GDE syllabification – A generalization of Dell and Elmedlaoui's syllabification algorithm[1]

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Abstract

This article shows how Dell and Elmedlaoui's well-known analysis of syllabification in Imdlawn Tashlhiyt Berber can be generalized so that it can be successfully applied in a much wider range of languages. Khalka Mongolian, which has extensive epenthesis and complex codas, could be a textbook example of templatic syllabification. Nevertheless, it is successfully analyzed by the generalization, with coda sonority sequencing derived as a consequence the basic idea of building syllable structure at sonority maxima, which is the heart of Dell and Elmedlaoui's analysis. The ultimate aim is to extend the theory to a universal theory of syllabification, supplanting templatic derivational analyses. This article should be viewed as a contribution towards developing such a universal theory.

1. Introduction

Dell & Elmedlaoui (1985), henceforth DE85, proposed an account of syllabification in Imdlawn Tashlhiyt Berber (ITB) that is based on an iterative process of what they termed core syllable construction. They recognized that the key to ITB syllabification was to target sonority peaks with a simple scheme of elementary syllable building rules. But because of the theoretical framework they adopted, D&E (Dell and Elmedlaoui) could only very awkwardly express this insight, although the formulation that they arrive at is transparently sonority

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[1] I would like to thank Morris Halle for a careful reading of an earlier draft; François Dell and Mohamed Eldmedlaoui for many helpful comments; and Sam Gutmann for extensive feedback on the ideas.

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controlled. Prince & Smolensky (1993) highlighted this weakness in the DE85 analysis and used it to motivate Optimality Theory as “a formal platform which can support” an analysis in which notions like ‘most sonorous’ play a central role.

The thesis of this article is that much less drastic revisions of the SPE theory of phonology are entirely sufficient to provide a “formal platform” to analyze ITB syllabification, and syllabification in general. The issue is the general form of iterative rules. In the wake of Chomsky & Halle (1968), there was much discussion of how rules whose structural descriptions are satisfied at multiple positions in the input form should apply. Kenstowicz & Kisseberth (1979: 318–327) has a very useful discussion of the issues, including simultaneous application and directionality, the two concerns most relevant to this article.[2] A consensus seems to have developed at the time that iterative rules were parameterized as ±LEFT, with application at each iteration being either the leftmost potential application or the rightmost, according to the parameter selected. This article will show that the discussion ended prematurely. No new formal platform is necessary to analyze ITB syllabification, simply an extension of the possible ways in which the point of application of iterative rules is determined at each iteration. In addition to the comparisons ‘more left’ and ‘more right’, comparisons such as ‘more sonorous’ must also be admitted as possible factors determining the locus of application of iterative rules.

Apart from a demonstration that D&E’s 1985 analysis of ITB can readily be brought within a rule-based theory in a way that grants sonority the central role in determining the course of syllable building, the larger aim of this article is to show that this approach to syllabification is quite general. D&E’s analysis of ITB is first generalized and then applied in a straightforward way to two other languages that have syllable building processes that differ significantly from the ITB process and from each other. The generalization is called Generalized Dell and Elmedlaoui (GDE) syllabification. The first is syllabification in Khalka Mongolian (KM), which Svantesson (1995) shows can be compactly analyzed as directional iteration of maximal template matching. ITB is famous for the fact that any phoneme is permitted to be nuclear while in KM only vowels can be nuclear. ITB makes almost no use of epenthesis in building syllable structure while KM makes extensive use of epenthesis. The second is Ath-Sidhar Rifian Berber (ASR), which was analyzed by Dell & Tangi (1993). It shares some of the characteristics of KM, with extensive use of epenthesis. In spite of the differences, it will be demonstrated that at a suitable level of abstraction the mechanism of syllable building is essentially the same in

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[2] Since lexical phonology had not yet been developed when this work was written, much of the evidence that they use to motivate their conclusions is no longer convincing. The effects they cite as evidence are the effects of cyclic phonology. The discussion is valuable nonetheless.

Imdlawn Tashlhiyt Berber, Khalka Mongolian, and Ath-Sidhar Rifian Berber. The differences come mainly from different Sonority Hierarchies and different conditions on which phonemes can and cannot be nuclei.

Section 2 will transform the core theoretical conclusions of DE85 into a form that can extend to a more general theory of syllabification, then develop the GDE theory. After using the GDE theory to analyze syllabification in Khalka Mongolian and Ath-Sidhar Rifian Berber in the following two sections, I will return to ITB in Section 5 and make some revisions to the Section 2 analysis of ITB based on the deeper understanding of ITB glides that is reached in Dell & Elmedlaoui (2002), henceforth DE02.

2. Dell and Elmedlaoui's 1985 analysis of ITB syllabification

Some examples of the data that D&E explain are given in (1). In what I call here surface forms, syllable nuclei are underlined and nonnuclear *i* and *u* are represented by *y* and *w*. These forms are surface forms in the sense that they represent the output of the phonology. There are further phonetic effects, which insert transitional vocoids that can be confused at the phonetic level with full-blown vowels.[3] Remarkably, any phoneme can be a syllabus nucleus. *k* is a nucleus in (1a, b), *f* is a nucleus in (1b), and *x* is a nucleus in (1f). References to examples in this section are to DE85 unless otherwise noted. References in this article are given in the form [*x*] or [*x* : *y*], where *x* is a page number and *y* an example number.

(1)		*underlying*	*surface*		
	a.	ra-t-kti	$r\underline{a}.t\underline{k}.t\underline{i}$	'she will remember'	[113:24i]
	b.	t-ftk-t	$t\underline{f}.t\underline{k}t$	'she suffered a sprain'	[113:24j]
	c.	ugl-x-tnt	$\underline{u}.g\underline{l}x.t\underline{n}t$	'I hung them (f.)'	[120:35]
	d.	ħaul-tn	$\hbar\underline{a}.w\underline{l}.t\underline{n}$	'make them (m.) plentiful'	[110:13]
	e.	rgl-x	$\underline{r}.g\underline{l}x$	'I locked'	[120:35]
	f.	sxːn	$s\underline{x}.x\underline{n}$	'dip (in sauce)'	[121:38]
	g.	t-xzn-t	$t\underline{x}.z\underline{n}t$	'you (sg.) stored'	[106:4]
	h.	t-xzn-a-s	$tx\underline{z}.n\underline{a}s$	'you (sg.) stored for him'	[106:4]

Syllable nuclei are underlined in (1), and throughout this article.

The surface syllable structure of (1f) is given below.

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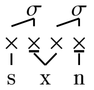
[3] See DE85 p. 116

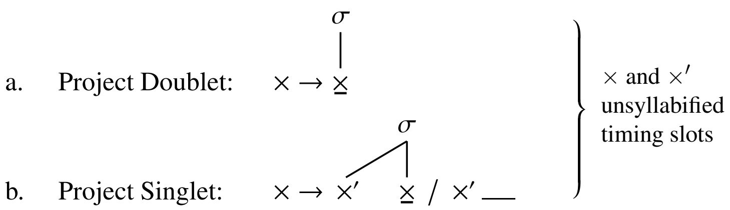
(2)



This makes it clear that it is inaccurate to say that "*x* is a nucleus," as we did above. We could equally well have said "*x* is an onset". It is not *x* that is a nucleus, but one of the timing slots associated with *x*. Syllables are groups of timing slots associated with an abstract syllable element, not groups of phonemes. The usual terminology should be understood in this way. The statement "any phoneme can be a syllable nucleus" should be understood as "any phoneme can be associated with a nuclear timing slot."

DE85 divides syllabification into two processes, an iterative rule of core syllabification followed by an iterative rule that adjoins the unsyllabified timing slots that remain as codas. Core syllabification uses the two rules (3). The first creates a one slot syllable with the targeted slot the nucleus. The second combines two adjacent slots into an onset-nucleus syllable, with the targeted slot the nucleus of the syllable.

(3)



The nuclei of the syllables that are created are underlined. The timing slots that are targeted by one of the projection rules become the nuclei of the syllables that are created. Since the point of application of iterative rules is significant, it is important to be clear that Project Doublet applies to the timing slot that becomes the nucleus of the new syllable, not to the pair of slots involved, nor to the slot that becomes the onset of the new syllable.

Core syllabification is carried out by applying the rule scheme (4) iteratively (in a manner specified below), subject to a derivational constraint against hiatus (adjacent nuclei).

(4) $\mathscr{R} = \begin{bmatrix} \text{Project Doublet} \\ \text{Project Singlet} \end{bmatrix}$

If $\mathscr{R}$ is a rule scheme subject to derivational constraints $\mathscr{K}$, I will denote the constrained scheme by $\mathscr{R};\mathscr{K}$, with the set of derivational constraints following the rule scheme, separated by a semicolon. The constrained scheme relevant to ITB syllabification is (5), with $\mathscr{K} = \{\text{*Hiatus}\}$.

(5) $\begin{bmatrix} \text{Project Doublet} \\ \text{Project Singlet} \end{bmatrix}; \text{*Hiatus}$

The major insight of D&E was to realize that the key to core syllabification is to target at each step an unsyllabified timing slot with maximal sonority among set of potential targets of (5). The *potential targets* of $\mathscr{R};\mathscr{K}$ are the slots that some subrule of $\mathscr{R}$ can apply to without violating the derivational constraints $\mathscr{K}$. The potential targets of (5) are the timing slots that are unsyllabified, so that they satisfy the structural conditions of the rules, and do not directly follow a syllabified timing slot, so that *Hiatus does not prevent the application of Project Singlet. The potential targets of $\mathscr{R};\mathscr{K}$ in a form α will be denoted by $\Omega(\alpha,\mathscr{R};\mathscr{K})$ or simply Ω if the form α and rule $\mathscr{R};\mathscr{K}$ are clear from the context. A slot in Ω has maximal sonority if there is no other slot in Ω with greater sonority. Maximal sonority is determined with respect to a fine-grained relation (6). The relation below is partial, restricted to the phonemes that appear in the examples in this article.

(6) ITB Sonority
low vowel > high vowel > liquid > nasal
{ a } { i, u} { l, r} { n, m }
> voiced fricative > voiceless fricative > voiced stop > voiceless stop
{ z, ɣ, ž, ɣ^{w}, ɦ } { s, x, f, ħ} { b, d, g } { q, k, t }

The core syllable structure of the examples in (1) is derived by carrying out (7).

(7) ITB iterative syllabification (version 1)[4]

$$\begin{bmatrix}\text{Project Doublet}\\ \text{Project Singlet}\end{bmatrix};{}^{*}\text{Hiatus}$$

Apply iteratively, targeting a potential target of maximal sonority at each step.

Some derivations are given in (8). In order to help the reader understand how (7) operates, the intermediate representations are heavily annotated; the potential targets are boxed and the sonority maximum is shaded. Nuclei are underlined.

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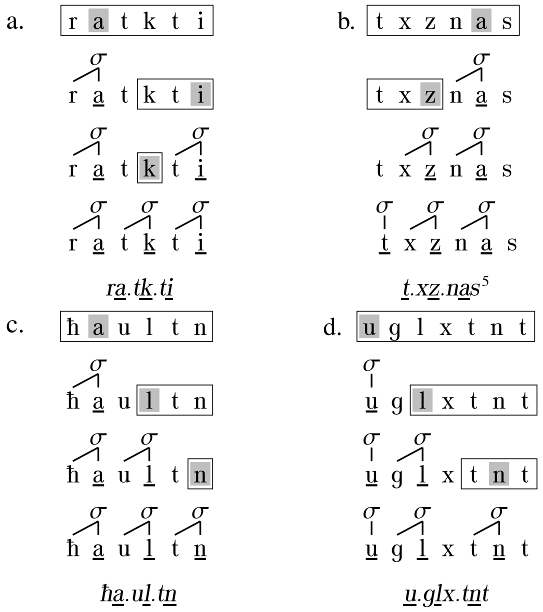
[4] Three more versions, progressively refined, will follow. See (30), (33), and (80).

(8)



a. *ra̲.tk̲.ti̲*

b. *t̲.xz̲.na̲s*[5]

c. *ħa̲.ul̲.tn̲*

d. *u̲.gl̲x.tn̲t*

The full syllable structure is built by following core syllable structure with coda adjunction.

Since DE85 did not challenge the idea that iterative rules are parameterized ±LEFT, (7) was not a possible iterative rule. D&E were led to conclude that core syllabification is carried out by a schema of iterative rules, each one operating at a particular sonority level. Specifically, they proposed the ordered list of iterative rules (9) in which each one is +LEFT.

(9) Dell Elmedlaoui Algorithm (DEA)

project low vowel syllable
project high vowel syllable
project liquid syllable
project nasal syllable
project voiced fricative syllable
project fricative syllable
project voiced stop syllable
project unvoiced stop syllable

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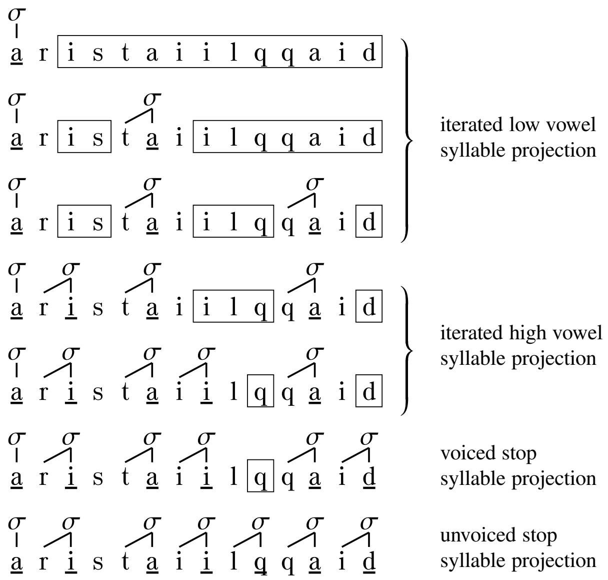
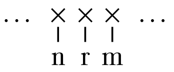
[5] There is a discrepancy between this form and *txz̲.na̲s* given in (1h). Dell & Elmedlaoui (1988) give evidence that there is a level at which the syllable structure is indeed *t̲.xz̲.na̲s*, but that a late rule desyllabifies initial onsetless syllables with obstruent nuclei and adjoins the obstruent to the following syllable as an onset. The main point for our purposes is that this late rule is not something that must be accounted for by iterative syllabification.

This produces derivations like the following:

(10) *ar-i-stai=i=lqqaid*→ *a̲.ri̲s.ta̲.ii̲.lq̲.qa̲.id̲*
‘he selects for the chief’ [117:29a]
Input: a r i s t a i i l q q a i d



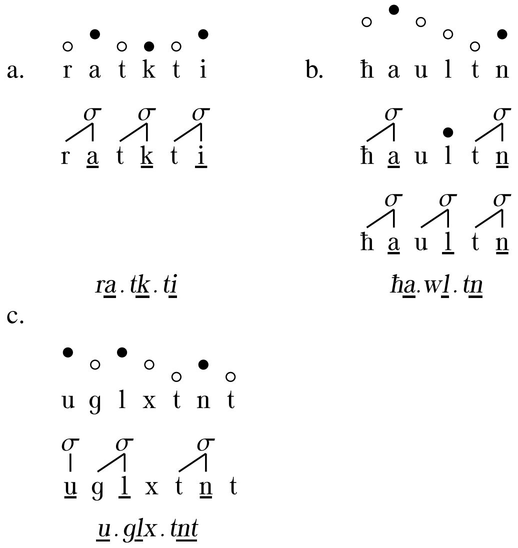
Aside from the awkward way that sonority is incorporated into the DEA, there is another important issue. Suppose we have (11), for example.

(11)


We know that *r* will syllabify as a nucleus with onset *n* whatever appears to the right and left of the *nrm* sequence. *r* will not syllabify as an onset because it is targeted before *m* is targeted. *n* will not syllabify as a nucleus because *r* is targeted before *n* is targeted. Therefore, the rule operating at the *r*-level will project a syllable with nucleus *r* and onset *n*. The same argument will apply whenever a slot is flanked by slots with lower sonority. This follows as a theorem from the DEA. Rather than a global explanation for a local fact, it would be much more desirable to explain the global facts by local relations and interactions, the standard aim in scientific work. In the derivations considered up to this point, rather than apply $\mathscr{R};\mathscr{K}$ to the leftmost global sonority maximum among the potential targets Ω, which is what the DEA does, it is sufficient to *apply* $\mathscr{R};\mathscr{K}$ *simultaneously to all of the local sonority maxima in* Ω. A local sonority maximum is any slot in Ω that is at least as sonorous as any adjacent slot in Ω. There may be two adjacent slots in Ω, or only one, or none at all. Adjacent local sonority maxima, which is a possibility, introduce a complication that we will deal with shortly.

The process can be visualized as shown in (12) and (13). The *relative heights* of the • and ◦ marks over adjacent slots gives the *relative sonorities* of the slots. Marks are placed over all the potential targets. The height of the marks does not indicate absolute sonority; relative heights give relative sonority.[6] The local sonority maxima are given a • mark and the other slots in Ω are given a ◦ mark. $\mathscr{R};\mathscr{K}$ applies at each of the slots with a • mark.

(12)



k in (12a) is a local sonority maximum because neither of the flanking slots has greater sonority.

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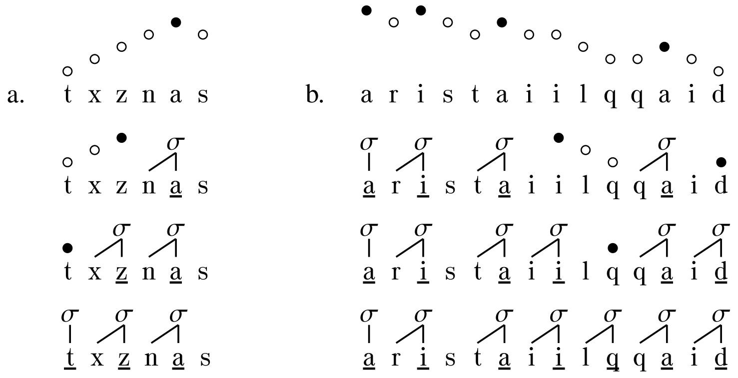
[6] There is in fact no notion of absolute sonority in linguistic theory. ITB, for example, does not assign numerical values from 1 to 8 to phonemes. All that phonology has access to is the relative sonority of phonemes.

(13)



$\underline{t}.x\underline{z}.n\underline{a}s$ $\underline{a}.r\underline{i}s.t\underline{a}.y\underline{i}.l\underline{q}.q\underline{a}.y\underline{d}$

In (12b), surface *w* denotes an underlying *u* that does not vocalize (i.e., syllabify as a nucleus) and in (13b), surface *y* denotes an underlying *i* that does not vocalize. This convention will be used in surface representations in what follows.

One aspect of left to right iteration at each sonority level does need to be incorporated into the idea that there is simultaneous application at all the local sonority maxima. Consider the examples in (14). In each case there is a sequence of two slots with the same sonority (*nn*, *sx*, and *iu*). In each case, the slot on the left vocalizes.

(14)

	underlying	*surface*			
a.	rks-x	$r.k\underline{s}x$	$*rk.s\underline{x}$	'I hid'	[114:27]
b.	bain-n	$b\underline{a}.y\underline{n}n$	$*b\underline{a}y.n\underline{n}$	'they (m.) appear'	[114:27]
c.	t-iun-t-a-s	$t\underline{i}.w\underline{n}.t\underline{a}s$	$*\underline{t}.y\underline{u}n.t\underline{a}s$	'you climbed for him'	[110]

The DEA predicts this because iteration goes from left to right.

We incorporate directionality into the theory by refining the sonority relation to a more fine-grained relationship that takes direction into account. We say that a slot x is *more prominent* than a slot y if x is more sonorous than y or if they are equally sonorous and x is to the left of y.

Some technical definitions are useful since secondary modifications of the sonority relation to produce a preference relation will be needed several times in what follows. It is one of the ways that language idiosyncrasies enter the iterative syllabification rule. A *slot preference relation* is a predicate ρ on ordered pairs of adjacent slots such that $\rho(x,y)$ and $\rho(y,x)$ are never both true. Given an slot preference relation ρ, we say $x > y\,[\rho]$ if $\rho(x,y)$ is true; $x < y\,[\rho]$ if $\rho(y,s)$ is true; and $x = y\,[\rho]$ if neither $\rho(x,y)$ nor $\rho(y,x)$ is true. Given an ordered sequence $\rho_1, \ldots, \rho_n$ of slot preference relations we recursively define a new slot preference relation by $x > y\,[\rho_1, \ldots, \rho_n]$ if $x > y\,[\rho_1]$ or if $x = y\,[\rho_1]$ and $x > y\,[\rho_2, \ldots, \rho_n]$. In these terms, the prominence relation for ITB is (15), where $x > y$ [Sonority] if x is more sonorous than y and $x > y$ [Left] if x is to the left of y.

(15) $$\text{Prominence} = \begin{bmatrix} \text{Sonority} \\ \text{Left} \end{bmatrix}$$

Whereas Sonority is a relation between phonemes, *Prominence is a slot preference relation, a relation between adjacent timing slots.*[7]

(16) (Definition) A slot x in Ω (the set of potential targets) is a *growth locus* if there is no adjacent slot in Ω that is more prominent than x.

There are at most two slots in Ω that are adjacent to x, but there can be none. A slot in Ω that has no adjacent slots in Ω is necessarily a growth locus. The notion of a growth locus is central to what follows since iterative syllabification operates by targeting growth loci. One can imagine various ways for the growth loci to be targeted: left to right, right to left, or simultaneously. I will not discuss the general issue here but, for the purposes of this article, assume (17).

(17) Iterative syllabification targets the growth loci simultaneously at each step in the derivation.[8]

The set of growth loci in a form completely changes at each step in the derivation. All of the growth loci are syllabified and are no longer potential targets, therefore no longer growth loci.

The desired syllabifications of the examples (14) are obtained from this in (18). The *relative heights* of the •-marks and ○-marks now indicate *relative prominence*. The growth loci are indicated by •-marks. The sequences *sx* in (18a), *nn* in (18b), and *iu* in (18c) each have two slots with the same sonority. Left therefore determines the relative prominence, making the initial slot in each sequence the more prominent.

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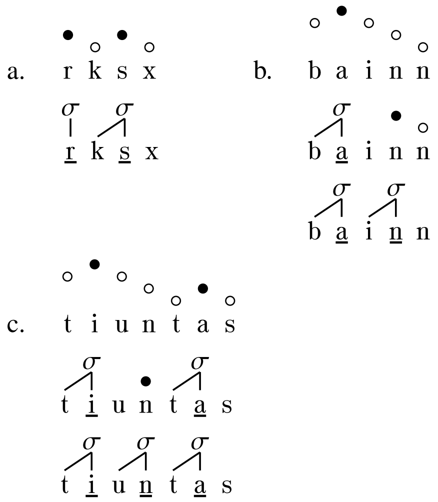
[7] The relation (15) could be considered a relation between arbitrary slots, not just between adjacent slots. We do not do this for two reasons. The first is conceptual. GDE syllabification is built around local relations, where locality is adjacency. The preference between nonadjacent slots is irrelevant; it plays no role in the theory. The second is that we will later encounter slot preference relations that are not naturally viewed as holding between nonadjacent slots. See (71) and (72) for example.

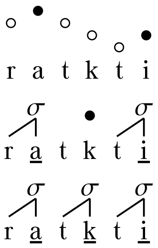
[8] I believe it to be the case that for the languages discussed in this article, the same results are obtained if the growth loci are targeted simultaneously or if the growth loci are targeted in any arbitrary order.

(18)



The derivation of the syllable structure of *ratkti* in (12a) is worth revisiting because it has a sonority plateau, a sequence of slots with equal sonority. The Prominence relations on a sonority plateau are different than the Sonority relations. Compare (19) with (12a).

(19)



The same outcome is derived, but the steps are somewhat different.

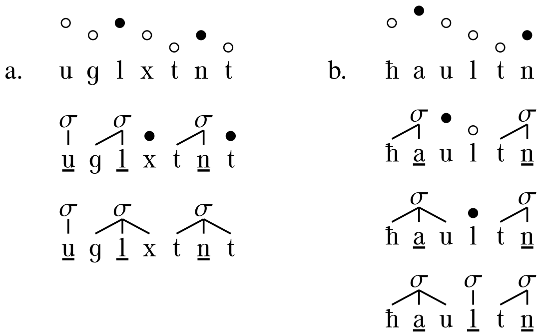
2.1. *Coda adjunction*

We now augment the basic rule scheme with Adjoin Coda so that $\mathscr{R};\mathscr{K}$ is (20).

(20) $$\begin{bmatrix}\text{Project Doublet}\\ \text{Project Singlet}\\ \text{Adjoin Coda}\end{bmatrix};\text{*Hiatus}$$

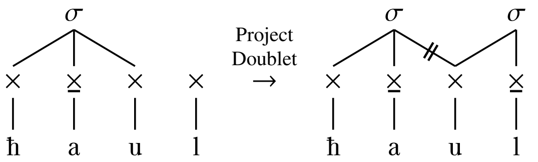
In some cases, (21a) for example, this gives the desired result without discussion. In others, (21b) for example, the derivation does not produce the desired result. Importantly, since Adjoin Coda is now a rule of $\mathscr{R}$, post nuclear slots are potential targets. But because of *Hiatus, the only subrule of $\mathscr{R}$ that can apply to a post nuclear slot is Adjoin Coda.

(21) a.



The problematic outcome in (21b) comes from the assumption that Project Doublet affects only unsyllabified slots. But we can modify the structural description of Project Doublet to remove the requirement that both the slots that it affects are unsyllabified. We allow Project Doublet to steal a coda slot from the previous syllable. Project Doublet is restricted to apply to an unsyllabified slot, but the left adjacent slot can be any nonnuclear slot. This allows, for example:

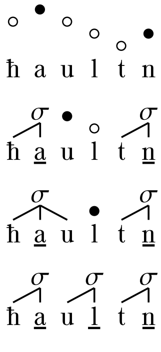
(22)



The slot associated with *u* disassociates from the first syllable when the second syllable is projected.

In place of (21b), we get (23), as desired.

(23)



ħa̲. wl̲. tn̲

The role that *Hiatus played in the 1985 analysis was to prevent syllable projection immediately following a nucleus. Now that Adjoin Coda has been included as an elementary syllable building operation and core syllabification extended to full syllabification, the role of *Hiatus can be seen differently. Its role is to insist that Adjoin Coda be used to syllabify immediately post nuclear slots rather than Project Singlet. This is a standard question of rule ordering. We can therefore reformulate (20) as (24), with no derivational constraint.[9]

$$(24)\qquad \begin{bmatrix}\text{Project Doublet}\\ \text{Adjoin Coda}\\ \text{Project Singlet}\end{bmatrix}$$

2.2. *Geminates*

The account to this point makes incorrect predictions for many words with geminates.

(25)		*underlying*	*predicted*	*actual*		
	a.	i-lːm-a-s	**i̱.ḻl.ma̱s*	*i̱ll.ma̱s*	‘he spun (e.g., wool) for him’	[122:39]
	b.	ldi-iːi	**ḻ.di̱.yi̱y*	*ḻ.di̱y.yi̱*	‘let him illuminate’	[114:27]
	c.	aiːis	**a̱.yi̱.ys̱*	*a̱y.yi̱s*	‘horse’	[122:42]
	d.	iːdar	**yi̱.da̱r*	*i̱y.da̱r*	‘(a man’s first name)’	[122:42]

DE85 shows that the desired results follow if there is a constraint on possible syllables: the second timing slot of a geminate cannot vocalize.[10] Call this the GemCondx (Geminate Condition). If GemCondx is imposed as a derivational constraint, the derivations (26) result. The geminates have been annotated with $\smile$ joining the two slots.

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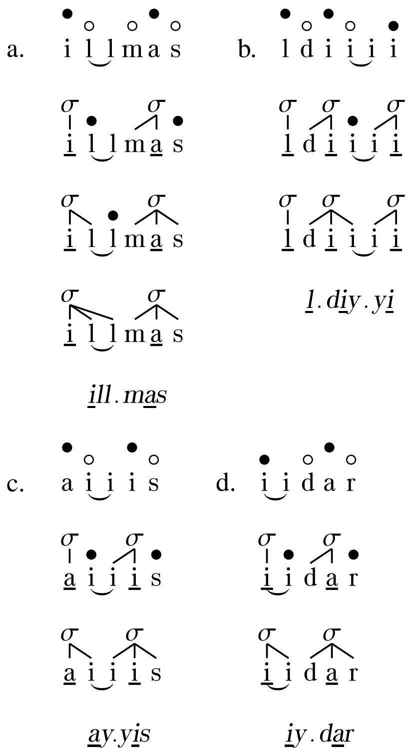
[9] It is debatable whether rule ordering is preferable to unordered syllable building rules whose order of application is controlled by constraints. There are arguments in both directions. Shedding light on this would require an extensive discussion that is tangential to developing the GDE theory.

[10] DE02 (pp. 103–106) argues that this is relaxed in poetry.

(26)



Note that since the second slot of the geminate cannot vocalize, it does not become a potential target (hence is not under a • or ○ mark) until the first slot is syllabified and it is subject to Adjoin Coda. Of course, it can be syllabified without ever becoming a potential target if it is gobbled up as an onset, as it is in (26b, c). A geminate can appear inside a syllable as a complex coda (26a), or a nucleus-coda sequence (26d), or can be split between syllables as a coda-onset sequence (26b, c) or a nucleus-onset sequence. For an example of the last case, see (29c).

2.3. Another secondary factor affecting relative prominence

Factors entering into prominence relations other than Sonority are considered to be secondary factors. Earlier, the Prominence relation was introduced as a modification of the Sonority relation by a secondary directional factor. Another secondary factor enters into relative prominence. The theory, as developed to this point, makes incorrect predictions in case the initial two slots have the same sonority.

(27)		*underlying*	*predicted*	*actual*		
	a.	i-ukr	$*\underline{i}w.k\underline{r}$	$y\underline{u}.k\underline{r}$	‘he stole’	[121]
	b.	i-urm	$*\underline{i}.u\underline{r}m$	$y\underline{i}.r\underline{m}$	‘he tasted’	[119:33]
	c.	sx:n	$*\underline{s}x.x\underline{n}$	$s\underline{x}.x\underline{n}$	‘dip (in sauce)’	[121:38]
	d.	bd:l	$*\underline{b}d.d\underline{l}$	$b\underline{d}.d\underline{l}$	‘exchange’	[121:38]

DE02 introduces what in our terms is a preference for vocalizing root slots over nonroot slots, which outranks Left, and explain (27a, b) on that basis. But a preference for vocalizing noninitial slots seems to be needed in any event to account for (27c, d).

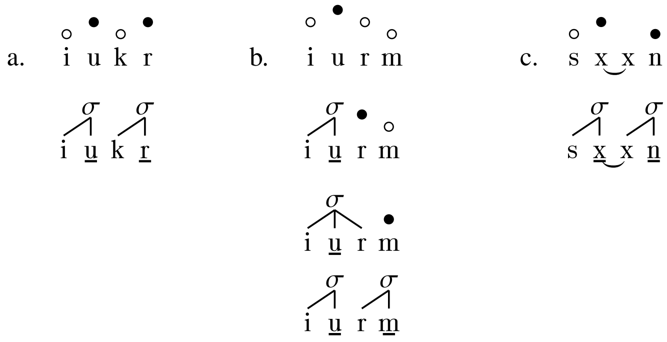
In all cases in (27) the initial two slots have equivalent sonorities, but it is the rightmost of the two that vocalizes, contrary to the precedence relation (26) that makes the initial slot have precedence over the second slot. We define the relation NonInitial between adjacent slots by saying that $\alpha > \beta$ [NonInitial] if α is not initial and β is. We then refine the Prominence relation (15) to (28).

$$(28)\quad \begin{bmatrix}\text{Sonority}\\ \text{NonInitial}\\ \text{Left}\end{bmatrix}$$

NonInitial overrules Left.

This yields the derivations (29), as desired.

(29)



The derivations of the syllable structures in (27d) and (27c) are identical.

It is worth pointing out that the complexity of (28) is not necessarily a mark against the theory being developed. Theories must be able to show how language particular idiosyncrasies can be incorporated into the theory as perturbations of the core architecture, without calling the architecture itself into question.

2.4. Summary

We can write the syllabification rule that has been developed as (30).

(30) ITB iterative syllabification (version 2)

$$\begin{bmatrix}\text{Sonority}\\ \text{NonInitial}\\ \text{Left}\end{bmatrix} :: \begin{bmatrix}\text{Project Doublet}\\ \text{Adjoin Coda}\\ \text{Project Singlet}\end{bmatrix} ;\ \text{GemCondx}$$

The prominence relation is written to the left of :: and the scheme of elementary syllable building operations and the set of derivational constraints that constrains them to its right. Application is simultaneously to the set of growth loci. This is iterated until no growth loci remain.

The scheme (31) of elementary syllable building rules occurs in all the iterative syllabification rules that will be considered in the coming sections. There is reason to believe that it is in some sense a default.

(31) $$\mathscr{R}_0 = \begin{bmatrix}\text{Project Doublet}\\ \text{Adjoin Coda}\\ \text{Adjoin Onset}\\ \text{Project Singlet}\end{bmatrix}$$

Iterative syllabification in all of the languages that are considered in this article will be viewed as variations on (32), where Sonority is a language particular order relation on the phoneme inventory and ⟨*direction*⟩ is either Left or Right. VP, the Vocalization Partition, is the set of language particular restrictions on which phonemes can or cannot vocalize (i.e., syllabify as nuclei).

(32) $$\begin{bmatrix}\text{Sonority}\\ \langle \textit{direction} \rangle\end{bmatrix} :: \mathscr{R}_0 ; \{\,\text{VP}\,\}$$

Iteration of simultaneous application at the growth loci is assumed. Variations are of three kinds: additional factors can enter into the prominence relations; additional syllable building rules can be added to $\mathscr{R}_0$; and derivational constraints in addition to VP can be imposed.

A languages Vocalization Partition establishes three classes of phonemes: those that must vocalize, called *strongly nuclear*; those that can vocalize or not depending on the context they occur in, called *seminuclear*; and those that cannot vocalize, called *nonnuclear*. In addition, there can be positional factors that restrict or demand vocalization. In Ath Sidhar Rifian Berber, for example, underlying glides are seminuclear when initial or final, otherwise nonnuclear. VP is a derivational constraint on iterative syllabification.

ITB is a poor illustration of the effects of the Vocalization Partition VP, since ITB so freely allows phonemes to vocalize or not. The only restriction seems to be that *a* must vocalize. It vocalizes in all the examples considered in this article, but there are no examples that demonstrate that a constraint insisting on this is required since *a* vocalizes through the normal working of the iterative syllabification rule in the examples considered. I will omit a proposal for accounting for the syllabification of sequences of occurrences of *a* since it is complex and would be a distraction from the main argument.[11] In most languages, VP plays a pervasive role in syllabification.

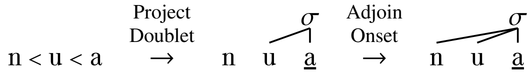
We view ITB as a variant of (32) by: choosing Left direction; adding GemCondx and *CmplxOnset as derivational constraints; and modifying the prominence relation with NonInitial.

(33) ITB iterative syllabification (version 3)

$$\begin{bmatrix}\text{Sonority}\\ \text{NonInitial}\\ \text{Left}\end{bmatrix} :: \mathscr{R}_0\,;\{\,\text{GemCondx}, \text{*CmplxOnset}, \text{VP}\,\}$$

The reason that *CmplxOnset is imposed is that if it were not, we would incorrectly get (34) since Adjoin Onset is ordered before Project Singlet.[12]

(34)



$$\text{n} < \text{u} < \text{a} \xrightarrow{\text{Project Doublet}} \text{n u }\underline{\text{a}} \xrightarrow{\text{Adjoin Onset}} \text{n u }\underline{\text{a}}$$

The correct syllabification is $\underline{n}.w\underline{a}$.

An alternative to imposing *CmplxOnset might have been to drop Adjoin Onset from the elementary syllable building rules. We will see in Section 5, however, that Adjoin Onset is required.

3. Khalka Mongolian syllabification

I rely on the particularly clear analysis of KM syllabification by Svantesson (1995). References in this section are to that article unless otherwise noted. Some examples of the data that must be accounted for are given in (35). The KM vowels are {*i* ,*e* ,*u* , *ɵ, a, ɷ, ɔ*} and the epenthetic vowel ə.[13]

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[11] Three different rules are involved, which are applicable only to syllabifying sequences of occurrences of *a*. But they are all simple and more widely used for syllabification in other languages: long nucleus formation, glide epenthesis, and deletion. If *Hiatus and the constraint against nonnuclear *a* are imposed as derivational constraints, use of one of the special rules to syllabify *a* is forced.

[12] There are syllables with complex onsets at the surface. See Footnote 5 for example. But they are produced by later rules, not iterative syllabification.

[13] I use Svantesson's phoneme symbols. They follow the IPA except for c [ts], č [tʃ], z [dz], ž [dʒ], š [ʃ], and l [lʒ].

(35)

	underlying	*surface*[14]		
a.	*bɔlžmr*	*bɔ̱lž.mə̱r*	‘lark’	[760:9]
b.	*zims-t*	*zi̱mst*	‘fruit-ADJ’	[758:5]
c.	*tarwg*	*ta̱r.wə̱g*	‘marmot’	[760:8a]
d.	*jɵrtnc*	*jɵ̱r.tə̱nc*	‘world’	[760:9]
e.	*ɢɷdmž*	*ɢɷ̱.də̱mž*	‘street’	[760:8h]
f.	*ɢɷrɢldai*	*ɢɷ̱r.ɢə̱l.da̱i̱*	‘nightingale’	[760:9]

An epenthetic vowel ə appears in all but (35b). The main thing that needs to be accounted for is the position of the epenthetic vowels. Why not *jɵ̱rt.nə̱c* or *zi̱m.sə̱t* or *ɢɷ̱d.mə̱ž* ?

Svantesson shows that Sonority is crucial in understanding KM syllabification. He proposes the relation (36). (Here, only phonemes that occur in the examples are included.)

(36) Khalka Mongolian Sonority

vowel $>$ sonorant, voiced velar or uvular stop[15]
a, ɔ, i, u, ɵ, ɷ, ə a, ɔ, i, u, ɵ, ɷ, ə

$>$ fricative $>$ stop, affricate
z, ž, x, s d, b, c, č, t

Svantesson makes the following observations about KM syllable structure:

(37) a. Vowels must vocalize; other phonemes cannot vocalize.
b. All noninitial surface syllables have an onset consisting of exactly one consonant.
c. Codas must have strictly decreasing sonority.

Svantesson takes (37) to be constraints on syllabification and shows how the observed syllable patterns can be derived from the assumption of right to left syllable maximization, inserting epenthetic ə as needed.

I will pursue a different approach, adapting the rule (32) to KM. I will adopt (37a) in toto as the Vocalization Partition of KM. I will also adopt one aspect of (37b) by imposing *CmplxOnset. (37c) will follow as a theorem. (37b) will be left without a full account because that would require an analysis of the syllabification of vowel sequences and Svantesson's article does not address

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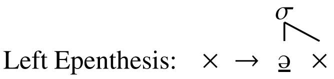
[14] This is called the “surface” form for want of a better term. It ignores variation in the surface form of the epenthetic vowel due to the local environment it appears in. The variation is irrelevant to the present inquiry.

[15] In most languages that make a phonological distinction between the sonority of fricatives and the sonority of stops, ITB for example, any stop is less sonorous than any fricative. KM appears to be an exception.

this issue. There is only one example in the article that has a diphthong, (35f). Aside from the question of vowel sequences, *CmplxOnset is sufficient to show that (37b) holds.

The main innovation that is needed is the introduction of a last resort syllable epenthesis subrule into the scheme of elementary syllable building rules.



Left Epenthesis: × → ə̲ ×

The targeted timing slot is integrated into the syllable structure as the coda of syllable whose nucleus is epenthetic.

Assuming the sonority relation (36) and VP (36a), KM iterative syllabification is specified by:

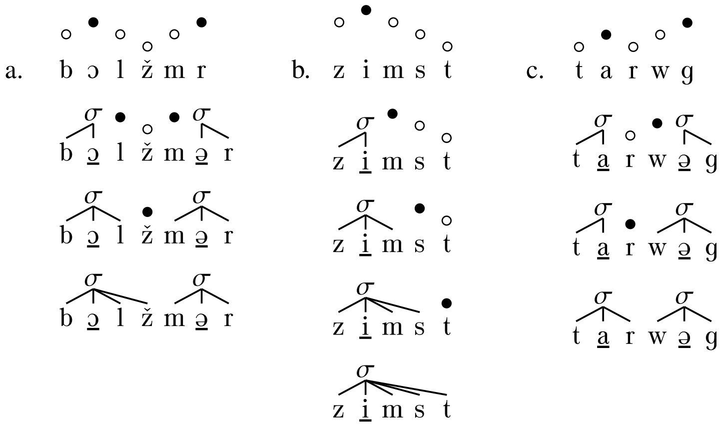
(38) KM iterative syllabification:

$$\begin{bmatrix}\text{Sonority}\\ \text{Right}\end{bmatrix};\begin{bmatrix}\mathscr{R}_0\\ \text{Left Epenthesis}\end{bmatrix};\{\text{*CmplxOnset, VP}\}$$

Compare this with the default rule (32). It should go without saying at this point that application is iterative with the growth loci targeted simultaneously at each step.

The derivations of the syllable structures (35a, b, c) are straightforward.

(39)



Since many derivations must be illustrated in what is to come, a more compact way to represent derivations is needed. What is required to verify the correctness of the derivations, is verification that 1) the set of potential targets Ω is as claimed; 2) the relative prominences are as claimed; 3) the growth loci (solid bullets) are located as claimed; and 4) at each growth locus the highest ranked elementary syllable building operation that can apply does apply. The latter is a question of the structural descriptions of the rules and the constraints $\mathscr{K}$. The representations in (40), which reproduce the derivations in (39), make it relatively easy to carry out the verification. There are two weaknesses compared to the representations above. One is that the growth loci are not so conspicuous. But it is not hard to figure out the location of the growth loci from the prominence relation annotations. The second is that in cases in which the Ω does not coincide with the set of unsyllabified slots, it may not be obvious what Ω is. These cases are rare. If necessary for clarity, the slots in Ω will be boxed so that there is no confusion. These representations are not only much more compact but in one way the representations (40) are more informative than those in (39). I have used $\alpha \ll \beta$ below, and will in the future, to indicate that α is less prominent than β, but not less sonorous. This makes it somewhat easier to verify that the prominence relations are as claimed. $\gg$ will be used in the corresponding way. In KM, $\alpha \ll \beta$ means that α and β are equally sonorous, but that β is to the right of α.

(40) a. b < ɔ > l > ž < m ≪ r
(b ɔ̱) l > ž < m (ə̱ r)
(b ɔ̱ l) ž (m ə̱ r)
(b ɔ̱ l ž) (m ə̱ r)
bɔ̱lž.mə̱r

b. ž < i > m > s > t
(ž i̱) m > s > t
(ž i̱ m) s > t
(ž i̱ m s) t
(ž i̱ m s t)
ži̱mst

c. t < a > r ≪ w ≪ g
(t a̱) r ≪ w (ə̱ g)
(t a̱) r (w ə̱ g)
(t a̱ r) (w ə̱ g)
ta̱r.wə̱g

The derivations of (35d, e, f) do not immediately produce the desired surface form.

(41) a. ɢ ‹ ɷ › r « ɢ « l › d ‹ a « i
(ɢ ɷ) r ≪ ɢ (ə̱ l) d < a (i̱)
(ɢ ɷ) r (ɢ ə̱ l) (d a̱) (i̱)
(ɢ ɷ r) (ɢ ə̱ l) (d a̱) (i̱)
ɢɷ̱r.ɢə̱l.da̱.i̱

b. ɢ < ɷ > d < m > ž
(ɢ ɷ̱) d (ə̱ m) ž
(ɢ ɷ̱ d) (ə̱ m ž)
ɢɷ̱d.ə̱mž

c. j < ɵ > r > t < n > c
(j ɵ̱) r > t (ə̱ n) c
(j ɵ̱ r) t (ə̱ n c)
(j ɵ̱ r t) (ə̱ n c)
jɵ̱rt.ə̱nc

Svantesson has a diphthong in place of the two vowels in hiatus in (41a). I will defer in this article an account of the syllabification of V-V sequences and leave this unexplained. Onsetless syllables headed by an epenthetic vowel are produced in (41b, c). I assume that iterative syllabification is cyclic and there is a post cyclic rule, perhaps very late in the derivation, which repairs onsetless syllables by stealing coda consonants when possible. Evidence for onsetless syllables in intermediate representations will be given when cyclic effects are considered.

The GDE account of KM syllabification is superior to the templatic account in an important way. The templatic account must stipulate that codas have decreasing sonority. The GDE account explains why this is so. It is a consequence of the way that the iteration proceeds, targeting growth loci at each step. We can prove that (42) is true in both ITB and KM. As a consequence, for example, since *z* is less prominent than *n* in both ITB and KM, it follows that *tẕn* is an impossible syllable in ITB and *ti̱zn* is an impossible syllable in KM.

(42) A coda slot is less prominent than the slot to its left.

To prove (42), suppose $\times_2$ is a coda slot and $\times_1$ is the slot to its left. We first note that $\times_2$ can syllabify as a coda in only two ways; by Adjoin Coda or, in KM, by Left Epenthesis. If it is the latter, then $\times_2$ cannot vocalize and $\times_1$ is an epenthetic vowel, which is more sonorous (and therefore more prominent) than any of the phonemes that cannot vocalize. If $\times_2$ becomes a coda via Adjoin Coda, then $\times_1$ must already be syllabified at the point that Adjoin Coda applies to $\times_2$. $\times_1$ cannot syllabify as an onset, because this would mean that $\times_2$ is a nucleus, not a coda. So $\times_1$ must become a growth locus while both $\times_1$ and $\times_2$ are still syllabified. But this is impossible because $\times_1$ was assumed to be less prominent than $\times_2$.

(42) is not as obvious for ITB as it might seem to be. Recall that there are onset-nucleus sequences in which the onset is more prominent than the nucleus. The second syllable of *ħa̱.uḻ.tṉ*, (8c), for example. But according to (42) there are no nucleus-coda sequences in which the coda is more prominent than the nucleus.[16]

3.1. *Cyclic effects in syllabification*

Svantesson (1995: 762–763) gives a number of minimal pairs that demonstrate cyclic effects.

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[16] We will see examples in Section 5 in which the coda is more sonorous than the nucleus; but is less prominent. As we shall see, underlying glides enter into highly irregular prominence relations in some contexts.

(43) a. xɷc t la → *xɷ̱.cə̱t.la̱*
ram VERB PAST
‘mounted (like a ram)’
b. xɷc tl a → *xɷ̱c.tə̱.la̱*
bark TERM REFL
‘until its barking’

(44) a. zɵwl lɵ → *zɵ̱.wə̱l.lɵ̱*
advice PAST
‘advised’
b. zɵwl l ɵ → *zɵ̱w.lə̱.lɵ̱*
advice NOUN REFL
‘his advice’

(45) a. alt d ml → *a̱l.tə̱d.mə̱l*
gold VERB ADJ
‘gilded’
b. ard čl l → *a̱rd.čə̱.lə̱l*
people VERB NOUN
‘democratization’

The sonority profiles of *alt-d-ml* and *ard-čl-l* in (45) are identical, so if there were no cyclic effects, we would expect them to syllabify in the same way.

The different positions of the epenthetic vowel seem to be a straightforward case of the persistence of epenthetic vowels inserted cyclically. For example:

(46) a. xɷ̱c + t → xɷ̱.cə̱t
xɷ̱.cə̱t + la → xɷ̱.cə̱t.la̱
b. xɷ̱c + tl → xɷ̱c.tə̱l
xɷ̱c.tə̱l + a → xɷ̱c.tə̱.la̱

But examples like (47) show that cyclic syllabification has a subtlety. Not all epenthetic vowels survive through later cycles.

(47) u̱i̱l + čl → u̱i̱l.čə̱l ‘to serve’ [761:10]
u̱i̱l.čə̱l + ul → u̱i̱lč.lul ‘to cause to serve’

A theory of cyclic syllabification is needed that will correctly account for the persistence of epenthetic vowels in some cases, like those in (46), and their deletion in cases like (47).

One approach might be to say that the outcome is initially *u̱i̱l.čə̱.lul* in (47), but that the epenthetic vowel deletes because its onset *č* can be integrated into the coda of the preceding syllable. But that would require a templatic condition on codas to decide if a particular onset slot could extend the coda of the previous syllable. But no template has been assumed.

Another approach is much more satisfactory. It relies on two things. First, the approach to syllabification above in which some epenthetic syllables remain onsetless until a post cyclic rule supplies them with an onset by stealing a slot from the preceding coda. Second, the following assumption about the mechanics of cyclic syllabification.

(48) Cyclic suffixation:
When the suffix is concatenated, the stem is reduced to core syllable structure and onsetless ə-syllables that remain are deleted.[17]

Reduction to core syllable structure desyllabifies codas and, in languages that have complex onsets, all but the innermost onset.

This yields the following derivations for the two forms in (46) and for the form in (47).

(49) a.
x ‹ ɷ › c
(x ɷ̱) c
(x ɷ̱ c)
+ t
(x ɷ̱) c ≪ t
(x ɷ̱) c (ə̱ t)
(x ɷ̱ c) (ə̱ t)
+ la
(x ɷ̱) c ≪ t < l < a
(x ɷ̱) c ≪ t (l a̱)
(x ɷ̱) c (ə̱ t) (l a̱)
(x ɷ̱ c) (ə̱ t) (l a̱)
xɷ̱.cə̱t.la̱

b.
x ‹ ɷ › c
(x ɷ̱) c
(x ɷ̱ c)
+ tl
(x ɷ̱) c ≪ t < l
(x ɷ̱) c ≪ t (ə̱ l)
(x ɷ̱) c (t ə̱ l)
(x ɷ̱ c) (t ə̱ l)
+ a
(x ɷ̱) c (t ə̱) l < a
(x ɷ̱ c) (t ə̱) (l a̱)
xɷ̱c.tə̱.la̱

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[17] Svantesson's account is much more stipulative. He says (1995: 763): "The algorithm is further seen to be governed by maximal right-to-left syllabification as well as the following restriction on resyllabification: A schwa may be deleted from the input string, inserted between the input string and the suffix, or inserted into the suffix, but no new schwa may inserted into the input string".

c. u « i › l
u (i̲) l
(u̲) (i̲ l)
+ čl
(u̲) (i̲) l č l
(u̲) (i̲) l > č < l
(u̲) (i̲ l) č (ə̲ l)
(u̲) (i̲ l č) (ə̲ l)
+ ul
(u̲) (i̲) l > č < l < u > l
(u̲) (i̲ l) č (l u̲) l
(u̲) (i̲ l č) (l u l)
u̲i̲lč.lu̲l

One might think that a less extreme reduction than that specified in (48) would be sufficient to correctly capture the cyclic effects. In particular, that the reduction of only the final syllable to core structure would be sufficient. But in (49a), for example, this would give (50), which is incorrect.

(50) (x ɷ̲ c) (ə̲ t)
+ la
(x ɷ̲ c) t < l < a
(x ɷ̲ c) t (l a̲)
(x ɷ̲ c t) (l a̲)

This is incorrect in a major way. An impossible syllable (*xɷ̲ct*) is formed, with the two coda consonants having equivalent sonority.[18]

The derivations of the forms in (44) and (45) are given in (51) and (52).

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[18] A less elegant, but computationally more efficient, alternative to (48) would be to desyllabify the right edge of the stem back to the rightmost nucleus that is either nonepenthetic or has an onset. Bare ə-syllables would then be deleted.

(51) a.
z < ɵ > w ≪ l
(z ɵ̲) w (ə̲ l)
(z ɵ̲ w) (ə̲ l)
\+ lɵ
(z ɵ̲) w ≪ l ≪ l < ɵ
(z ɵ̲) w ≪ l (l ɵ̲)
(z ɵ̲) w (ə̲ l) (l ɵ̲)
(z ɵ̲ w)(ə̲ l) (l ɵ̲)
zɵ̲.wə̲l.lɵ̲

b.
(z < ɵ > w ≪ l
(z ɵ̲) w (ə̲ l)
(z ɵ̲ w) (ə̲ l)
\+ l
(z ɵ̲) w ≪ l ≪ l
(z ɵ̲) w ≪ l (ə̲ l)
(z ɵ̲) w < (l ə̲ l)
(z ɵ̲ w) (l ə̲ l)
\+ ɵ
(z ɵ̲ w) (l ə̲) l < ɵ
(z ɵ̲ w) (l ə̲) (l ɵ̲)
zɵ̲w.lə̲.lɵ̲

(52) a.
a › l › t
(a̲) l > t
(a̲ l) t
(a̲ l t)
\+ d
(a̲) l > t ≪ d
(a̲ l) t (ə̲ d)
(a̲ l t) (ə̲ d)
\+ ml
(a̲) l > t ≪ d < m ≪ l
(a̲ l) t ≪ d < m (ə̲ l)
(a̲ l) t ≪ d (m ə̲ l)
(a̲ l) t (ə̲ d) (m ə̲ l)
(a̲ l t) (ə̲ d) (m ə̲ l)
a̲l.tə̲d.mə̲l

b.
a › r › d
(a̲) r > d
(a̲ r) d
(a̲ r d)
\+ čl
(a̲) r > d ≪ č < l
(a̲ r) d ≪ č (ə̲ l)
(a̲ r) d (č ə̲ l)
(a̲ r d) (č ə̲ l)
\+ l
(a̲) r > d (č ə̲) l ≪ l
(a̲ r) d (č ə̲) l (ə̲ l)
(a̲ r d) (č ə̲ l) (ə̲ l)
a̲rd.čə̲.lə̲l

4. Ath-Sidhar Rifian Berber

This section is based on Dell & Tangi (1993). All of the data and empirical generalizations are theirs as well as several analytical insights. References are to that article unless otherwise noted.

Ath-Sidhar Rifian Berber (ASR) syllabification of input phoneme sequences that do not involve *r* is for the most part quite familiar. Some representative examples follow in (53). Epenthetic ə is used to break up consonant sequences that could not otherwise be syllabified. Morpheme boundaries will be shown in the input. # denotes a clitic boundary; other morpheme boundaries are denoted by -. The latter do not affect the output, but clitic boundaries can (see Section 4.3).

(53)		*underlying*	*surface*		
	a.	nudm-n	*nu̲d.mə̲n*	‘they dozed’	[5]
	b.	ʒbð-ʁ	*ʒə̲b.ðə̲ʁ*	‘I pulled’	[5]
	c.	zawr	*za̲.wə̲r*	‘forgive’	[14]
	d.	nqs	*nqə̲s*	‘decrease’	[12]

As a starting point, I assume the following Sonority relation and Vocalization Partition VP. The vowels are *a*, *i*, and *u*.

(54) a. Sonority: vowel $>$ *r* $>$ other
b. VP: Vowels are strongly nuclear; initial and final glides (*w* and *y*) are seminuclear.

The iterative syllabification rule, except for one amendment to the prominence relation that will be needed, is identical to the KM rule (38), given the differences in Sonority and VP. Left Epenthesis is the same as the KM operation.

(55) ASR iterative syllabification (version 1)

$$\begin{bmatrix}\text{Sonority}\\ \text{Right}\end{bmatrix};\begin{bmatrix}\mathscr{R}_0\\ \text{Left Epenthesis}\end{bmatrix};\{\,\text{*CmplxOnset}, \text{VP}\,\}$$

As in ITB and KM, the growth loci are targeted simultaneously. An amendment to the prominence relations will be necessary later to account for some special properties of *r*.

Derivations for the examples (53) are given in (56).

(56) a. nudm-n
n ‹ u › d « m « n
(n u̲) d ≪ m (ə̲ n)
(n u̲) d (m ə̲ n)
(n u̲ d) (m ə̲ n)

nu̲d.mə̲n

b. ʒbð-ʁ
ʒ ≪ b ≪ ð ≪ ʁ
ʒ ≪ b ≪ ð (ə̲ ʁ)
ʒ ≪ b (ð ə̲ ʁ)
ʒ (ə̲ b) (ð ə̲ ʁ)
(ʒ ə̲ b) (ð ə̲ ʁ)
ʒə̲b.ðə̲ʁ

c. z ‹ a › w ‹ r
(z a̲) w (ə̲ r)
(z a̲ w) (ə̲ r)

za̲.wə̲r

d. nqs
n ≪ q ≪ s
n ≪ q (ə̲ s)
n (q ə̲ s)
(ə̲ n) (q ə̲ s)
nqə̲s

Just as in KM, iterative syllabification sometimes produces onsetless epenthetic syllables, as in (56c,d). I assume that they are eliminated by a post cyclic rule (ONS) that steals a coda from the previous syllabic (as in KM), if possible, otherwise deletes the epenthetic vowel and adjoins the stranded consonant to the adjacent syllable. (56c) illustrates coda theft and (56d) illustrates epenthetic vowel deletion.

Word final glide vocalization is illustrated in (57).

(57) a. fsy-θ ‘untie (imperf. 2sg) [43]
f ≪ s ≪ y ≪ θ
f ≪ s ≪ y (ə̲ θ) †
f ≪ s (y ə̲ θ)
f (ə̲ s) (y ə̲ θ)
(f ə̲ s) (y ə̲ θ) ONS
fə̲s.yə̲θ

b. fsy ‘untie (imperf. 2pl) [43]
f ≪ s ≪ y ‡
f (s y̲)
(ə̲ f) (s y̲)
(f s y̲) ONS
fsi̲

The *y* in † is nonnuclear, so the highest ranked rule that applies is Adjoin Onset. The *y* in ‡ is seminuclear, because it is word final, so it can vocalize. The highest ranked rule that can apply is Project Doublet. Word initial glide vocalization will be illustrated later in (66a).

4.1. *The special features of r-syllabification*

Here are some representative examples.

(58)		*underlying*	*predicted*	*actual*		
	a.	frin	*ə̲f.ri̲n*	*fri̲n*	‘sort (neg stem)’	[12]
	b.	!rða[19]	*ə̲r.ða̲*	*a̲.ða̲*	‘gratefully accept’	[18]
	c.	!rʒf	*ə̲r.ʒə̲f*	*a̲.ʒəf*	‘make noise’	[18]
	d.	fsr	*ə̲f.sə̲r*	*fsa̲*	‘hang up washing’	[15]
	e.	frn	*fə̲rn*	*fa̲n*	‘sort (perf stem)’	[12]

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[19] Emphatic pronunciation, represented by ! in the underlying form, has no effect on syllabification and will be systematically ignored in derived forms.

What is called ‘predicted’ is the predicted output of cyclic syllabification. Post cyclic application of ONS yields the correct surface form in (58a), but the predictions in (58b–e) are wildly incorrect.

One might conclude on the basis of data like these that there is a *ər*→*a* rule that yields the desired outputs. But this cannot be correct. If *r* is the first timing slot of a geminate, both *a* and *r* appear.

(59)		*underlying*	*predicted*	*actual*		
	a.	frrn	*fə̲rr. ə̲n*	*fa̲r.rə̲n*	‘sort (imperf. stem)’	[12]
	b.	!rrʒf	*ə̲rr.ʒə̲f*	*a̲rr.ʒə̲f*	‘uproar’	[18]

This suggests that there are two rules, *a*-insertion (A-INS) and *r*-deletion (R-DEL), with A-INS applying in both (58) and (59), but with R-DEL blocked by geminate inalterability in (59). I will pursue that approach.[20]

If we carry out iterative syllabification, followed by *ə→a in the context of coda* r (A-INS), followed by *deletion of coda* r *in syllables with an* a*-nucleus* (R-DEL), the correct predictions are made for (58a–d). Here are the derivations.

(60)	a.	frin	b.	rða	c.	fsr
		f < r < i > n		†r > ð < a		f ≪ s < r
		f (r i̲) n		(ə̲ r) (ð a̲)		f ≪ s (ə̲ r)
		(ə̲ f) (r i̲ n)				f (s ə̲ r)
						(ə̲ f) (s ə̲ r)
A-INS				(a̲ r) (ð a̲)		(ə̲ f) (s a̲ r)
R-DEL				(a̲) (ð a̲)		(ə̲ f) (s a̲)
		fri̲n		*a̲.ða̲*		*fsa̲*

	d.	fsr	e.	frn
		f ≪ s < r		†f < r > n
		f ≪ s (ə̲ r)		f (ə̲ r) n
		f (s ə̲ r)		(f ə̲ r n)
		(ə̲ f) (s ə̲ r)		
A-INS		(ə̲ f) (s a̲ r)		(f a̲ r n)
R-DEL		(ə̲ f) (s a̲)		(f a̲ n)
		fsa̲		*fa̲n*

At the places marked †, *r* is more prominent than the consonant to its right because it is more sonorant than other consonants according to (54a). This has

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[20] Dell and Tangi’s preliminary analysis combines *a* insertion and *r* deletion, but they abandon it in favor of an “*r*-vocalization” analysis, for reasons that are not entirely clear to me.

no effect on the syllabification in (60b) but does in (60e), causing the epenthetic vowel to be inserted to the left of *r*.

The derivations of the forms in (59) are given below under the assumption that geminate inalterability prevents Left Epenthesis from applying to the second slot of a geminate. That would require splitting the geminate with a medial ə. Initially, the second slot of the *r*-geminate is not a potential target. It is not a target of Project Doublet or Project Singlet because it cannot vocalize. Left Epenthesis is blocked and the Adjunction operations cannot apply because there is no structure to adjoin to. To make it easier for the reader to verify the derivations, frames have been put around the potential targets below in the forms in which not every slot is a potential target.

(61)	a.	frːn	b.	rːʒf
		$\boxed{\text{f} < \text{r}}$ r $\boxed{\text{n}}$		$\boxed{\text{r}}$ r $\boxed{\text{ʒ} \ll \text{f}}$
		f (ə̲ r) r (ə̲ n)		(ə̲ r) r > ʒ (ə̲ f)
		(f ə̲ r r) (ə̲ n)		(ə̲ r r) ʒ (ə̲ f)
				(ə̲ r r ʒ) (ə̲ f)
	A-INS	(f a̲ r r) (ə̲ n)		(a̲ r r ʒ) (ə̲ f)
	ONS	(f a̲ r) (r ə̲ n)		(a̲ r r) (ʒ ə̲ f)
		fa̲r.rə̲n		*a̲rr.ʒə̲f*

R-DEL is blocked by geminate inalterability.

4.2. Word final *ry* and *rw*

Something more must be said about word final *r*-glide sequences. We need to account for the following data.

(62)		*underlying*	*surface*		
	a.	ħry	*ħri̲*	‘grind (imperf. 2sg)’	[43]
	b.	ħry-θ	*ħa̲.yə̲θ*	‘grind (imperf. 2pl)’	[43]
	c.	tt-!arw	*!tta̲.ru̲*	‘give birth (imperf. stem)’	[44]
	d.	tː-!arw-ʁ	*!tta̲.wə̲ʁ*	‘give birth (imperf. 1sg)’	[44]

Under the assumptions made to this point, the derivations are as given in (63).

(63)	a.	ħ < r > y	b.	ħ < r > y ≪ θ
		ħ (ə̲ r) y		ħ (ə̲ r) y (ə̲ θ)
		(ħ ə̲) (r y̲)		(ħ ə̲ r) (y ə̲ θ)
	A-INS			(ħ a̲ r) (y ə̲ θ)
	R-DEL			(ħ a̲) (y ə̲ θ)
		ħə̲.ri̲		*ħa̲.yə̲θ*

	c.	$\boxed{\text{t}}\ \text{t}\ \boxed{\text{a} > \text{r} > \text{w}}$	d.	$\boxed{\text{t}}\ \text{t}\ \boxed{\text{a} > \text{r} > \text{w} \ll \text{ʁ}}$
		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\,)\ \text{r} > \text{w}$		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\,)\ \text{r} > \text{w}\ (\,\underline{\text{ə}}\ \text{ʁ}\,)$
		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\ \text{r}\,)\ \text{w}$		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\ \text{r}\,)\ \text{w}\ (\,\underline{\text{ə}}\ \text{ʁ}\,)$
		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\,)\,(\,\text{r}\ \underline{\text{w}}\,)$		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\ \text{r}\ \text{w}\,)\,(\,\underline{\text{ə}}\ \text{ʁ}\,)$
R-DEL				$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\ \text{w}\,)\,(\,\underline{\text{ə}}\ \text{ʁ}\,)$
ONS		$(\,\text{t}\ \text{t}\ \underline{\text{a}}\,)\,(\,\text{r}\ \underline{\text{w}}\,)$		$(\,\text{t}\ \text{t}\ \underline{\text{a}}\ \text{w}\,)\,(\,\underline{\text{ə}}\ \text{ʁ}\,)$
		$\textit{tt}\underline{\textit{a}}\textit{.r}\underline{\textit{u}}$		$\textit{tt}\underline{\textit{a}}\textit{.w}\underline{\textit{ə}}\textit{ʁ}$

Note that R-DEL applies in (63c) and A-INS does not, giving further evidence that A-INS and R-DEL are separate rules. (63a) is a problem. The epenthetic vowel is inserted in the wrong place.

It must be the case that the prominence of *r* is reduced in (63a) so that it is not targeted in the first step of the derivation. Formally, we proceed as follows. We define the relation WFG (word final glide) by saying $\alpha > \beta$ [WFG] if α is a word final glide and β is an adjacent *r*, and amend the prominence relation in (55) to the one in (64).

(64) ASR iterative syllabification (version 2)

$$\begin{bmatrix} \text{WFG} \\ \text{Sonority} \\ \text{Right} \end{bmatrix} ; \begin{bmatrix} \mathscr{R}_0 \\ \text{Left Epenthesis} \end{bmatrix} ; \{\,\text{*CmplxOnset}, \text{VP}\,\}$$

This is the first example of a secondary modification of a prominence relation that can overrule Sonority in certain contexts. There will be another one in the next section, which also involves glides (in ITB). It would be simpler if language idiosyncrasies in syllabification never overruled Sonority. But it seems that sometimes they do. An ordered list of preference relations is a relatively straightforward way to formalize this.

This modification of the prominence relation will affect the derivations (63a) and (63c). We get the following, as desired. Note that the prominence relations between the final glide and the preceding *r* are the opposite of the corresponding (63a) and (63c) relations.

(65)	a.	$\text{ħ} < \text{r} \ll \text{y}$	b.	$\boxed{\text{t}}\ \text{t}\ \boxed{\text{a} > \text{r} \ll \text{w}}$
		$\text{ħ}\ (\,\text{r}\ \underline{\text{y}}\,)$		$(\,\underline{\text{ə}}\ \text{t}\,)\,(\,\text{t}\ \underline{\text{a}}\,)\,(\,\text{r}\ \underline{\text{w}}\,)$
		$(\,\underline{\text{ə}}\ \text{ħ}\,)\,(\,\text{r}\ \underline{\text{y}}\,)$		
		$\textit{ħr}\underline{\textit{i}}$		$\textit{tt}\underline{\textit{a}}\textit{.r}\underline{\textit{u}}$

Fortunately, (65a) corrects (63a) while (65b) still produces the same (correct) result as (63c).

4.3. Cyclic effects

If an *r* final stem combines with a vowel initial clitic, and syllabification is assumed to follow concatenation, the syllabification rules proposed do not make the correct predictions.

(66)

	underlying	*predicted*	*actual*		
			n-final stem		
a.	y-ðhnˁit	*i̲.ðə̲h.ni̲t*	*i̲.ðə̲h.ni̲t*	‘he rubbed her’	[38]
			r-final stem		
b.	y-!ndrˁit	*i̲.nə̲d.ri̲t*	*yə̲n.da̲.ri̲t*	‘he threw (perf.) it (f.)’	[16]
c.	i-!ʁzrˁa	*i̲.ʁə̲z.ra̲*	*i̲ʁ.za̲.ra̲*	‘river’	[38]
d.	a-!zwrˁa	*a̲.zə̲w.ra̲*	*a̲z.wa̲.ra̲*	‘blood vessel’	[38]

In order to distinguish the *r*-final cases from the others, Dell and Tangi proposed that clitics attach to a syllabified stem but that when the clitic is concatenated with the stem, the syllable structure of the stem is reduced, as in Khalka Mongolian (where the process applies to all affixes, not just clitics). The reduction is even more aggressive than it is in KM, reducing the syllable structure to core syllables and deleting all the epenthetic vowels (in KM, only epenthetic vowels in onsetless syllables are deleted). We can then account for (66b, c, d) by assuming that A-INS applies cyclically, but that R-INS is post cyclic along with ONS. Since A-INS is cyclic, the position of epenthetic vowels that have been replaced by *a* escape deletion when the clitic is concatenated. This is somewhat similar to cyclic syllabification in Khalka Mongolian. In KM, epenthetic syllables that have acquired an onset cyclically are protected from deletion when a suffix is concatenated. Under these assumptions, the derivations of (65a) and (65b) are given below.

(67) a. y-ðhn#it → *i.ðəh.nit*

First cycle	Clitic cycle
y ≪ ð ≪ h ≪ n	y ð h n + i t
y ≪ ð ≪ h (ə̲ n)	y ≪ ð ≪ h ≪ n < i > t
y ≪ ð (h ə̲ n)	y ≪ ð ≪ h (n i̲) t
y (ə̲ ð) (h ə̲ n)	y ≪ ð (ə̲ h) (n i̲ t)
(y ə̲ ð) (h ə̲ n)	(y̲) (ð ə̲ h) (n i̲ t)
(y ə̲ ð) (h ə̲ n)	

b. y-!ndr#it → yən.da.rit

First cycle		Clitic cycle
y ≪ n ≪ d < r		y n (d a̲) r + i t
y ≪ n ≪ d (ə̲ r)		y ≪ n (d a̲) r < i ⌢ t
y ≪ n (d ə̲ r)		y (ə̲ n) (d a̲) (r i̲) t
y (ə̲ n) (d ə̲ r)		(y ə̲ n) (d a̲) (r i̲ t)
(y ə̲ n) (d ə̲ r)		
(y ə̲ n) (d a̲ r)	A-INS	

Note that since R-DEL is assumed to be post cyclic, *r* escapes deletion in (67b) in the first cycle. It survives to the surface because it becomes an onset before R-DEL can apply.

5. Dell and Elmedlaoui 2002

DE02 presents a new analysis of ITB syllabification and much new empirical data. Its careful accumulation of the relevant data and its organization into sharp empirical generalizations is impressive. The analysis is in OT terms. In my opinion, the constructive analysis of DE85 is far superior so I will have little comment on the DE02 analysis. The constraints they propose to better analyze the new empirical data are insightful but I believe that they are better expressed in the framework elaborated here.

5.1. Underlying glides in ITB

DE85 assumes that the surface vowel *i* and the surface glide *y* in ITB both derive from the same underlying phoneme and that the surface difference is due only to how the phoneme is syllabified. The surface vowel *i* appears when the underlying phoneme vocalizes and the surface glide *y* appears when the underlying phoneme is syllabified as an onset or coda. A corresponding assumption is made about the surface vowel *u* and the surface glide *w*. DE02 shows that this is untenable.

DE85 did note the inadequacy of the proposals made there to account for the syllabification of some forms involving *i* and *u*. D&E gave the pairs in (68), [115:28] in DE85. The syllabification of the forms on the right should have been the same as the forms on the left, both according to their theory and to the theory developed in this article to this point.

(68)	a.	su̲y	‘let pass!’	z̲.wi̲	‘beat down!’
	b.	lu̲r	‘give back!’	l̲.wr̲	‘run away!’
	c.	tu̲r.ti̲t	‘garden’ (f.)	twr̲.ta̲t	‘kind of feline’ (f.)

D&E speculated that “the lexical representation of the root in the second member of each pair must induce the back HV [high vowel] to behave exceptionally with respect to CS [core syllabification].”

DE02 develops this idea and gives extensive evidence that there are indeed underlying glides corresponding to the high vowels. With D&E, I will assume that there are underlying glides *i̊* and *ů* that differ from the corresponding high vowels only in how they syllabify.[21] Both *i̊* and *i* vocalize in some contexts and syllabify as onsets or codas in other contexts. Vocalized *i̊* and vocalized *i* are identical phonetically at the surface, as are nonvocalized *i̊* and nonvocalized *i.* The corresponding facts are true of *ů* and *u.*

The differences between the syllabification of glides and their high vowel counterparts is summarized in the empirical generalizations (69).

(69) a. An *i̊*α sequence does not syllabify as a nucleus-coda sequence if α is a high vowel.
b. A *ů*α sequence does not syllabify as a nucleus-coda if α is coronal and not a stop.
c. An α*ů* sequence that does not follow a slot that vocalizes does not syllabify as an onset-nucleus sequence if α is a sonorant.

The generalizations are illustrated in (70). The versions with asterisks are what would be expected if glides and high vowels had the same syllabification properties. (70a) illustrates (69a), (70b–e) illustrate (69b), and (70f) illustrates (69c).

(70)	*underlying*	*actual*	*predicted*		
a.	n-ħi̊ i	*n̲ħ.yi̲*	**n̲.ħi̲y*	‘keep alive (neg 1p)’	[198:6g]
b.	zůi	*z̲.wi̲*	**zu̲y*	‘beat down!’	[197:4a]
c.	t-ůrta-t	*t̲.wr̲.ta̲t*	**tu̲r.ta̲t*	‘ko feline’	[203:17a]
d.	t-ůznauas-t	*t.wz̲.na̲.wa̲.st̲*	**tu̲z.na̲.wa̲.st̲*	‘glow-worm’	[203:17c]
e.	t-ůšk-in	*t̲.wš̲.ki̲n*	**tu̲š.ki̲n*	‘pendants’	[203:17b]
f.	i-s-nůi=ad	*i̲.sn̲w.ya̲d*	**i̲s.nu̲.ya̲d*	‘this cooking’	[217]

One could explain (69a) by supposing that the sonority of the glides is intermediate between the sonority of the high vowels and the sonority of the liquids. But (69b, c) are not amenable to a solution in terms of sonority. A sonority based solution is suspect in any event because sonority is grounded in phonetic properties, which is not what distinguishes the glides and high vow-

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[21] The notation here is mine. The diacritic (round cap) used to denote the glide counterparts of the high vowels is nonstandard. It has the advantage that is widely available but appears to have no standard usage, so it is not likely to be confused with anything else.

els.[22] I will assume that glides and high vowels are equally sonorous, but that the glides enter into an exceptional slot preference relation with adjacent slots, called EGP (Exceptional Glide Prominence), which modifies the prominence relation (28). Specifically:

(71) Exceptional glide prominence (EGP)

a. $\mathring{\imath}, \mathring{\mathrm{u}} < \alpha$ [EGP] if α is a right adjacent high vowel.
b. $\alpha > \mathring{\mathrm{u}}$ [EGP] if α is a left adjacent nonglide sonorant.[23]
c. $\mathring{\mathrm{u}} < \alpha$[EGP] if α is a right adjacent coronal that is not a stop.

(72)
$$\text{Prominence} = \begin{bmatrix}\text{EGP}\\ \text{Sonority}\\ \text{Noninitial}\\ \text{Left}\end{bmatrix}$$

(71a) overrules Left in the case of a glide-high vowel sequence so that the high vowel is more prominent; (71b) overrules Sonority in the case of a glide-consonant sequence if the consonant is a coronal sonorant or coronal fricative; and (71c) overrules Sonority in the case of a consonant-glide sequence if the consonant is a sonorant.

Assuming (72), the following derivations are obtained.

(73) a. $\mathrm{z} < \mathring{\mathrm{u}} \ll \mathrm{i}$
$\mathrm{z}\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{i}}\ )$
$(\ \underline{\mathrm{z}}\ )\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{i}}\ )$
$\underline{z}.w\underline{i}$

b. $\mathrm{n} > \hbar < \mathring{\imath} \ll \mathrm{i}$
$(\ \underline{\mathrm{n}}\ )\ \hbar\ (\ \mathring{\imath}\ \underline{\mathrm{i}}\ )$
$(\ \underline{\mathrm{n}}\ \hbar)\ (\ \mathring{\imath}\ \underline{\mathrm{i}}\ )$
$\underline{n}\hbar.y\underline{i}$

c. $\mathrm{t} < \mathring{\mathrm{u}} \ll \mathrm{r} > \mathrm{t} < \mathrm{a} > \mathrm{t}$
$\mathrm{t}\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{r}}\ )\ (\ \mathrm{t}\ \underline{\mathrm{a}}\ )\ \mathrm{t}$
$(\ \underline{\mathrm{t}}\ )\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{r}}\ )\ (\ \mathrm{t}\ \underline{\mathrm{a}}\ \mathrm{t}\ )$
$\underline{t}.w\underline{r}.t\underline{a}t$

d. $\mathrm{t} < \mathring{\mathrm{u}} \ll \check{\mathrm{s}} > \mathrm{k} < \mathrm{i} > \mathrm{n}$
$\mathrm{t}\ (\ \mathring{\mathrm{u}}\ \underline{\check{\mathrm{s}}}\ )\ (\ \mathrm{k}\ \underline{\mathrm{i}}\ )\ \mathrm{n}$
$(\ \underline{\mathrm{t}}\ )\ (\ \mathring{\mathrm{u}}\ \underline{\check{\mathrm{s}}}\ )\ (\ \mathrm{k}\ \underline{\mathrm{i}}\ \mathrm{n}\ )$
$\underline{t}.w\underline{\check{s}}.k\underline{i}n$

e. $\mathrm{i} > \mathrm{s} < \mathrm{n} \gg \mathring{\mathrm{u}} \ll \mathrm{i} < \mathrm{a} > \mathrm{d}$
$\mathrm{i}\ (\ \mathrm{s}\ \underline{\mathrm{n}}\ )\ \mathring{\mathrm{u}}\ (\ \mathrm{i}\ \underline{\mathrm{a}}\ )\ \mathrm{d}$
$(\ \mathrm{i}\ )\ (\ \mathrm{s}\ \underline{\mathrm{n}}\ \mathring{\mathrm{u}}\ )\ (\ \mathrm{i}\ \underline{\mathrm{a}}\ \mathrm{d}\ )$
$\underline{i}.s\underline{n}w.y\underline{a}d$

f. $\mathrm{t} < \mathring{\mathrm{u}} \ll \mathrm{z} < \mathrm{n} < \mathrm{a} > \mathrm{u} < \mathrm{a} > \mathrm{s} > \mathrm{t}$
$\mathrm{t}\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{z}}\ )\ (\ \mathrm{n}\ \underline{\mathrm{a}}\ )\ (\ \mathrm{u}\ \underline{\mathrm{a}}\ )\ \mathrm{s} > \mathrm{t}$
$(\ \underline{\mathrm{t}}\ )\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{z}}\ )\ (\ \mathrm{n}\ \underline{\mathrm{a}}\ )\ (\ \mathrm{u}\ \underline{\mathrm{a}}\ \mathrm{s}\ )\ \mathrm{t}$
$(\ \underline{\mathrm{t}}\ )\ (\ \mathring{\mathrm{u}}\ \underline{\mathrm{z}}\ )\ (\ \mathrm{n}\ \underline{\mathrm{a}}\ )\ (\ \mathrm{u}\ \underline{\mathrm{a}}\ )\ (\ \mathrm{s}\ \underline{\mathrm{t}}\ )$
$\underline{t}.w\underline{z}.n\underline{a}.w\underline{a}.s\underline{t}$

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[22] The same logic implies that it may have been a mistake to group *g* and *ɢ* in Khalka Mongolian with the sonorants with respect to sonority rather than introducing an exceptional prominence relation.

[23] The restriction is to a nonglide sonorant rather than an arbitrary sonorant avoids a contradiction with (71a).

All of the » and « relations in (73) would be reversed without the effect of EGP, leading to different outcomes. In (73a, b) EGP overrules Left and in the other examples overrules Sonority.

Some examples in which glides vocalize even when they are adjacent to more prominent slots are given in (74), with derivations in (75). In (74a), *ů* vocalizes even though it is flanked on both sides by more prominent slots.

(74)		*underlying*	*surface*		
	a.	i-!gzůi=ad	*i̲g.zu̲.ya̲d*	‘this brook’	[217]
	b.	i-růl=ak	*i̲.ru̲.la̲k*	‘he flees + 2msg-dative’	[216:34d]

(75)	a.	i > r ≫ ů ≪ l < a > k	b.	i > g < z < ů ≪ i < a > d
		(i̲) r ≫ ů (l a̲) k		(i̲) g < z < ů (i a̲) d
		(i̲ r) ů (l a̲ k)		(i̲) g (z ů̲) (i a̲ d)
		(i̲) (r ů̲) (l a̲ k)		(i̲ g) (z ů̲) (i a̲ d)
		i̲.ru̲.la̲k		*i̲g.z!u.y!ad*

This account of the exceptional behavior of underlying glides is stipulative, as is D&E’s account. It does contribute something, however, to see that it is fairly straightforward to incorporate this kind of language particular idiosyncrasy into the general framework as a departure from the default behavior. What is particularly idiosyncratic is that EGP can overrule Sonority.

5.2. *Gemination*

An ITB noun is inflected for number, gender and for a free/bound state distinction that is determined by the syntactic context that the noun appears in. The free state prefix is ∅ before a vowel and *a* otherwise. The bound state prefix is ∅ in the feminine and high vowel in the masculine. It is not relevant here to discuss how the choice of the high vowel *i* or *u* is made. The singular paradigms of the C-initial noun *frux* ‘boy’ and the V-initial noun *urti* ‘garden’ are given below. Syllabification is as expected.

(76)			C-initial		V-initial	
	masc.	free	a-frux	*a̲f.ru̲x*	∅-urti	*u̲t.ti̲*
		bound	u-frux	*u̲f.ru̲x*	u-urti	*wu̲r.ti̲*
	fem.	free	t-a-frux-t	*ta̲f.ru̲.xt̲*	t-∅-urti-t	*tu̲r.ti̲t*
		bound	t-∅-frux-t	*t̲f.ru̲.xt̲*	t-∅-urti-t	*tu̲r.ti̲t*

u-urti→*wur.ti* (**u.wr.ti*) since NonInitial overrules Left in deciding the relative prominence of slots with the same sonority.

If the noun is glide initial, the syllable structure of the various singular noun forms is also as expected from the analysis developed to this point, except for the feminine bound state form.

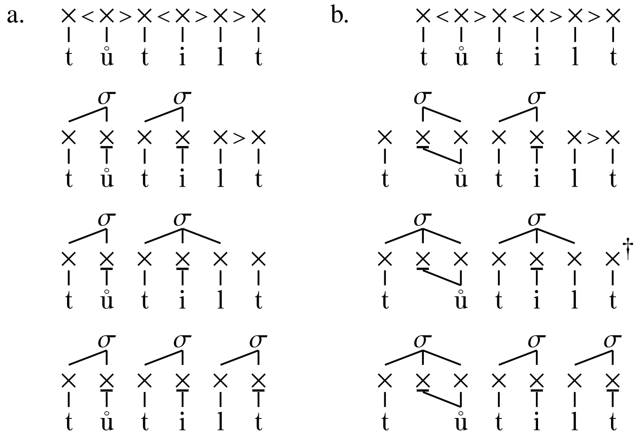
(77)

		ůrz 'hinge'		*ůtil* 'hare'	
masc.	free	a-ůrz	*a.wrz*	a-ůtil	*aw.til*
	bound	u-ůrz	*u.wrz*	u-ůtil	*uw.til*
fem.	free	t-a-ůrz-t	*ta.wr.zt*	t-a-ůtil-t	*taw.ti.lt*
	bound	t-ůrz-t	*t.wr.zt*	t-ůtil-t	*tuw.ti.lt* (**tu.ti.lt*)

In the feminine bound state singular form of *ůrz*, the prominence maximum shifts to the right off *ů* onto the right adjacent coronal sonorant *r*, and *ů* syllabifies as an onset. In the feminine bound state singular form of *ůtil*, there is no exceptional prominence shift and *ů* remains a growth locus. We expect therefore that *ů* will vocalize, but it does not.

The derivation expected is (78a), but what occurs appears to be (78b).

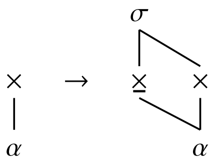
(78)



Adjoin Onset applies at †. In ITB, the only position in which Adjoin Onset can apply is an unsyllabified initial slot that directly precedes an onsetless syllable. If the slot is not initial, Project Doublet or Adjoin Coda would bleed Adjoin Onset. The syllable on the left to which it adjoins must be onsetless, otherwise *CmplxOnset would block adjunction. The gemination operation in (78b) creates this environment, which otherwise does not appear in ITB iterative syllabification.

D&E interpret this in OT terms. They propose that the language has a desideratum that underlying glides should surface as glides.[24] The gemination in (78b) is in response to this desideratum. Although one leg of the geminate is nuclear, the other occurrence of the underlying glide is nonnuclear, so there is a surface glide associated with the underlying glide. This idea can be implemented in the present framework by augmenting VP with the constraint (79a) and the scheme of elementary syllabification rules by (79b).

(79) a. NRCondx:
The initial slot of a glide initial noun root does not vocalize.
b. Left Geminating Epenthesis (LGE)



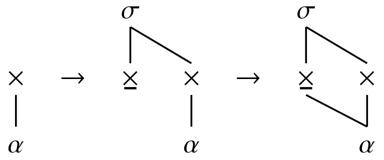
(80) ITB iterative syllabification (version 4)

$$\begin{bmatrix}\text{Sonority}\\ \text{NonInitial}\\ \text{Left}\end{bmatrix} :: \begin{bmatrix}\mathscr{R}_0\\ \text{LGE}\end{bmatrix};\{\,\text{GemCondx}, \text{*CmplxOnset}, \text{NRCondx}\,\}$$

Since LGE is ordered after all the other elementary syllable building rules, it will almost always be bled by more highly ranked rules. NRCondx, however, will block projecting a noun root initial slot and in certain contexts force the use of LGE as a last resort. LGE cannot apply in any event unless α is seminuclear since it surfaces as both a nucleus and a coda.

The LGE is very similar to the epenthesis rules used in Khalka Mongolian and Ath-Sidhar Rifian Berber. They are compared below, broken down into substeps.

(81) Left Geminating Epenthesis:



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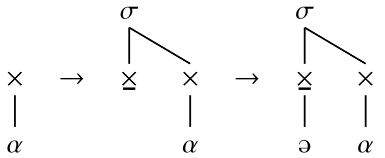
[24] D&E introduce the constraint: “Underlying glides do not become nuclei,” which they call GlideFaith. It is very misleading to see this as an instance of “faithfulness”. What exists in the input structure, a timing slot and an associated phoneme, is faithfully reproduced in the output structure whether or not the timing slot becomes a nucleus.

Left Vowel Epenthesis:



A timing slot is epenthesized to the left in each case. The only difference is that in one case the phonemic content of the epenthesized timing slot is supplied by an epenthetic vowel and in the other by association with an already present phoneme. Association is only an option if α is a semivowel because it syllabifies as both a nucleus and a coda.

6. Conclusion

A critique of Dell and Elmedlaoui's 1985 analysis of ITB syllabification played a major role in Prince and Smolensky's argument against rule-based theories of phonology. It is therefore valuable to review that critique. It goes something like this. Rule-based theories proceed by building one level before they proceed to a higher level. Taking this seriously, according to Prince and Smolensky, requires that nuclei be located before syllable structure is built. ITB, however, shows that you cannot do this. Therefore, rule-based theories cannot be correct.

There are other conclusions that can be drawn. The most obvious is that there is no basis for assuming that there is a "nuclear level". There is no a priori reason to believe that locating nuclei is not one of the tasks of iterative syllabification or that epenthesis rules are not syllabification rules. Dell and Elmedlaoui's work made it clear that locating nuclei was an aspect of syllabification and Ito's work should have made it clear that epenthesis was as well. Once the idea that there is a nuclear level is dismissed, the tasks of iterative syllabification are much clearer and Prince and Smolensky's claim can be seen to have no basis.

What has been accomplished in this article is to show that a fairly broad class of syllabification systems have essentially the same iterative syllabification rule, with the gross surface differences in syllabification due not to the mechanics of syllabification but mainly to the different ways the languages designate their phonemes as ones that must vocalize and ones that cannot vocalize, and to the different sonorant relations they impose on their phoneme inventory.

One major accomplishment has been to derive coda sonority sequencing in a language with complex codas (KM) from the same elementary mechanism that locates nuclei in a typologically very different language (ITB). I believe that these results can be extended to a broader variety of syllabification systems, in particular those with complex onsets and onset sonority sequencing. The role of directionality in syllabification will need to be more carefully considered. This article assumed that syllable building took place simultaneously at all the growth loci. There are other possibilities. One is iterative syllable building at the leftmost (or rightmost) growth locus. I hope to investigate these possibilities in future work. If such an extension can be accomplished, a very general derivational theory of iterative syllabification will be possible.

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