Syllabification and Reduplication in Bella Coola[1]

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Introduction

In this paper I would like to examine some of the interactions between morphology and phonology, specifically between some types of templatic morphology and syllabification. In particular, I will argue that by building syllable structure in two distinct phases, with morphology applying in-between, some aspects of the morpho-phonology of Bella Coola (BC) are illuminated.

Thus, the pertinent questions will be: whether syllable structure is built uniformly and exhaustively, the number of passes or phases of syllable construction and the ordering of morphological and phonological processes.

Bella Coola Morpho-Phonology

Bella Coola, a Coast Salishan language spoken in British Columbia, is renowned for tolerating long sequences of obstruents, and for having a complex system of reduplication. Bella Coola has words and even sentences without sonorants:

(1)	ɬq	*wet*
	t'χt	*stone*
	ɬχ^{w}tɬcx^{w}	*you spat on me*

Bella Coola examples have been drawn from several works, most notably Bagemihl (1989), Nater (1984) and a series of articles by Newman (1947, 1969, 1971). There has been considerable debate about the nature of the syllable in languages such as Bella Coola, running the gamut from nearly every segment forming its own syllables to the lack of any syllables whatsoever. Newman (1947) proposes that Bella Coola lacks syllables, Hockett (1955) always all obstruents to form nuclei, and Greenberg (1962), Fudge (1976) and Hoard (1978) fall in-between. Bagemihl (1989) has enumerated some of the hypotheses regarding syllable structure, giving the following classification of approaches:

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1 I would like to thank all the people who read and commented on various drafts of this material. These include my committee members: Jay Keyser, Ken Hale and Wayne O'Neil, along with Morris Halle, François Dell and the members of the Phonology-Morphology Workshop.

	lake	*shoot with a bow*	*stone*
No Syllables	caɬ	t'ksn	t'χt
Syllabic Obstruents	(ca)(ɬ)	(t')(k)(sn)	(t')(χ)(t)
Complex Syllables	(caɬ)	(t'ksn)	t'χt
Simple Syllables	(caɬ)	t'k(sn)	t'χt

(2) Syllabicity Hypotheses

Bagemihl argues for a version of the Simple Syllable Hypothesis on the basis of facts of reduplication in Bella Coola. Bagemihl's analysis will be examined in detail below.

In the alternative analysis to be developed here, we will try to achieve a combination of the attractive aspects of the complex, syllabic obstruent and simple syllable approaches. This will be possible due to the construction of more than one syllable structure during a derivation. Initially, simple syllables will be constructed, forming the Core Syllablification (CS); later, more extensive (in fact, exhaustive) syllable structure will be formed, incorporating previously unsyllabified elements, forming the Phonetic Syllabification (PS). Also important to this analysis will be core syllabification that do not maximize onsets.

Bella Coola also has a rich inventory of consonant types, including glottalized and labialized consonants. The inventory of consonants is:

	labial	coronal			dorsal				glottal
					velar		uvular		
plain	p	t	c		k	k^w	q	q^w	ʔ
glottalized	p'	t'	c'	λ'	k'	k'^w	q'	q'^w	(ʔ)
fricative		s		ɬ	x	x^w	χ	χ^w	(h)
sonorant	m	n		l	y	w			

(3) Bella Coola Consonants

There are three vowels: /a/, /i/, and /u/, and there are two associated glides: /y/ and /w/. In addition, all other sonorants (/mnl/) can form syllable peaks, and can be distinctively long or short as nuclei. The dorsal consonants are described in Nater (1984) as being velar and uvular, and so the appropriate characters are shown. The phonetic characterization of the dorsal consonants does not necessarily settle phononlogical questions about their feature representations. In one of the reduplication patterns the reduplicative vowel is determined by the consonantal context: /u/ before labialized consonants and /i/ before velars. This suggests that consonants can contribute articulator specifications to neighboring vowels. Specifically, the dorsal articulator can be shared between consonants and vowels, and the Labial articulator can be shared when they already share the Dorsal articulator. Significantly, bilabial consonants do not induce labialization of the following vowel. This provides support for theories such as Sagey (1986) that distinguish primary and secondary articulators, for the generalization in Bella Coola can then be perspicuously captured: vowels and consonants can share a secondary articulators only if they share the primary articulator.

As in other Salishan languages, reduplication is used to mark the diminutive and the continuative. However, some diminutives and continuatives are formed without reduplication, and there is usually suffixation present alongside reduplication. BC reduplication can copy up to three segments of the stem, sometimes skipping initial material, and sometimes containing pre-specified or epenthetic segments. In addition, there are several morpho-phonemic alternations of the stem and reduplicate segments. The stem changes include consonant spirintization, hardening, and labialization; and vowel shortening, lengthening and syncope. I will assume that these processes are lexically specified, as no general account of the patterning has yet been found.

Newman (1971) describes the patterns of reduplication. I will arrange them here by the type of the reduplicated syllable. The formulas used to describe the patterns are meant to resemble those used by Newman (1971) and Nater (1984). They are not intended to denote theoretical positions on the mechanisms of reduplication. The competing theories of reduplication in Bella Coola will be presented in the following sections. First, we have reduplicated forms yielding CV- words:

(4) 1V12....[2]

k^wn -	k^wuk^wn -	*take*
smt	sasmt - i	*mountain*
xnas	xixna:s-i	*woman*

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2 The vowel is predictable in these forms, /i/ with velars, /u/ with rounded consonants and /a/ elsewhere. There is a single form with the pattern 1n12: xm → xnxm *break*.

The final form in (4) also illustrates one of the morpho-phonemic processes, in this case lengthening of the stem vowel in the reduplicated form.

(5) 1n1n2 (nuclear epenthesis before reduplication)
ɬq' ɬnɬnq' *slap*

In the forms in (5), a sonorant is epenthesized prior to the application of reduplication.

(6) 1212
k'm k'mk'm *bite*
ni:χ^{w} nini:q^{w}-i *fire*
tlk'^{w} tltlk'^{w} *swallow*

We can see from the form for *fire* that vowel length is not necessaily transferred into the reduplicated portion, in this case the long stem vowel is copied as a short vowel.

(7) 1213 (stem syncope)
qinχ qiqnqi *shoe*

The form in (7) illustrates two stem changes: hardening of /χ,/ to /q/ and the loss of the stem vowel.

(8) ʔ212
q'ay ʔaq'ay *basket*
k'^{w}n ʔnk'^{w}n *point at*

(9) ʔ213 (syncope)
k'inax^{w} ʔik'na:x^{w} - i *crab*

Bagemihl treats the forms in (8) and (9) as involving a rule of initial consonant deletion followed by ʔ epenthesis.

The reduplication types yielding words with initial CVC- are:

(10) 123123
ʔin'a ʔin'ʔin'a *give food*

(11) 12313 (stem syncope)
q'iɬ q'iɬqɬ *scratch*
silin silslini *kidney*
qaχ qaχqχ-i *rabbit*

(12) 1i212, 1n21n2 (nucleus epenthesis)

xli	xilxli	*penis*
sχ	siχsχ	*peel*

The form for *peel* is treated by Bagemihl as involving nuclear epethesis of /i/, followed by reduplication, followed by stem syncope. I will follow this analysis here as well.

(13) 12n12, 12x12, 12x13 (coda epenthesis, syncope)

kix^w	kixkix^w	*gnaw*
citum	cincitum	*fall asleep*
ma:χsa	maxmqsni	*nose*

(14) 1ix1i2 (nucleus and coda epenthesis)

sx^w	sixsix^w	*burn*

The forms in (13) and (14) point either to epethesis or to template pre-specification. Bagemihl chooses pre-specification; I will account for these forms with coda epethesis. The choice of analysis of these forms depends on other choices regarding syllable structure and reduplication mechanisms.

The "skipping" of initial segments in reduplication yields similar situations, with C*CV- and C*CVC- results. The C*CV- types are:

(15) C*1212

skma	skmkmay	*moose*
sxlikt	sxlxlikt	*be angry*
spliɬ	splpliɬ	*labia*
t'ksn	t'ksnsn	*shoot with a bow*
st'q^{w}lus	st'q^{w}lq^{w}lu:si	*black bear snare*

(16) C*1213 (syncope)

cpan'k	cpapn'k	*wipe the side*
sq^{w}ca:ls	sq^{w}caclsi	*cheek*

(17) 1323

spus	supus	*leaf*
sk'ma	smk'm-ni	*comb*

The forms in (17) can be seen as analogous to those in (8) and (9), where reduplication is marked on the surface as the copying of just the first vowel of the stem. In addition, the form for *comb* also shows the application of stem syncope.

The C*CVC- types are:

(18) C*123123
s+kʷu+lχsa+ skʷu+kʷu+lχsa+i *toe*

(19) C*12n12 (epenthesis)
λ'pa λ'panpa *cut with shears*

(20) C*12313 (syncope)
kʷpa+ kʷpa:+p+-i *liver*

(21) 12334 (syncope, ʔ loss)[3]
ʔixa ʔi:xxni *foot*

Such a rich inventory of reduplication types makes BC morphology difficult to describe and account for. We will examine Bagemihl's solution in the next section, and present another analysis later.

Overview of the Analyses

A comparison of two analyses of Bella Coola will be made. The first, Bagemihl (1989) is a moraic account following McCarthy and Prince's (1986, 1989) model of prosodic reduplication. The other analysis follows Steriade's (1988) model of reduplication with the modification that any prosodic constituent may be copied. Both accounts abound with lexical stipulation, this problem will be addressed in a later section, where an alternative, lexical model of reduplication is sketched.

The two theories differ in several ways. The primary difference in the reduplication models is that Bagemihl's analysis involves re-association of melody and prosodic skeleta, thereby predicting cases of non-transfer effects. The alternative analysis copies entire prosodic structures, thereby predicting transfer effects. Morphological processes can be said to transfer or not to transfer various phonological properties. As an example (from Dell and Elmedlaoui 1990) the base *lmmus* is mapped onto the template **uCCiC** and yields *ulmis*, rather than **ulmim* or **ummis*. Thus, in this case the transfer of the entire melody takes precedence over the transfer of the quantity of the *m*. In cases where the quantity can be tranferred in the mapping onto this template it is: *kkm* becomes *ukkim* and not **ukmim*.

This difference of approach to reduplication leads to differences in the theories of syllable structure. Since Bella Coola has a particularly diverse phonetic syllable structure many questions about its nature are still open. Since Bagemihl's model deals well with cases of non-transfer of prosodic structure

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3 Only occurs with ʔ initial stems, see below for Bagemihl's analysis.

this is exploited by the analysis. On the other hand, since I wish to pursue a theory of reduplication that copies prosodic constituents, what is copied by reduplication is used as a diagnostic for the prosodic (i.e. syllabic) structure in my analysis. Since Bella Coola has some syllable-sensitive rules of the phonology, there are also diagnostics for syllable structure at particular points in the derivation. The interesting point of the Bella Coola data is that these two diagnostics are often at odds. Their divergence is handled in different ways by the two theories. Bagemihl's analysis handles this divergence by allowing reduplication to build non-parallel structures through re-association of melodies. I handle this divergence by allowing different syllable structures at different points in the derivation. Both theories allow for non-exhaustive syllabification; Bagemihl's is a permanent non-exhaustivity, mine is temporary. Finally, because the approaches to constituency in reduplication are different, different initial syllabifications are created by the two theories. Bagemihl's follows the phonetic structure of the language more closely, mine is more abstract at this point. This difference is due to the different uses of the two diagnostics. Bagemihl builds syllable structure consistent with the application of the phonological rules, I build the initial structure from the patterns of reduplication, modifying this structure to achieve phonetic syllabification.

Bagemihl's analysis will be presented in the next section, my analysis will be presented in the subsequent sections.

Bagemihl's Analysis

Bagemihl (1989) has offered an interesting and insightful analysis of Bella Coola reduplication, deriving differences in reduplication shapes from differences in syllabification. He reduces the number of reduplication templates to two: σ_C (core syllable, mono-moraic, CV) and $\sigma_{\mu\mu}$ (bi-moraic, CVC). These templates combined with lexical parameterization of other effects such as vowel prespecification, stem syncope and affix consonant changes account for the variety of reduplicative forms.

First, we will consider the construction of syllables in Bella Coola phonology. Bagemihl presents two arguments that BC phonology must include some syllable structure, based on syllabicity alternations in morpheme concatenation and two rules of vowel allophony. First, he notes that the diminutive suffix is realized as either [i] or [y] depending on the final segment of the stem:

(22)	t'n̥χʷ	t'n̥χʷ - i	*head*
	saλ'a	sa:λ'a - y	*spoon canoe*
	qaɬayu	qaɬayw - i	*fish hook*

In addition, other morpheme concatenations provide similar syllabicity alternations:

(23)	ti	+ aɬ	→	tyaɬ	*standing firmly*
	$q^{w}i$	+ nu...uc	→	$nuq^{w}yuc$	*to open the door*
	c'u	+ $i{:}\chi^{w}$	→	$c'wi{:}\chi^{w}$	*(having) grey hair*
	tuk'ṃ	+ a:χaɬ	→	tuk'ma:χaɬ	*to sprain an ankle*
	stṇ	+ a:ɬ	→	stna:ɬ	*wooden spoon*

Further, there are allophonic rules for vowels which can be used as diagnostic tests for syllable structure, at least in the later portions of the phonology. The point of application of these rules will become important because my theory allows for changes in syllabification during a derivation. One rule lowers high vowels before tauto-syllabic resononats:

(24) $V \rightarrow [-\text{high}] \;/\; \_\; [+\text{son}]\,]_{\sigma}$

/sim/	→	[sem]	*cedar limb rope*
/c'ima/	→	[c'imæ]	*intestines*
/tums/	→	[toms]	*breast*
/ʔanu-tum-uc/	→	[ʔænutumuc]	*kind of spear*

and the other rule centralizes /a/ before a tauto-syllabic rounded velar:

$$\text{(25)}\quad V \rightarrow [-\text{low}] \;/\; \_\; \overset{C}{\begin{bmatrix}\text{dorsal}\\ \text{+round}\end{bmatrix}}\,]_{\sigma}$$

$/klax^{w}/$	→	$[k^{y}l\wedge x^{w}]$	*muskrat*
$/sax^{w}a/$	→	$[sæx^{w}æ]$	*dipnet*

Thus, there is good evidence that the phonology of BC requires reference to syllabic constituency.

Bagemihl actually builds his syllables in a rather unconventional way, using moraic theory and a non-standard construction method. His uses of moras differs substantially from the view of McCarthy and Prince. One of the striking parts of Bagemihl's analysis is the extent of the manipulation of moraic elements. Each segment initially projects its own mora[4], and then simple syllables are built on these moras, with the requirement that nuclei be sonorant.

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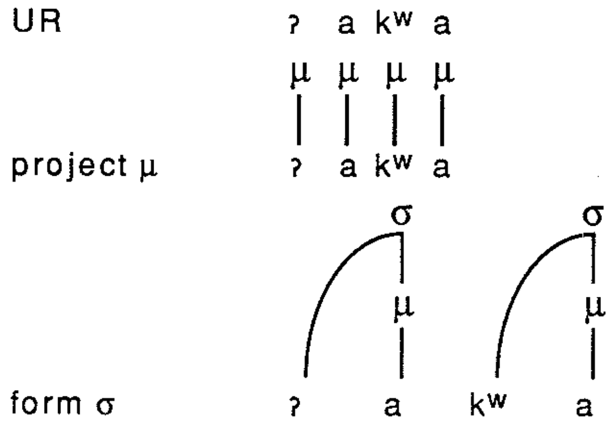
4 Geminates are represented as being underlyingly moraic, the projection of a mora on such segments effectively adds a mora, giving them two.

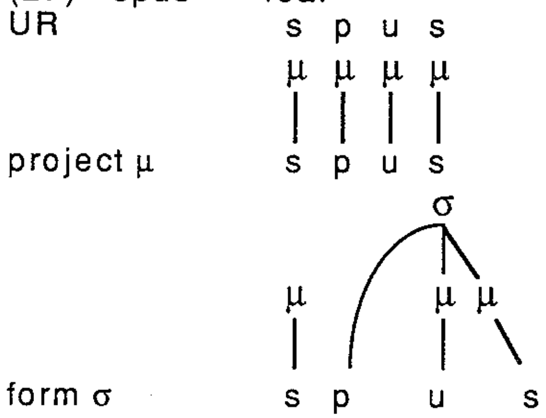
At this point moras are acting as elements on a purely organizational tier, as x-slots. Segments subsequently syllabified as onsets lose their moraic status:

(26) ʔakʷa *to buy*



Thus, in this example, all segments initially receive a mora, and then when the syllables are built (maximally bi-moraic) the formation of onsets eliminates some of the moras. Such an algorithm does not produce necessarily exhaustive syllabification, as Bagemihl notes:

(27) spus *leaf*



Accordingly, Bagemihl modifies the notion of Prosodic Licensing from Itô (1986). Bagemihl allows languages to choose whether segments are licensed by moras or by syllables. If a language chooses the μ as the licensing element, then segments need only be dominated by a mora to be considered "licensed". If a language keeps the default setting of σ, then segments must be incorporated into syllables or they will not be licensed and thus will be eliminated by Stray Erasure. In this fashion Bagemihl circumvents the application of Stray Erasure to initially syllabified forms in Bella Coola. Because every element will project its own mora, everything will be licensed. Thus, Stray Erasure plays no part in the syllabification of Bella Coola forms. I will argue that this is a misguided view of the function of licensing, in that licensing is a *general* prosodic phenomena and that it would be incoherent to parameterize its application in this fashion. Additionally, Bagemihl allows complex onsets to be formed, thus making the maximal syllable CRVVC.

Bagemihl's analysis of reduplication is also cast in a moraic framework, that of McCarthy and Prince (1986, 1989). There are two reduplication templates: σ_c (core syllable, mono-moraic, CV) and $\sigma_{\mu\mu}$ (bi-moraic, CVC). These templates are combined with lexical parameterization of stem and affix morpho-phonemic changes. Together with template prespecification this accounts for the variety of reduplicative forms. This is a vast improvement over the enormous taxonomy presented in the original source, Newman (1971), where there is a staggering variety of initial, medial and final templates of varying lengths.

Bagemihl	Nater
σ_{μ}	→ 1212....
$\sigma_{\mu\mu}$	→ 123123....
σ_{μ} + initial deletion	→ ʔ212....
$\sigma_{\mu\mu}$+ initial deletion	→ ʔ23123....
$\sigma_{\mu\mu}$ + syncope	→ 12313....
σ_{μ}+ initial deletion + syncope[5]	→ ʔ213....

(28) Comparison of Reduplication Accounts

Bagemihl's account of reduplication is that it copies the melody of the first foot of the stem, and associates it with a lexically specified template affixed to that foot. Although Bagemihl does not articulate a theory of foot construction, it is obvious from his analysis that he intends feet to be built on top of syllables. This is in fact necessary for his analysis, for if feet were built directly on moras (orthogonal to syllable structure) then unsyllabified material could be incorporated into feet, defeating the purpose of having non-exhaustive syllabification. Thus, this is at odds with remarks in McCarthy and Prince (1986) that point out that analyzing quantity sensitive languages as syllables having branching rimes involves "peeking down" into a structure you should not have access to. Bagemihl

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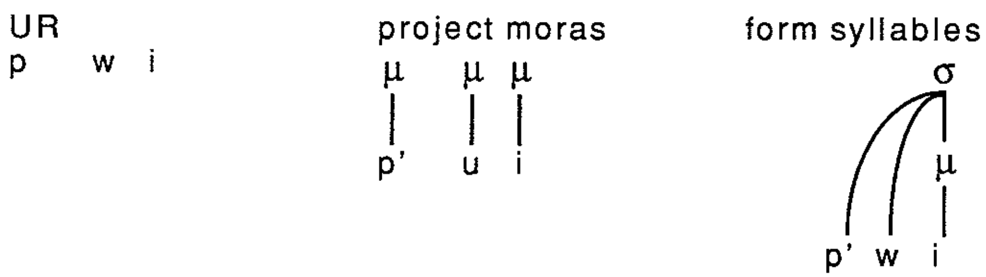
5 This category of Nater's actually subsumes a variety of "odd" reduplication patterns. These will be discussed in detail below.

apparently allows feet to be bi- or tri-moraic, although it is impossible from the number of examples cited to discern all aspects of the inherent theory of foot construction.

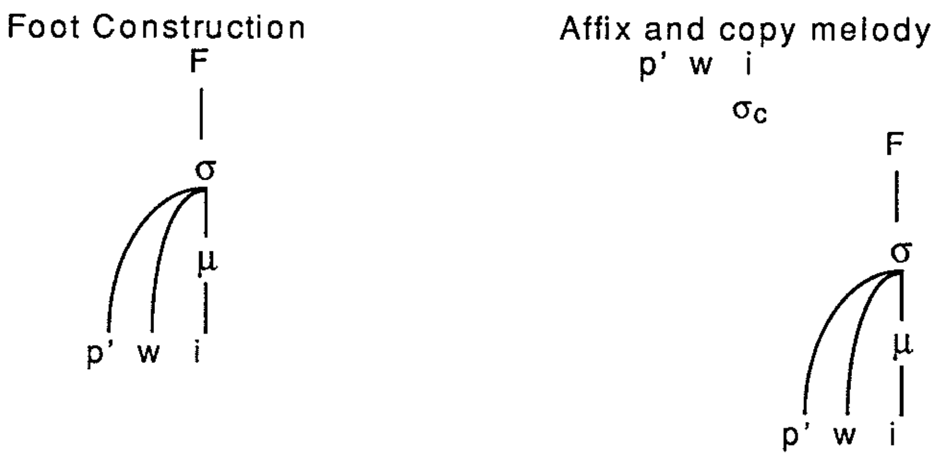
The template can have some prespecification of melody, corresponding to what I have termed the epenthetic segments. Because the melody alone is copied and not the prosodic constituency, it is possible for the reduplicated portion to have syllable structure that is not the same as that of the stem. That is, stem syllable structure is not necessarily transferred by reduplication. This is an important current issue, for in theories such as Steriade (1988) transfer effects are accounted for by copying prosodic structure completely.

A sample derivation of one of Bagemihl's forms, involving the copying and association of elements contra their stem syllabification is:

(29) p'wi ʔupwi: *halibut*

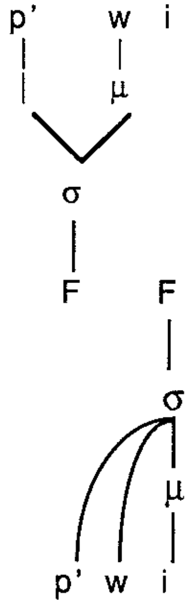


In the first step moras are projected for each segment in the underlying representation. Then whole syllables are formed, maximally CRVVC, eliminating moras from elements incorporated as onsets. In this way, the complex onset consisting of /p'w/ is formed, and so /p'/ and /u~w/ lose the moras that they initial projected. Feet are then constructed on top of the syllables.

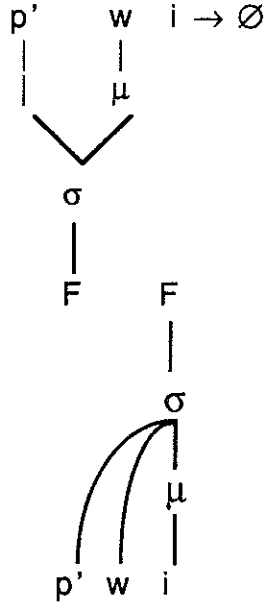


The σ_C indicates that the affix is a "core syllable". For Bella Coola this means that it is a mono-moraic syllable without a branching onset. The syllable is affixed onto a different plane from the stem, and the melodic material associated with the first foot of the stem is copied onto this plane.

Associate L → R

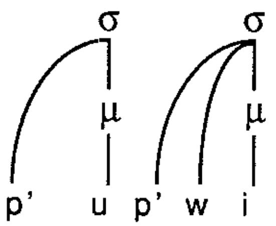


Stray Erasure

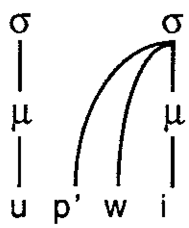


Notice that the association is allowed to attach the /u~w/ to the nuclear position because sonorants can be syllabic (moraic) in Bella Coola. Thus, a segment which was non-moraic in the stem shows up as moraic in the reduplicated affix. This goes against the evidence in Steriade (1986), in which complex onsets simplify when transferred onto templates disallowing complex onsets. This would yield the form /* p'ip'wi/ at this point.

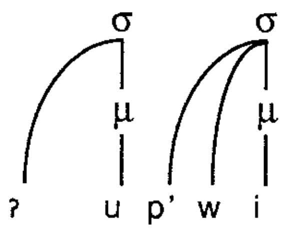
Plane Conflation



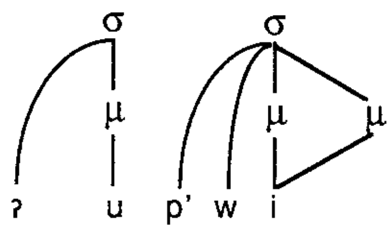
Initial deletion



? epenthesis



Vowel Lengthening



The substitution of /ʔ/ for the initial consonant proceeds in two steps for two reasons. The first is that the gloattal stop is generally added word initially to words beginning with a syllabic sonorant. The second argument is that the glottal stop only appears when the consonant deletes and stays word-initial. When the nominalizer /s-/ is added, the glottal stop does not appear:

(30) pus → s - upus - ɬp *grow → young willow tree*
* sʔupus - ɬp

Such an account is made necessary by further aspects of the McCarthy and Prince model. Their templates are restricted to be types of syllables (or feet), and it is a tenet of the theory that aspects of onsets are not specifiable in the templates. Thus, onsetless syllables are not possible templates. In the theory that I will outline, any prosodic constituent is a legitimate constituent to copy, hence it will be possible to copy only the vowel in such forms.

To review the aspects of Bagemihl's model, unsyllabified elements at the beginning of a word will not participate in reduplication because they are not incorporated into the foot structure built in Bagemihl's theory. Note again, that this crucially relies on foot structure being built *on top of* syllable structure and not being built directly upon moraic structure. If feet were constructed directly on moras then those segments would be copied, defeating the intent of having extra-syllabic segments.

Copy Core Syllable Reduplication

Since I wish to adopt a theory akin to Steriade's in copying stem syllable structure during reduplication, we will claim that the core syllable structure which defines the reduplication syllabifies stems such as /p'wi/ as (CR)(V). Prosodic aspects of the stem will be transferred in reduplication, but aspects of phonetic syllabification will yield the differences in syllabicity.

The major innovation in this account of Bella Coola is to allow two major phases of syllabification, which I will term core and phonetic. The core syllable structure is the structure to which morpho-phonemic processes apply. The phonetic syllable structure is the structure to which phonological processes apply. The core syllable structure is simple and non-exhaustive. The phonetic syllable structure is more complex and exhuastive. In BC, the maximal core syllable will be CVR. The nucleus of these syllables can be any sonorant. Hiatus structures can be built in BC, that is CRV sequences will be syllabified as (CR)(V).[6] Only

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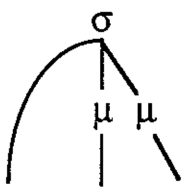
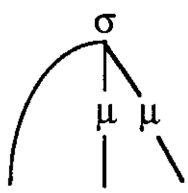
6 One exception is word initial sonorants, they are syllabified #(RV) rather than #(R)(V). This should follow from a general preference for syllabifying pairs of items as opposed to singletons, see Dell and Elmedlaoui (1985) for discussion of such facts in Berber.

certain types of codas will be built, those involving geminates, and those involving sonorants. Some examples of core syllabification are:

(31)	(xl)(i)	*penis*
	(ʔa)(k^{w}a)	*buy*
	(qay)t	*hat*
	s(pu)s	*leaf*
	t (qn) k	*be under*

Pre-nuclear material must have non-decreasing sonority and post-nuclear material must have non-increasing sonority in order to form a syllable. Thus while /#mn/ is syllabified (mṇ) /#in/ is syllabified (in), not (yṇ). The syllabification of /#mn/ as (mṇ) also points out that though hiatus is possible, at word edges one syllable instead of two hiatus syllables is constructed. There are many ways to achieve these results, but I will propose the following set of general parameters:

Parameter	Core Syllabification	Phonetic Syllabification
maximal syllable		
maximize onsets	no	no
nucleus	+son	any segment[7]
coda	+son, geminates[8]	any segment
allow hiatus	yes	yes

(32) Bella Coola Syllabification parameters

Specific construction methods will be considered later. The differences between the two syllabification phases are that any segment can form the basis for a phonetic syllable, including obstruents, and phonetic codas are formed generally. Hiatus is in fact not tolerated phonetically, and this would usually indicate that the phonetic parameter for hiatus should disallow building hiatus structures. However, there will be pre-existing hiatus structures formed by the core syllabification and these structures will have to be emended. As well,

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7 Except glottal stop.

8 The formation of core codas with geminates is a likely candidate for universality.

some questions of obstruent syllabicity may lead to phonetic syllabification with hiatus. A general rule of hiatus resolution will be formulated below.

There is only one case of possible syllabic ambiguity with Bella Coola core syllables: intervocalic sonorants. Since only sonorants can form codas in CS, intervocalic obstruents will be syllabified as onsets: (ʔa)(k^wa). However, intervocalic sonorants could be syllabified as either codas or onsets (or both). Bella Coola reduplication allows the transfer of intervocalic sonorants in some forms:

(33)	silin	silsiln - i	*kidney*

and we want a theory of reduplication in accordance with Steriade's, where we transfer a constituent, and then possibly change it. Therefore, to achieve the transfer of the /l/ in this form, we will assume that BC core syllabification does not maximize onsets. Specifically inter-vocalic sonorants will be syllabified as codas. The initial syllabification of /silin/ is (sil)(in), reduplication of the first syllable then yields (sil)(sil)(in).

Phonetically, there is evidence from the vowel alternations discussed in the previous section that indicates that for the purposes of those rules the inter-vocalic sonorants do not close the preceding syllable:

(34) V → [- high] / _ [+son] $]_\sigma$

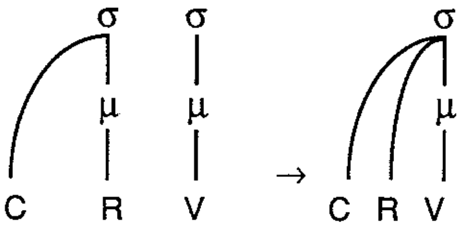
/sim/	→	[sem]	*cedar limb rope*
/c'ima/	→	[c'imæ]	*intestines*
/tums/	→	[toms]	*breast*
/ʔanu-tum-uc/	→	[ʔænutumuc]	*kind of spear*

pointing out a need for a rule of resyllabification of sonorant codas in hiatus. In addition, we will need a rule combining two syllables into one under hiatus, as the following forms indicate:

(35)	ti	+ aɬ	→	tyaɬ	*standing firmly*
	q^wi	+ nu...uc	→	nuq^wyuc	*to open the door*
	c'u	+ i:χ^w	→	c'wi:χ^w	*(having) grey hair*
	tuk'm̩	+ a:χaɬ	→	tuk'ma:χaɬ	*to sprain an ankle*
	stn̩	+ a:ɬ	→	stna:ɬ	*wooden spoon*

Formalizing the rule, we have:

(36) Hiatus Resolution



The application of hiatus resolution is subject to the condition on normal syllabification that the resulting onset-nucleus sequence have non-decreasing sonority. It has a further condtition that the material within the onset has rising sonority, Thus /mna/ *man* appears to contain un-resolvable hiatus, and remains syllabified as (mn)(a). The same rule can be used in mono-morphemic forms to resolve the hiatus created in core syllabifications, as in:

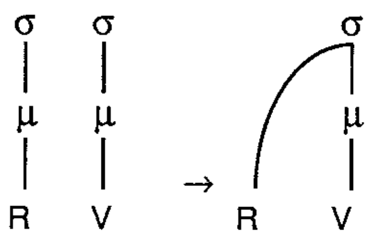
(37)	(xl)(i)	→	(xli)	*penis*

Phonetic syllabification allows for more coda and nucleus types, giving the following phonetic syllabifications:

(38)	(qay)t	→	(qayt)	*hat*
	s(pu)s	→	(s)(pus)	*leaf*
	t(qn)k	→	(t) (qnk)	*be under*

with every element belonging to some syllable. Thus, as in the analysis of Berber given by Dell and Elmedlaoui (1985, 1988, 1990) obstruents can be syllabic when no more sonorous material surrounds them. Hiatus resolution is similar in condition and effect to the resyllabification of core sonorant codas. We could generalize the process to de-morify an element under hiatus:

(39) Demoraification



Thus morpho-phonemic processes, such as reduplication, apply to the core syllabification structures, and rules of the phonology, such as the vowel allophony rules, apply to phonetic syllable structures. After constructing phonetic syllable structures we have a general mechanism of hiatus resolution, amending seqences of core syllabification that do not conform to the phonetic syllabification parameters. These build otherwise exceptional syllables that contain branching onsets. Thus, we will not describe the full set of phonetic syllabification patterns in our parametric analysis of Bella Coola syllable structure. Rather, some rules of the phonology serve to eliminate violations of hiatus, and in doing so yield otherwise exceptional syllable structures. These structures do conform to the major syllable structure constraint in Bella Coola, that pre-nuclear material have non-decreasing sonority and post-nuclear material have non-increasing sonority. The syllables resulting from hiatus resolution are not constrained to only a single pre- or post-nuclear segment.

Turning now to the question of the mechanism for reduplication, there are some things to notice regarding Bagemihl's analysis. Perhaps the most striking is the pre-specification patterns in the data. Nuclear prespecification in CiX- forms occurs only with CL- stems, such as *xilxli (penis dim.)*. Likewise, CVn-reduplicated forms only occur with CV- stems. Thus, it would seem that what is in fact occuring is that when a bi-moraic template is attached to a syllable with insufficient material, epenthetic material is added so as to form a core syllable of type CVR. Such an analysis is not possible within Bagemihl's framework because he copies the melody of an entire foot, and constructs CRV syllable types.

We will adopt the epenthetic analysis by using a reduplication theory similar to that of Steriade (1988), copying a constituent. This will differ from the particulars of Steriade's theory in that we will allow any prosodic constituent to be copied, not just full stem copy.

For such a theory to work, we will also need to be able to impose a syllable structure upon the copied constituent, as in Steriade's theory. We will also need to be able to copy the various sub-parts of the syllable, as well as the syllable itself. Thus, BC reduplication consists of the copying of a prosodic (syllabic) constituent plus the imposition of a specified syllable structure upon the copy. We will need to be able to copy the onset, nucleus, rime or syllable. This parameter will need to be lexically specified. In addition, we will need to specify the target syllable structure, as mono- or bi-moraic, as in Bagemihl's analysis.

Some example lexical forms and parameters are:

Word	Copied constituent	Target Syllable
xli → xilxli	syllable	heavy
spus → supus	rime/nucleus	light
xnas → xixna:s-i	onset	light

(40) Lexical parameters

The derivation of *xilxli* is:

(41)	UR	xli	*penis*
	core syllabification	(xl)(i)	
	copy [syllable]	(xl)(xl)(i)	
	impose [heavy] syllable	(xil)(xl)(i)	
	phonetic syllabification	—	
	hiatus resolution	(xil)(xli)	

and the derivation of *silsilin* is:

(42)	UR	silin	*kidney*
	core syllabification	(sil)(in)	
	copy [syllable]	(sil)(sil)(in)	
	impose [heavy] syllable	—	
	phonetic syllabification	—	
	hiatus resolution	(sil)(si)(lin)	
	vowel lowering	(sel)(si)(len)	

The imposition of a heavy syllable structure upon a light syllable is underdetermined by what we have seen so far when (CR) syllables are considered. The result of imposing heavy syllable structure on light syllables varies according to the sonorancy of the initial nucleus, CV syllables become CV[+son], and CR syllables become C[+vocoid]R. This suggests that the rime is undiffentiated, with no special status being given to the nucleus, as resonants can switch their function from nuclues to coda readily. A derivation with an epenthetic coda is:

(43)	UR	citum	*fall asleep*
	core syllabification	(ci)(tum)	
	copy [syllable]	(ci)(ci)(tum)	
	impose [heavy] syllable	(cin)(ci)(tum)	
	phonetic syllabification	—	
	hiatus resolution	—	
	vowel lowering	(cen)(ci)(tom)	

Because some elements are unsyllabified in the core syllabification, they will not participate in the reduplication because they are not prosodically incorporated. An example of this is:

(44)	UR	skma	*moose*
	core syllabification	s(km)(a)	
	copy [syllable]	s(km)(km)(a)	
	impose [light] syllable	—	
	phonetic syllabification	(s)(km)(km)(a)	
	hiatus resolution	(s)(km)(kma)	

Turning to the copying of less than a complete constituent, copying of the rime/nucleus leads to two situations when the core syllable type is imposed. If there is syllabifiable material to the left, then it is used to construct the syllable:

(45)	UR	spus	*leaf*
	core syllabification	s(pu)s	
	copy [rime/nucleus]	su(pu)s	
	impose [light] syllable	(su)(pu)s	
	phonetic syllabification	(su)(pus)	
	hiatus resolution	—	

When no such material is available, the epenthetic onset, /ʔ/ is used:

(46)	UR	k'inax^w	*crab*
	core syllabification	(k'in)(a)x^w	
	copy [rime]	in(k'in)(a)x^w	
	or copy [nucleus]	i(k'in)(a)x^w	
	impose [light] syllable	(ʔi)(k'in)(a)x^w	
	syncope	(ʔi)(k'n)(a)x^w	
	phonetic syllabification	(ʔi)(k'n)(ax^w)	
	hiatus resolution	(ʔi)(k'nax^w)	
	vowel lengthening	(ʔi)(k'na:x^w)	

There is a case which points out the necessity of copying rimes, and the transfer of geminate consonants, which may be obscured by other matters of the morphology. The form:

(47) c'us-m̩ ʔ usc'us-m-i *evening*

copies the /s/ along with the /u/, to the exclusion of the /c'/. To capture this we will need to copy the rime. However, in this case the rime exceptionally includes the non-sonorant /s/. There are several ways of marking this exceptionality. One would be to mark the lexical item as exceptionally syllabifying consonants generally as codas (lexically altering the parameter for coda formation). Another way would be to claim that the final consonant in this form is geminate. This second alternative will not be pursued here, though some properties of geminates in languages such as Bella Coola will be considered below. The raised o (°) will be used to indicate exceptional syllabification, however it is accomplished. The /m/ is a incohative or transitive marker so I will assume that it does not participate in the syllabification within the derivational morphology. This form displays the nominalizing use of reduplication.

(48)	UR	c'us° - m	*to become dark*
	core syllabification	(c'us) - (m)	
	copy [rime]	us(c'us) - (m)	
	impose [light] syllable	(ʔus)(c'us) - (m)	
	phonetic syllabification	(ʔus)(c'us) - (m) - (i)	
	hiatus resolution (twice)	(ʔus)(c'u)(smi)	

Finally, the copying of just the onset leads to epethetic nuclei when the core syllable type is imposed:

(49)	UR	xnas	*woman*
	core syllabification	(xn)(a)s	
	copy onset	x(xn)(a)s	
	impose [light] syllable	(xi)(xn)(a)s	
	phonetic syllabification	(xi)(xn)(as)	
	hiatus resolution	(xi)(xnas)	

There is an alternative to this lexical specification of constituent to copy, which is to follow Bagemihl's analysis of a lexical rule of initial onset deletion, and always copy an entire syllable. In the cases where light syllable structure is imposed upon the copy it will not matter if we copy too much. The relevant data would be to find stems with heavy initial syllables that display epenthetic consonants in reduplication. The form:

(50) t'cu-ulmc *sweep-floor* t'cunculmc-ta *broom*

comes closest to matching our requirement. However, because of the consecutive /u/'s (belonging to different morphemes) and because hiatus is acceptable in CS, we can see this form as being another CV → CVnCV case. Thus, we cannot find any cases requiring the copying of only the nucleus. Furthermore, copying of the nucleus alone is not required to derive any of the reduplication forms because of the possible imposition of syllable types. Thus, what must be lexically specified is whether to copy the onset, rime or entire syllable, and the target syllable type to be imposed. We will still need to retain various rules of stem modification, such as syncope, spirantization and vowel lengthening and these will remain lexically specified.

What is different between these two analyses is the treatment of pre-specification, association, lexical parameterization and licensing. Bagemihl allows prespecification and association, instead I offer constituent copy and epenthesis. Bagemihl has lexical parameterization of rules, my analysis has lexical parameterization of constituent size. His approach allows licensing to be suspended at different prosodic levels, mine delays its application.

Theoretical Consequences

In this section I will examine some of the theoretical consequences of the theories of Bella Coola syllabifiication and reduplication. Among these issues are licensing, construction methods, mora theory, geminates, hiatus, and edge effects.

Licensing Prosodic Structure

Bagemihl's analysis involves an unusual addition to the mechanisms available within prosodic theory. It allows for items to remain unincorporated into higher prosodic structure throughout a derivation: once segments have become licensed as moraic, no further licensing of these segments is necessary. This is at odds with principles of prosodic structure such as those espoused by Selkirk (1984, 1986), and with other prosodic theories which involve exhaustive incorporation of subordinate constituents. A comparison can also be made to the theory of Halle and Vergnaud (1987), where the initial projection of stressable elements is not exhaustive, but subsequent layers of prosodic structure *are* exhaustively built. Licensing applies to prosodic levels generally, for example as in Selkirk's (1986) formulation of the properties of prosodic structure:

(51) *Properties of Prosodic Structure* (Selkirk 1986: 384)

...

b. For any prosodic category, the sentence is exhaustively parsed into a sequence of such categories.

..

Every level of prosodic structure is exhaustively incorporated into the next higher level. Thus, I believe that Bagemihl's solution of parameterized licensing is not consonant with the general meaning of licensing. Taken at his word, such an account of licensing would entail that syllables and the rest of higher level prosodic structure would not need to be built, and thus presumably for reasons of perspicuity would not be. However, his account of reduplication requires such constituents as syllables and feet, thus he clearly intends higher level prosodies to be constructed. If they were not constructed he would have no means of reduplicating a foot.

The view that licensing is a general prosodic constraint does not entail that all prosodic structure is "Strictly Layered":

(52) *Strict Layer Hypothesis* (Selkirk 1984: 26)

We have proposed that a category of level *i* in the hierarchy immediately dominates a (sequence of) categories of level *i-1* ...

(53) *Properties of Prosodic Structure* (Selkirk 1986: 384)

...

c. The Prosodic categories are ordered in a hierarchy ..., and in phonological representation they are strictly organised into layers according to that hierarchy ...., i.e. prosodic constituents of a same category are not nested.

d. The hierarchical arrangement of prosodic categories forms a well-formed bracketing.[9]

Neither does it preclude such layering. It does mean that Bella Coola must construct syllables, feet and other types of metrical constituents, in accordance with general prosodic principles. Licensing then makes sure that every element visible to a prosodic level is incorporated into that prosodic structure by the end of the derivation. In this way, licensing in Bella Coola appears to be no different from prosodic licensing elsewhere. In my analysis I retain this general notion of licensing, applied as a filter, at the end of the phonology.

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9 That is, a tree as opposed to a graph -- BI.

Bagemihl parameterizes licensing so that syllable construction can be made non-exhaustive. The same non-exhaustivity of syllable construction can be achieved by delaying the application of licensing tests until after the application of morpho-phonological processes (e.g. reduplication). In this way the alternative analysis is a generalization of extra-prosodicity: certain elements do not form part of the prosodic structure during initial phases of its construction, but are later incorporated. Such an innovation allows a Bagemihl-like analysis of reduplication patterns based on syllabicity differences, but will retain general notions of licensing, modifying them only in delaying the application of syllabic licensing, bringing it in conformance with licensing in theories with extra-prosodicity. To bring this about, I propose a model of syllable construction that takes place in two phases. The first phase forms simple, core syllables, and is not exhaustive. The second phase forms more marked syllables, and is exhaustive. In between these two phases morphological processes may apply, notably, BC reduplication. Thus, the model of morphology-phonology interaction that I am advocating here follows Halle (1989) and Halle and Bromberger (1989). All morphological operations precede all phonological rules. However, syllabification is not taken to be either morphological or phonological. Thus, the model is:

UR	→	Core Syllabifcation	→	Morphology	→	Phonetic Syllabification	→	Phonology

(54) Partial Structure of PF

Specifically, the Core Syllabification can be seen as part of the morphological component, and the phonetic syllabification as part of the phonological component:

UR →	Morphology Core Syllabification → Processes	→	Phonology Phonetic Syllabification → Processes	

(55) Components of PF

Another view is to enrich the underlying representation with syllable structure, and have the rest of syllabification confined to the phonology. This question will be briefly considered in the section on a lexical approach to Bella Coola reduplication. Further, to correctly derive some reduplication patterns while reduplicating at most one syllable of material, some common assumptions about syllable structure, specifically the maximization of onsets will be questioned.

There are other issues involved in the application of a concept as abstract as licensing. Itô's theory seems open to a variety of interpretations as to its implementation. It can be viewed as a template construction method, whereby syllable structure is built not through projection of higher level constituents but by matching one of a set of templates. Alternatively, it can be seen as only a device which checks the legimatacy of a sequence of segments, not building any structure. Bella Coola allophonic rules require access to syllabification constituency, so if licensing is checking, the allophonic rules must be applied as the checking procedure is done, because no permanent structure is built through checking. This is an unintuitie and unsatisfactory approach, as it would require the conglomeration of all syllable-sensitive rules into the template-checking procedure. It is simpler to build the syllable structure and then refer to it. Thus, it is more helpful to separate licensing from templates; with template matching as a construction method and licensing as a checking procedure.

Maximizing Onsets

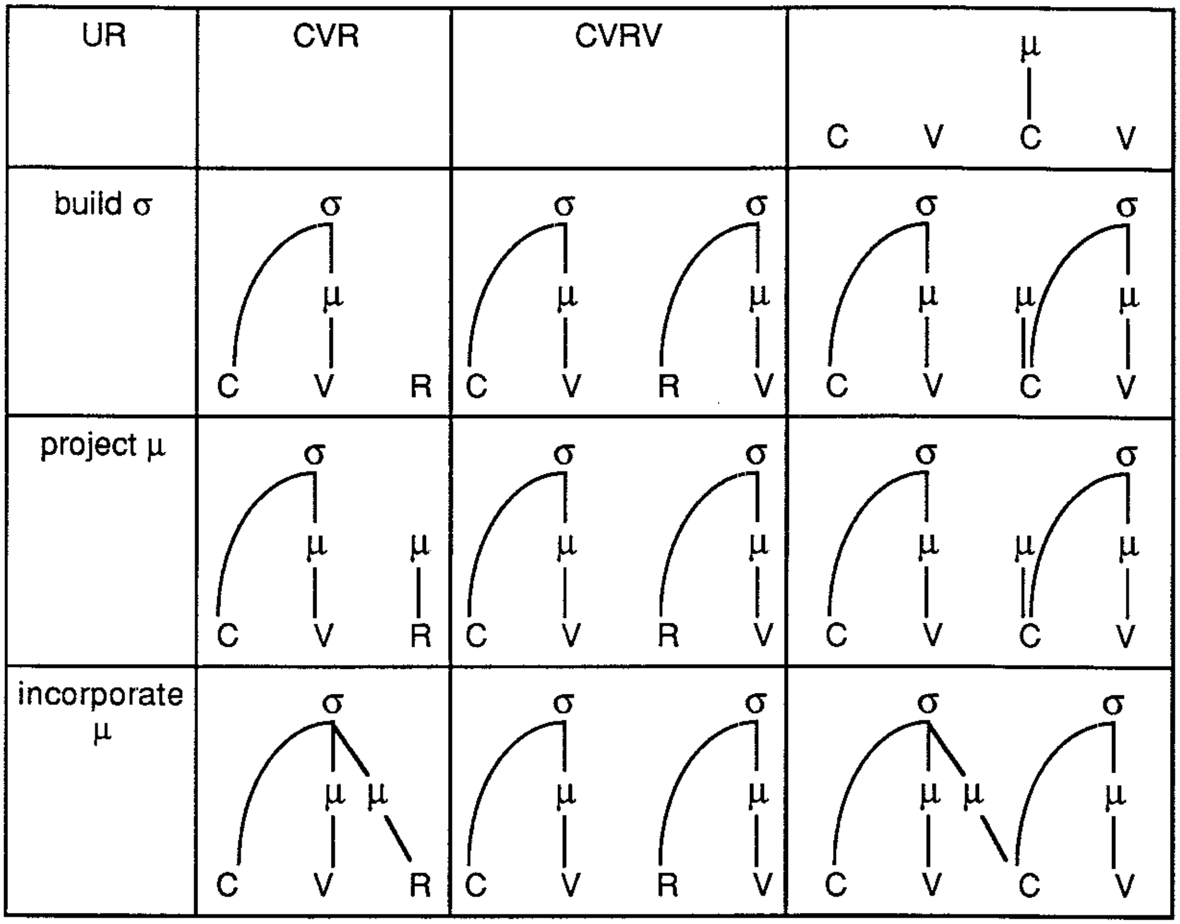
There have been several different proposals for syllable construction methods. They can be broken down along a number of dimensions. The first differentiation can be termed *projective* and *non-projective* theories. Projective theories involve the projection of higer level constituents by rule upon lower level ones. Examples of such theories are Steriade (1982), Clements and Keyser (1982) and Levin (1985). Non-projective theories match segments to pre-defined syllable shapes. They are usually termed "template-matching" systems. The major distinction is in terms of number of operations. The projective theories perform several distinct operations to build a syllable, for example: project nucleus, project onset, project rime. Template-matching, on the other hand, builds structure by association to terminal elements, thus, if it can be said to be to involve ordered operations at all, the phases are the assignments of the individual association lines.

Since I am claiming that syllabification has two distinct major phases, much of the construction debate is of subsidiary interest. We will need to make two full passes at syllabification, whether we want to use templates or projection. One of the main concerns in Bella Coola reduplication is the transfer of inter-vocalic sonorants:

(56) silin silsiln - i *kidney*

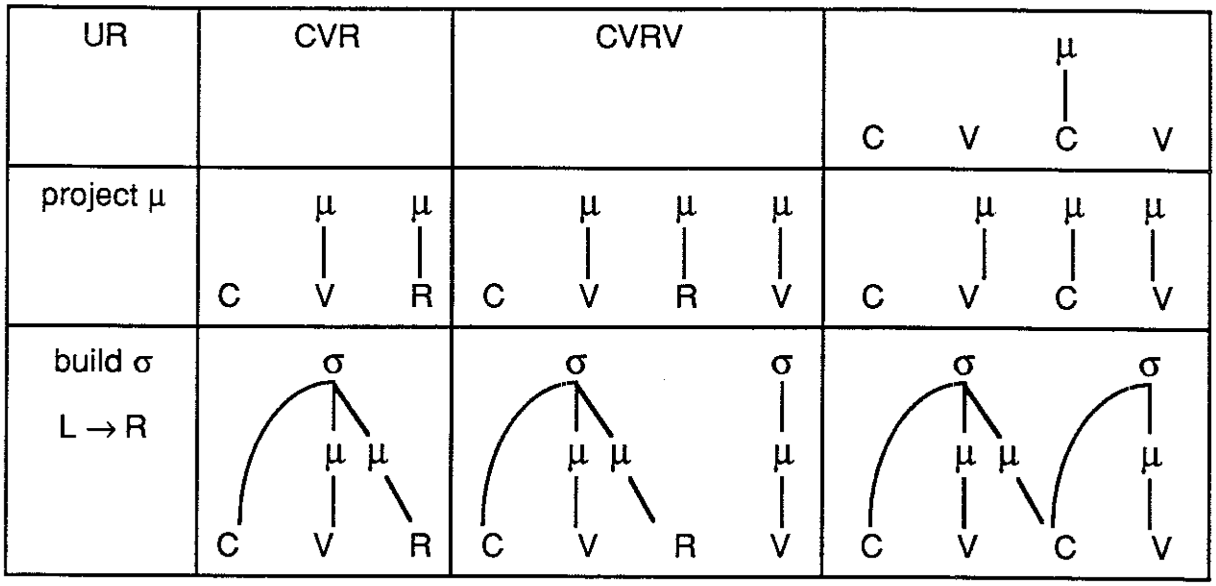
This was accounted for by syllabifying the sonorant with the previous vowel, maximizing codas in this language. Turning now to actual construction methods, we see that this non-maximization of onsets is in fact easier to achieve here than maximization of onsets. If we apply a "greedy" syllabification procedure from left to right across the string, we will end up with inter-vocalic sonorants syllabified with the preceding vowel: ....VRV.... → (VR)(V). In order to get maximization of onsets, syllables must be constructed in at least two passes, separating onset formation from coda formation or we must incorporate some sort of non-determinism or look-ahead. Projective theories of syllable structure work by breaking syllabification into sub-procedures, but they work by incorporating material into a higher level constituent (σ, $\overline{\overline{N}}$) prior to filling out a lower level one (rime, $\overline{N}$), even though the beginning of the construction is bottom-up with the projection of the nucleus. Thus, the construction of the syllable does not follow its constituency. Bagemihl's construction algorithm has the same sort of formal dichotomy, building moras generally and deleting them upon incorporation as onsets. Thus, we gain a more uniform approach by not trying to maximize onsets in BC. The construction of initial syllabification without maximizing onsets allows for the characterization of reduplication as constituent copy.

The attempt to maximize onsets in BC is also the cause of problems in Bagemihl's "project μ" method of syllable construction. Using a projective moraic theory such as Bagemihl's it is tempting to relate the sonorancy of coda material in the initial phase of syllabification with the sonorancy of the nucleus. That is, in BC the conditions for core nuclei and core codas are the same. If it is desirable to bring these two observations together we would like to project moras (i.e. syllable heads and codas) uniformly. There is some question about the attractiveness of such a move, for languages certainly seem able to restrict coda consonants in ways different from their nucleic restrictions. There is no way to satisfactorily project moras uniformly, have maximally bi-moraic syllables and maintain the maximization of onsets. If we first build mono-moraic syllables without hiatus so as to maximize onsets, and then project unsyllabified [+son] segments as moraic we achieve maximization of onsets, but at the cost of two projections of moraic material within a syllabification pass:



(57) Maximization of onsets by 2 projections of moras

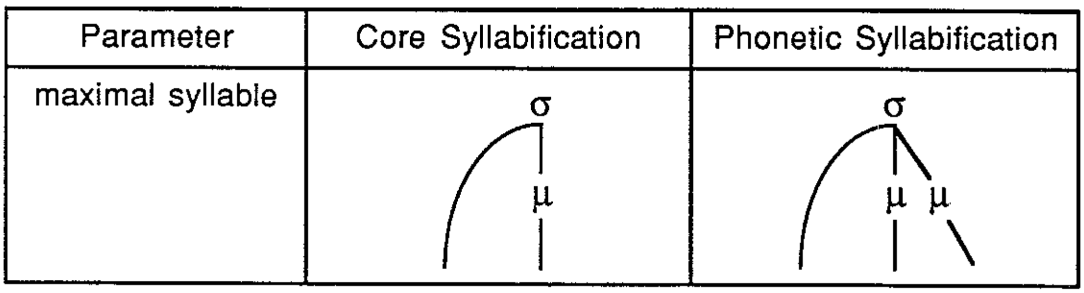
If we do the strict bottom-up approach, projecting moras onto [+son] segments, then we will have to "de-morify" segments incorporated as onsets. This problem is solved if we do not assume that onsets are maximized in BC. Then we can project moras onto [+son] elements uniformly, and build bi-moraic syllables left to right, allowing hiatus:



(58) Maximization of codas

This leaves us with the problem of characterizing languages *with* maximization of onsets, if indeed such languages really exist. One approach is to try to relate the maximization of onsets to the availability of hiatus structures in a language. If hiatus structures were unavailable, and all potentially nucleic material projected nuclei, then we would have a situation where only maximization of onsets would meet all necessary conditions. This is predicated on the availability of less complicated syllable structures, that is, the maximal syllable type is not the only syllable type. Therefore, we will assume that CV syllables are universally acceptable. Another way to maximize onsets would be to apply the syllabification algorithm without look-ahead right to left across the form. This would incorporate intervocalic material as onsets rather than as codas.

A third way to achieve maximization of onsets within a framework of multiple syllabification phases is to mimic the traditional construction methods in the two phases of syllable construction:



(59) Parameter settings to maximize onsets in two passes

In the first phase we would build CV syllables, followed by a second phases where CVC syllables are constructed. Such an approach would necessitate interpreting the second phase of syllabification to be augmentative: syllables constructed during a previous pass could be *enlarged* to include previously unsyllabified material. In this way, the mimicry would be nearly complete, with the exception of the innovation of the possibility of morphological operations applying in-between the incorporation of onsets and the incorporation of codas.

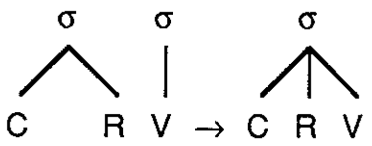
Thus, syllabification and reduplication in Bella Coola together point out some questionable assumptions in theories of syllable structure: how many phases and whether onsets are maximized. It is particularly gratifying to find a language which does not maximize onsets at all phases. This allows us to reconsider the status of a principle maximizing onsets. Bella Coola seems to indicate that at least maximization of onsets is language specific, perhaps even due to a particular configuration of Core and Phonetic Syllabification parameters. This allows us to have universal syllabification procedures that do not make direct reference to whether onsets are maximized. This allows us to employ construction methods that mirror syllable constituency, thus applying constituency constraints to the construction procedure itself. This means that syllable construction adheres to a strict bottom-up construction method, or by the strict left-to-right matching of maximal templates in a "template" approach. This gives us theories in which syllabic constituency is constructed entirely bottom-up within a phase, or in which templates are matched without look-ahead.

Hiatus, Geminates and Syllabification

The adoption of a theory that allows for the maximization of codas also sheds light on the hiatus resolutions:

(60)	ti	+ aɬ	→ tyaɬ	*standing firmly*
	q^{w}i	+ nu...uc	→ nuq^{w}yuc	*to open the door*
	c'u	+ i:χ^w	→ c'wi:χ^w	*(having) grey hair*
	tuk'm̩	+ a:χaɬ	→ tuk'ma:χaɬ	*to sprain an ankle*
	stn̩	+ a:ɬ	→ stna:ɬ	*wooden spoon*

A natural way to account for such alternations is to base the distinction on syllabic structure, amending hiatus when it occurs. Especially significant here is the patterning of nasals along with the vocoids. If we treat the distinction between vowels and glides as inherent in the segment, using the feature [± vocalic] or [± syllabic] then this feature would have to apply also to the rest of the sonorants, including nasals. This would lead to inconsistancies in the feature system necessitating further differentiation between glides and liquids. Thus, it is simpler to cast syllabicity alternations in terms of prosodic structure:

(58)


However, we also have the form:

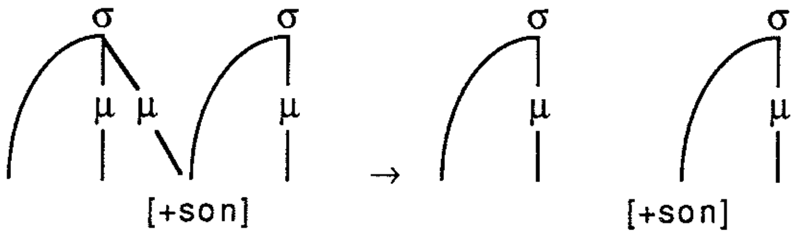
(61) qałayu qałayw - i *fish hook*

The form for *fish hook* illustrates a sequence VGGV. The appearance of such a form, rather than VGVG (/ayuy/) poses some questions regarding the construction of syllables in Bella Coola. If the stem were syllabified as (a)(yu), the addition of the suffix would not normally cause a complex onset (yw) to be created. Thus, we must see the addition of the suffix as triggering an unexpected change in syllabification. However, with the syllabification algorithm proposed earilier, we would have (ay)(u). This would allow the gliding of the preceding vowel through syllable merger (due to hiatus), without having to re-syllabify the /y/.

There is another possible analysis of this problem, and of core codas in Bella Coola generally: intervocalic sonorants are geminates. One of the other attractions of the mora theory is that it could capture directly the similarity of geminates and sonorants in forming codas by making them both moraic. However, the two items are being treated differently at this point: geminates span two syllables, and sonorants are being confined to the coda of the preceding syllable. However, a theory where geminates and sonorants are similarly treated could capture some interesting observations. There is a general constraint in Bella Coola involving inter-vocalic sonorants. No distinction is made in BC between inter-vocalic geminate and non-geminate sonorants. Thus, there is some leeway in the representation of their syllabification. It has generally been assumed when a VCV sequence is encountered that the syllabification will proceed so as to maximize onsets, and we have maximized codas when there is a VRV sequence. These are not the only possibilities, and since geminates are not distinguished from non-geminates with intervocalic sonorants a gemination analysis might be fruitfully pursued. A similar situation, pointed out to me by François Dell, is that Berber seems to have the same non-distinctness in intervocalic glides. This points to another way of handling the inter-vocalic sonorant problem: to treat all such sonorants as geminate within core syllabification. This is particularly appealing in the moraic theory, as we could project moras onto [+son] material and then build syllables in which all syllables have onsets, in the case of hiatus syllables, their onsets come from the preceding coda: these are the lexical geminates and sonorants.

If we adopt a geminate theory of intervocalic sonorants, then the rules of hiatus resolution would not apply, and we would need a rule of de-gemination:

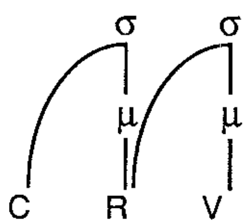
(62) Sonorant Degemination



This would then capture the behaviour of sonorants in reduplication and in syllabic process of vowel allophony by giving them different syllable structures due to their point of application. Reduplication could copy the part of the geminate sonorant associated with the first syllable, but after de-gemination the vowel allophony rules would yield the correct results. We will still require rules for hiatus combination, though some of these could be analyzed as involving prior gemination:

(63)	ti	+ aɬ	→	tyaɬ	*standing firmly*
	q^wi	+ nu...uc	→	nuq^wyuc	*to open the door*
	c'u	+ i:χ^w	→	c'wi:χ^w	*(having) grey hair*
	tuk'ṃ	+ a:χaɬ	→	tuk'ma:χaɬ	*to sprain an ankle*
	stṇ	+ a:ɬ	→	stna:ɬ	*wooden spoon*

If we allow nuclear material to be shared similarly to coda geminates, we could characterize these cases, along with cases like *xli (penis)* as:



(64) Nuclear geminates instead of hiatus

The rule of syllable merger would then apply to this structure directly.

Edge Effects

Let us examine another question of syllabification procedure, that of the syllabification of sonorants at the beginning of a domain. Bella Coola allows individual sonorants at the beginning of a word to be syllabic:

(65) ʔṇλ' *dark* s-ṇλ' *darkness*

The glottal stop is epenthetic, as is shown by its non-occurance when the nominalizer /s-/ is present. We have also seen that a sequence #RR is syllabified #(RṚ) when there is non-decreasing sonority:

(66) mus musmus *cow*

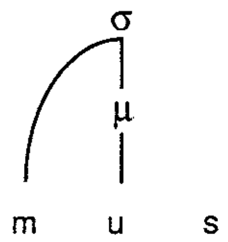
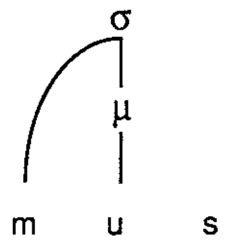
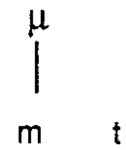
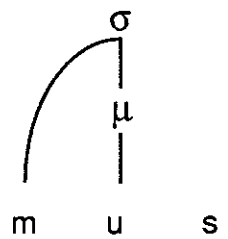
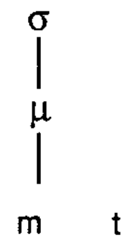
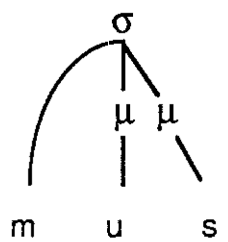
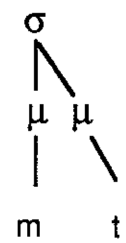
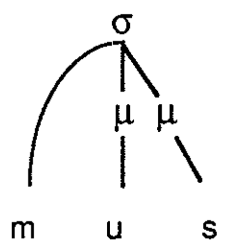
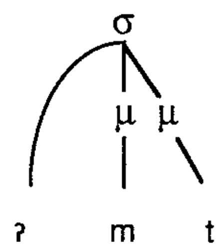
contrasting with the behaviour in the context #CRR:

(67) plak pḷplak *both arms missing*

where the first sonorant is reduplicated as moraic. Bagemihl achieves this distinction by *construction* of initial moraic and syllabic structure but left-to-right re-association to syllable *templates* in reduplication. However, this preference for syllabifying pairs of segments to building two hiatus syllables is also present in Berber (Dell and Elmedlaoui 1985). Thus, there seems to be a general ability to cope with this distinction. One method of achieving this result would be to make two scans in the first pass, one with the first element extra-moraic, and the second scan eliminating extra-moraicity:

(68) Extra-prosodic edge sonorants

UR	mus *cow*	mt *get up from bed*
mark #[+son] extra-moraic	[m]us	[m] t
project μ	μ | [m] u s	[m] t
build σ	σ / | / μ / | m u s	[m] t

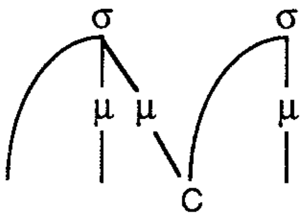
loss of extra-moraicity		mt
project μ		
build σ		
phonetic syllabification		
onset epenthesis		

This approach is attractive because of the "edge-effect" nature of the problem. Look-ahead or non-deterministic solutions are less desirable as their effects would be evident word-internally as well. The two scan approach could also be viewed as exhaustive syllabification of certain elements, the sonorants. The relevant generalization is that all sonorants in Bella Coola words are syllabified by the end of core syllabification.

Returning to the question of exceptional codas in such forms as:

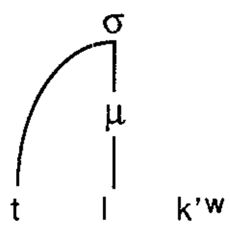
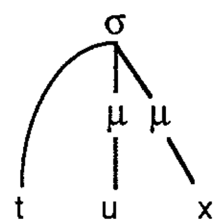
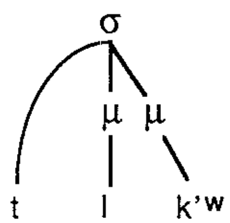
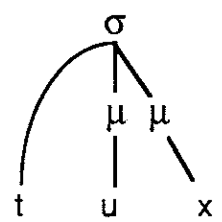
(69) c'us-m̩ ʔ usc'us-m-i *evening*

we can examine the question of representing these roots as having final geminates. The end of the word will show edge effects regarding the syllabification of geminates. When geminates are located between syllabic peaks, they are realized as both closing the preceding syllable and opening the following syllable:



(70) Inter-syllabic geminate

However, in Bella Coola if we represent geminates as underlyingly moraic, then it is possible for geminates to appear in positions that in the core syllabification will not yield inter-syllabic positions. Two such positions are before obstruents and at the end of a word. In such cases, the consonant will be incorporated into the syllabic structure as a coda to the preceding syllable, but not as an onset to the following syllable. Thus, forms with final consonants are neutralized phonetically, though they are distinct in the core syllabificaiton:

UR	t l k'w	
Core Syllabification		
Phonetic Syllabification		
Reduplication	t l t l k'w	t u x t u x

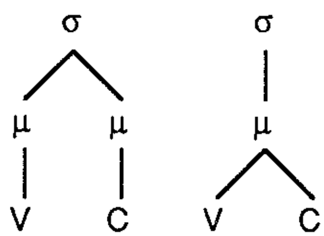
(71) Behaviors of word-final consonants

Thus, the introduction of multiple phases of syllable structure allows for a more complex interaction between syllabifcation and geminates. This allows us to express distinctions between phoneticallly similar syllable structures at earlier points in the derivation based on underlying differences.

Mora Theory

Much of the discussion has been framed in moraic terms. It is useful to examine these notions in some detail. A theory which copies syllabic constituents to effect reduplication makes predications about the internal structure of Bella Coola syllables. We saw that we did not require reference to a nucleus constituent in the copying analysis. We could copy an onset, rime or the entire syllable. Further, we could impose certain syllable structures on the reduplication syllable.

Within moraic theory there are two ways of representing rimes involving short vowels and consonants:



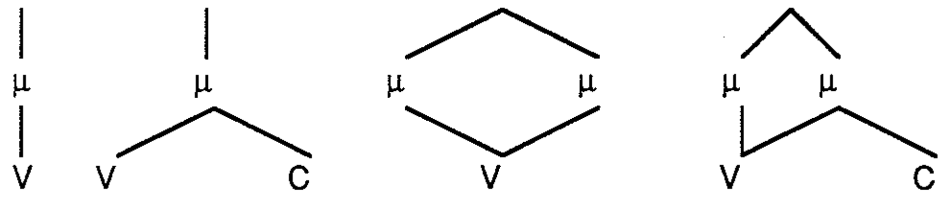
(72) Moraic representations of closed syllables

Since Bella Coola allows CRVVC syllables at least phonetically, we must be able to have bi-moraic syllables and branching moras. However, since we are seemingly unable to reduplicate a nucleus and then impose a closed syllable (*CVR → CVnCVR) the representation of CVR syllables must be mono-moraic. Likewise, because we are able to copy the rime without the onset (c'usm̩ → ʔusc'usm-i), the (underlying geminate) /s/ must form a constituent with the /u/ *to the exclusion of* the /c'/. Again, we are led to the conclusion that closed syllables are mono-moraic.

We should turn now to the question of the imposed syllable structures. Many questions remain regarding the lengthening and shortening of nuclei in Bella Coola. It is possible to have stems with long vowels reduplicate and display /n/ epenthesis:

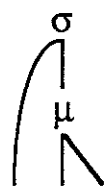
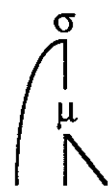
(73) sp'-u:ɬ *hit ball* sunp'u:ɬnm *play baseball*

Since we are copying the entire prosodic structure, it is reasonable to assume that vowel length is being copied. Thus, it must be that the imposition of the target syllable types carries the information that no long vowels are tolerated. Since Bella Coola permits V:C syllable types phonetically, it must distinguish between structures such as:



(74) Bella Coola Rimes in Moraic Terms

The first of these is the sructure that is imposed on the reduplicated syllable to make it light. The second is the structure imposed to make it "heavy", in light of this "closed" might be a better term. Both of these structures are mono-moraic. Thus, we can conclude that Bella Coola restricts the imposed syllables to be the mono-moraic syllables. Thus, vowel length is lost through the imposition of either type target syllable. Further the closed structure also accounts for the varieties of epenthesis, for it indicates the position of items by their unmarked core levels of sonority: CR → CVR, CV → CVn. In light of these factors, we should revise our parameters for Bella Coola to indicate the correct moraic analysis of reduplication by constituent:

Parameter	Core Syllabification	Phonetic Syllabification
maximal syllable		
maximize onsets	no	no
nucleus	+son	any segment
coda	+son, geminates	any segment
allow hiatus	yes	yes

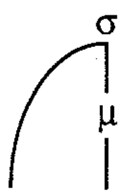
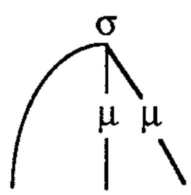
(75) Bella Coola Syllabification parameters revised

This entails certain consequences for the moraic viewpoint. It appears that it is sometimes necessary to know what is contained under a mora. In this case, it is sufficient to know whether the mora is branching or not. Thus, the two imposed syllable types could be specified as mono-moraic with non-branching mora and mono-moriac with branching mora. Thus, some of the divisions generally available in other theories of the syllable, such as a nucleus/rime distinction appear to be necessary in Bella Coola. They can be captured here with a particular type of mora theory, provided that we are allowed to know and specify branchingness on moras. This analysis of Bella Coola syllable struction makes strong predications about analyses of other prosodic phenomena in Bella Coola. Thus, we would not expect the rules of syncope to be formulated to treat long vowels and closed syllables similarly, because we have represented them as being distinct: long vowels are bi-moraic and closed syllables are mono-moraic.

Comparison with Berber

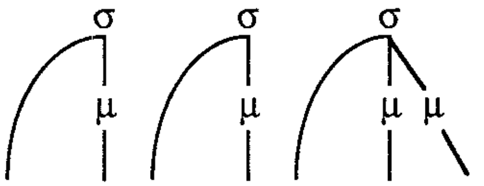
Recently Dell and Elmedlaoui in a series of papers (Dell and Elmedlaoui 1985, 1989, Elmedlaoui 1985) have offered an analysis of Berber phonology and morphology in which the syllable structure is constructed iteritively. In their model syllables are built for each descending level in the sonority hierarchy: a, i/u, liquids, nasals, fricatives, stops. This allows for a uniform lexical characterization of syllabicity alternations. That is, there is no underlying distinction between y and i or n and ṇ.

Although Berber and Bella Coola are phonetically similar in allowing obstruents to form syllable peaks they differ in the details of the syllable construction. The striking thing about Berber in comparison with Bella Coola is Berber's complete disdain of hiatus.

Parameter	Core Syllabification	Phonetic Syllabification
maximal syllable		
maximize onsets		yes
nucleus	[+son, -cons]	any segment
coda		any segment
allow hiatus	no	no

(76) Berber Syllabification parameters

This non-tolerance of hiatus structures leads to phonetic syllables that do not conform to typical sonority generalizations. Phonetically, Berber can have syllables in which the onset is more sonorant than the nucleus:



(1) t i w n t a s *you climbed on him*

Dell and Elmedlaoui propose that the syllabification of Berber words iterates over the values of the sonority scale, starting with /a/ and continuing down to obstruents. For the phonetic syllabification we will follow this iterative procedure. This same phenomenon is observed in Bella Coola, so we might conclude that the creation of syllables within the phonology always applies iteratively through the sonority scale. For core syllabification, however, we saw in Bella Coola that words such as:

(77) (mn)(a) *child*

were syllabified with hiatus. If the syllabification procedure applied iteratively at this point we would have *(m) (na). Thus, Bella Coola indicates that core syllabification does not proceed iteratively. To capture the behavior of Berber /a/ we will need to add the constraint that /a/ always forms syllable peaks. Since /a/ cannot be an onset nor a coda, because core syllables even in Berber obey sonority sequencing generalizations, it is sufficient to indicate that all underlying /a/'s must be syllabified in the core. The same is not true of the high vocoids, as we have seen.

The interesting claim that such an analysis offers for Berber is that there is a distinguished phase of syllabification within Berber morpho-phonology where words are partially syllabified into CV syllables. By using this structure as the basis for morphological operations, we achieve a C-V segregation in the nucleus/non-nucleus distinction. Berber seems to have some Arabic-like C-V morphology (Dell and Elmedlaoui 1989), but this morphology does not alter non-vocalic nuclei. Since the morphology only replaces vowels, it can be recast under this analysis as the replacement of core nuclei. In this way, core syllabification is the foundation of tier segregation in Berber. This presents a novel view of the nature of tier segregation, an issue too complex to pursue here.

Lexical Syllable Structure

Reviewing what was proposed in the previous sections, we will notice that a great deal of lexical stipulation remains. We need to know for each lexical item whether it undergoes reduplication, and if it does whether it takes a heavy or light syllable, how much it copies and whether it undergoes stem modifications. Jay Keyser has suggested that much of this stipulation could be traded for lexical specification of syllable structure. Such a theory is particularly enticing, as it would explain immediately why we seem to need two syllable structures. The core syllabification would then correspond to an *underlying* syllable structure, and the phonetic syllabification would correspond to syllables created in the derivation. This would then reduce the syllable structure problem to the usual underlying/derived distinction.

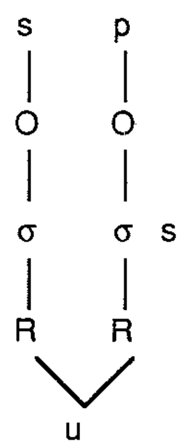
UR	→	Morphology	→	Phonology
Core Syllabification		Processes		Phonetic Syllabification → Processes

(78) Components of PF

In addition, it would allow us to place the morphological block strictly prior to the phonological block. That is, the morphological operations would apply directly to underlying representations, simplifying the child's acquisition task considerably. The child would no longer have to figure out what parts of the phonology must apply prior to morphological processes (although the child would have to construct lexical representations containing syllabification information). This would also yield a more uniform set of representations, bringing the lexical representations closer to the standard phonological representations, and allowing for straightforward accounts of "tip-of-the-tongue" phenomena involving prosodic structures. Let's sketch out how such a theory might work for Bella Coola.

As pointed out above, BC reduplication never copies more than about a syllable's worth of material. If we segregate subconstituents of the syllable onto their own tiers (as presaged in the suggestion about Berber C-V segregation by syllable position) then we can represent such sharing by the sharing of onsets and rimes between two syllables:

(79)

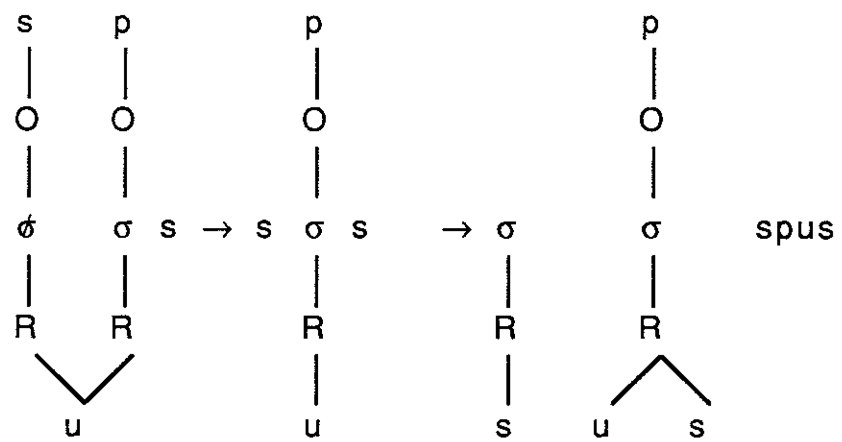


spus/supus root

In the root of *spus~supus* the vowel is shared by both syllables. The final /s/ is not yet incorporated into the syllable structure. That is, it is unsyllabified. The initial /s/ forms the onset to the first syllable, the /p/ is onset to the second. Upon syllabification of the final /s/ we have the representation of the reduplication form.

Giving the onset and the rime their own tiers permits a limited amount of "crossing lines", just enough to be able to share a syllable's worth of melodic material. The process of reduplication would now be formulated as the absence of the application of a rule of truncation. The truncation rule would apply in normal forms, eliminating the first node on the syllabic tier. Since in this case the melodies associated with that syllable are still born by other syllables, there will be no melodic loss with this truncation:

(80)

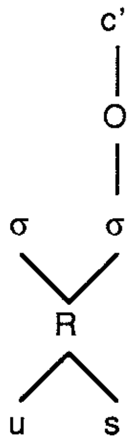


Another attraction of this theory is that it allows for a general method of exceptions to syllabifcation, for example non-sonorant core codas. Recall the form:

(81) c'us-ṃ ʔ usc'us-m-i *evening*

This will be represented as the sharing of a rime that happens to have a non-sonorant coda:

(82)



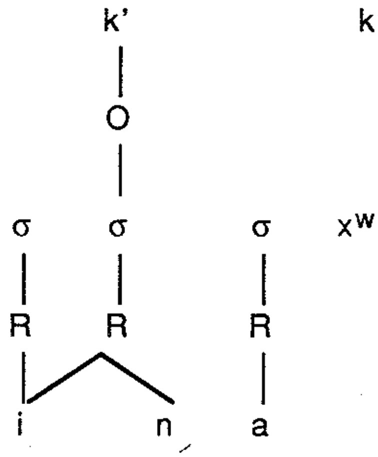
c'us root

The forms that were analyzed as involving the imposition of light syllable structure upon a heavy copied syllable will be represented as the sharing of structure beneath the rime. Forms such as:

(83)	UR	k'inax^{w}	*crab*
	core syllabification	(k'in)(a)x^{w}	
	copy [rime]	in(k'in)(a)x^{w}	
	impose [light] syllable	(ʔi)(k'in)(a)x^{w}	

will be represented as:

(84)



k'inax^{w}

A trickier question involves the representation of forms with epenthesis. There are two types of cases, vowel and coda epenthesis:

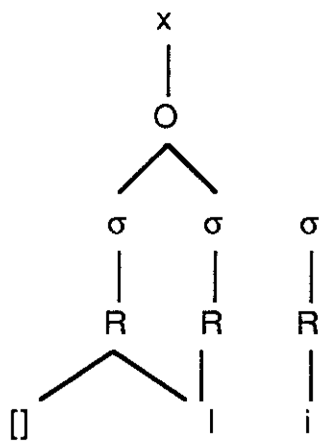
(85)	UR	xli	*penis*
	core syllabification	(xl)(i)	
	copy [syllable]	(xl)(xl)(i)	
	impose [heavy] syllable	(xil)(xl)(i)	

(86)

UR	citum	*fall asleep*
core syllabification	(ci)(tum)	
copy [syllable]	(ci)(ci)(tum)	
impose [heavy] syllable	(cin)(ci)(tum)	

This will require some method of indicating that the initial rime branches, but does not have a melody associated with part of a branch:

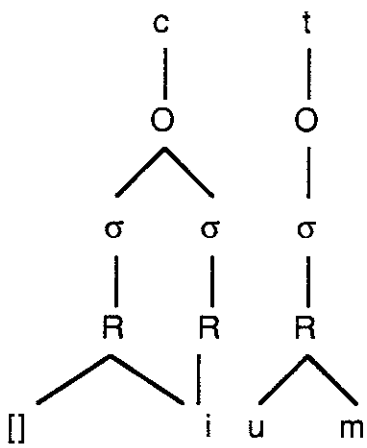
(87)



xli

The second form is more problematic if we want left-to-right order on the page to correspond to increasing time on all tiers. This assumption can be questioned, however, if we feel that the timing is encoded on certain tiers, and motor control instructions are on other tiers. This question requires further examination that is beyond the scope of this paper. For concreteness, let us give the form *citum* the same representation:

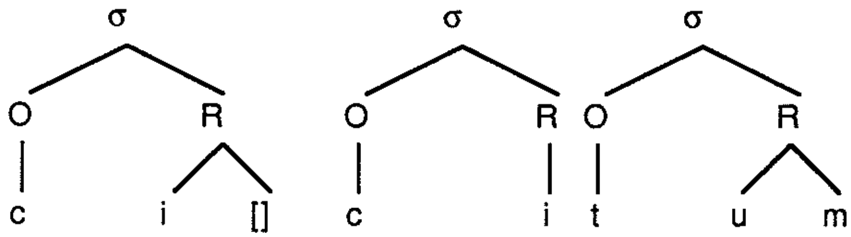
(88)



citum

When this structure is interpreted by the phonetic/motor-control component, some equivalent to tier conflation will apply, splitting shared components which are temporally contiguous. This will yield the more familiar non-shared syllable structures:

(89)



At this point, the order of elements within the rime is determined, according to the sonority of those elements. If the empty item has a vocalic sister, the empty element follows the vowel. If the sister is a liquid or a nasal, the empty element is realized as the head of the syllable. The process of tier conflation might allow for a characterization of some puzzling problems in iteraction between reduplication and phonological processes. Marantz (1982) describes cases of under- and over-application of phonological rules in conjunction with reduplication. The sharing of syllabic components and melodies allowed in this view of reduplication would define a phase of the derivation where it would be possible to modify components shared by two syllables. Thus, over- (and under-) application would result from rules applying to un-conflated shared structures. This view of the interaction could be separated from the lexical syllable structure hypothesis by allowing empty prosodic constituents to be affixed to partially syllabified stems, and then receive their melodies through association rather than copying.

Though this theory has many attractions, it still appears to require some sort of lexical stipulation for stem syncope. To really qualify as a complete alternative, it will be necessary to find a compatible prosodic account of vowel quantity in Bella Coola. This theory is also a radical departure from previous views of syllable structure. For one, it treats nodes in prosodic structure more like nodes in auto-segmental representations. For another, there is no clear way of defining underlying syllables, for no construction method is applied to them. In other theories of syllabification, the work is parcelled out between the construction algorithm and conditions on syllable types. In a lexical syllable structure theory all constraints would have to be formulated as conditions. It does have great flexibility, and could provide a firmer basis for theories of contextually underspecification. However, such a move would have many consequences for theories of prosody and segment structure, with implications too complex to be adequately treated here.

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