form /kam-n-m̄an-n/ 'for her brother', a potential output †*kam.nɨ.m̄an.nɨ* is worse than the actual form *kam.nɨ.m̄a.nɨn* for this reason.

(if not all consonants).[18] Furthermore, Hajnal (2009)'s claim that the expected Attic-Boeotian development to †*-nt-* in feminine participles was prohibited due to potential homonymy with the masculine / neuter, is speculative at best. Such homonymy would presumably have been applicable only as concerns the shape of the participial stem itself; fully inflected, there would be no ambiguity between forms.

To sound an additional potential source of concern with the 'morphology-first' approach, we might also comment on the implications of a contemporaneous development of **pant-i̯a* and **melit-i̯a* type forms in the context of the relative chronology of other sound changes in the history of Ancient Greek. We know that **pant-i̯a* must have developed early enough so as to feed the Second Compensatory Lengthening, in which a sequence -V*ns*-, involving, crucially, an *s* of secondary origin, developed to -V̄*s*- and beyond in Attic-Ionic and most Doric; thus **pant-i̯a* > *pansa*, Thessalian *pánsa*, Lesbian *paîsa*, Attic *pā̂sa*. We also know that the development of a form such as **met*^{h}*i̯os* 'middle', in which no morpheme boundary intervenes between **t* and **i̯*, should have been early enough such that the resulting geminate *-ss-* could simplify in Attic-Ionic and Arcado-(Cypriot) to *mésos* (cf. Dor., Lesb. Thess. *méssos*), as original *-ss-* did. Now, if one considers these two instances of secondary singleton *s* as belonging to a similar period of change, then this would have to mean that the change in **pant-i̯a* predates the change in **melit-i̯a* (Ion. *mélissa*, delayed late enough to avoid simplification to †*melisa*), just as the change to **met*^{h}*i̯os* (at least in the southern dialects) does under anyone's view.[19] If one adheres to this position, it consequently becomes a more complicated matter to motivate a strict 'morphology-first' account.

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[18] With room for idiosyncratic development, in light of *érrǭ* as derived by Forssman (1980) (see above).

[19] Note this would not necessarily place this change earlier than the change in **met*^{h}*i̯os*, though; this separate but related claim is supported by the fact that a form with singleton *s* (or some continuation thereof) is found pan-dialectally.

The discussion in the preceding paragraphs suggests that outright rejection of a syllable-based account of **ti̯* development such as Allen's is easier said than done. Even if only the chronology of his account is questioned, this does not mean that syllable structure need have necessarily played no role in the phenomenon, as an account such as that of Hajnal (2009) demonstrates.

Still, from a more theoretically-minded perspective, we might debate even this aspect of the approach as well. Indeed recent literature has questioned the role of the syllable in accounting for phonotactic phenomena, opting instead for analyses couched in segmental terms (Steriade 1999a, Blevins 2003); any given syllable-based account should always be amenable to such an alternative, as comparatively less elegant as it might potentially be. A principal aim of such work has been to reconcile conflicting syllabifications which may be required for different phenomena within a single language: such cases can be resolved, it is claimed, by finding alternative explanation for phonotactics. In Klamath, for example, while obstruent laryngeal neutralization would require syllabifying V.TRV (where *T* is an obstruent and *R* a sonorant), stress, vowel reduction, and syncope all point to VT.RV; as a solution, Blevins (1993) analyzes neutralization, presumably a phonotactic phenomenon, elsewise (cf. the discussion in Chapter 7).

However, the situation in Greek is noticeably different than that in Klamath, for word-internal syllabification as independently verified *does* match-up with the structure required by **ti̯* palatalization, arguably another example of a phonotactic phenomenon. In this case, where phonotactics and syllable structure converge, Steriade and Blevins argue that syllable structure is not explanatory, but rather secondarily determined through appeal to word-edge behavior (word-edge phonotactics). Thus, for example, for the sequence VTRV, a heterosyllabic parse VT.RV is favored in a language like Arabic, which does not allow the sequence TR word-initially, but a tautosyllabic parse V.TRV is favored in a language like Spanish, which does.

Such an explanation cannot work in Greek, however: if phonotactics were the only driving force available as a means of explaining these distributions, we would expect **ti̯* to behave in the same way in all environments, on the pattern of word-initial cases like **ti̯eg^{w}etoi* > *sébetai*. But the distinct singleton versus geminate word-medial treatments in **pant-i̯a* and **melit-i̯a* respectively preclude such an explanation. Rather, **ti̯* develops a geminate outcome only when it can be accommodated across two syllables, as the independently-motivated syllable structure allows. A segmental characterization (singleton postconsonantally, geminate postvocalically) may satisfy descriptive adequacy, yet fails to make this obvious connection.

Given these findings, we posit that syllable structure should be allowed as an explanatory force for at least some phonotactic phenomena, especially where medial syllabification cannot be treated as secondarily derivable. The syllable-less approaches to phonotactics developed by Steriade and Blevins, in which either phonotactics and syllable structure diverge (Klamath), or phonotactics inform syllable structure (Arabic, Spanish), prove too restrictive in the case of Greek.

9.1.3 Syllable Structure in Depth

Assuming that syllable structure does play a role in the development of **ti̯*, we focus now in particular on Allen's account of the phenomenon. Seen on its own the logic behind Allen's account of the development of **ti̯* is certainly plausible. The sequence **ti̯* has the same outcome word-initially and word-medially after a consonant; if this is to be due to syllable structure, and if initial **ti̯* is a complex onset (a justifiable assumption), then medial post-consonantal **ti̯* must be an onset as well. Furthermore, as postconsonantal **ti̯* does not share an outcome with postvocalic **ti̯*, the latter must be syllabified differently – so it is not a complex onset, but a coda + onset. In either case one might also point to the nature of the outcomes themselves – singleton versus geminate – as additional justification for the posited syllable structures. And, of course, outside of this development the syllabification VC.CV finds confirmation in other phenomena as well, most prominently metrical structure. More likely than not this fact served as Allen's starting point in differentiating the outcomes of **ti̯*: if V*ti̯*V and VC*ti̯*V behaved differently, and if Greek syllabified VC.CV, then the latter must have been syllabified VC.*ti̯*V; this also neatly matches the word-initial situation.[20]

While the interdependency of the steps in the argumentation underlying this account is clear, it should be pointed out that with respect to the actual word-medial syllable structures posited – VC.CCV, VC.CV – one does not necessarily entail the other, or vice versa. A syllabification **pant.i̯a* is compatible with either **meli.ti̯a* or **melit.i̯a*[21]; and in fact, all else being equal, one might argue that a syllabification VC.CCV would more readily imply V.CCV, and a syllabification VC.CV would more readily imply VCC.CV. The weight of Allen's assumptions about Greek syllable structure rests squarely on the need to differentiate the postvocalic from the postconsonantal outcomes of **ti̯*, and is not alleviated or supported by any inherent association between the two medial syllabifications involved.

[20] We note, though, that in and of itself the syllabification VC.CCV lacks independent motivation, apparently supported only by the facts of **ti̯* development. This point is taken up below.

[21] The forms **pant-i̯a* and **melit-i̯a* have been selected as examples in this discussion due to their shared morphological structure. Of course this may seem as if to obscure the diachronic aspects of the phenomenon; for according to Allen's account, **pant-i̯a* would have undergone its development earlier than **melit-i̯a*, as part of the first successive palatalization affecting tautosyllabic **ti̯*. Change would have come much later for **melit-i̯a*, which suggests perhaps that its syllable structure need not have been verifiably Proto-Greek in age.

We argue, however, that the comparison between these two form types, and the consideration of their syllable structure as Proto-Greek in age, are valid. Under Allen's account, syllable structure is the only means of differentiating **pant-i̯a* from **melit-i̯a*. If then these two forms should share such structure, issues arise; this should become clear in the course of the discussion.

Given the tension between these two syllable structures VC.CV and VC.CCV, then, can the facts of *ti̯ palatalization reasonably be accounted for with any alternatives? Indeed if a syllable-based account of this phenomenon is compatible with multiple possible syllable structures for Proto-Greek, then its value as independent evidence for Greek syllable structure, in particular the heterosyllabification of medial consonants, comes into question. We explore this issue in greater detail now.

For the two (more specific) sequences VORV (*melit-i̯a*), VRORV (*pant-i̯a*) we imagine four possible combinations of syllabification.[22] These are presented below in (4); associated Optimality-Theoretic constraint rankings are included to facilitate comparison.

(4)

	VORV	VRORV	Minimal Constraint Ranking
a.	VO.RV	VR.ORV	*COMPLEX$_{\text{CODA}}$ » *COMPLEX$_{\text{ONSET}}$ » NOCODA
b.	VO.RV	VRO.RV	*COMPLEX$_{\text{ONSET}}$ > NOCODA
c.	V.ORV	VRO.RV	??
d.	V.ORV	VR.ORV	ONSET, NOCODA

Allen's combination is of course type (4)a.: it is the result in a system in which a complex onset is dispreferred (*melit.i̯a*), but less so than a complex coda (*pan.ti̯a*).[23] The dispreference goes the other way in type (4)b., where complex codas are preferred over complex onsets (*melit.i̯a*, *pant.i̯a*). With respect to (4)c., it is difficult to conceive of a scenario in which this combination would hold, as the priorities associated with each of the forms seem diametrically opposed; at the very least, in an Optimality Theoretic framework the constraint ranking for this type would have

[22] Assuming, minimally, the relevance of sonority sequencing and that the syllable headed by the second vowel has at least one onset segment. We also for these purposes abstract away from any influence by morphological structure, as Allen does.

[23] One could in theory also invoke a dispreference for superheavy syllables (formalized as the constraint *3μ) to achieve the same result, but as noted above, because *ti̯ after V̄ does not seem to have developed as postconsonantal *ti̯ did, avoidance of superheavy syllables does not seem to be the relevant motivation here for the syllabification VR.ORV.

to countenance a relatively higher degree of idiosyncrasy in its constituency. Finally, in type (4)d. the onset in both **meli.ti̯a* and **pan.ti̯a* is maximized (to the extent sonority sequencing allows); arguably this is the type least marked from the typological perspective, as suggested also by the simplicity of its associated constraint ranking.

Of the three syllabification combinations (4)b-d., can any feasibly be posited for Proto-Greek, while still yielding the ultimately attested outcomes? (4)c. we eliminate outright from consideration, due to its paradoxical nature; but what of (4)b. and (4)d.? If Proto-Greek were a type (4)b. language, then we would have a more difficult time motivating the geminate outcome in **melit.i̯a* (> *mélitta*, *mélissa*) versus the singleton outcome in **pant.i̯a* (> *pansa* etc.): if **pant.i̯a* is acceptable, why not *pans.sa*? For that matter, if **melit-i̯a* and **pant-i̯a* share syllable structure, should they not both be subject to the latest wave of palatalization, both equally retarded by the morpheme boundary intervening between **t* and **i̯*? While these issues are not insignificant, indeed one could salvage such a scenario by relying on the diachronic aspect of the change, arguing that subsequent to a Proto-Greek **pant.i̯a* a dispreference for complex codas established itself in the language (one which presumably would already have been present in Proto-Greek proper, by Allen's reckoning), which by the time of expected *pans.sa* would have precluded this form from occurring; thus, *pansa*. Such an approach can perhaps be interpreted in the development of intermediate stages such as *panssa* > *pansa* as posited by e.g. Rix (1992), if one desired to explain such stages with reference to syllable structure. Furthermore, the restriction on complex codas could have been strong enough to cause **pant-i̯a* to change at an earlier time than **melit-i̯a*, thereby accounting for their distinct treatments; alternatively, we might point to Hajnal (2009: 249), according to whom a form like **pant-i̯a* would not have developed to something like †*panta* in Attic or Boeotian, so as to preclude possible homonymy with analogous masculine / neuter forms.

As for type (4)d., which coincides most closely with the view of Proto-Greek in the Steriade-Guion account (and is, again, typologically least marked), in this case the situation is somewhat more complicated. The crux of the issue here is how one actually conceives of the relationship between syllable structure and the geminate / singleton outcomes of **ti̯*: basically, do we posit that **ti̯* developed everywhere into something akin to $*t^{j}t^{j}$, even postconsonantally, and that by virtue of syllable structure this geminate was subsequently reduced?[24] Or did syllable structure preclude the geminate from occurring in this position at the outset? On this issue (and indeed the details of the analysis in general) Allen is silent; but if we follow again e.g. Rix, who includes an intermediate stage **panssa*, perhaps the former is a fair assumption.

In any case the viability of a development starting from syllabification type (4)d. would seem to be contingent on this point. For if we assume that tautosyllabic syllable structure forestalls a geminate outcome, then a starting form **meli.ti̯a* will presumably come out as †*melita* etc. On the other hand, if we assume an initial geminate stage regardless of position within the syllable, then one could arguably conceive of a less problematic path from the Proto-Greek state to the attested outcomes. The restriction on complex codas mentioned above in connection to type (4)b. could be operational already in Proto-Greek itself. Accompanying it we would simply have to posit an additional restriction disfavoring tautosyllabic geminates, in a way a highly specialized type of the heterosyllabification assumed to be across-the-board by Allen. In collaboration these two restrictions would yield the result whereby gemination is allowed in biconsonantal sequences (ultimately V*t.t*V / V*s.s*V) but disallowed in triconsonantal ones

[24] Admittedly, a geminate sequence $*t^{j}t^{j}$ would be unusual from a phonetic perspective; more likely palatalization would be limited to the second member.

(ultimately VC.*s*V), in other words, exactly what we observe to be the case in *mélitta* / *mélissa* versus *pansa*. Again, as was the case with the syllabifications in (4)b., with **pan.ti̯a* and **meli.ti̯a* both having tautosyllabic **ti̯* we face the question of why the distinct developments; as above we point to the strength of the restrictions involved as a possible means of explanation.

So as to provide an even more explicit basis for comparison of these differing syllabifications, we present below in (5) the diachronic scenarios associated with starting syllabifications (4)b. and (4)d., as well as (my formulations) of the scenario associated with Allen's syllabification (4)a. For the scenarios in (5)a. syllable structure is assumed to *preclude* gemination (i.e., **ti̯* > *t^{i} when tautosyllabic); for those in (5)b. it is assumed to *resolve* it (i.e., **ti̯* > $t^{i}t^{i}$ > t^{i} when post-consonantal). Identical developments are similarly shaded. Note that in each individual scenario the development of **pant-i̯a* and **melit-i̯a* are not necessarily meant to be concurrent; again, Allen's account holds that the former changed at an earlier time than the latter.

(5) *Two Views on the relationship between syllable structure and gemination*

a. Syllable structure <u>precludes</u> gemination

(4)a.

pant-i̯a	***melit-i̯a***
pan.ti̯a	melit.i̯a
pan.t^{i}a	melit^{i}.t^{i}a
pan.t^{s}a	melit^{s}.t^{s}a
pansa	*mélitta*

(4)b.

pant-i̯a	***melit-i̯a***
pant.i̯a	melit.i̯a
pant^{i}.t^{i}a pan.t^{i}a	melit^{i}.t^{i}a
pan.t^{s}a	melit^{s}.t^{s}a
pansa	*mélitta*

(4)d.

pant-i̯a	***melit-i̯a***
pan.ti̯a	meli.ti̯a
pan.t^{i}a	meli.t^{i}a
pan.t^{s}a	meli.t^{s}a
pansa	†*melisa*

b. Syllable structure <u>resolves</u> gemination

(4)a.

pant-i̯a	***melit-i̯a***
pan.ti̯a	melit.i̯a
pan.t^{i}t^{i}a	melit^i.t^{i}a
pant^i.t^{i}a	
pan.t^{i}a	
pan.t^{s}a	melit^s.t^{s}a
pansa	*mélitta*

(4)b.

pant-i̯a	***melit-i̯a***
pant.i̯a	melit.i̯a
pant^i.t^{i}a	melit^i.t^{i}a
pan.t^{i}a	
pan.t^{s}a	melit^s.t^{s}a
pansa	*mélitta*

(4)d.

pant-i̯a	***melit-i̯a***
pan.ti̯a	meli.ti̯a
pan.t^{i}t^{i}a	meli.t^{i}t^{i}a
pant^i.t^{i}a	melit^i.t^{i}a
pan.t^{i}a	
pan.t^{s}a	melit^s.t^{s}a
pansa	*melitta*

In Allen's account in (5)a. we start with syllabifications **pan.ti̯a* and **melit.i̯a* in Proto-Greek; by virtue of its constituting either a complex onset or a coda + onset, **ti̯* then develops either a singleton or geminate outcome, respectively. In contrast, starting with syllabification (4)b. requires a point of syllable structure repair in the diachronic process for the postconsonantal **ti̯* forms. Proto-Greek **pant.i̯a* develops into the intermediate form **pant^i.t^{i}a* with heterosyllabic geminate; but the restriction on complex codas, recently arisen, then disfavors *panti̯.* and is resolved through deletion of *ti̯*. Finally, in (5)a. syllabification (4)d. breaks down with respect to the postvocalic forms: tautosyllabic **ti̯* predicts a singleton outcome in the development of **melit-i̯a*.

In the scenarios in (5)b., which assume a geminate outcome for **ti̯* subsequently simplified when restrictions on syllable structure demand it, Allen's account becomes more complex: Proto-Greek postconsonantal **pant-i̯a* is syllabified **pan.ti̯a*, but upon palatalization and gemination, becomes subject to both a restriction on tautosyllabic geminates and one on complex codas, with simplification to singleton **ti̯* as a result. Under syllabification (4)b., **ti̯* in **pant.i̯a* geminates to **pant^i.t^{i}a*, and the restriction on complex codas (which in this case, again, would presumably have to be subsequent to Proto-Greek proper) results in simplification to **pan.t^{i}a*. For both (4)a. and (4)b., the development of **melit-i̯a* proceeds comparatively more straightforwardly. Finally, with respect to syllabification (4)d., with the assumption of across-the-board gemination both developments of **ti̯* are able to go through successfully; the development of **pant-i̯a* matches that process in (4)a., while that of **melit-i̯a* requires resyllabification of intermediate **meli.t^{i}t^{i}a* to **melit^{i}.t^{i}a* to resolve the disfavored tautosyllabic geminate.

What to make of all this? It is unclear to me how to resolve the question of the role, direct or not, of syllable structure in the development of **ti̯*, and as such, whether our focus should be on the scenarios in (5)a. or those in (5)b. However, we can note that regardless of how one does proceed, the syllabification (4)d. would seem to fare poorest among the three: in (5)a. in its predicted outcome for **melit-i̯a*, and in (5)b. in the relatively more cumbersome diachronic processes it would entail. Such a result is noteworthy given that this syllabification, involving onset maximization, is, again, the very one posited by the Steriade-Guion view of Greek syllable structure (not to mention the more typologically common as well).

As for evaluating syllabifications (4)a. and (4)b., which differ only in the treatment of **pant-i̯a* type forms, under the view in (5)a. the former would seem to provide the simpler account, while under the view in (5)b. the latter would. How to proceed, then? It is true that within an Optimality-Theoretic framework, the constraint ranking required to yield the syllabifications of Allen's account (4)a. is more complex than that required for (4)b., but the very constraint(s) distinguishing the two, *COMPLEX$_{\text{CODA}}$ and / or *3μ, would have to play a role in the development of **ti̯* even given syllabification (4)b.: again, the form **pant.i̯a* developing to **pant^{i}.t^{i}a* has to simplify to **pan.t^{i}a*. So really, the critical point is the status of the restriction on complex codas: do we place it in Proto-Greek (as in (4)a.), or posit it as a subsequent development (as in (4)b.)? While we cannot know for certain, the simpler approach would probably be to assume its position in Greek from the outset, a point in favor of Allen's account.

We note, in this regard, that evidence for syllable structure external to the phenomenon of **ti̯* development cannot help us to evaluate one account over the other. Metrical practice is silent on the matter of VCCCV syllabification, telling us only that the syllable headed by the first vowel in a sequence VCC(C)V is heavy; no distinction is made between heavy (VC.CV) and superheavy by complex coda (VCC.CV) syllables for these purposes. Nor to my knowledge is there any other evidence in Greek for a clear syllabification VCC.CV (more properly, VRO.RV) over VC.CCV (VR.ORV).

Regardless of the treatment of triconsonantal sequences, however, crucially, that the heterosyllabicity of medial biconsonantal sequences involved in both (4)a. and (4)b. would seem to be a necessary component in the satisfactory analysis of **ti̯* development (if one wishes to analyze it in terms of syllable structure), speaks strongly to the evidential value of this phenomenon for the determination of Greek syllable structure.

9.1.4 Conclusion

In closing the discussion of **ti̯* development, we comment on a few outstanding issues which remain. First, the position of the form *diksós* – how should it be factored into the account, if at all? As noted above, because of its simpler morphological structure Peters does not consider it analogous to **nt-i̯a* forms, and for him this is enough to exclude it from consideration in the morphology-first analysis of **ti̯* palatalization which he favors. In Allen's account, though, morphological structure in the **-nt-i̯a* forms is irrelevant; for him the same should hold of *diksós* as well. It would be no surprise, then, that *diksós*, if from $*dik^ht^hi̯os$, has developed as it has, because this shape is exactly what would be predicted – tautosyllabic *tı̯ resulting in singleton *s*. Still, one ought to acknowledge the obstacles to a full embrace of *diksós* as a reliable instantiation of *tı̯ palatalization: chiefly, its limited attestation, only in Ionic (mainly in Herodotus), as well as of course the fact that it is the sole example of its kind. There is also the possible counterevidence of (*u̯*)*ánassa*, if indeed from **u̯anakt-ı̯a*, in which practically the same sequence must have undergone a different change; this conflict is identified first by Hart (1965) (citing the derivation in Schwyzer 1939: 319), but reiterated by Wathelet (1970), Crespo (1985), Hajnal (2009), et al. Peters (1980) notes the (*u̯*)*ánassa* ~ *diksós* issue as well, but dismisses any comparison between the two because of the differing morphological structure; at the same time, he also argues against **u̯anakt-ı̯a* in favor of **u̯anak-ı̯a*, so that for him no secure examples of *tı̯ after an obstruent, on par with the feminine participial forms, can be identified. (Hence, again, his own belief that the presence of *n* in particular conditions the outcome in e.g. **pant-ı̯a*).

Also, a note concerning word-initial position: while the discussion developed here has treated this environment only minimally, it is worth pointing out its special nature. While initial *tı̯ results in a singleton *s*, an outcome it shares with its postconsonantal counterpart, in an Optimality-Theoretic instantiation of Allen's account the same constraint ranking achieving the word-internal outcome could not straightforwardly derive this result. The word-internal heterosyllabification of consonant sequences is not matched word-initially, where OR-type sequences freely occur. In order to yield the singleton *s* initially, one strategy would be to posit the same restriction against tautosyllabic geminates introduced above in the context of the type (4)d. syllabifications, in which onsets are maximized. This restriction would allow for word-initial complex onsets, but not those that would consist of a geminate consonant. In a similar vein we might point out Brixhe's scenario for the word-initial situation: namely a geminate / singleton outcome of **ti̯* in complementary distribution, conditioned by a preceding word-final vowel or consonant, respectively (1996: 49).

9.2 On VOO.RV and VR.OOV in Optimality Theory

9.2.1 Introduction

Our goal in this section is to assess the ease with which Optimality Theory, as a current approach in phonological theory, can be utilized to generate an analysis of syllabification in Proto-Indo-European involving the syllabifications VOO.RV, VR.OOV. These syllabifications have been reconstructed for Proto-Indo-European, VOO.RV emerging out of consideration of phenomena such as the *metron* rule (6) (Saussure 1922: 424, Mayrhofer 1986: 111), VR.OOV posited based on the phenomenon of 'bear' metathesis (7) (Schindler 1977a: 33).

(6) a. */med-tro-/ 'measure' → **mett.ro-* > **met.ro-* (tautosyllabic *-*tt*- blocks dental+dental *s*-epenthesis)

b. */u̯id-to-/ 'known' → **u̯it.to-* > **u̯it.sto-* (heterosyllabic *-*tt*- allows dental+dental *s*-epenthesis)

(7) a. */$h_2$ertk̂o-/ 'bear' → *h_2*er.tk̂o-* > *h_2*ar.k̂þo-* (tautosyllabic *-*tk̂*- becomes *-*k̂þ*-)

b. */$h_2$rtk̂o-/ 'bear' → *h_2*r̥t.k̂o-* (heterosyllabic *-*tk̂*- remains *-*tk̂*-)

On the face of it these syllabifications are unusual, on two levels. In and of themselves they suggest a rather lax conception of the sonority sequencing principle: an OO. coda is preferred over an .OR onset, while an .OO onset is preferred over an RO. coda. Furthermore, in conjunction, they flout basic typological implications: a coda of shape OO. implies one of shape RO. will be acceptable (but, VR.OOV), while an onset of shape .OO implies one of shape .OR will be acceptable (but, VOO.RV).

Importantly, though, to my knowledge these syllabifications are not directly contradicted by any other evidence assigned to the Proto-Indo-European period. As we have seen in the preceding chapter, the facts of Vedic Sanskrit do suggest that that language syllabified VO.ORV, VRO.OV (via strong sonority sequencing), while the facts of Ancient Greek are silent on this question, only arguing clearly in the development of the sequence **tį*, as we saw in the previous section, for the syllabification VR.ORV (involving a sequence the treatment of which in Vedic, was only speculated upon). The diachronic development of proposed VOO.RV, VR.OOV into these two states-of-affairs would thus seem to be a rather reasonable one to conceive: a clear change in Vedic, and only possibly one in Ancient Greek.

Given, then, that the strongest argument against these syllabifications would appear to be a typological one, intellectual honesty compels us to at least attempt to treat them as holding for Proto-Indo-European. As such, we should expect that the mechanisms of current phonological theory ought to be able to account for them. If such mechanisms do not exist, we should consider why, as both an assessment of our understanding of the facts, and the theory.

We note, in relation to the issue of typological plausibility, the reconstruction of the three stop series of Proto-Indo-European – voiceless, plain voiced, voiced aspirate – which has been the target of criticism along these very lines (Gamkrelidze and Ivanov 1973, Hopper 1973). Despite such criticism, this reconstruction remains accepted by many in the field; following such an example, we might equally well dispatch with any concerns about VOO.RV, VR.OOV.

I would argue, however, that the comparison of syllabification to an element of the phonemic inventory of Proto-Indo-European is only superficially valid. In fact we are comparing two different aspects of the phonology of the language, one predictable, the other not. In an Optimality Theoretic framework, this distinction should mean that while syllabification is a phonological phenomenon whose possible outputs should be evaluated by constraint ranking, the phonemic inventory should, in its unpredictability, already be a component of the input, and not subject to the same type of scrutiny (Richness of the Base notwithstanding).

The typological underpinnings of the concern over the stop series is thus chiefly observational in nature, while that associated with the syllabifications in question is potentially more substantive – the implausibility of VOO.RV, VR.OOV *should* be understood in Optimality Theory as a function of the constraints available to the system and their ranking with respect to each other. From this perspective, then, concerns over the stop series are more easily dismissed; but we will be in a more comfortable position to dismiss concerns against the two syllabifications only after thoroughly evaluating the ease with which they can be generated by the grammar. Even then, we may wish to argue that any difficulty in generating VOO.RV, VR.OOV ought to be a failing of the theory, not of our interpretation of the facts.

The rest of the chapter is organized as follows. In 9.2.2 we attempt to generate these treatments solely on the basis of what we term syllable-structural preferences, involving constraints concerned with the locating of syllable boundaries. In 9.2.3, we consider an alternative type of account, which incorporates reference to syllable weight. In 9.2.4 we evaluate these two analyses as a means of predicting the syllabification of VCCV and V̄CCV sequences, two further shapes whose treatment in this regard has been addressed in the literature. Finally, having undertaken this exercise, discussion follows in 9.2.5, where we return to the original questions outlined above, and conclude.

9.2.2 A Structural Approach to Generating VOO.RV, VR.OOV

We begin to develop the analysis by introducing a set of typical syllable-structural constraints, given in (8).

(8) a. SONORITY-SEQUENCING (after Zec 2007: 187)

For every pair of segments *s* and *z* in a syllable, *s* is less sonorous than *z* if

(a) (i) $s < z < Nucleus$

or (ii) $Nucleus > z > s$

or (b) (i) $s < z$ and z is the nucleus

or (ii) $z > s$ and z is the nucleus

b. *COMPLEX$_{ONSET}$

No complex onsets.

c. *COMPLEX$_{CODA}$

No complex codas.

We assume SONORITY-SEQUENCING is highly-ranked, if not undominated. For the sequences in question, VOORV and VROOV, there ought to be a crucial ranking of the two *COMPLEX constraints. We immediately see, however, a mismatch in treatment depending on which of the two possible rankings are posited (correct, yet unselected outputs are noted with ☹):

(9) *Ranking:* *COMPLEX$_{CODA}$ » *COMPLEX$_{ONSET}$

a.

/VROOV/	SON-SEQ	*COMPLEX$_{CODA}$	*COMPLEX$_{ONSET}$
i. V.ROOV	*!		*
☞ ii. VR.OOV			*
iii. VRO.OV		*!	
iv. VROO.V		*!	

b.

/VOORV/	Son-Seq	*Complex$_{\text{Coda}}$	*Complex$_{\text{Onset}}$
☞ i. V.OORV			*
☞ ii. VO.ORV			*
☹ iii. VOO.RV		*!	
iv. VOOR.V	*!	*	

(10) *Ranking:* *Complex$_{\text{Onset}}$ » *Complex$_{\text{Coda}}$

a.

/VROOV/	Son-Seq	*Complex$_{\text{Onset}}$	*Complex$_{\text{Coda}}$
i. V.ROOV	*!	*	
☹ ii. VR.OOV		*!	
☞ iii. VRO.OV			*
☞ iv. VROO.V			*

b.

/VOORV/	Son-Seq	*Complex$_{\text{Onset}}$	*Complex$_{\text{Coda}}$
i. V.OORV		*!	
ii. VO.ORV		*!	
☞ iii. VOO.RV			*
iv. VOOR.V	*!		*

In (9) the ranking *Complex$_{\text{Coda}}$ » *Complex$_{\text{Onset}}$ holds, which correctly selects the output syllabification VR.OOV in (9)a., but fails to select the syllabification VOO.RV in (9)b.; the competition comes down to either V.OORV or VO.ORV because they do not have a complex coda, nor violate the sonority sequencing principle.[25] On the other hand, given the ranking *Complex$_{\text{Onset}}$ »*Complex$_{\text{Coda}}$ in (10), VOO.RV is correctly selected (10)b., but VR.OOV in (10)a. is disfavored in comparison to VRO.OV and VROO.V because it features a complex onset.[26]

A ranking involving only the standard constraints governing the determination of syllable boundaries fails to account for the syllabification of both VROOV and VOORV sequences. We

[25] Under a different interpretation of this principle, involving stricter standards with respect to complex onsets of three consonants – perhaps that triconsonantal complex onsets must rise in sonority, with no possibility of the plateau afforded to their biconsonantal counterparts – the evaluation process can settle on a single candidate, i.e., VO.ORV. This is a moot point, of course, since crucially the right candidate would still be ruled out.

[26] Introducing the constraint Onset into the hierarchy will rule out VROO.V in favor of VRO.OV, but again, this makes no difference, considering the result we want is VR.OOV.

need to introduce additional constraints into the mix in order to generate the right results. So as to pinpoint the focus of these novel constraints, we begin with the recognition that markedness constraints of the sort we have considered above are either positively cast, in which case they state a preference for the structure concerned, or negatively cast, in which case they state a dispreference for it. In the domain of syllabification we might equally well conceive of positive constraints as *attracting* the syllable boundary to a particular position in a string of segments, and negative constraints as *repelling* it. Under this view, then, four possible means of understanding each of the syllabifications VOO.RV, VR.OOV are available to us; these are given in (11).

(11) a. VOO.RV̄ i. O codas repelled; **OR**
ii. R onsets attracted; **OR**
iii. OO codas attracted; **OR**
iv. OR onsets repelled.

b. VR.OOV̄ i. O onsets repelled; **OR**
ii. R codas attracted; **OR**
iii. OO onsets attracted; **OR**
iv. RO codas repelled.

As can be seen, there are available to each of the syllabifications VOO.RV, VR.OOV two explanations tied to simple syllabic structures (i.-ii.) and two tied to complex syllabic structure (iii.-iv.). We pursue here a formalization involving the former pairs, if for no other reason than that such explanations ought to translate into simpler constraints; nevertheless the relevance of the latter is a matter revisited in the next section, in the discussion of a weight-based approach to the syllabifications in question.

In the conjunction of these two syllabifications, it follows that there are four logically possible combinations of explanation stemming from those in both sets of (i.-ii.) above:

(12) a. The system **repels** O codas and **repels** O onsets.

b. The system **repels** O codas and **attracts** R codas.

c. The system **attracts** R onsets and **repels** O onsets.

d. The system **attracts** R onsets and **attracts** R codas.

But if we examine these conjoined explanations further, we see that in fact they can be straightforwardly restated in terms of the following two generalizations:

(13) a. The system **repels** O at syllable-edge.

b. The system **attracts** R at syllable-edge.

The explanations in (12)a. and (12)d. can be collapsed into the generalizations in (13)a. and (13)b., respectively, while the explanations in (12)b.-c., similarly translated, require both. In the interest of analytical elegance, we thereby set aside the explanations in (12)b.-c., and focus on how the two generalizations in (13) might each be incorporated into the account.

The simplest way of introducing the generalizations in (13) into an Optimality-Theoretic analysis would be to express them as the markedness constraints in (14):

(14) a. $*O]_{\sigma}$[27]

Avoid obstruents at syllable-edge.

[27] Granted, by their structure these two constraints explicitly denote the left-edge of the syllable only; it remains to be confirmed if our more general conception of them as concerning *either* edge is a valid extension. If not, we could of course introduce two more constraints, $*[O_{\sigma}$, $[R_{\sigma}$, to address the right margin. (Note that these are the very constraints which would be required to capture the explanations in (12)b.-c. – the former constraint in conjunction with $R]_{\sigma}$ for (12)b., the latter one in conjunction with $*O]_{\sigma}$ for (12)c.)

b. R]$_\sigma$[28]

Sonorants should occur at syllable-edge.

As we are inclined to introduce only one of these two constraints, since we have chosen to forego consideration of the relatively more complex explanations in (12)b.-c., we must now determine which of the two better allows us to capture the syllabifications VOO.RV, VR.OOV.

Beginning with *O]$_\sigma$, we immediately encounter problems with the implementation of the analysis. Consider the rankings in (15)-(16), each of which is subordinate to high-ranking SONORITY-SEQUENCING.

(15) *Ranking:* *O]$_\sigma$ » *COMPLEX$_{ONSET}$

a.

/VOORV/	SON-SEQ	*O]$_\sigma$	*COMPLEX$_{ONSET}$
i. V.OORV		*	*!
ii. VO.ORV		**!	*
☞ iii. VOO.RV		*	
iv. VOOR.V	*!		

b.

/VROOV/	SON-SEQ	*O]$_\sigma$	*COMPLEX$_{ONSET}$
i. V.ROOV	*!		*
☹ ii. VR.OOV		*	*!
iii. VRO.OV		**!	
☞ iv. VROO.V		*	

(16) *Ranking:* *O]$_\sigma$ » *COMPLEX$_{CODA}$

a.

/VOORV/	SON-SEQ	*O]$_\sigma$	*COMPLEX$_{CODA}$
☞ i. V.OORV		*	
ii. VO.ORV		**!	
☹ iii. VOO.RV		*	*!
iv. VOOR.V	*!		*

[28] We note that the markedness constraint R]$_\sigma$ can also be conceived of as an Alignment constraint (McCarthy and Prince 1993) ALIGN(σ, R) – or, perhaps more explicitly, two constraints, ALIGN-R(σ, R) and ALIGN-L(σ, R). Incidentally, such translation is not so easily accomplished for the alternative constraint *O]$_\sigma$, unless we allow for anti-Alignment (Buckley 1998, Downing 1998); but in any case as will be seen in the discussion this constraint is problematic for more crucial reasons.

b.

/VROOV/	SON-SEQ	*O]$_\sigma$	*COMPLEX$_{CODA}$
i. V.ROOV	*!		
☞ ii. VR.OOV		*	
iii. VRO.OV		**!	*
iv. VROO.V		*	*!

The problem with the constraint *O]$_\sigma$ is that it is sufficiently general enough to be violated not only by single obstruents at syllable-edge, but also by a sequence of obstruents, precisely what is found in VOO.RV, VR.OOV. Since the influence of *O]$_\sigma$ is therefore neutered, evaluation is dependent on the next highest-ranked constraint. In (15) this constraint is *COMPLEX$_{ONSET}$, which again selects the correct output syllabification VOO.RV, but also selects VROO.V. Alternatively in (16) the next highest-ranked constraint is *COMPLEX$_{CODA}$, which selects VR.OOV, but also V.OORV.[29] Introducing *O]$_\sigma$, then, we are exactly where we started; as it has been conceived, its introduction into the constraint ranking is unable to satisfactorily generate the right results.

How does R]$_\sigma$ fare? Consider the rankings and associated tableaux in (17)-(18) (which assume, again, high-ranking SONORITY-SEQUENCING, though this constraint need not dominate R]$_\sigma$):

(17) *Ranking:* R]$_\sigma$ » *COMPLEX$_{ONSET}$

a.

/VOORV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{ONSET}$
i. V.OORV		*!	*
ii. VO.ORV		*!	*
☞ iii. VOO.RV			
iv. VOOR.V	*!		

b.

/VROOV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{ONSET}$
i. V.ROOV	*!		*
☞ ii. VR.OOV			*
iii. VRO.OV		*!	
iv. VROO.V		*!	

[29] Note in the absence of SONORITY-SEQUENCING the winning candidates would be VOOR.V and V.ROOV, an even more untenable outcome.

(18) *Ranking:* R]$_\sigma$ » *COMPLEX$_{CODA}$

a.

/VOORV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{CODA}$
i. V.OORV		*!	
ii. VO.ORV		*!	
☞ iii. VOO.RV			*
iv. VOOR.V	*!		*

b.

/VROOV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{CODA}$
i. V.ROOV	*!		
☞ ii. VR.OOV			
iii. VRO.OV		*!	*
iv. VROO.V		*!	*

Introducing the constraint R]$_\sigma$ into the hierarchy generates the right results, both VOO.RV and VR.OOV. Furthermore, these results are attained regardless of which constraint we rank immediately below R]$_\sigma$, a perhaps neat result. Yet, it would arguably provide for a more satisfying analysis if we could more conclusively select one of the two rankings in (17)-(18). Since the two sequences VOORV, VROOV provide us with no insight into this question, we propose to consider the syllabification of a third triconsonantal sequence, VRORV. The syllabification of this sequence is arguably VR.ORV, given one interpretation of the facts of Sievers' Law, for example (as in Schindler 1977b); and as already noted in the introduction, this syllabification would seem to hold for the pre-history of Ancient Greek as well, based on one interpretation of the facts of **ti̯* development (after Allen 1958, discussed in the previous section).

If we would like the analysis to select the syllabification VR.ORV, only one of the two rankings is viable: R]$_\sigma$ » *COMPLEX$_{CODA}$. Its successful evaluation is shown in the tableau in (20), in comparison to the unsuccessful evaluation of the ranking R]$_\sigma$ » *COMPLEX$_{ONSET}$, shown in (19).

(19) *Ranking:* R]$_\sigma$ » *COMPLEX$_{\text{ONSET}}$

/VRORV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{\text{ONSET}}$
a. V.RORV	*!	*	*
☹ b. VR.ORV		*	*!
☞ c. VRO.RV		*	
d. VROR.V	*!	*	

(20) *Ranking:* R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$

/VRORV/	SON-SEQ	R]$_\sigma$	*COMPLEX$_{\text{CODA}}$
a. V.RORV	*!	*	
☞ b. VR.ORV		*	
c. VRO.RV		*	*!
d. VROR.V	*!	*	*

Because the constraint R]$_\sigma$ is violated by both sets of candidates in (19) and (20), since they each feature one sonorant in the sequence not at a syllable margin, the selection process is contingent on the next highest-ranked constraint. Only placing *COMPLEX$_{\text{CODA}}$ in this position will select the correct output, VR.ORV.

In summary, to construct an analysis capable of generating both syllabifications VOO.RV, VR.OOV (not to mention VR.ORV), purely from the perspective of syllable-structural phonotactics, we have been required to introduce a novel constraint, R]$_\sigma$, which prefers sonorants at syllable margins, and incorporate it into the following constraint ranking:

(21) SONORITY-SEQUENCING, R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$

In the next section we undertake to explore these same syllabifications as a phenomenon tied to syllable weight, and seek to sketch an Optimality-Theoretic account accordingly.

9.2.3 A Weight-Based Approach to Generating VOO.RV, VR.OOV

An alternative to the analysis developed above would be one dependent to some extent on syllable weight. Such an analysis could arguably provide a more satisfying understanding of the syllabifications VOO.RV, VR.OOV, in forcing us to delve deeper than statements on syllable-edge phonotactics, stipulative as they are, allow us to.

We begin this discussion first by showing that established approaches to syllable weight in Optimality Theory are unable to garner the results we are interested in obtaining. For instance, a prime candidate for involvement in the constraint ranking would be the constraint *3μ, defined in (22):

(22) *3μ

No trimoraic syllables.

This constraint, in militating against syllables three moras in weight, would allow us to select the correct outputs in the case of VROOV and VRORV, given the ranking in (23) and the understanding that both sonorants and obstruents are capable of being moraic.[30] The tableaux in (24)-(25) demonstrate as much.

(23) *3μ » *COMPLEX$_{ONSET}$

(24)

/VROOV/	SON-SEQ	*3μ	*COMPLEX$_{ONSET}$
a. V.ROOV	*!		*
☞ b. VR.OOV			*
c. VRO.OV		*!	
d. VROO.V		*!	

[30] This characteristic should also be a result of constraint ranking (in Chapters 4-6, we invoked *APPENDIX » *μ/CONSONANT), but we set the matter aside for now.

(25)

/VRORV/	SON-SEQ	*3μ	*COMPLEX$_{ONSET}$
a. V.RORV	*!		*
☞ b. VR.ORV			*
c. VRO.RV		*!	
d. VROR.V	*!	*	

Note that essentially here *3μ provides a weight-based motivation – avoiding a syllable of three moras – for what *COMPLEX$_{CODA}$ provides a structural motivation for (assuming multiple postvocalic consonants can be moraic). As a result, we come to face the same problem as noted above, when we turn to the syllabification of the sequence VOORV:

(26)

/VOORV/	SON-SEQ	*3μ	*COMPLEX$_{ONSET}$
☞ a. V.OORV			*
☞ b. VO.ORV			*
☹ c. VOO.RV		*!	
d. VOOR.V	*!	*	

According to the ranking in (23) (and assuming the moraicity of coda obstruents), the syllabifications V.OORV or VO.ORV should be most optimal for this sequence. In order to yield VOO.RV, the ranking of *3μ and *COMPLEX$_{ONSET}$ must be reversed, much like the ranking of *COMPLEX$_{CODA}$ and *COMPLEX$_{ONSET}$ would have to be reversed under a purely structural approach: so, again, we face a ranking paradox.

Note this paradox cannot be resolved by invocation of the notion of appendix (Sherer 1994), a subsyllabic unit associated with non-moraic segments. If, for example, we allow only obstruents immediately following a vowel to be moraic, and relegate any others to the appendix, we can remove VOO.RV's violation of *3μ, but we then encounter a problem with VROOV and VRORV – if VOO.RV would not violate *3μ under this proposal, then why should VRO.OV or VRO.RV? In other words, why should only an obstruent following another obstruent qualify as an appendix, and not an obstruent following a sonorant?

Given issues such as these in developing a weight-based account of the syllabifications VR.OOV and VOO.RV, which I take to be representative of the situation as a whole, it would seem that such an analysis requires us to consider alternatives beyond already established approaches. In the following discussion we do just that.

As syllable-weight is traditionally tied to the right margin of the syllable, we begin to sketch the weight-based approach in earnest first by considering the segmental constituencies posited for this domain. Evidenced from VR.OOV and VOO.RV is the fact that VR. and VOO. are acceptable syllable rhymes in this context, while VRO. and VO. are not. If we are to assume that syllable weight plays a role, it is a valid hypothesis to distinguish the weight of VR. from VRO., and the weight of VOO. from VO.; some aspect of the weight profile of VR. and VOO. make them more desirable, at least in comparison to their respective alternatives.

We might reasonably suppose that this weight-related aspect is not merely a quality shared by both VR. and VOO., but specifically a *quantity* – in other words, that these two rhymes are in fact equivalent in weight. Their both being licit coda sequences would be a reflection of their both satisfying the same preference for syllable weight, a preference which would not be satisfied by VRO. or VO. Logically, if this equivalence holds, we must conclude that coda obstruents project half as much weight as their sonorant counterparts do: 2 O = 1 R. By this equation, the weight of the coda RO. would be one and a half times greater than the weight of R. ($1 + \frac{1}{2} > 1$), and the weight of the coda O. would be only half as large ($\frac{1}{2} < 1$).

The next step in developing this hypothesis further is to transform the weight equation, and its implications for licit codas, into a constraint on syllable weight. To do so, it will be useful to consider how we might express the equation 2 O = 1 R in terms of the units of syllable weight, i.e., moras. In a sense, how many moras we actually assign to sonorants and obstruents might be considered arbitrary, so long as the equation is upheld; but in fact if we draw into the discussion the status of vowels vis-à-vis weight, the set of plausible options narrows considerably. By maintaining the well-established notion that (short) vowels are monomoraic, we have a reasonable upper limit for the moraic value of sonorants: it would be highly unlikely (if not unprecedented) for a language to privilege consonants (sonorants or not) over vowels with respect to weight (admittedly, a typological argument). We hypothesize, then, that sonorant consonants in coda position project a single mora, just as short vowels do; we have no reason to claim any lesser value should hold.

Once we approach the question of the moraicity of obstruents, returning to the equation we must conclude that obstruents in coda position project half a mora. Despite any potential theoretical awkwardness of such a value, we will proceed with it in mind, as it would seem to form a necessary component of a weight-based approach to the syllabifications in question.

Having interpreted the equation in terms of actual units of syllable weight, we see that rhymes in Proto-Indo-European should optimally be bimoraic, as VR. ($1 + 1 = 2$) and VOO. ($1 + ½ + ½ = 2$) are, but VRO. ($1 + 1 + ½ = 2.5$) and VO. ($1 + ½ = 1.5$) are not. We thus posit a strictly bimoraic preference for syllable weight, which in Optimality-Theoretic terms, takes the form of a constraint 2μ:

(27) 2μ

Syllables should be bimoraic.[31]

We maintain a strict conception of this constraint, in the sense that its ideal syllable is both minimally and maximally bimoraic; a trimoraic syllable, though containing two moras, would be just as bad by its standards as a monomoraic syllable would.

[31] Cf. Broselow's (1992: 10) Bimoraicity Constraint ("Syllables are maximally and optimally bimoraic") for Arabic.

This constraint must crucially outrank either *COMPLEX$_{\text{ONSET}}$ or *COMPLEX$_{\text{CODA}}$; at first blush either constraint, introduced into the hierarchy, would be sufficient on its own to generate the correct results, as demonstrated in the following tableaux. (The constraint SONORITY-SEQUENCING is included here in accordance with its presence in the tableaux presented so far; crucially, however, its presence is not necessary, as any candidate it would eliminate from consideration also incurs a violation of 2μ.)

(28) *Ranking:* 2μ » *COMPLEX$_{\text{CODA}}$

a.

/VOORV/	SON-SEQ	2μ	*COMPLEX$_{\text{CODA}}$
i. V.OORV		*!	
ii. VO.ORV		*!	
☞ iii. VOO.RV			*
iv. VOOR.V	*!	*	*

b.

/VROOV/	SON-SEQ	2μ	*COMPLEX$_{\text{CODA}}$
i. V.ROOV	*!	*	
☞ ii. VR.OOV			
iii. VRO.OV		*!	*
iv. VROO.V		*!	*

(29) *Ranking:* 2μ » *COMPLEX$_{\text{ONSET}}$

a.

/VOORV/	SON-SEQ	2μ	*COMPLEX$_{\text{ONSET}}$
i. V.OORV		*!	*
ii. VO.ORV		*!	*
☞ iii. VOO.RV			
iv. VOOR.V	*!	*	

b.

/VROOV/	SON-SEQ	2μ	*COMPLEX$_{\text{ONSET}}$
i. V.ROOV	*!	*	*
☞ ii. VR.OOV			*
iii. VRO.OV		*!	
iv. VROO.V		*!	

The tableaux in (28), in which 2μ explicitly outranks *COMPLEX$_{\text{CODA}}$, show how, in the case of VOORV, it is preferable for the leftmost syllable to be bimoraic, in spite of the fact that such quantity comes at the cost of a complex coda; whereas in the case of VROOV, the posited syllabification VR.OOV goes through without any issue, in comparison to its chief competitor VRO.OV, which is doubly problematic, in that the first syllable is both trimoraic and features a complex coda. Similarly, in the tableaux in (29), the influence of *COMPLEX$_{\text{ONSET}}$ is moot in the case of VOORV̄ the failing candidate VO.ORV, while violating this constraint, more importantly violates higher-ranked 2μ; on the other hand, in the case of VROOV, the ranking is crucial, as otherwise VRO.OV could be selected as more optimal.

We also see, further, that either ranking works in the case of VRORV, as shown in the tableaux in (30)-(31):

(30) *Ranking:* 2μ » *COMPLEX$_{\text{ONSET}}$

/VRORV/	SON-SEQ	2μ	*COMPLEX$_{\text{ONSET}}$
a. V.RORV	*!	*	*
☞ b. VR.ORV			*
c. VRO.RV		*!	
d. VROR.V	*!	*	

(31) *Ranking:* 2μ » *COMPLEX$_{\text{CODA}}$

/VRORV/	SON-SEQ	2μ	*COMPLEX$_{\text{CODA}}$
a. V.RORV	*!	*	
☞ b. VR.ORV			
c. VRO.RV		*!	*
d. VROR.V	*!	*	*

Under either ranking the non-optimal syllabification abiding by the sonority sequencing principle, VRO.RV, loses because it violates 2μ, as the first syllable is greater than two moras in quantity.

To conclude this section, we note that, importantly, the constraint 2μ must go hand-in-hand with the semi-moraic status of coda obstruents; we cannot maintain one without the other. If obstruents were capable of being fully moraic, then a ranking involving 2μ would incorrectly select as most optimal, in the case of the sequence VOORV, the syllabification VO.ORV, regardless of whether this constraint immediately outranks *COMPLEX$_{ONSET}$ or *COMPLEX$_{CODA}$:

(32)

/VOORV/	2μ	*COMPLEX$_{ONSET}$	*COMPLEX^{CODA}
a. V.OORV	*!	*	
☞ b. VO.ORV		*	
☹ c. VOO.RV	*!		*
d. VOOR.V	*!		*

Likewise, if we replaced the constraint 2μ with the already established *3μ, but maintained the semi-moraic status of obstruents, we would end up with the same type of ranking paradox already noted above:

(33)

/VROOV/	SON-SEQ	*3μ	*COMPLEX$_{CODA}$	*COMPLEX$_{ONSET}$
a. V.ROOV	*!			*
☞ b. VR.OOV				*
c. VRO.OV			*!	
d. VROO.V	*!	*	*	

(34)

/VRORV/	SON-SEQ	*3μ	*COMPLEX$_{CODA}$	*COMPLEX$_{ONSET}$
a. V.RORV	*!			*
☞ b. VR.ORV				*
c. VRO.RV			*!	
d. VROR.V	*!	*	*	

(35)

/VOORV/	SON-SEQ	*3μ	*COMPLEX$_{CODA}$	*COMPLEX$_{ONSET}$
☞ a. V.OORV				*
☞ b. VO.ORV				*
☹ c. VOO.RV			*!	
d. VOOR.V	*!	*	*	

No potential syllable rhyme would violate *3μ (without also violating SONORITY-SEQUENCING), as they would be either two and a half moras in weight (VRO.), two moras in weight (VR., VOO.), or one mora in weight (VO). As such, this constraint would lack any influence, and candidate evaluation would crucially hinge on the relative ranking of *COMPLEX$_{\text{ONSET}}$ or *COMPLEX$_{\text{CODA}}$. As we have already seen, the former needs to outrank the latter in the case of VROOV and VRORV, but the latter must outrank the former in the case of VOORV. Clearly, then, we must maintain both of these aspects of the account, to satisfactorily predict the correct syllabifications.

9.2.4 Analyzing Proto-Indo-European Syllabification in General

The two analyses presented in this chapter have been developed with exclusive focus on medial sequences of three consonants: VOORV, VROOV, and, where we have deemed relevant, VRORV. But of course these sequences alone do not exhaustively capture the set of consonant combinations reconstructed for word-internal position in Proto-Indo-European: to the more general VCCCV we can also add VCCV and, with long vowel, V̄CCV as two additional shapes whose syllabification has been analyzed in the literature. In order to prove viable analyses, then, the two approaches should be able to be straightforwardly integrated into a more general account of Proto-Indo-European syllabification, one which covers these sequences as well.

In this section we explore the extent to which this is the case. In 9.2.4.1 we consider the syllabification of VCCV, and in 9.2.4.2 that of V̄CCV.

9.2.4.1 VCCV

We start with VCCV, for which the syllabification VC.CV has been posited, regardless of the nature of the consonants involved. Evidence comes from a variety of sources (see e.g. Chapter 7), though arguably metrical practice in Vedic Sanskrit (and Ancient Greek) provides the strongest argument for this claim.

Taken alone, the simplest way to account for the across-the-board heterosyllabification of medial biconsonantal sequences using established means in Optimality Theory is, as we have seen in Chapter 8, through the crucial ranking in (36), which involves the as yet unintroduced here constraints ONSET ('Syllables have onsets') and NOCODA ('Syllables do not have codas'), along with *COMPLEX$_{\text{ONSET}}$. Given this ranking, a syllabification involving a coda consonant is preferred over one involving a complex onset (37).

(36) ONSET, *COMPLEX$_{\text{ONSET}}$ » NOCODA

(37)

/VCCV/	ONSET	*COMPLEX$_{\text{ONSET}}$	NOCODA
a. V.CCV		*!	
☞ b. VC.CV			*
c. VCC.V	*!		**

For any combination of consonant – in terms of sonorants versus obstruents, VOOV, VORV, VROV, VRRV – the same result will be obtained: the two consonants will preferably be syllabified into a sequence of coda + onset.

The ranking in (36) can easily be integrated into the rankings required for the structural and weight-based analyses. As a first pass, we posit the following two amalgams, which incorporate all relevant constraints:

(38) a. Structural Account

SON-SEQ, ONSET, R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

b. Weight-Based Account

ONSET » 2μ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

It may be the case, though, that with these expanded rankings there also comes some degree of superfluity: the effect of certain constraints may be duplicated by others, suggesting a more parsimonious account can be obtained. We consider this possibility for each of the two approaches in turn.

9.2.4.1.1 The Structural Account

Beginning with the structural approach, the tableaux in (39), using the ranking in (38)a., show the process by which optimal syllabifications are obtained for the four possible types of VCCV sequence, VOOV (a.), VORV (b.), VROV (c.), VRRV (d.).

(39) a.

/VOOV/	SON-SEQ	ONS	R]$_\sigma$	*COMP$_{\text{CODA}}$	*COMP$_{\text{ONS}}$	NOCODA
i. V.OOV					*!	
☞ ii. VO.OV						*
iii. VOO.V		*!		*		**

b.

/VORV/	SON-SEQ	ONS	R]$_\sigma$	*COMP$_{\text{CODA}}$	*COMP$_{\text{ONS}}$	NOCODA
i. V.ORV			*!		*	
☞ ii. VO.RV						*
iii. VOR.V	*!	*		*		**

c.

/VROV/	SON-SEQ	ONS	R]$_\sigma$	*COMP$_{\text{CODA}}$	*COMP$_{\text{ONS}}$	NOCODA
i. V.ROV	*!				*	
☞ ii. VR.OV						*
iii. VRO.V		*!	*	*		**

d.

/VRRV/	SON-SEQ	ONS	R]$_\sigma$	*COMP$_{\text{CODA}}$	*COMP$_{\text{ONS}}$	NOCODA
i. V.RRV			*!		*	
☞ ii. VR.RV						*
iii. VRR.V		*!	*	*		**

As can be seen, there is one arguably superfluous constraint operating here: ONSET. In the context of VCCV sequences, this constraint served to militate against the syllabification VCC.V (see (37) above). But once we take into account VCCCV sequences, for which the constraint *COMPLEX$_{\text{CODA}}$ is required, its function is no longer needed: any violation of ONSET is matched by a violation of *COMPLEX$_{\text{CODA}}$. Nor can we entertain the alternative scenario of maintaining ONSET but eliminating *COMPLEX$_{\text{CODA}}$; while doing so would not pose a problem to the syllabification of VOORV or VROOV, it would yield the wrong result with respect to the sequence VRORV̄

(40)

/VRORV/	SON-SEQ	ONS	R]$_\sigma$	*COMP$_{\text{ONS}}$	NOCODA
a. V.RORV	*!		*	*	
☹ b. VR.ORV			*	*!	*
☞ c. VRO.RV			*		**
d. VROR.V	*!	*	*		***

ONSET is incapable of negotiating between the two candidates in (40)b.-c., and indeed in the absence of *COMPLEX$^{\text{CODA}}$, VRO.RV would be chosen over VR.ORV.

It may also seem possible to eliminate the constraint SONORITY-SEQUENCING from the ranking as well, but recall that its presence is crucial for ruling out illicit complex onsets such as V.ROOV, V.RORV. On the other hand, its ruling out illicit complex codas such as VOOR.V, VROR.V is a result duplicated by NOCODA.

In view of these findings, we revise the initial ranking given in (38)a. above as follows:

(41) *Structural account, second pass:*

SON-SEQ, R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

9.2.4.1.2 The Weight-Based Account

In (42) we present tableaux for the four types of VCCV sequence, relying on the ranking given in (38)b. above, which involves preferences related to syllable weight. Recall that the weight-based analysis also requires us to treat obstruents as being semi-moraic, i.e., capable of projecting only half a mora in coda position.

(42) a.

/VOOV/	ONSET	2μ	*COMPLEX$_{\text{ONSET}}$	NOCODA
i. V.OOV		*	*!	
☞ ii. VO.OV		*		*
iii. VOO.V	*!			**

b.

/VORV/	ONSET	2μ	*COMPLEX$_{\text{ONSET}}$	NOCODA
i. V.ORV		*	*!	
☞ ii. VO.RV		*		*
iii. VOR.V	*!	*		**

c.

/VROV/	ONSET	2μ	*COMPLEX$_{\text{ONSET}}$	NOCODA
i. V.ROV		*!	*	
☞ ii. VR.OV				*
iii. VRO.V	*!	*		**

d.

/VRRV/	ONSET	2μ	*COMPLEX$_{\text{ONSET}}$	NOCODA
i. V.RRV		*!	*	
☞ ii. VR.RV				*
iii. VRR.V	*!	*		**

These tableaux demonstrate that the ranking as initially constructed cannot be simplified further: each constraint, in one case or another, plays a crucial role in the evaluation process. The only ostensible exception to this claim, 2μ, is the very constraint upon which the successful syllabification of triconsonantal sequences hinges, so its inclusion is validated. As for NOCODA, which does not actively select any of the winning outputs, its presence is justified as a demonstration of the stronger dispreference for complex onsets in the system, as compared to coda segments.

Finally, we address the absence of the constraint *COMPLEX$_{\text{CODA}}$ in the ranking. Recall that the weight-based account, as developed, functioned equally well regardless of whether the constraint 2μ crucially dominated either *COMPLEX$_{\text{ONSET}}$ or *COMPLEX$_{\text{CODA}}$ (see the tableaux in (28)-(31) above). It would seem that given the additional burden of selecting the optimal syllabification of VCCV sequences as well, the simpler account is the one which includes *COMPLEX$_{\text{ONSET}}$ in the ranking, but omits *COMPLEX$_{\text{CODA}}$.[32]

So, with regard to the shape VCCV, we see that for all possible sequences – VOOV, VORV, VROV, VRRV – both analyses, given some refinement, are capable of predicting the same result, namely heterosyllabification of the consonants involved. The necessary rankings yielding this result are given in (43).

(43) a. Structural Account

SON-SEQ, R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

b. Weight-Based Account

ONSET » 2μ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

[32] Note the overlap in function between *COMPLEX$_{\text{CODA}}$ and ONSET, which in the case of biconsonantal sequences would both militate against the syllabification VCC.V. One might suppose, then, that a combined analysis could maintain the former constraint, and do away with the latter. This approach would not work: *COMPLEX$_{\text{CODA}}$ ought to rank below 2μ, as demonstrated by the tableau in (28)a. above, and this same ranking would incorrectly predict the output VOO.V:

/VOOV/	2μ	*COMPLEX$_{\text{CODA}}$	*COMPLEX$_{\text{ONSET}}$	NOCODA
a. V.OOV	*!		*	
☹ b. VO.OV	*!			*
☞ c. VOO.V		*		**

Here highest-ranked 2μ forces the selection of the only candidate that does not violate it, despite the fact that this candidate features a complex coda at the cost of an empty onset for the rightmost syllable. For the proper syllabification of VCCV sequences, we do need to posit high-ranking ONSET.

This is a treatment that is, again, in accordance with that which has been posited for the language. It is worth pointing out, though, that this heterosyllabic treatment is technically no longer arrived at in the exact same way for all four sequences concerned; in some cases, the novel constraints $R]_\sigma$ and 2μ, by virtue of their position in their respective constraint rankings and their relevance to the forms concerned, now play an active role in the evaluation process.

9.2.4.2 V̄CCV

In the literature, the same view of Sievers' Law which holds that the sequences VOORV and VROOV are syllabified with a complex coda and a complex onset respectively, also maintains the syllabification V̄.CRV, that is, after a long vowel a consonant followed by a sonorant will be tautosyllabified into a complex onset (Schindler 1977b: 59).

Of the four possible obstruent-sonorant pairings in this environment, this claim covers two, V̄ORV and V̄RRV. With respect to the remaining two, V̄OOV and V̄ROV, invoking only the sonority sequencing principle – which, we note, has not been violated in any of the syllabifications we have considered so far by a tautosyllabic sonority reversal (i.e., .RO or OR.) – we extrapolate the syllabifications V̄.OOV and V̄R.OV, and consider them the most likely candidates to complete this system.[33]

But what kind of syllabifications for sequences involving long vowels do the two analyses predict? In fact as we will see, neither approach, as they have been developed thus far, would produce exactly this set of syllabifications, although one, the weight-based account, comes closer.

[33] Indeed the case for syllabifying V̄R.OV is arguably bolstered by the evidence of Osthoff's Law shortening in, for example, Greek, if we choose to analyze this phenomenon as resolving syllable overlength. Cases of Osthoff's targeting V̄RRV sequences would presumably have to be an extension of the original development (although how many examples of shortening can be adduced for this environment in the first place requires confirmation).

9.2.4.2.1 The Structural Account

Since the only difference between sequences of shape V̄CCV versus those of shape VCCV resides in the quantity of the leftmost vowel, and vowel length is not a feature targeted in any way by the established constraint hierarchy, the structural approach will predict the same treatment here, namely, heterosyllabification of the two consonants concerned. We see this clearly in the four tableaux in (44).

(44) a.

/V̄OOV/	SON-SEQ	R]$_\sigma$	*COMP$_{CODA}$	*COMP$_{ONS}$	NOCODA
i. V̄.OOV				*!	
☞ ii. V̄O.OV					*
iii. V̄OO.V			*!		**

b.

/V̄ORV/	SON-SEQ	R]$_\sigma$	*COMP$_{CODA}$	*COMP$_{ONS}$	NOCODA
i. V̄.ORV		*!		*	
☞ ii. V̄O.RV					*
iii. V̄OR.V	*!		*		**

c.

/V̄ROV/	SON-SEQ	R]$_\sigma$	*COMP$_{CODA}$	*COMP$_{ONS}$	NOCODA
i. V̄.ROV	*!			*	
☞ ii. V̄R.OV					*
iii. V̄RO.V		*!	*		**

d.

/V̄RRV/	SON-SEQ	R]$_\sigma$	*COMP$_{CODA}$	*COMP$_{ONS}$	NOCODA
i. V̄.RRV		*!		*!	
☞ ii. V̄R.RV					*
iii. V̄RR.V		*!	*		**

If we would like to generate the outcomes suggested in the literature for V̄CCV (and those complementary ones we have extrapolated), we need only introduce the constraint *3μ into the hierarchy, crucially ranked below SONORITY-SEQUENCING (so as to generate V̄.CCV in every case except V̄ROV), and additionally, make explicit the assumption that obstruents are fully moraic in coda position. But doing so would necessarily increase the complexity of this account, and introduce an element which the alternative approach, as we will now see, more or less gets us for free, in its revolving around weight to begin with.

9.2.4.2.2 The Weight-Based Account

The weight-based approach predicts complex onsets across-the-board; any alternative would involve a violation of high-ranking 2μ, as demonstrated by the tableaux in (45).

(45) a.

/V̄OOV/	ONSET	2μ	*COMPLEX$_{ONSET}$	NOCODA
☞ i. V̄.OOV			*	
ii. V̄O.OV		*!		*
iii. V̄OO.V	*!			**

b.

/V̄ORV/	ONSET	2μ	*COMPLEX$_{ONSET}$	NOCODA
☞ i. V̄.ORV			*	
ii. V̄O.RV		*!		*
iii. V̄OR.V	*!	*		**

c.

/V̄ROV/	ONSET	2μ	*COMPLEX$_{ONSET}$	NOCODA
☞ i. V̄.ROV			*	
ii. V̄R.OV		*!		*
iii. V̄RO.V	*!	*		**

d.

/V̄RRV/	ONSET	2μ	*COMPLEX$_{ONSET}$	NOCODA
☞ i. V̄.RRV			*	
ii. V̄R.RV		*!		*
iii. V̄RR.V	*!	*		**

So with this analysis as is we are able to obtain the right results in three of the four cases of V̄CCV, the exclusion being V̄ROV (c.). The reversal in sonority which the complex onset .RO involves violates even the weakest functional conception of the sonority sequencing principle, and as such it is difficult to accept. If we would like the hierarchy to select the more plausible heterosyllabified alternative, we can include the constraint SONORITY-SEQUENCING into the ranking, a constraint which – as pointed out above in the discussion of the tableaux in (28)-(29) – is fully compatible with this approach, albeit unnecessary in the case, at least, of VCCCV syllabification. SONORITY-SEQUENCING must crucially dominate 2μ: the syllabification V̄.ROV, violating the former despite satisfying the latter, will thereby be eliminated from consideration, in favor of V̄R.OV.

To summarize, contrary to sequences of shape VCCV, for which both predict across-the-board syllabification, the two analyses we have developed here diverge in their treatment of sequences of shape V̄CCV. Without further adjustment, the structural approach once again predicts heterosyllabification of CC, while the weight-based approach predicts tautosyllabification. It is the latter analysis, as it had been developed, that is in closer agreement with the claims of the literature; but if both approaches are to predict this same result, we must adopt the following revised constraint rankings:

(46) a. Structural Account

SON-SEQ » *3μ, R]$_\sigma$ » *COMPLEX$_{\text{CODA}}$ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

b. Weight-Based Account

SON-SEQ » ONSET » 2μ » *COMPLEX$_{\text{ONSET}}$ » NOCODA

Doing so, however, we are presented with the question of whether, if weight is to play a crucial role in the syllabification of one set of sequences – those with long vowel – should we assume its significance in all types of sequences? In other words, should we prefer the weight-based account over the structural account, because of its inherent basis in weight-motivated syllabification? Indeed, all else being equal, its relative simplicity (elegance? uniformity?) makes the weight-based account an arguably more attractive approach as compared to its alternative.

But, for all the ostensible advantage of the weight-based account in more straightforwardly accounting for the various syllabifications we have seen, it is worth noting that the tautosyllabic treatment of consonants following a long vowel is a result already easily obtained in established approaches to syllable weight in Optimality Theory. We need not maintain the idiosyncratic half-weight of coda obstruents, nor introduce the constraint 2μ, to yield general V̄.CCV; this result can be obtained, as we already saw, through crucially ranked *3μ. Thus the claims we have been compelled to make to account for the posited syllabification of VCCCV sequences would seem to be best and apparently only justified in consideration of these particular cases.

9.2.5 Discussion

In this section we have sought to determine how a unified Optimality-Theoretic analysis capable of generating the ostensibly incompatible syllabifications VR.OOV, VOO.RV would have to look. We operated along two distinct lines of analysis: one syllable-structure-based, the other syllable weight-based. We found that the Optimality-Theoretic analysis relying on syllable-structural constraints required the introduction of a novel constraint $R]_{\sigma}$, while the analysis in terms of syllable weight required not only the introduction of the constraint 2μ, but also a novel conception of weight whereby obstruents in the coda project half the weight of sonorants. In other words, accounting for both VR.OOV and VOO.RV in one and the same system proves, as was perhaps to be expected, no straightforward affair.

As far as evaluating how the two analyses fare with respect to other types of consonantal syllable structures, we found that both can work, given the right additional constraints. Extending them to other areas within the domain of syllabification, however, we find that the weight-based account has a potentially fatal flaw: namely, its direct conflict with the phenomenon of righthand sonorant vocalization. If a constraint 2μ, preferring bimoraic syllables, were truly active in the Proto-Indo-European grammar to the degree that its position in the ranking in (46)b. would suggest, then we would not expect the by now familiar form **k̂u̯n̥bʰis*, but rather †*k̂unbʰis*, with bimoraic initial syllable. We take this to be a significant issue with the weight-based account, one which the structural account does not face.[34]

Still, the structural account faces problems of its own. Given a traditional conception of Optimality Theory, it is difficult to conceive of the constraint $R]_\sigma$ as existing within a vacuum; rather, we might expect that its existence presupposes the existence of a constraint $O]_\sigma$. The existence of this constraint poses a problem, though, if we view $R]_\sigma$ and $O]_\sigma$ as part of a positively-cast variation on the MARGIN family of constraints (in a relationship perhaps akin to that holding between de Lacy 2004's *HEAD and *NON-HEAD families of constraints, the latter of which may arguably be reconceived as doubly-negated **HEAD). Under this view, there should be some precedence holding between $O]_\sigma$ and $R]_\sigma$: since obstruents generally make better syllable margins, under a fixed ranking of constraints we expect $O]_\sigma$ to outrank $R]_\sigma$, while under a stringency ranking, the constraints should presumably be of shape $O]_\sigma$ and $O;R]_\sigma$. Thus unless we do away with these theoretical expectations, the syllable structural account is difficult to motivate as well.

The question of whether jettisoning such expectations is a valid step to take is intimately connect to what we might loosely refer to as the phonological 'plausibility' of accounts such as those we have developed here. I would argue that, ironically enough, the most obvious way to address the plausibility issue is to look at other languages and see if they behave in similar ways

[34] For more on the compatibility of righthand sonorant vocalization and the heterosyllabic treatment of medial consonants, see Chapter 10.

– i.e., a typological approach. To be sure, preliminary review of the languages collected in Maddieson (2011) featuring so-called "complex syllable structure" – three or more consonants allowed in onset position, and / or two or more consonants allowed in coda position – show no exemplar of the Proto-Indo-European pattern. But are there languages in which particular segments or classes of segments attract syllable boundaries? Or are there languages with a weight system allowing for all consonants to bear weight, but which crucially distinguish between the 'heaviness' of sonorants versus obstruents? We must seek out answers to these questions through extensive cross-linguistic survey; doing so will inform our perspective on the analyses developed here.

I note that this approach is 'ironic' in the sense that it may be reminiscent of our earlier discussion, in the introduction to this section, in which we criticized the typological argument against positing VOO.RV, VR.OOV for Proto-Indo-European. Would the typological study we call for here be the same as looking for these syllabifications in the languages of the world, not finding them, and concluding they should not be posited? I would say not: we are looking for evidence for more general mechanisms (in Optimality-Theoretic terms, constraints, and, operating with a less than strict – albeit still principled – conception of 'universality', constraint *types*), which are capable of generating (through crucial ranking) the Proto-Indo-European situation; we are still very much allowing for language-specific peculiarities, which VOO.RV and VR.OOV could certainly be.[35]

[35] One could also consider in this context the question of which syllabification to abandon, VOO.RV or VR.OOV, if the difficulty of fashioning a unified Optimality-Theoretic analysis is treated as a fault of the analysis, as opposed to the theory. Tentatively I would sooner suggest doing away with VOO.RV, assuming the syllabification VR.OCV holds of the language, since as we have noted above, a complex coda OO. would suggest a complex coda RO. to be acceptable, which it is apparently not (at least when triconsonantal sequences are concerned).

In fact one of the bases of VOO.RV, the *metron* rule (see (6)), can find alternative explanation. The form *métron* could instead be built to the root **meh$_1$-* 'measure' (*LIV* 424-425; *IEW* 703-704), as opposed to 1.**med-* 'measure' (*LIV* 423; *IEW* 705-706): **méh$_1$-trom*, after application of the *Weather* rule (whereby a laryngeal between a vowel and a stop + liquid sequence is deleted), would give the right result (Weiss 2009b: 113-114).

9.3 Conclusion

Our concern in this chapter was the treatment of medial sequences of three consonants in Proto-Indo-European. We examined this issue first in consideration of data from the development of Ancient Greek, which we have shown to provide convincing evidence for the syllabification VR.ORV in early stages of this language, and by extension – given no evidence to the contrary in Vedic Sanskrit – in Proto-Indo-European itself. We then assessed two ways in which the syllabifications VR.OOV and VOO.RV, which have been posited for Proto-Indo-European, might be analyzed in the current phonological framework of Optimality Theory. While more work on the typological front remains to be done in order to more fully appreciate the issues at play here, nevertheless we hope to have brought to light, in at least a preliminary capacity, the theoretical difficulties inherent in accepting these two treatments as holding within one and the same language.

CHAPTER 10

CONCLUSION

10.1 The Compatibility of Righthand Sonorant Vocalization and VC.CV

10.1.1 Introduction

Having surveyed a select assortment of evidence pointing to the heterosyllabic treatment of consonant clusters in Proto-Indo-European, we are now in a better position to fully engage the issue faced in accounting for such a treatment in Optimality Theory, given the analysis we have developed for sonorant vocalization in this same language.

As argued in Part II, the most straightforward translation into a formal analysis of consonant sequence heterosyllabification would conflict with a ranking using NoCoda for nucleus selection: to generate the syllabification VC.CV, *Complex$_{\text{Onset}}$ must outrank NoCoda, as shown in (1).

(1)

/VCCV/	*Complex$_{\text{Onset}}$	NoCoda
a. V.CCV	*!	*
☞ b. VC.CV		*
c. VCC.V		**!

A tautosyllabic onset in (1)a. violates *Complex$_{\text{Onset}}$; a tautosyllabic coda in (1)c. doubly violates NoCoda (we could also imagine this candidate eliminated due to violation of Onset). The remaining candidate, VC.CV in (1)b., best negotiates these constraints, as it does not violate the first, and incurs only a single violation of the second.

However, this very ranking would have highly undesirable effects for the sonorant vocalization analysis developed in Part I. This phenomenon is seemingly concerned with minimizing codas, a preference which, all else being equal, must be in tandem with one maximizing onsets: in other words, it requires the opposite ranking to be operative, as shown in (2):

(2)

/k̑u̯n-b^{h}is/	NOCODA	*COMPLEX$_{ONSET}$
a. k̑un.b^{h}is	**!	
☞ b. k̑u̯n̥.b^{h}is	*	*

Here, in the canonical example of Proto-Indo-European nucleus selection, the candidate in (2)b. is deemed most optimal, despite the fact that it has a complex onset. The alternatives are eliminated due to violations of what must be higher-ranked NOCODA and ONSET (which must be included in the ranking). What we are presented with, then, is a ranking paradox: one set of facts suggests one ranking, another set of facts suggests its very opposite.

As we have seen in Chapter 3, NOCODA cannot be the only constraint effecting the vocalization of righthand sonorants, as it is incapable of accounting for the syllabification **per.u̯r̥*. Rather, we saw fit to improve the explanatory breadth of the analysis by introducing some form of an alignment constraint, either in conjunction with NOCODA (ALIGN-R(σ, PrWd), after Mester and Padgett 1994), or replacing it entirely (ALIGN-L(C, PrWd), after Rose 2000), or our proposed ALIGN-L(μ, PrWd)). So if we wish to assess the ranking paradox outside of a hypothetical domain (so far as study of Proto-Indo-European allows), we ought to consider its status under either of these two approaches; although we have already proceeded in the previous section in favor of our mora-based approach, nonetheless we do not think it unreasonable to revisit in this context the approaches following Mester and Padgett and Rose as well.

The tableaux in (3)-(5) evaluate output candidates for the present stem form /d^{h}ru̯b^h-i̯e-/ (**d^{h}rub^h-i̯é-* > Gk. *t^{h}ruptō̜*), built to the root **d^{h}reu̯b^h-* 'break' (*LIV* 156; *IEW* 275), the first using the ranking built on Mester and Padgett's approach, the second using that built on Rose's approach, and the third using that built on our moraic approach. (Here and throughout the rest of this chapter, the constraint *PK/NASAL is omitted in tableaux featuring input /d^{h}ru̯b^{h}-i̯e-/, and the constraint *PK/LIQUID is omitted in tableaux featuring input /k̂u̯n-b^{h}is/, in the interests of space; the position of these constraints is acknowledged in the relevant tableaux by double solid lines.)

(3) *Syllable-Based Alignment* (Mester and Padgett 1994)

/d^{h}ru̯b^{h}-i̯e-/	DEP-IO	ALIGN-R(σ, PrWd) σ$_1$	σ$_2$	σ$_3$	ONSET	NOCODA	*PK/LIQ	*PK/GLI
☞ a. d^{h}ru.b^{h}i̯e-		*						*
☹ b. d^{h}rub^{h}.i̯e-		*				*!		*
c. d^{h}r̥u̯.b^{h}i̯e-		*				*!	*	
d. d^{h}r̥u̯b^{h}.i̯e-		*				*!*	*	
e. d^{h}r̥.u.b^{h}i̯e-		**!	*		*		*	*
f. d^{h}r̥.ub^{h}.i̯e-		**!**	*		*	*	*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!	*				*		
h. d^{h}rVu̯b^{h}.i̯e-	*!	*				**		

(4) *Consonant-Based Alignment* (Rose 2000)

/d^{h}ru̯b^{h}-i̯e-/	DEP	ONS	ALIGN-L(C, PrWd) C$_2$	C$_3$	C$_4$	C$_5$	*PK/LIQ	*PK/GLI
☞ a. d^{h}ru.b^{h}i̯e-			* (r)	*** (b^{h})	**** (i̯)			*
☞ b. d^{h}rub^{h}.i̯e-			* (r)	*** (b^{h})	**** (i̯)			*
c. d^{h}r̥u̯.b^{h}i̯e-			** (u̯)	*** (b^{h})	****! (i̯)		*	
d. d^{h}r̥u̯b^{h}.i̯e-			** (u̯)	*** (b^{h})	****! (i̯)		*	
e. d^{h}r̥.u.b^{h}i̯e-		*!	*** (b^{h})	**** (i̯)			*	*
f. d^{h}r̥.ub^{h}.i̯e-		*!	*** (b^{h})	**** (i̯)			*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!		* (r)	*** (u̯)	**** (b^{h})	***** (i̯)		
h. d^{h}rVu̯b^{h}.i̯e-	*!		* (r)	*** (u̯)	**** (b^{h})	***** (i̯)		

(5) *Mora-Based Alignment*

/d^{h}ru̯b^h-i̯e-/	DEP	ONS	ALIGN-L(μ, PrWd) μ1	μ2	μ3	μ4	*PK/ LIQ	*PK/ GLI
☞ a. d^{h}ru.b^{h}i̯e-			** (u)	***** (e)				*
☹ b. d^{h}rub^h.i̯e-			** (u)	*** (b^h)	***!** (e)			*
c. d^{h}r̥u̯.b^{h}i̯e-			* (r̥)	** (u̯)	*****! (e)		*	
d. d^{h}r̥u̯b^h.i̯e-			* (r̥)	** (u̯)	*****! (e)		*	
e. d^{h}r̥.u.b^{h}i̯e-		*!	* (r̥)	** (u)	*****(e)		*	*
f. d^{h}r̥.ub^h.i̯e-		*!	* (r̥)	** (u)	*** (b^h)	***** (e)	*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!		** (V)	*** (u̯)	****** (e)			
h. d^{h}rVu̯b^h.i̯e-	*!		** (V)	*** (u̯)	****** (e)			

Although the desired outcome is selection of the candidate in (3)-(5)b., in which the medial biconsonantal sequence -*b^{h}i̯*- is heterosyllabified, none of the evaluations presented here converge on this candidate. In (3), the candidates in a.-c. equally satisfy the Alignment constraint, and evaluation comes down to NOCODA, which crucially eliminates three of them, including the desired winner, in favor of the candidate in (5)a., in which -*b^{h}i̯*- serves as a complex onset. Similarly, in (5) the same three candidates eliminated by NOCODA in the syllable-based approach are eliminated due to their greater violation of the moraic Alignment constraint.[1] Finally, in (4), on the other hand, no single candidate is converged upon; the evaluation comes down to the candidates in a.-b., which equally well satisfy the consonantal Alignment constraint (candidates in c.-d. fare less well), and share violation profiles of the lower-ranked sonorant-based PEAK constraints. So while these analyses can generate both **k̑u̯n̥.b^{h}is* and **per.u̯r̥* (not to mention the other forms we considered in Chapter 4), once we factor in the issue of medial consonant heterosyllabification, they come up short.

[1] Note for these purposes we have assumed that obstruents are not moraic when following a tautosyllabic VC sequence (cf. the discussion in Chapter 5), but even if they were, the overall result of the evaluation would not be affected.

At least one of these analyses can be straightforwardly revised to generate the desired results. Given the fact that inclusion of NOCODA in our adaptation of Rose's approach was shown to be unnecessary (i.e., it can be considered inert in the grammar), we could easily introduce in its absence *COMPLEX$_{\text{ONSET}}$, and thereby achieve the correct result. Such a revised ranking is deployed in (6).

(6) *Consonant-Based Alignment, second pass*

/d^{h}ru̯b^h-i̯e-/	DEP	ONS	ALIGN-L(C, PrWd) C$_2$	C$_3$	C$_4$	C$_5$	*COMP$_{\text{ONS}}$	*PK/ LIQ	*PK/ GLI
a. d^{h}ru.b^{h}i̯e-			*	***	****		**!		*
☞ b. d^{h}rub^h.i̯e-			*	***	****		*		*
c. d^{h}r̥u̯.b^{h}i̯e-			**	***	****!		*	*	
d. d^{h}r̥u̯b^h.i̯e-			**	***	****!			*	
e. d^{h}r̥.u.b^{h}i̯e-		*!	***	****			*	*	*
f. d^{h}r̥.ub^h.i̯e-		*!	***	****				*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!		*	***	****	*****	**		
h. d^{h}rVu̯b^h.i̯e-	*!		*	***	****	*****	*		

With NOCODA not in the picture, the candidate in (6)b. is selected as most optimal, since it features one fewer complex onset than its rival in (6)a. We note that ranking *COMPLEX$_{\text{ONSET}}$ any higher than its current position would create a problem for the successful analysis of **k̂u̯n̥.b^{h}is*, as an output lacking the initial complex onset (i.e. †*k̂un.b^{h}is*) would then be favored; as it is, being ranked crucially below ALIGN-L(C, PrWd) (unlike NOCODA, which was not crucially ranked) is justified in view of the fact that otherwise, the candidate in (6)d., lacking any complex onsets, would be favored.

The analyses following Mester and Padgett (1994) and based on our moraic Alignment approach are not so easily revised to account for the new data. For the former, this is because of the crucial role NOCODA plays in the analysis of **k̂u̯n̥.b^{h}is*, which makes the ranking paradox with *COMPLEX$_{\text{ONSET}}$ a very real problem. The tableau in (7) demonstrates as much:

(7) *Syllable-Based Alignment, second pass*

/d^{h}ru̯b^h-i̯e-/	DEP	ALIGN-R(σ, PrWd) σ_1	σ_2	σ_3	*COMP ONS	ONS	NOCODA	*PK/ LIQ	*PK/ GLI
a. d^{h}ru.b^{h}i̯e-		*			**!				*
☹ b. d^{h}rub^h.i̯e-		*			*!		*		*
c. d^{h}r̥u̯.b^{h}i̯e-		*			*!		*	*	
☞ d. d^{h}r̥u̯b^h.i̯e-		*					**	*	
e. d^{h}r̥.u.b^{h}i̯e-		**!	*		*	*		*	*
f. d^{h}r̥.ub^h.i̯e-		**!**	*			*	*	*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!	*			**		*		
h. d^{h}rVu̯b^h.i̯e-	*!	*			*		**		

Whereas the ranking in the tableau in (3) above selected the candidate in (3)/(7)a. as most optimal, inserting *COMPLEX$_{ONSET}$ results in the candidate in (3)/(7)d. receiving that status, as it minimizes complex onsets over codas. Regardless, the desired winner, the candidate in (3)/(7)b., loses. For the latter, introducing *COMPLEX$_{ONSET}$ into the ranking is problematic, regardless of its position vis-à-vis the Alignment constraint: if *COMPLEX$_{ONSET}$ outranks ALIGN-L(μ, PrWd), then the analysis selects the complex onset-less form †*d^{h}r̥u̯b^h.i̯e-* as most optimal (8), and if it does not, then it plays no role in the evaluation of the input /d^{h}ru̯b^h-i̯e-/, as the evaluation would end with ALIGN-L(μ, PrWd) (cf. (5) above).

(8) *Mora-Based Alignment, second pass*

/d^{h}ru̯b^h-i̯e-/	DEP	ONS	*COMP ONS	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3	μ_4	*PK/ LIQ	*PK/ GLI
a. d^{h}ru.b^{h}i̯e-			*!*	**	*****				*
☹ b. d^{h}rub^h.i̯e-			*!	**	***	***!**			*
c. d^{h}r̥u̯.b^{h}i̯e-			*!	*	**	*****!		*	
☞ d. d^{h}r̥u̯b^h.i̯e-				*	**	*****!		*	
e. d^{h}r̥.u.b^{h}i̯e-		*!	*	*	**	*****!		*	*
f. d^{h}r̥.ub^h.i̯e-		*!		*	**	***	*****	*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!		*	**	***	******			
h. d^{h}rVu̯b^h.i̯e-	*!			**	***	***!***			

In order to generate the right result using either of these approaches – in particular, the mora-based approach, which as we argued in Chapter 4, is currently our preferred method of analyzing the data – we need a means of differentiating the complex onset in the initial syllable of *d^{h}rub^{h}.i̯e- (and, for that matter, *k̂u̯n̥.b^{h}is), versus one occurring word-internally. To make such a distinction, we will invoke the notion of Positional Markedness (Zoll 1998), applying it to the Proto-Indo-European data below in 10.1.3. First, though, as a basis of comparison, we show in 10.1.2 that the alternative approach of Positional Faithfulness (Beckman 1999) cannot work.

10.1.2 A Positional Faithfulness Account

Positional Faithfulness (Beckman 1999) allows for prominent positions in the word to maintain stronger faithfulness than non-prominent positions to an input form, even if such faithfulness entails greater markedness. In this section we entertain two possible approaches to the Proto-Indo-European facts, developed in the spirit of Positional Faithfulness. As we will see, however, neither is able to generate the desired results.

We first consider including the constraint MAX-IO in the ranking, the faithfulness constraint militating against deletion. Positioned above *COMPLEX$_{ONSET}$, we might expect that this constraint can force complex onsets to be tolerated only in initial position, but avoided elsewhere, because of the limits of heterosyllabification (9).

(9)

/CCVCCV/	MAX-IO	*COMPLEX$_{ONSET}$
a. CCV.CCV		**!
☞ b. CCVC.CV		*
c. CCV.CV	*!	*
d. CV.CCV	*!	*
e. CVC.CV	*!	
f. CV.CV	*!*	

The candidates in (9)c.-f. are eliminated because they show deletion of at least one consonant from the input: part of the medial sequence in (9)c., part of the initial sequence in (9)d.-e., and parts of both in (9)e. These absences all incur violations of higher-ranked MAX-IO, which means the elimination of these candidates from the evaluation. Remaining are those in (9)a.-b., of which the second is the winner, as it features a fewer number of disfavored complex onsets. The fact that the candidates in (9)e.-f. have no complex onsets is of no consequence, because of their lower degree of faithfulness.

The approach seems to have merit, and could constitute the makings of a valid account for languages with edge / internal asymmetries with respect to possible onsets, such as Klamath (Blevins 1993), Icelandic (Gouskova 2004), Munster Irish (Green 2003), and Tagalog (Schachter and Otanes 1972, McCarthy 2003). But once we attempt to apply this analysis to the Proto-Indo-European data, a serious problem emerges, one which should become clear in view of the tableaux in (10)-(11).

(10)

/k̂u̯n-bʰis/	MAX-IO	*COMPLEX$_{ONSET}$
☞ a. k̂u̯n̥.bʰis		
☹ b. k̂un.bʰis		*!

(11)

/dʰru̯bʰ-i̯e-/	MAX-IO	*COMPLEX$_{ONSET}$
b. dʰru.bʰi̯e-		*!*
☹ c. dʰrubʰ.i̯e-		*!
d. dʰr̥u̯.bʰi̯e-		*!
☞ e. dʰr̥u̯bʰ.i̯e-		

In both of these cases the wrong candidate is selected as most optimal, and it is the one with no complex onsets. This is because MAX-IO is consistently satisfied by all candidates, since no segment is ever deleted – rather, the status of certain segments (sonorant *u̯* or *n* in (10); *r* or *u̯* in

(11)) simply changes from consonantal to vocalic. This constraint is unable, then, to help us negotiate the evaluation process to the right result for Proto-Indo-European.[2]

As a second attempt at a Positional Faithfulness-based approach to the phenomenon, we could claim that segments constituting a complex onset in a position of prominence, initial position, are particularly faithful to their input correspondents. The associated constraint could then be as in (12).

(12) IDENT-INITIALSYLLABLE(complex onset)

The segments of a complex onset in the initial syllable of a word are identical to their input correspondents.

Once we attempt to insert this constraint into the ranking, however, we see that it is in fact incapable of effecting any desired outcome. In the case of **k̂u̯n̥b^{h}is* in (13), the constraint does not penalize any of the viable candidates, but the correct candidate happens to be selected anyway; on the other hand, in the case of **d^{h}rub^h-i̯e-* in (14), the constraint's irrelevance, where it ought to be active, leads to the wrong result.

(13)

/k̂u̯n-b^{h}is/	IDENT-#σ (COMP$_{ONS}$)	DEP	ONS	ALIGN-L(μ, PrWd) μ1	μ2	μ3	μ4	*PK/ NAS	*PK/ GLI
☞ a. k̂u̯n̥.b^{h}is				**	****	*****		*	
b. k̂un.b^{h}is				*	**	****	*****!		*
c. k̂u.n̥.b^{h}is			*!	*	**	****	*****	*	*
d. k̂u̯Vn.b^{h}is		*!		***	***	*****	******		

[2] One might claim that MAX-IO would be violated by unfaithful realization of *any* aspect of the input, down to subsegmental features such as syllabicity. If we allow for this possibility, the matter becomes no clearer: all of the candidates in the two tableaux would violate the constraint equally, as they each feature exactly one syllabic sonorant.

(14)

/dʰru̯bʰ-i̯e-/	IDENT-#σ (COMP$_{ONS}$)	DEP	ONS	ALIGN-L(μ, PrWd) μ1	μ2	μ3	μ4	*PK/ LIQ	*PK/ GLI
☞ a. dʰru.bʰi̯e-				**	*****				*
☹ b. dʰrubʰ.i̯e-				**	***	***!**			*
c. dʰr̥u̯.bʰi̯e-				*	**	*****!		*	
d. dʰr̥u̯bʰ.i̯e-				*	**	*****!		*	
e. dʰr̥.u.bʰi̯e-			*!	*	**	*****		*	*
f. dʰr̥.ubʰ.i̯e-			*!	*	**	***	*****	*	*
g. dʰrVu̯.bʰi̯e-		*!		**	***	******			
h. dʰrVu̯bʰ.i̯e-		*!		**	***	******			

The constraint IDENT-#σ(COMPLEX$_{ONSET}$) is essentially intended to negotiate between the competitors in (14)a.-d., with (14)b. supposed to be favored because its sole complex onset occurs initially. But the constraint simply does not work this way, and cannot do so. Positional Faithfulness constraints are not concerned with what can and cannot occur outside of the designated prominent position; thus the fact that complex onsets occur elsewhere in candidates (14)a. and (14)c. cannot be counted as a mark against them. Furthermore, the constraint cannot be violated by a sequence which does not contain a complex onset; so the fact that the initial syllable of (14)d. features vocalized *r* cannot serve to rule this candidate out. Even if we redefined the constraint to focus on initial onsets more generally, rather than strictly initial complex onsets, no benefit would be gained: all segments of initial onsets, complex or otherwise, are faithful to their corresponding inputs, in all candidates.

In sum, invoking the concept of Positional Faithfulness cannot help us to account, in one and the same analysis, for both the facts of sonorant vocalization and medial sequence heterosyllabification in Proto-Indo-European. A more viable approach involves a Positional Markedness constraint, as we will now show.

10.1.3 A Positional Markedness Account

Positional Markedness characterizes a situation in which marked structures are permitted only in prominent positions, and disfavored elsewhere. In other words, it allows for prominent positions in the word to abide by markedness restrictions less strictly than non-prominent positions. Positional Markedness is crucially to be differentiated from Positional Faithfulness, which as we have seen holds that underlying structure is most faithfully realized in prominent positions. As an example to differentiate these two notions, Zoll (1998) presents the case of vowel length in the Australian language Guugu Yimidhirr. In this language long vowels are licit only in the first two syllables of a word, whether this length is underlying (15), or derived through morphological concatenation, a process which may trigger lengthening in the final syllable of a base (16).

(15) *Underlying vowel length*

a. First syllable

waaʈigan 'moon'

guuʈumugu 'meat hawk'

b. Second syllable

dawaaɽ 'star'

gambuugu 'head'

(16) *Lengthening by suffix* -nda

a. Lengthening occurs

/maŋal-nda/ *ma.ŋaal.nda* 'clay'

b. Lengthening blocked

/wuluŋgur-nda/ *wu.luŋ.gur.nda* (**wu.luŋ.guur.nda*) 'lightning, flame-ERG'

The suffix *-nda*, added to a disyllabic stem with a short second vowel in (16)a., triggers lengthening of this vowel; but when added to a stem of three or more syllables in (16)b., the process is blocked.[3] The fact that vowel length of either derived or underived character can only occur in one of the first two syllables of the word (a position of prominence which Zoll characterizes, after Kager 1996, as the "Head Prosodic Word") speaks to the need to maintain a notion of Positional Markedness. The alternative, Positional Faithfulness, would predict that only *underlying* length distinctions should be realized in prominent positions, in other words that a form like /maŋal-nda/ should surface as such, with lengthening blocked.

The notion of Positional Markedness is useful in the domain of Proto-Indo-European syllabification in the following way. Recall that the simplest means of generating the heterosyllabic treatment of medial consonant sequences is through the constraint ranking *COMPLEX$_{ONSET}$ » NOCODA. When introduced into the analysis of nucleus selection, however, the wrong candidate is selected as most optimal:

(17)

/k̂u̯n-b^{h}is/	*COMPLEX$_{ONSET}$	NOCODA
☹ a. k̂u̯n̥.b^{h}is		*
☞ b. k̂un.b^{h}is	*!	

The candidate in (17)a. is the desired winner, but is eliminated under this ranking because it features a complex onset in the initial syllable of the word; its rival (17)b., which avoids a complex onset at the cost of having a coda consonant, is selected instead. The issue should perhaps be even more clear in consideration of a form such as **d^{h}rub^h-i̯é-*; the relevant tableau is presented in (18).

(18)

/d^{h}rub^h-i̯é-/	*COMPLEX$_{ONSET}$	NOCODA
a. d^{h}ru.b^{h}i̯é-	**!	
☞ b. d^{h}rub^h.i̯é-	*	*
☞ c. d^{h}r̥u̯.b^{h}i̯é-	*	*
d. d^{h}r̥ub^h.i̯é-	*	**!

[3] Presumably if added to a monosyllabic stem lengthening will occur as well, but Zoll presents no examples of such.

The four candidates included here are differentiated according to two parameters: sonorant vocalization (*u̯* or *r*) and treatment of the medial sequence *-b^h-i̯-* (tauto- or heterosyllabification). One pair of diametrically opposed candidates, (18)a. and (18)d., are eliminated from contention under the ranking *COMPLEX$_{\text{ONSET}}$ » NOCODA, the former because it has two complex onsets, the latter because it has two coda segments. The remaining candidates (18)b.-c., also differing from each other along both parameters, are equally optimal under this ranking, as they each have only one complex onset and one coda segment. But we predict that the winner should ultimately be candidate (18)b.; thus any emendation of the constraint ranking ought to proceed in favor of this form.

Comparing the structure of the two candidates (18)b.-c., we note that the predicted winner is of shape CCVC.CV (where *V* is a true vowel or syllabic sonorant), while the candidate predicted to lose is of shape CVC.CCV. The only difference between them in this view, then, is the position of the complex onset which they each feature: initial in favored (18)b., medial in disfavored (18)c. Returning to the example of **k̂u̯n̥b^his* presented above in the tableau in (18), we see that here, too, the favored winner features an initial complex onset, while the candidate which ought to lose does not. In view of these distinctions, we propose, invoking the concept of Positional Markedness, that complex onsets, while disfavored in medial position (hence heterosyllabic VC.CV), are nevertheless tolerated word-initially. This is an understandable state-of-affairs, since initial consonant sequences, at least when a word is in isolation, do not have the option of being broken up across syllables, as medial consonants do. Languages such as Klamath (Blevins 1992), Icelandic (Gouskova 2004), Munster Irish (Green 2003), and Tagalog (Schachter and Otanes 1972, McCarthy 2003) all show an asymmetry between word-initial and medial tolerance for complex onsets, allowing certain sequences (of rising sonority) to occur initially, which are treated as a coda + onset internally. Furthermore, that the initial position played a role of some prominence in Proto-Indo-European (morpho)phonology may be independently confirmed by the operation of the process known as the *neognós* rule, whereby a laryngeal in the environment R_V was deleted only in *non*-initial syllables of 'long' words, including compounds and reduplicated forms (Weiss 2009b: 113).[4]

To formally encode the preference that complex onsets be restricted to the initial syllable, we introduce the COINCIDE constraint in (19), defined in accordance with Zoll (1998).

(19) 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

This constraint penalizes any complex onset falling outside of the initial syllable; for the present purposes we incorporate it into the constraint ranking as in the tableaux in (20)-(21). (In the interests of space the constraint *PK/NASAL is omitted in tableaux featuring input /d^{h}ru̯b^h-i̯e-/; its position is acknowledged by the double solid lines dividing ALIGN-L(μ, PrWd) and *PK/LIQUID.)

(20)

/k̂u̯n-b^{h}is/	COINCIDE	DEP	ONS	ALIGN-L(μ, PrWd) μ_1	μ_2	μ_3	μ_4	*PK/NAS	*PK/GLI
☞ a. k̂u̯n̥.b^{h}is				**	****	*****		*	
b. k̂un.b^{h}is				*	**	****	*****!		*
c. k̂u.n̥.b^{h}is			*!	*	**	****	*****	*	*
d. k̂u̯Vn.b^{h}is		*!		***	***	*****	******		

[4] Recall the fact that moraic Alignment, as developed in Chapter 4, also privileges the right edge of the prosodic word (see fn. 21 there).

(21)

/d^{h}ru̯b^h-i̯e-/	COINC	DEP	ONS	ALIGN-L(μ, PrWd) μ$_1$	μ$_2$	μ$_3$	μ$_4$	*PK/ LIQ	*PK/ GLI
a. d^{h}ru.b^{h}i̯e-	*!			**	*****				*
☹ b. d^{h}rub^h.i̯e-				**	***	****!*			*
c. d^{h}r̥u̯.b^{h}i̯e-	*!			*	**	*****		*	
☞ d. d^{h}r̥u̯b^h.i̯e-				*	**	*****		*	
e. d^{h}r̥.u.b^{h}i̯e-	*!		*	*	**	*****		*	*
f. d^{h}r̥.ub^h.i̯e-			*!	*	**	***	*****	*	*
g. d^{h}rVu̯.b^{h}i̯e-	*!	*		**	***	******			
h. d^{h}rVu̯b^h.i̯e-		*!		**	***	******			

These tableaux present a fuller range of candidates than those entertained above, including forms in which both sonorants are vocalized, in (20)c. and (21)e.-f. In the tableau in (20), COINCIDE(.CC, #_) does not actually serve to eliminate any candidate; but this is an improvement over the result which would be attained using the constraint *COMPLEX$_{\text{ONSET}}$: here the correct candidate (20)a. wins the evaluation, as opposed to being eliminated because of its initial complex onset.

In (21), on the other hand, we do not quite reach a satisfactory conclusion by introducing COINCIDE(.CC, #_) alone. Violation of this constraint eliminates two candidates, (21)a. and (21)c., which both feature medial complex onset -.*b^{h}i̯*-. But ultimately this allows for candidate (21)d. to be selected as most optimal – crucially, if we assume that VC_. obstruents are not moraic; if we do treat them as moraic, then (21)d. is also eliminated, in favor of (21)b. If we wish to render this issue moot, we need another means of differentiating the candidates in (21)b. and (21)d. I propose introduction of an additional constraint, *COMPLEX$_{\text{CODA}}$; this constraint disfavors the candidate in (21)d. since it has a complex coda:

(22)

/dʰru̯bʰ-i̯e-/	*COMP CODA	COINC	DEP	ONS	ALIGN-L(μ, PrWd) μ1	μ2	μ3	μ4	*PK/ LIQ	*PK/ GLI
a. dʰru.bʰi̯e-		*!			**	*****				*
☞ b. dʰrubʰ.i̯e-					**	***	*****			*
c. dʰr̥u̯.bʰi̯e-		*!			*	**	*****		*	
d. dʰr̥u̯bʰ.i̯e-	*!				*	**	*****		*	
e. dʰr̥.u.bʰi̯e-		*!		*	*	**	*****		*	*
f. dʰr̥.ubʰ.i̯e-				*!	*	**	***	*****	*	*
g. dʰrVu̯.bʰi̯e-		*!	*		**	***	******			
h. dʰrVu̯bʰ.i̯e-			*!		**	***	******			

Evaluation of this form provides no clear indication of the ranking of *COMPLEX$_{CODA}$ with respect to COINCIDE(.CC, #_), so for now we consider them freely rankable.

Indeed consideration of these data shows that once we recognize the fact that complex onsets are generally restricted to initial positions in Proto-Indo-European, and formalize accordingly, the ranking paradox we have been touting becomes something of an illusion, as *COMPLEX$_{ONSET}$ » NOCODA is no longer really required; in fact, neither of these constraints need be considered active in the grammar.

10.1.4 Extension to VCOCV Sequences

Recognizing a restricted distribution for complex onsets, and formalizing accordingly, has allowed us to posit an analysis which generates the right results with respect to both the selection of syllabic nuclei, and the treatment of medial consonant sequences. But we note that to provide a more comprehensive account, we must also recognize the fact that sometimes complex onsets *may* arise outside of initial syllables. Specifically, if we take as evidence relevant for Proto-Indo-European syllable structure established analyses of phenomena such as the development of the sequence **ti̯* in Greek, we are faced with the syllabification VR.ORV, as in pre-Greek **pan.t-i̯a* nom. sg. fem. 'all', reflected in Attic *pȃsa* and the like with singleton *s* (see Chapter 9). Given the analysis in its present form, though, the wrong result is predicted, namely no clear winner, as in (23) (again, assuming that obstruents in the position VC_. are not moraic).

(23)

/VRORV	SON-SEQ	*COMP$_{CODA}$	COINC	ALIGN-L(μ, PrWd) μ$_1$	μ$_2$	μ$_3$
a. V.RORV	*!		*		****	
☞ b. VR.ORV			*		*	****
☞ c. VRO.RV		*			*	****
d. VROR.V	*!	*			*	?

In order to generate VR.ORV, we must not only include in the ranking the constraint *COMPLEX$_{CODA}$, which prefers the avoidance of complex codas such as RO., but we must also crucially rank it over COINCIDE(.CC, #_). Its influence in this dominating position is seen in the revised tableau in (24).

(24)

/VRORV	SON-SEQ	*COMP$_{CODA}$	COINC	ALIGN-L(μ, PrWd) μ$_1$	μ$_2$	μ$_3$
a. V.RORV	*!		*		****	
☞ b. VR.ORV			*		*	****
c. VRO.RV		*!			*	****
d. VROR.V	*!	*			*	?

With this constraint inserted into the ranking – as well as explicitly including high-ranking SONORITY-SEQUENCING to militate against (24)a. in particular – the formerly viable candidate (23)-(24)c. is thereby eliminated, and candidate (23)-(24)b. is selected as most optimal.

10.2 Conclusion

Over the preceding nine chapters of this dissertation, we have explored two aspects of Indo-European syllable structure: the phenomenon of sonorant vocalization on the one hand, and the heterosyllabic treatment of medial consonants on the other.

In Part I we developed a new Optimality-Theoretic analysis of Proto-Indo-European sonorant vocalization, whereby sonorants become syllable nuclei to enable the syllabic parsing of otherwise unsyllabifiable strings of segments. We introduced the phenomenon in Chapter 2, and showed that previous Optimality-Theoretic translations of Schindler (1977b)'s standardly-accepted rule failed to capture all aspects of the phenomenon, proving insufficient on two grounds: failure to formally encode the non-alternating status of both obstruents, which are never syllabic, and non-high vowels, which are never not syllabic, and, more importantly, failure to fully translate the descriptively leftward application of this process, leaving a number of data unaccounted for. We resolved the first issue in Chapter 3 by explicitly interleaving relevant members of the PEAK and MARGIN families of constraints into the hierarchy, and resolved the second in Chapter 4 through introducing a moraic variation of the Alignment-based proposal of Mester and Padgett (1994), developed to account for the directionality effects examined by Itô (1989). In Chapter 5 we showed that an alternative analysis, in which information about morphological structure plays a role in defining the input to the Optimality-Theoretic evaluation, is unnecessarily complex. Finally, we took steps in Chapter 6 to more explicitly position Proto-Indo-European within a typology of languages with syllabic consonants, the evaluation of which in connection to directional phonological effects has been absent in the literature.

In Part II we explored syllable margins. In Chapter 7 we first reevaluated the evidence for and against medial consonant cluster syllabification in Vedic Sanskrit, reconfirming the traditionally posited heterosyllabic treatment VC.CV. We then developed in Chapter 8 an analysis of this treatment, one which, in view of data from 'perfect union vowel' epenthesis, compelled us to reconsider the notion of locality in Pater (2009)'s constraint indexation approach to morphologically-conditioned phonology. Moving beyond Vedic, in Chapter 9, in the interests of reassessing the reconstructed state-of-affairs in the proto-language, we considered evidence from the development of Ancient Greek and evaluated the reconstructed Proto-Indo-European syllabifications VOO.RV, VR.OOV, ultimately demonstrating the difficulty of capturing both of these treatments in one and the same account.

Finally, uniting the foci of Parts I and II, we addressed in the beginning of this chapter the compatibility of the righthand vocalization of sonorants on the one hand, and the treatment VC.CV on the other, the simplest accounts of which in Optimality Theory result in a ranking paradox: the former requires the ranking NoCoda » *Complex$_{\text{Onset}}$, the latter *Complex$_{\text{Onset}}$ » NoCoda. Invoking the notion of Positional Markedness (Zoll 1998), we developed a unified analysis capable of generating both.

10.3 Future Work

This dissertation is a snapshot of a research program still in progress, and still with many avenues to follow. In this final section, I will present a sampling of the more prominent areas remaining to be incorporated into a fuller appreciation of the Proto-Indo-European system of syllabification and its cross-linguistic parallels.

First of all, a complete picture of Proto-Indo-European phonology must take into account the three laryngeals, the status of which remains a matter of intense discussion. In the particular domain of syllabification, the laryngeals are interesting because of their various vocalic developments in the daughter languages, including what is traditionally assumed to involve an anaptyctic vowel, which renders syllabifiable otherwise unsyllabifiable sequences featuring these segments. In some cases this anaptyctic vowel is thought to precede the adjacent laryngeal, in others, to follow it; a future incarnation of the analysis proposed here might have something to say about this varying pattern of placement. (Note that the analysis as currently laid out makes no real predictions about the syllabicity of the laryngeals in one way or another, as we have pointedly not explicitly factored laryngeals into the sonority hierarchy forming the basis of the constraints used in the Optimality-Theoretic account, classifying them simply as obstruents).

Secondly, no discussion of Proto-Indo-European syllable structure is arguably complete without a treatment of – or at least, reference to – the phenomenon known as Sievers' Law (and Lindemann's Law, if one considers the two related). In fact in the very same work – Schindler 1977b – which has underlied much of the discussion here because of its rule of sonorant vocalization, Schindler also proposes his famous account of Sievers' Law, tying the occurrence of the high vowel to syllable structure, in particular VR.OGV (> VR.OV̲.GV), V̄.OGV (> V̄.OV̲.GV), but crucially not VOO.GV. Especially considering the fact that we have gone to some length here to dispute the plausibility of this last syllabification (especially in conjunction with the also reconstructed VR.OOV), more work remains to be done to satisfactorily integrate the relevant data into our general story. We believe that such an aim is well within reach, however, and may involve the notion of syllable weight, a variable which Schindler himself did not seem to consider, but has been mentioned in more recent work (e.g. Keydana 2004, Weiss 2009b:39 fn. 42).[5]

[5] We might also mention in this context the recent account of Sievers' Law by Byrd (2010), cast in the framework of Optimality Theory, although we do not fully endorse all aspects of his stratal approach.

Indeed the problem one runs into in introducing weight into the picture is the inevitable conclusion that obstruents in Proto-Indo-European cannot have been weight-bearing, a finding which clearly runs counter to the

More generally, it will also be important moving forward to expand the scope of our investigation, by introducing more data from the daughter languages into the picture. What aspects of their various reflexes of the proto-language's vocalic sonorants, if any, might be better understood in terms of the analysis we have developed here?

Finally, venturing beyond Proto-Indo-European, we have also in this dissertation touched upon issues of typology, in particular concerning the phenomenon of consonant vocalization, and the directionality observable therein. A related issue that has come into play given the shape our analysis has taken is the moraicity of coda consonants: specifically, our analysis generates results distinct from those of Rose (2000), under different views of final consonant moraicity. Clearly, a broader understanding of the possible interactions between the presence and/or absence of various degrees of coda weight and syllabic consonants cross-linguistically would grant us a firmer footing from which to evaluate the two approaches, and others.[6]

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evidence of Vedic and Greek (unless one takes a view of the development of the metrical system in these languages after e.g. Pulgram 1981, one disputed by Devine and Stephens 1977, 1980, 1994, whereby obstruent coda moraicity is a "*productio metrica*," a metrical phenomenon extending from sonorant coda moraicity, which is truly phonological). One tentative solution to this conflict may lie in adopting Steriade's (1990) distinction between obligatory and conditional moraicity, the former being associated with the 'nuclear' segments of a given language: Sievers' may be tied to the weight of obligatory, or 'nuclear' moras (sonorants), not all moras (thus allowing obstruents to be moraic, but not triggers of Sievers' in the position V_CGV). Relatedly, we may follow Gordon's (2006) perspective, and simply allow that Sievers' calculates weight one way in Proto-Indo-European (ignoring obstruents), but other phenomena (such as metrical practice) calculate it another way (including obstruents).

[6] One question worth considering in this context is whether the presence of syllabic consonants in a language necessarily implies at least some degree of coda weight, a prediction essentially made by Zec (1988), who proposed that the set of syllabic segments in a language is a proper subset of the set of moraic segments. A preliminary examination of Gordon's (2006) database of languages casts doubt on such a relationship holding: of the eleven languages he includes with syllabic nasals, only two, Cantonese (Sino-Tibetan) and Kabiye (Niger-Congo), allow moraic codas (specifically, sonorants), at least for the purposes of tone placement, while a third, Kung (Zu|'Hõaši; Khoisan), does not allow syllables of shape *CVVC, suggesting perhaps a preference for bimoraicity.

APPENDIX

1. Data for **Table 2.1**, Word-initial sonorant distribution in Proto-Indo-European

Env.	Son.	Form	*LIV*	*IEW*
#_O	*m*	**m$_a$sd-i̯é-* pres. > Ved. *médyati* ‘become fat’ **m̥s-i̯é-* pres. > Gk. **asi̯omai* >> *maíomai* ‘seek for’	422 441	[694] 693
	n	**n̥b^h-ro-* > Ved. *abhrá-* neut. ‘thundercloud’ [*NIL* 499-504]		
	l	*no examples*		
	r	**r̥g^h-sk̂é-* pres. > Gk. *árk^{h}ǭ* ‘begin’	498	[854, 863]
	i̯	*no examples*		
	u̯	**uh$_2$g(ĝ)-néu̯-* pres. > Gk. *ágnūmi* ‘break’	664-665	1110
#_RC	*m*	**mik̂-sk̂é-* pres. > Gk. *mísgǭ* ‘mix’	428-429	714
	n	**nig^w-i̯é-* pres. > Gk. *nízdǭ*, *nízdomai* ‘wash (oneself)’	450	761
	l	**lip-i̯é-* pres. > Gk. *líptǭ* ‘desire’	409	671
	r	**rikh$_2$-é-* pres. > Ved. (RV) *ā́ rikha* ‘tear up!’	504	858
	i̯	**i̯ug-tó-* > Ved. (RV+) *yuktá-* ‘yoked’ [*NIL* 397-404]		
	u̯	**u̯ig-é-* pres. > Ved. *vijáte* ‘moves’ **u̯l̥-néu̯-* pres. > Ved. *vr̥ṇóti* ‘encloses’	667-668 674	[1130-1131] 1138
#_RV	*m*	**mléu̯h$_2$-* pres. > Ved. *brāvīti* ‘says’	446-447	--
	n	*no examples*		
	l	*no examples*		
	r	*no examples*		
	i̯	*no examples*		
	u̯	**u̯l-éh$_1$-* fient. > Gk. *alē̂nai* ‘pushes’	674	1138
#_V	*m*	**méd-e-* pres. > Ved. *mādati* ‘enjoys’	423-424	[694-695, 706]
	n	**ném-e-* pres. > Gk. *némǭ* ‘divide’	453	763
	l	**léĝ-e-* pres. > Gk. *légǭ* ‘gather’	397	658
	r	**réi̯d^h-e-* pres. > OIr. *-réid*, *riadait* ‘ride’	502	861
	i̯	**i̯ét-e-* pres. > Ved. *yátate* ‘is laid down’	313-314	506-7
	u̯	**u̯éd^h-e-* pres. > OIr. *fedid* ‘leads’ **u̯éĝ^h-e-* pres. > Ved. *váhati* ‘blows’	659 661-662	[1116-1117] 1118-1120
#O_O	*m*	**d^{h}m̥b^h-i̯é-* pres. > Gk. *t^{h}áptǭ* ‘bury’	143	248-249
	n	**k^{w}n̥d^h-sk̂é-* pres. > Gk. *pásk^{h}ǭ* ‘suffer’	390	641
	l	**g$^{(w)}$l̥d^h-i̯é-* pres. > Ved. part. *gŕ̥dhyant-* ‘greedy’ **sl̥ĝ-é-* pres. > Ved. *sr̥játi* ‘lets go’	185 528-529	434 900-901
	r	**b^{h}r̥ĝ^h-i̯é-* pres. > Hitt. *parkiyanzi* ‘be high’ **pr̥k̂-sk̂é-* pres. > Ved. *pr̥ccháti* ‘asks’	78-79 490-491	140-141 821-822
	i̯	**mik̂-sk̂é-* pres. > Gk. *mísgǭ* ‘mix’	428-429	714
	u̯	**b^{h}ug-i̯é-* pres. > Lat. *fugiō*, *-ere* ‘flee’	84	152
#O_RC	*m*	**smr̥d-h$_1$i̯é-* essiv. > Lith. *smìrdžiu*, (*smirdeti*) ‘stink’	570	970
	n	**snig^{wh}-i̯é-* pres. > OInd. ep. class. *snihyati* ‘attaches’	573	974
	l	**k̂lu-tó-* > Ved. *śrutá-* ‘heard’ [*NIL* 425-432]		
	r	**d^{h}rub^h-i̯é-* pres. > Gk. *t^{h}rúptǭ* ‘break’	156	275
	i̯	**si̯uH-i̯é-* pres. > Ved. *sī́vyati* ‘sews’*	545	915-916
	u̯	**su̯id-sk̂é-* pres. > YAv. *xvīsaṯ* ‘get into a sweat’ **k̂u̯n̥-ko-* > OIn. *śvaka-* ‘wolf’ [*NIL* 436-440]	607	1043

Env.	Son.	Form	_LIV_	_IEW_
#O_RV	_m_	*_g^{w}m̥-i̯é-_ pres. > Gk. _baínǭ_ ‘go’	209-210	464-465
	_n_	*_k̂n̥-néu̯-_ pres. > YAv. _ā-sənaoiti_ ‘climbs up’	324	--
	_l_	*_sl̥-i̯é-_ pres. > Gk. _hállomai_ ‘spring’	527-528	899
	_r_	*_k^{w}r̥-néu̯-_ pres. > Ved. _kr̥ṇóti_ ‘do, make’	391-392	641-642
	_j_	*_di-u̯-es-o-_ > OIn. (ep. +) _divasa-_ m. ‘sky’ [_NIL_ 69-81]		
	_w_	*_k̂un-ós_ > Gk. _kunós_ gen.sg. ‘dog’ [_NIL_ 436-440]		
#O_V	_m_	*_smér-e-_ pres. > Ved. _smárati_ ‘think of’	569-570	969
	_n_	*_ĝneh$_3$-_ aor. > Gk. _égnǭn_ ‘known’	168-170	376-378
	_l_	*_b^{h}léi̯ĝ-e-_ pres. > Lat. _flīgō_, _-ere_ ‘strike’	88-89	160-161
	_r_	*_b^{h}réh$_1$ĝ-e-_ pres. > Ved. _bhrā́jate_ ‘gleams’ *_sréu̯-e-_ pres. > Ved. _srávati_ ‘flows’	92 588	139-140 1003
	_i̯_	*_ti̯ég^{w}-e-_ pres. > Gk. _sébomai_ ‘feel shame before’	643	1086
	_u̯_	*_d^{h}u̯én-e-_ pres. > Ved. (KS) _adhvenat_ ‘tinges’	158	277
#R_O	_m_	*_lm̥b^{h}-é-_ pres. > Ved. _rábhate_ ‘takes’	411-412	652
	_n_	*_ln̥d^{h}-i̯é-_ pres. > Ved. (AV) _rádhyatu_ ‘should be subject to’	412-413	[675, 961]
	_l_	*_ml̥k^{w}-i̯é-_ pres. > Gk. _bláptǭ_ ‘harm’	434-435	[737]
	_r_	*_mr̥s-i̯é-_ pres. > Ved. _mŕ̥ṣyate_ ‘forgets’	440-441	737-738
	_j_	*_lip-i̯é-_ pres. > Gk. _líptǭ_ ‘desire’	409	671
	_w_	*_lug-é-_ pres. > Ved. _rujáti_ ‘breaks’	415-416	686
#R_RC	_m_	_no examples_		
	_n_	_no examples_		
	_l_	*_mluh$_2$-_ pres. > Ved. _bruvánti_ ‘say’	446-447	--
	_r_	*_u̯rik̂-i̯é-_ pres. > YAv. _uruuisiieiti_ ‘turns’	699	1158-1159
	_i̯_	_no examples_		
	_u̯_	_no examples_		
#R_RV	_m_	_no examples_		
	_n_	*_mn̥-i̯é-_ pres. > Ved. _mányate_ ‘thinks’	435-436	726-728
	_l_	*_u̯l̥-néu̯-_ pres. > Ved. _vr̥ṇóti_ ‘encloses’	674	1138
	_r_	*_mr̥-i̯é-_ pres. > Ved. _mriyáte_ ‘dies’	439-440	735
	_i̯_	_no examples_		
	_u̯_	_no examples_		
#R_V	_m_	_no examples_		
	_n_	*_mn-éh$_1$-_ fient. > Gk. Ion.-Att. _emánę̄n_ ‘became mad’	435-436	726-728
	_l_	*_mléu̯h$_2$-_ pres. > Ved. _brávīti_ ‘say’	446-447	--
	_r_	*_u̯rég-e-_ pres. > Ved. _vrájant-_ ‘going’	697	1181
	_i̯_	_no examples_		
	_u̯_	_no examples_		
#V_O	_no examples_			
#V_RC	_no examples_			
#V_RV	_no examples_			
#V_V	_no examples_			

2. Data for **Table 2.2**, Word-medial sonorant distribution in Proto-Indo-European

Env.	Son.	Form	*LIV*	*IEW*
O_O	*no examples*			
O_RC	*no examples*			
O_RV	*no examples*			
O_V	*m*	**té-tm-e-* aor. > Gk. ep. *étetme* ‘met at, reached’	624	--
	n	*no examples*		
	l	*no examples*		
	r	*no examples*		
	i̯	*no examples*		
	u̯	*no examples*		
R_O	*m*	*no examples*		
	n	*d^h*u̯n̥s-éi̯e-* pres. > Ved. *dhvasáyati* ‘lets scatter’	159	268-269
	l	*no examples*		
	r	*no examples*		
	i̯	*no examples*		
	u̯	*d^h*rub*^{h}*-i̯é-* pres. > Gk. t^h*rúptǭ* ‘break’	156	275
R_RC	*no examples*			
R_RV	*m*	**dr̥m-i̯é-* pres. > Lat. *dormiō*, *-īre* ‘sleep’	128	226
	n	*no examples*		
	l	*no examples*		
	r	*no examples*		
	i̯	*no examples*		
	u̯	*no examples*		
R_V	*m*	*no examples*		
	n	*no examples*		
	l	*no examples*		
	r	*no examples*		
	i̯	*no examples*		
	u̯	*b^h*éru̯-e-* pres. > Lat. *feruō*, *-ere* ‘boil’	81	143-145
V_O	*m*	**ĝémb*^{h}*-e-* pres. > Alb. *dhemb* ‘hurts’	162-163	369
	n	*d^h*u̯éns-e-* pres. > Ved. (YV^p) *dhvám̐sate* ‘scatter’	159	268-269
	l	*k^w*élh*$_1$*-e-* pres. > Ved. *cárati* ‘moves’ **sélk-e-* pres. > Gk. *hélkǭ* ‘draw’	386-388 530-531	639-640 901
	r	**mérh*$_2$*-e-* pres. > Hitt. *marritta*, *marrattari* ‘is crushed’ **pérd-e-* pres. > Gk. *pérdomai* ‘fart’ **sérp-e-* pres. > Ved. *sárpati* ‘creeps’	440 473-474 536	735-736 819 912
	i̯	*b^h*éi̯d-e-* pres. > Lat. *fīdō*, *-ere* ‘trust’	71-72	117
	u̯	*b^h*éu̯d*^{h}*-e-* pres. > Ved. *bódhati* ‘notices’	82-83	150-152
V_RC	*no examples*			
V_RV	*m*	*no examples*		
	n	*no examples*		
	l	*no examples*		
	r	*b^h*éru̯-e-* pres. > Lat. *feruō*, *-ere* ‘boil’	81	143-145
	i̯	*no examples*		
	u̯	*no examples*		

Env.	Son.	Form	*LIV*	*IEW*
V_V	*m*	**b^{h}rém-e-* pres. > Lat. *fremō*, *-ere* ‘roar’	94	142-143
	n	**d^{h}u̯én-e-* pres. > Ved. (KS) *adhvenat* ‘tinges’	158	277
	l	**k̂él-e-* pres. > Lat. *oc-culō*, *-ere* ‘conceal’	322-323	553-554
	r	**b^{h}ér-e-* pres. > Ved. *bhárati* ‘bears’	76-77	128-132
	i̯	**g^{w}éi̯-e-* pres. > Ved. *jáyati* ‘wins’	206	469
	u̯	**dréu̯-e-* pres. > Ved. *drávati* ‘runs’	129	205-206

3. Data for **Table 2.3**, Word-final sonorant distribution in Proto-Indo-European

Env.	Son.	Form	*NIL*
O_#	*m*	**pó/ed-m̥* > Gk. *póda* acc. sg. ‘foot’	526-540
	n	*no examples*	
	l	*no examples*	
	r	**u̯ódr̥* > Hitt. *wātar* nom. acc. sg. ‘water’	706-715
	i̯	**pó/ed-i* > Gk. *podí* loc. sg. ‘foot’	526-540
	u̯	**-su* > Ved. *-su* loc. pl.	
R_#	*m*	**suH-num* acc. sg. ‘son’	686-690
	n	*no examples*	
	l	**séh$_2$u̯l̥* (**sh$_2$u̯l̥* > Ved. *súvar* nom. acc. sg. ‘sun’)	606-611
	r	**péru̯r̥* > (**per(u̯)ar* >) Gk. *pẹ̄̂rar* nom. acc. sg. ‘end, limit’	--
	i̯	*no examples*	
	u̯	*no examples*	
V_#	*m*	**h$_1$ék̂u̯-o-m* > Gk. *híppon* acc. sg. ‘horse’	230-233
	n	**sh$_2$u̯éns* > OAv. *x^{v}ə̄ṇg* gen. sg. ‘sun’	606-611
	l	*no examples*	
	r	**u̯ódr̥* > Gk. *húdọ̄r* nom. acc. sg. ‘water’	706-715
	i̯	*no examples*	
	u̯	*no examples*	
O_O#	*m*	*no examples*	
	n	**pó/ed-n̥s* > Gk. *pódas* acc. pl. ‘foot’	526-540
	l	*no examples*	
	r	*no examples*	
	i̯	**-b^{h}is* > Ved. *-bhis* inst. pl. **h$_1$óg^{wh}-i-s* > Gk. *óp^{h}is* nom. sg. ‘snake’	--
	u̯	*no examples*	
O_R#	*no examples*		
O_V#	*no examples*		
R_O#	*m*	*no examples*	
	n	*no examples*	
	l	*no examples*	
	r	*no examples*	
	i̯	**h$_2$óu̯-i-s* > Lat. *ovis* nom. sg. ‘sheep’	335-339
	u̯	*no examples*	
R_R#	*no examples*		

Env.	Son.	Form	*NIL*
R_V#	*no examples*		
V_O#	*m*	**ĝ^{h}ii̯em-s* > Lat. *hiems* nom. sg. 'winter'	162-169
	n	*no examples*	
	l	*no examples*	
	r	*no examples*	
	i̯	*no examples*	
	u̯	*no examples*	
V_R#	*m*	*no examples*	
	n	*no examples*	
	l	*no examples*	
	r	*no examples*	
	i̯	*no examples*	
	u̯	**di̯éu̯i* > Ved. *dyávi* loc. sg. 'sky-god'	69-81
V_V#	*no examples*		

4. Data for **Table 2.6**, RR sequences in Proto-Indo-European uniform zero-grade paradigms, C_ _C

The form **dr̥m-i̯é/ó-* is an exception to the general trend, and addressed in Chapter 6.
Rows in gray are questionable, and probably should be excluded from serious consideration.

R_1	R_2	Root	Form	Reflex(es)	*LIV*	*IEW*
i̯	***u̯***	**spti̯eu̯H-*	**spti̯uH-é/ó-* (1o)	Ved. (YV) *ní ṣṭhīvati* 'spits' (AV) *praty-áṣṭhīvan* 'spit' Goth. (+) *speiwan* 'spew'	583-584	999-1000
i̯	***u̯***	**Hi̯eu̯d^{h}-*	**Hi̯ud^{h}-sḱé/ó-* (1p)	[Toch. A *yutkatār* 'worries'	225-226	511-512
i̯	***u̯***	**si̯eu̯H-*	**si̯uH-i̯é/ó-* (1q)	Ved. *sī́vyati* 'sews' Oss. *xwyj-/xuj-* 'sew' Goth. (+) *siujan* 'sew' CSl. *šijǫ*, (*šiti*) 'sew'	545	915-916
i̯	***u̯***	**Hi̯eu̯d^{h}-*	**Hi̯eu̯d^{h}-i̯é/ó-* (1q)	Ved. *yúdhyati* 'fights' YAv. *yūiδiieiti* 'fights'	225-226	511-512
l	***u̯***	**h$_{2}$leu̯-*	**h$_{2}$lu-sḱé/ó-* (1p)	Gk. *alúskǭ* 'escape'	278	27-28
l	***u̯***	**h$_{2}$leu̯-*	**h$_{2}$lu-i̯é/ó-* (1q)	Toch. B subj. *ālyinträ* 'should keep away'	278	27-28
n	***i̯***	**knei̯d-*	**knid-i̯é/ó-* (1q)	Gk. *knízdǭ* 'scratch, rub'	366	561-562
n	***i̯***	**snei̯g^{wh}-*	**snig^{wh}-i̯é/ó-* (1q)	OInd. ep. class. *snihyati* 'gets wet' [OIr. *snigid* 'rains, snows'	573	974
r	***m***	2.**drem-*	**dr̥m-i̯é/ó-* (1q)	Lat. *dormiō*, *-īre* 'sleep' ?[OCS (+) *-drěmljǫ*, (*-drěmati*) 'slumber'	128	226
r	***u̯***	**kreu̯s-*	**krus-é/ó-* (1o)	Lith. *krušù*, (*krùšti*) 'mash, crush'	371	622
r	***u̯***	**preu̯s-*	**prus-sḱé/ó-* (1p)	[SC (+) *pȑskām*, *pŕskati* 'spray'	493-494	809-810, 846
r	***u̯***	**preu̯s-*	**prus-néu̯-/-nu-* (1l)	Ved. *pruṣṇuvánti* 'sprinkle'	493-494	809-810, 846
r	***u̯***	**b^{h}reu̯s-*	**b^{h}rus-i̯é/ó-* (1q)	OIr. *bruïd* 'breaks' (verb only Celt.)	97	171

R$_1$	R$_2$	Root	Form	Reflex(es)	*LIV*	*IEW*
r	**u̯**	*d^{h}reu̯b^h-	*d^{h}rub^h-i̯é/ó- (1q)	Gk. _t^{h}rúptō̜_ ‘break, crumble (tr.)’	156	275
r	**u̯**	1.*d^{h}reu̯g^h-	*d^{h}rug^h-i̯é/ó- (1q)	Ved. (YV) _drúhyati_ ‘inflicts damage’ OAv. part. _a-drujiiaṇt-_ Y. 31,15 ‘not deceiving’; YAv. _aiβi.družaiti_ ‘cheats’; OPers. 3 sg. impf. _adurujiya_ ‘lied’	157	276
u̯	**i̯**	*du̯ei̯-	*du̯i-sk̂é/ó- (1p)	[Arm. _erknčʿim_ ‘afraid’	130	227-8
u̯	**i̯**	1.*su̯ei̯d-	*su̯id-sk̂é/ó- (1p)	YAv. _x^{v}īsaṯ_ ‘sweat’ ?[Latv. _svîstu_, (_svîst_) ‘sweat’	607	1043
u̯	**i̯**	1.*su̯ei̯d-	*su̯id-i̯é/ó- (1q)	?OVed. (ṢaḍvB) _svidyati_ ‘sweats’ OHG _swizzen_ ‘sweat’ Toch. B _/sya-/_ ‘sweat’	607	1043
u̯	**i̯**	*h$_2$u̯i̯ed^h-	*h$_2$u̯id^h-i̯é/ó- (1q)	Ved. _vídhyati_, impf. _ā́vidhyat_ ‘hurt’	294-295	1127-1128
u̯	**n**	*d^{h}u̯ens-	*d^{h}u̯n̥s-éi̯e/o- (1s)	Ved. _dhvasáyati_ ‘lets scatter’	159	268-269
u̯	**r**	*tu̯er-	*tu̯r̥-néu̯-/-nu- (1l)	[Gk. _otrū́nō̜_ ‘drive’	655	1100
u̯	**r**	*ǵ^{h}u̯er-	*ǵ^{h}u̯r̥-sk̂é/ó- (1p)	Ved. (YV) _hū́rchati_ ‘comes from’	182	[489]
r	**i̯**	*u̯rei̯k̂-	*u̯rik̂-i̯é/ó- (1q)	YAv. _uruuisiieiti_ ‘turns’	699	1158-1159

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