

## Syllabification in Chukchee: a Constraints-Based Analysis\*

(FLSM 4, 1994)

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One measure of progress in linguistic theory is when descriptive insights and generalizations that are theoretically recalcitrant suddenly become expressible with a change in perspective. In this paper we develop this point through a study of syllabification in Chukchee--in particular the complex process of schwa epenthesis. I shall argue that the most insightful analysis does not build these complexities into the rules of epenthesis. Rather they are the byproduct of competing UG representational constraints. In essence, there is free insertion of schwa and the job of the constraints is to block all but the correct output. Our analysis is couched within the constraints-based approach to phonology known as Optimality Theory (Prince & Smolensky 1993).

Chukchee is a member of the Paleo-Siberian language family spoken on the Kamchatka Peninsula in far-eastern Siberia. Our data come primarily from Skorik (1961) and build on the results of Kenstowicz (1979a,b) and Krause (1979). (See also Spencer 1993 who independently arrives at conclusions similar to those reported here). There are six vowels [a,e,i,o,u and schwa] in Chukchee and a dominant-recessive vowel harmony in which dominant [a,o] cause high vowels to shift to mid and mid [e] to [a]. The syllable template of the language is CVC with no apparent coda conditions. Chukchee has morphemes with stable nonalternating schwa as well as schwas that alternate with zero. By familiar reasoning, I assume that stable schwa is underlying and alternating schwa is epenthetic. As in languages like Yawelmani, Arabic, and Somali there is no clustering of consonants at the beginning or end of words and no medial triconsonantal clusters. The alternating (epenthetic) schwas have the distribution we expect from syllable theory: they are only called into play to support stray (unparsed/unsyllabified) consonants. However, unlike in Arabic and Somali, the distribution of the epenthetic schwa is much more complex.

In (1) I list the central premises of Optimality Theory that will be relevant to the analysis of Chukchee syllabification (Prince & Smolensky 1993).

- (1) i. Syllabification is determined by a set of UG wellformedness constraints.
- ii. Constraints select among a candidate set of syllabic parses.
- iii. Constraints are violable and ranked.

Instead of rules that build up the syllable incrementally (Steriade 1982, Levin 1985) or map the string of phonemes to a template (Itô 1986), syllabification is determined by UG well-formedness constraints that select among a set of candidate syllabic parses supplied by a general function GEN that constructs all possible syllabifications that the input string could have in any language. The candidates are considered in parallel. There are thus no rules or repairs and no step by step, serial derivation. Rather syllabification takes place essentially in one step. The constraints are violable and ranked; i.e. they can and often will be contradicted by actual surface forms in order to satisfy higher ranked constraints. Finally, different grammars arise from a different ranking of the constraints.

The leading idea of the OT approach is to come to terms with a basic crisis in phonological theory: while many aspects of phonological structure seem to reflect and are arguably the product of UG representational constraints, actual outputs of the grammar often conflict with these constraints. One can detect various responses to this problem in current thinking. One view sees the constraints as inviolable laws of grammar (e.g. "all syllables have an onset") like the principles of GB syntax; in the face of seeming counterexamples, one can try to defend the proposition that the counterexamples are only apparent and postulate empty elements that bring the representation into conformity with the proposed UG constraints. This is the basic strategy of the Government and Charm school consciously modeled on the methodology and ideas of GB syntax (see Kaye, Lowenstamm and Vergnaud 1990, Kaye 1990, Charette 1991, Gussmann & Kaye 1993, Yoshida 1993, among others). Alternatively, one can be impressed with the apparent diversity of phonological structures and downplay

the role of constraints, emphasizing instead a simple inventory of atoms and rules for their combination. Large scale diversity among languages arises from the way the simple rules and representations interact in building up complex structures through sometimes long derivations in which subsequent rules may obscure or entirely obliterate the conditions that give rise to earlier rules. This appears to be the position of Bromberger & Halle (1989) and more or less reflects the conception of phonology that has been standard in generative grammar since its inception. I see Optimality Theory as trying to synthesize the truth lying behind each of these points of view by agreeing with G&C that much of phonological structure directly reflects general UG constraints on representation and thereby downplay the role of "arbitrary" rules and long derivations with many intermediate steps but still take the data at more or less face value and minimize the amount of hidden structure. Differences among grammars reflect a difference in the prioritization of the constraints. In other words, any given grammar is a particular resolution of tension among competing forces--an intuition that one can find expressed in the early work of Charles Kisseberth and David Stampe (see in particular Kisseberth 1973 and Stampe 1973).

In (2) I try to make the discussion more concrete by a specific example that will set the stage for our analysis of Chukchee. We are familiar with the fact that an underlying word-final stop+liquid sequence such as /..atr/ is hard to syllabify because of the cluster's rising sonority. Nevertheless, many languages have lexical items of precisely this form and assign their phonologies the job of imposing a syllabification. The typical outcomes are illustrated in the English versus French treatments for a word such as theater vs. théâtre in (2a).

- (2) a. /theatr/
- |            |                           |
|------------|---------------------------|
| ...a{tar}  | English                   |
| ...{at}<r> | Popular (Canadian) French |
| ...{atr}   | Standard French           |
- b. Sonority Sequencing: prefer syllables in which the onset rises in sonority and the coda falls in sonority.

Parse: avoid unsyllabified segments.  
 Fill: avoid epenthesis.

From the OT perspective the choices in (2a) reflect different prioritizations of the three basic syllabification constraints in (2b). The sonority sequencing constraint is familiar from traditional study of the syllable. Parse says that phonological systems prefer representations in which segments are assigned to a syllable; segments escaping syllabification and hence violating Parse are typically "stray-erased". Fill says that phonological representations prefer to be composed of segments that are exponents of elements in the lexicon (cf. Sapir's distinction between "organic" and "inorganic" segments discussed in Kenstowicz 1977). Prince & Smolensky (1993) and McCarthy & Prince (1993a) represent epenthetic consonants and vowels as empty segments that terminate Onset and Nuclear (moraic) nodes; the prosodic nodes are thus "unfilled" at the segmental level and supplied with phonetic content by a later spellout process (as proposed by Selkirk 1981)--a position we provisionally accept here while acknowledging such problematic cases as Yawelmani where the epenthetic vowel blocks rounding harmony in virtue of its [+high] specification (see Goldsmith 1993 for recent discussion).

The constraints in (2b) express the idea that there is a cost associated with stray consonants and epenthetic ("inorganic") vowels: languages typically avoid such representations unless called upon to syllabify a recalcitrant cluster. In OT, the competition among the constraints is depicted in the form of table or "tableau" as in (3).

(3)	/theatr/	Sonority	Parse	Fill
	\$..{a}{tə}	√	√	*
	..{atr}	*!	√	√
	..{at}<r>	√	*!	√
	..{a}{tə}{rə}	√	√	**!

In the upper left column is the underlying lexical representation and below it are the alternative syllabifications constructed by GEN to be evaluated by the constraints listed along the top. The output of the grammar is the most highly valued candidate, given the constraint ranking. I shall mark the output with the dollar sign. We can think of

the constraints as a series of sieves that successively sift the candidate set until just one representation is left. The various outcomes of /theatr/ in (2) reflect different rankings of the UG Sonority, Parse, and Fill constraints. Thus, when presented with the various candidates, English must rank Fill lowest so that the Sonority and Parse constraints can sift out the incorrect alternatives. Prince & Smolensky (1993) represent failure on a constraint with the asterisk. Success is marked by the check. The exclamation denotes the point at which a candidate is rejected in favor of an alternative. Thus, the Sonority constraint rejects  $..{atr}$  and the Parse constraint sifts out  $..{at}\langle r \rangle$ . The only representation remaining in the candidate set is  $..{a}\{tar\}$ . It is defective in having an inorganic vowel and hence violates Fill; but it is the best among the alternatives. The final case  $theat[a]r[\emptyset]$  with two schwas will be excluded since it has two Fill violations and is thus less optimal than  $theat[a]r$  with one. It shows that the constraints will weed out cases of gratuitous epenthesis and comes to terms with Selkirk's (1981) insight that epenthesis is employed minimally. Other plausible candidates such as  $..{a}\{tra\}$  must be excluded by constraints that control the directional orientation of the epenthetic vowel; see section IV.

In Canadian French underparsing (stray erasure) is employed instead of epenthesis. Thus, the  $\{a\}\{tar\}$  and  $\{atr\}$  candidates must be sifted out from the candidate set in favor of  $\{at\}\langle r \rangle$ . This result follows if the constraint priorities are changed so that Sonority and Fill are ranked higher than Parse. The tableau in (4) depicts this hierarchy. The last form shows that underparsing is applied minimally; in effect, it is nonoptimal to leave out underlying segments and this will only be allowed when it does useful phonological work such as relieving a difficult cluster.

(4)	/theatr/	Fill	Sonority	Parse
	$..{a}\{tar\}$	*!	√	√
	$..{atr}$	√	*!	√
	$\$.{at}\langle r \rangle$	√	√	*
	$..{a}\langle t \rangle \langle r \rangle$	√	√	**!

The tableau in (5) depicts the outcome represented by Standard French which chooses to syllabify the difficult

cluster at the cost of incurring a violation of the Sonority constraint.

(5)	/theatr/	Parse	Fill	Sonority
	..{a}{tar}	√	*!	√
	\$.{atr}	√	√	*
	..{at}<r>	*!	√	√

The simplified example of the /...atr/ cluster discussed above illustrates the fundamental point that systematic differences among languages arise from changing the rankings of the constraints--the sequence in which the candidates are passed through the constraint filters. To indicate the ranking exhibited by a particular grammar, Prince & Smolensky (1993) employ the double precedence sign. The constraint rankings required for the paradigm in (2) are summarized in (6).

- (6) English: {Sonority, Parse} >> Fill  
Canadian French: {Fill, Sonority} >> Parse  
Standard French: {Parse, Fill} >> Sonority

One more point. From the OT perspective the Sonority, Parse, and Fill constraints are present in UG and hence in all grammars that develop from UG. A major task in learning any language is to determine the proper constraint ranking which sorts among the candidates constructed by GEN to choose the observed output.

## II

With this background, we now turn to Chukchee syllabification. Chukchee deals with stray consonants in the English fashion--through epenthesis of schwa--and hence ranks the Parse-C constraint (avoid stray consonants) above the Fill constraint (avoid epenthesis). However, additional constraints are active in positioning the epenthetic vowel in Chukchee. First, as shown by the data in (7), a schwa is placed at the gap between morphemes rather than within a morpheme.

- (7) a. CC+C → CCaC

-ret 'set of' (S. 317)

lili-ret	'pair of sleeves'	lele-lɣan	'sleeve'
qonax-rat	'set of pants'	qonax-te	'pants'
tumɣ-ə-ret	'group of comrades'	tumɣatum	'comrade'

-jocɣ-ən 'container' (S. 312)

kale-jocɣ-ən	'school bag'	keli-t	'books'
meml-ə-jocɣ-ən	'pail'	miml-	'water'

-ɣiniw 'lots of X' (S. 319)

jara-ɣenew	'lots of houses'	jara-ŋə	'house'
aʔaceɣ-ɣenew	'lots of youths'	aʔacek	'youth'
qeɟŋ-ə-ɣiniw	'lots of brown bears'	qeɟŋ-ən	'brown bear'

b. C+CC → CəCC

-nleŋ 'place bereft of' (S. 319)

jara-nleŋ	'place without houses'	jara-ŋə	'house'
watap-ə-nleŋ	'place without moss'	watap	'moss'
kəɣəcq-ə-nleŋ	'place without dry surface'	kəɣəcq-ən	'dry'

-tʔul 'piece of, meat' (S. 312)

milute-tʔul	'hare meat'	milute-t	'hare' pl.
rʔew-ə-tʔul	'whale meat'	rʔew	'whale'
ŋilɣ-ə-tʔul	'piece of strap'	ŋilɣ-ən	'strap'
wʔen-ə-tʔul	'navaga meat'	wəqən	'navaga'
qeɟŋ-ə-tʔul	'brown bear meat'	qeɟŋ-ən	'brown bear'

-tku 'small group of' (S. 322)

jara-tku-n	'village'	jara-ŋə	'house'
nəm-ə-tku-n	'group of villages'	nəmnəm	'village'
ɣil-ə-tku-n	'group of ice'	ɣilɣil	'ice'
umk-ə-tku-n	'thicket'	umkuum	'brushwood'

c. /mlq/

/miml-qaca-n/ → miml-a-qaca-n 'place near water'  
/wejem-lq-n/ → wejem-a-lqan 'teeming with rivers'

Thus, given a triconsonantal cluster spanning a morpheme boundary, the schwa is placed between the second and third consonants when the first morpheme ends in two consonants (7a); but if the first morpheme ends in a single consonant and the second begins with two, then the schwa is regularly placed between the first and second elements of the CCC cluster (7b). It is even possible to find minimal pairs in which the same sequence of three consonants is broken differently depending on the location of the morpheme break (7c). Positioning the epenthetic vowel in the morpheme gap is a robust generalization of Chukchee phonology.

Chukchee thus differs from English, Arabic, Yawelmani and many other languages in which the epenthetic vowel freely enters inside a morpheme. The restriction of the epenthetic vowel to morpheme gaps is also found in Sierra Miwok (Sloan 1991); and in Axininca Campa (Payne 1981, Spring 1991, McCarthy & Prince 1993a) V+V hiatus is resolved by epenthesis of [t]—but only when the vowel sequence spans a morpheme boundary. Morpheme-internal vowel sequences are permitted in Axininca. The constraint I propose to restrict epenthetic material to the morpheme gaps is stated in (8); a similar constraint is independently suggested by McCarthy & Prince (1993a: 50, fn. 41).

(8) Contiguity: if /...xy.../ are contiguous in lexical structure then avoid [...xay...] in prosodic structure, where [a] is either [ ] (epenthetic material) or <a> (underparsed material).

It says that if two segments /x/ and /y/ are adjacent in the lexical representation of a morpheme, then representations in which the exponents of /x/ and /y/ are separated by extraneous segment(s) in prosodic structure are nonoptimal. As stated, the Contiguity constraint militates against gaps as well as "dummies". In the former guise it subsumes the "no skipping" provision of Marantz (1982) and McCarthy & Prince (1986) that guides the mapping of phonemes to prosodic templates. For example, in her analysis of hypocoristic formation in Spanish, Prieto (1992) postulates a disyllabic



template which is anchored to the left edge of the input base. The final syllable of the hypocoristic in general is light. Forms in which the second syllable of the base is composed of a rising sonority diphthong systematically fill the template with the onglide as nucleus rather than the more sonorous mid or low vowel found in the base: Daniél → Dani (\*Danie); Adrián → Adri (\*Adria); Manuél → Manu (\*Manue). A candidate such as \*Dane also terminates in a light syllable but is nonoptimal in comparison to Dani<el> because it splits the prosodic representation with a gap--the unparsed segment: Dan<i>e. A more complex example from Korean is discussed in the appendix.

The Contiguity constraint may have some parsing motivation, preferring candidates in which the input is realized as a substring of the output or vice versa. The tableau in (9) shows the effects of Contiguity in Chukchee.

(9)	/miml+qaca+n/	Contiguity	Fill
	\$mimlqacan	√	*
	mimalqacan	*!	*

When we turn to the margins of the word, Contiguity predicts that the epenthetic schwa should appear at the edge of the word: #aCCV and VCCa#. But in fact just the opposite state of affairs is found, as shown by the data in (10). (See Bonet 1991 for a possible example from Catalan in which epenthetic schwa is placed at the periphery of the domain.)

(10) word-margin epenthesis

a. #CCV → #CaCV

/pne/	pane-k 'to grind'	ɣe-mne-lin past tense
/tm/	tam-ak 'to kill'	ɣa-nmæ-len
/ŋt/	ŋæt-ak 'divide'	ɣe-ntæ-lin
/tnut/	tanut-ak 'to swell'	ɣe-nnut-lin
/tnjiw/	tanjiw-ak 'to send'	ɣe-nŋiw-lin
	luŋ-anŋiw-e 'he didn't send'	

b. VCC# → VCaC#

/qepl/	qepəl 'ball'	qepl-e erg.
/miml/	miməl 'water'	meml-aratɣəɣən 'waterfall'

Let us discuss these cases one by one. The choice of #CaC over #aCC is what we expect on general grounds of syllable markedness. Either of Prince & Smolensky's (1993) Onset ("prefer syllables with onsets") or No-Coda ("avoid syllables with codas") constraints will suffice to force the schwa inside the initial consonant cluster.

(11) /pne+k/	Onset	No-Coda
apnek	*!	**
\$panek	√	*

Although Chukchee certainly has (initial) onsetless as well as closed syllables, the Onset and No-Coda constraints could still be active at the periphery of the system in positioning the epenthetic vowel. For word medial /VCCCV/ inputs, VCaCCV and VCCaCV candidates are equivalent as far as Onset and No-Coda are concerned. However, additional data suggests that a different constraint is at work in choosing #CaC over #aCC.

Chukchee has a number of roots that begin with a triconsonantal cluster. As shown by the verb forms in (12), the cluster is broken by schwa in the unprefixated infinitive, while the past tense prefixed forms truncate the initial consonant of the cluster.

(12) talɣ-ək	ɣe-lɣə-lin	'melt'	/tlɣ/
ratrił-ək	ɣe-trit-lin	'supply'	/rtrił/
tattet-ək	ɣe-ttet-lin	'climb'	/tttet/
rənɾ-ək	ɣe-nrə-lin	'hold'	/nrɾ/

Thus, underlying /ɣe-rtrił+lin/ is realized as [ɣe-<r>trit-lin] with underparsing of the [r]. These data indicate that the Contiguity constraint barring insertion of schwa inside a morpheme is strong enough to compel a Parse violation and thus argues that Contiguity dominates Parse-C.

(13) /ɣe+rtrił+lin/	Contiguity	Parse-C	Fill
\$ɣe-<r>trit-lin	√	*	√
ɣe-ratrił-lin	*!	√	*

If we accept that Contiguity dominates Parse-C, however, then the Onset constraint will not be sufficient to force a choice of #CaC over #aCC for initial clusters. This point is shown by the tableau in (14). Underparsing the initial consonant in the cluster satisfies the Onset and Contiguity constraints and so should triumph over panek which violates Contiguity.

(14) /pne+k/	Onset	Contiguity	Parse-C	Fill
panek	√	*!	√	*
\$<p>nek	√	√	*	√

Thus, some other constraint must be at work to force the choice of #panek over <p>nek, given that underparsing is an option word-medially.

In their analysis of Axininca, McCarthy & Prince (1993a) make extensive use of a constraint requiring the initial phoneme of the input representation to be the initial phoneme in the corresponding output in order to achieve an alignment between the left edge of the lexical structure and the left edge of the prosodic structure. Epenthetic as well as underparsed segments are sufficient to dealign a structure. If we invoke a similar constraint for Chukchee and rank it higher than Contiguity, it will choose the candidate with internal epenthesis #panek over initial epenthesis #apnek or underparsing of the initial consonant <p>nek. In #apnek the initial segment of the lexical representation /p/ does not match the initial segment of the parsed prosodic structure [a]. A similar mismatch appears in <p>nek: the initial /p/ of the input does not coincide with the initial [n] of the prosodified output. Both panek and p<n>ek satisfy alignment. They also tie on Contiguity: each receives an asterisk. The next constraint in the hierarchy--Parse-C--then decides the issue in favor of panek. The tableau in (15) demonstrates the intricate sorting among the options for /pnek/under the proposed constraint ranking.

(15) /pne+k/	Align	Contiguity	Parse-C	Fill
\$panek	√	*	√	*
apnek	*!	√	√	*
<p>nek	*!	√	*	√
p<n>ek	√	*	*!	√

The Alignment constraint may also have functional motivation as a parsing strategy indicating that the first segment of the word is more salient and functions as its signature. If parsing proceeds from an initial recovery of the syllables (Mehler et al. 1981), then lexical access is presumably faster if the first element of the prosodic category is also the first element in the lexical representation.

Turning to final clusters, the choice of CaC# over CCa# may reflect a conspiracy for words to terminate in a VC sequence that is specific to Chukchee. Krause (1979) noted that a number of factors conspire to produce this surface shape in the absolutive singular of the noun. We content ourselves with one example here. He observes that for bases of the structure stem+nominalizer, the absolutive is marked by a suffix -n as a function of the shape of the nominalizing affix: those affixes ending in a vowel take -n while those ending in VC do not. Nominalizing affixes ending in -CC take -an. In each case, the surface form terminates in VC#.

- (16) -tʔul        'part or piece of an object'  
       -ɣiŋ        'base of an object'  
       -ret        'specific number of an object'  
       -ɣiniw     'group of an object'
- jikwi-n    'extent of an object'  
       -čaku-n    'inner part of an object'  
       -tku-n     'small group of objects'  
       -qača-n    'place near object'
- tk-an      'upper quality of an object'  
       -mk-an     'small group of objects'  
       -čurm-an   'limit or border of object'  
       -jolɣ-an   'implement of action'

### III

To briefly summarize the discussion so far, we have proposed that Chukchee freely inserts schwa. The correct positioning in the output forms is determined by two

constraints: Contiguity forces the schwa to a morpheme gap while Align forces it inside an initial consonant cluster. The high ranking Contiguity constraint thus distinguishes Chukchee from languages that orient the epenthetic vowel consistently to the left or to the right in a triconsonantal cluster regardless of morpheme boundaries. Compare the well-known minimal pair of /ʔakl+na/ 'our food' and /katab+t+ha/ 'I wrote it' fem. which are realized as ʔakilna and katabitha in Levantine Arabic and ʔaklina and katabtaha in Egyptian Arabic (Broselow 1981). There is one class of medial clusters in Chukchee that we have not yet accounted for--cases of the form ..C+C+C.. where there are two morpheme gaps. It is here that we might expect the preference for a left vs. rightward orientation of the epenthetic vowel to assert itself. In fact this is not quite true because an additional constraint optimizing syllable contact intervenes. Krause (1979) identified five cases of C+C+C strings; the medial consonant is chosen from the coronals {l,c,j}. He discovered the generalization that when the stem ends in a coronal the epenthetic vowel goes between the second and third consonant, unless the third is also a coronal, in which case it goes between the first and second. The preference to not break up a cluster of coronals presumably reflects the optimization of a syllable contact in which the coda and following onset share the same articulator--a factor playing a role in the epenthesis of many languages in which geminates are not broken. The forms in (17) sample the C+C+C clusters. To briefly summarize the data, the singulative /l/ and the two evaluative suffixes ("positive" /j/ and "negative" /c/) take the nominalizing theme suffix /ŋ/ followed by the absolutive /-n/. The (a) forms show stems ending in a vowel; (b) forms end in a single coronal while (c) stems terminate in a noncoronal; (d) forms end in a cluster. The /ŋ/ appears as /ɣ/ after a consonant by a general process we ignore here.

(17) i.singulative /C+l+ŋ/

a.	lili-t	'sleeves'	lele-l-ɣ-ən	'sleeve'
b.	eŋer-ti	'stars'	aŋat-l-aŋ-ən	'star'
	maren-ti	'mosquitoes'	maran-l-aŋ-ən	'mosquito'
c.	wenuq-at	'cheeks'	wanoq-əl-ɣ-ən	'cheek'
	tiɣ-at	'skis'	teɣ-əl-ɣ-ən	'ski'
d.	mənɣ-at	'hands'	mənɣ-əl-ɣ-ən	'hand'

ii. suffixes of subjective evaluation

positive: /C+j+ŋ/ (S. 300)

a.	wala	wala-j-ŋ-ən	'knife'
	umqe-t	omqa-j-ŋ-ət	'polar bears'
c.	a?acek	a?acek-ə-j-ŋ-ən	'youth'
	kenciq-at	kanceq-ə-j-ŋ-ət	'whip'
d.	Rayt-at	Rayt-ə-j-ŋ-ən	name
	wəkw-ən	wəkw-ə-j-ŋ-ən	'stone'

negative: /C+c+ŋ/ (S. 302)

b.	jarar	jarar-c-əŋ-ən	'tambourine'
	ɣilɣil-ti	ɣelɣel-c-əŋ-ət	'ice floe'
	jat?ol	jat?ol-c-əŋ-ən	'fox'
		ŋawəcqat-c-əŋ-ən	'women'
c.		Raq-əc-ɣ-epə	personal name
	a?acek	a?acek-əc-ɣ-epə	'youth'
d.	pojɣ-ən	pojɣ-əc-ɣ-ən	'spear'
	tiim-at	teim-əc-ɣ-ət	'eagles'
	enaal?-ən	enaal?-əc-ɣ-ən	'neighbor'

iii. directional cases

ablative /C+j+pə/ (S. 162)

a.	titi-	tete-j-pə	'needle'
		omqa-j-pə	'brown bear'
b.	ricit	recet-ɣ-əpə	'belt'
	ŋej	ŋaj-ɣ-əpə	'hill'
	qapar	qapar-ɣ-əpə	'wolverine'
	rekwat	rakwat-ɣ-əpə	'important matters'
c.	r?ew	r?aw-ɣ-əpə	'whale'
d.	milɣ-ən	melɣ-ə-j-pə → [melɣ-e-pə]	'match'

allative: /j+tə/

a.	milute-	melota-ɣtə	'rabbit'
b.	ricit	recet-aj-tə → [recet-eta]	'belt'
	ilir-	ilir-aj-tə [eler-eta]	'island'
c.	r?ew-	r?aw-aj-tə [r?aw-eta]	'whale'

d.	nelyɣ-	nalyɣ-əj-tə	[nalyɣ-eta]	'shell, hide'
	kejŋ-	kajŋ-əj-tə	[kajŋ-eta]	'brown bear'

We see that when the stem ends in a single coronal schwa appears after the singulative suffix (/T+l+ŋ/ → /Tləŋ/) while if stem ends in a noncoronal it appears before the singulative (/K+l+ŋ/ → /Kəlŋ/). When the stem ends in a cluster, the schwa appears in the middle of the four consonant sequence: /CC+l+ŋ/ → CCəlŋ. The other four cases in (17) are essentially consistent with this generalization except for one case: ablative stems ending in a single noncoronal place the schwa between the second and third consonants instead of the first and second. Krause cites just one form illustrating this pattern (rʔaw-ɣ-apə) and I have been unable to locate it in Skorik's grammar. If we put this case aside, then given a choice between VCəCCV and VCCəCV, Chukchee prefers representations in which the coda of the closed syllable shares place with the following onset. In cases where a difference in contact fails to resolve the choice, either because each shares place (e.g. T+j+tə) or each does not (e.g. K+l+ŋ) then schwa is placed between the first and second elements: i.e. CəCC is preferred to CCəC (again with the ablative -pə an apparent exception). Finally, in the case when the stem ends in a cluster, the schwa is placed between second and third elements of the four-consonant cluster.

Optimization of syllable contact is a relatively weak constraint in Chukchee. It never forces schwa inside a morpheme word-medially in violation of Contiguity (cf. /ɣil+tku+n/ 'group of ice' → ɣilatkun not \*ɣiltakun) and it never blocks insertion of schwa inside an initial cluster (cf. tanutək 'to swell' from /tnut+k/). Nevertheless, the data in (17) indicate that when given a chance by the C+C+C clusters, Syllable Contact makes its presence felt. Even more remarkable is the leftwards orientation evident in (17). It operates at the very fringes of the system. But if our analysis is correct, this is the same constraint that is much more deeply rooted in Levantine Arabic where it is not undermined by Contiguity and Alignment. The fact that OT allows one to equate the two phenomena as instances of the same constraint is one of this framework's most noteworthy features. To summarize, the final constraint ranking governing the

placement of the epenthetic schwa in Chukchee is given in (18).

(18) Align >> Contiguity >> Contact >> Leftwards

#### IV

We must now confront the question of what is meant by leftward versus rightward placement of the epenthetic element. While we could identify inserted material by its telltale empty segment, designing a constraint to single out the placement of empty elements is reminiscent of the rules inserting the vowel to the left or the right of a stray consonant in the early nonlinear treatments of epenthesis such as Halle (1977) or Clements & Keyser (1983). If the constraints-based approach is truly on the right track, the location of the epenthetic vowel should follow from something more general. The best known hypothesis in this regard is Itô's (1986, 1989) conjecture that variable positioning of the epenthetic vowel reflects a difference in the direction of syllabification--conceived as the mapping of segments to a syllable template. OT lacks any rules of template mapping and so directionality effects must be derived in some other fashion. In order to simulate the effects of directional metrical parsing, Green (1993) and McCarthy & Prince (1993b, following a suggestion of Robert Kirchner) propose alignment constraints that optimize the stressed vowel or the edge of the stress foot with respect to edge of the word (measured in terms of the number of intervening syllables). For example, if each metrical foot wants to be as far to the right as possible, then (σσ)σ(σσ) is better than (σσ)(σσ)σ and σ(σσ)(σσ) is the best of all. Rightward alignment of stress feet will thus choose metrifications that realize the wellknown stress contour of Warao: σ('σσ)...('σσ).

Mester & Padgett (1993) briefly explore an extension of the same idea a step lower in the prosodic hierarchy to alignment of syllables with respect to the edges of the word (measured in terms of moras or even segments). We can see what is at stake by examining the tableau in (19) that



measures the number of moras that intervene between each syllable and the left edge of the word.

- (19) /#CVCC+CV#/                      Align-Left  
       \${CV}{CaC}{CV}                    #, #μ, #μμμ  
       {CVC}{Ca}{CV}                    #, #μμ!, #μμμ

In the first (winning) candidate the initial syllable is flush against the left edge of the word; the second syllable is separated from the left edge by a single mora and the third syllable by three moras. The second candidate is less optimal because its medial syllable is separated from the left word edge by two moras. Measuring from the right word edge chooses {CVC}{Ca}{CV} over {CV}{CaC}{CV}.

Since in OT these constraints are defined on the output representations, certain types of underparsing might also be expected to diagnose directional syllabification. For example, consider vowel hiatus. If we measure alignment from the nucleus of the syllable, underparsing the second vowel of a V+V sequence optimizes leftward alignment. As (20) shows, a single mora separates the nucleus of the second syllable from the left edge of word in the winning {CV}{CV}<V>{CV} candidate while two moras intervene in the {CV}{C<V>V}{CV} candidate--the mora of the initial syllable and the mora of the underparsed vowel. Under rightward alignment, the winning and loosing candidates again switch places.

- (20)            /#CVCV+VCV#/                      Align-Left  
                   \${CV}{CV}<V>{CV}                    #, #μ, #μμμ  
                   {CV}{C<V>V}{CV}                    #, #μμ!, #μμμ

There is an intriguing contrast between directional template matching on the one hand and these alignment constraints on the other. Leftwards template matching locates the epenthetic vowel between the first and second elements of the triconsonantal cluster. It also predicts underparsing of the initial vowel in hiatus. Rightwards template matching predicts the opposite.

(21) right-to-left CVC template mapping:

aktbu → akt{bu} → a{kat}{bu} → {a}{kat}{bu}

kata+ebu → kata+e{bu} → ka{t<a>e}{bu} → {ka}{te}{bu}

left-to-right CVC template mapping:

aktbu → {ak}tbu → {ak}{tə}bu → {ak}{tə}{bu}

kata+ebu → {ka}ta+ebu → {ka}{ta}+ebu → {ka}{ta}e{bu}

If epenthesis and truncation truly diagnose leftwards vs. rightward syllable orientation then we have a potentially crucial difference between the derivational and constraints-based models. Systematic study of several languages will be required to see if epenthesis and truncation tend to co-vary and if so then what the attested connections are. For what it is worth, Chukchee regularly deletes the first of two vowels in hiatus (unless it is schwa, in which case schwa deletes; Skorik 1961:41). If the epenthesis in (17) really does reflect leftwards orientation, then the derivational model would be supported over the evaluation of output forms. On the other hand, if there turns out to be no crosslinguistic correlation between location of the epenthetic vowel and the underparsed segment in hiatus resolution then separate constraints over gaps and epenthetic elements will be required. This would also be evidence that the derivational approach may be the correct one in the final analysis: systematic generalizations hold at arbitrary points in the sequence of rules but are either unstatable or make no sense when viewed from the perspective of the surface output forms. Questions such as these are sure to occupy the attention of phonologists in the near future as the derivational and the constraints-based frameworks compete for empirical adequacy. Stay tuned!

## Appendix

The Contiguity constraint (8) was defined over dummy epenthetic segments as well as gaps arising from underparsing. Our discussion in the text concentrated on the former. A possible example of the latter is presented by the paradigm in (22) which has been discussed extensively in the

Korean phonology literature. We rely on Ahn 1992 for data as well as analytic insight. (/tols/ has been reanalyzed to /tol/ in the standard dialect.)

(22)	/ps/ →	/p/	kap<s>	'price'
	/ks/	/k/	mok<s>	'share'
	/nc/	/n/	an<c>	'to sit'
	/nh/	/n/	an<h>	'not'
	/lh/	/l/	il<h>	'to lose'
	/ls/	/l/	tol<s>	'anniversary'
	/lth/	/l/	hal<th>	'to lick'
	/lm/	/m/	ku<l>m	'to starve'
	/lp/	/p/	pa<l>p	'to tread on'
	/lp <sup>h</sup> /	/p/	ɨ<l>p	'to recite'
	/lk/	/k/	hɨ<l>k	'soil'

Like Chukchee, Korean in general bars clustering of consonants in syllable onsets and codas. When followed by a vowel, the cluster in CVCC stems surfaces as a coda plus onset sequence. But before a consonant or pause one of the consonants truncates reflecting underparsing plus stray erasure. In the Seoul dialect sometimes the first consonant is excluded while at other times the second one is. The choice is a function of the following place of articulation hierarchy: labial, velar > coronal > laryngeal. The coronal vs. {labial, dorsal} asymmetry is of course familiar and has been interpreted formally in terms of underspecification or a node "peripheral" intervening between Oral Place and the labial and dorsal articulators in the feature tree (cf. Rice 1992). The greater saliency of the peripheral consonants has an analog in the vowels where central vowels are less salient than front or back ones; for example, recall that Chukchee schwa deletes in hiatus regardless of direction. Kenstowicz 1993 discusses a number of Peak Prominence stress systems that seek out more salient peripheral vowels. We suggest that the Korean paradigm in (22) reflects something similar. When given a choice, the system parses a more salient consonant along the place dimension. This chooses the labials in kap<s> and pa<l>p. In the case of a tie in which both elements of the cluster are coronal such as hal<th>, the choice is resolved by a lower ranking constraint of Contiguity (or possibly leftward orientation).

(23)	/kaps/	Parse-Pl	Contiguity
	\$kap<s>	√	√
	ka<p>s	*	*
	/palp/		
	\$pa<l>p	√	*
	pal<p>	*	√
	/haltʰ/		
	\$hal<tʰ>	*	√
	ha<l>t	*	*!

In the Kyengsang dialect the peripheral stops [p] and [k] delete instead of the lateral: pal<p>, h+l<k>. This is easily described as a constraint reranking in which Contiguity dominates Parse-Place. Ahn (1992) mentions two noteworthy complications. First, the /lm/ cluster requires special treatment. Older Kyengsang speakers may parse both [l] and [m] so that /salm+to/ 'life too' is realized as [salm.do]. Younger speakers simplify the cluster but underparse the [l] instead of the [m], violating Contiguity: [samdo]. At worst, the latter requires appeal to a special constraint preferring [m] codas that outranks Contiguity. Second, in some dialects Yip's (1991) Cluster Condition seems to play a role as well: /palp/ underparses its lateral when the following onset is a coronal but retains the lateral when the following onset is a velar: /palp+ta/ → [papt'a] but /palp+ko/ → [palk'o]. Yip pointed to a number of languages in which consonant clusters are restricted to a single Place specification with the proviso that a coronal can be freely added to the cluster like a wild card. For these Korean dialects the Cluster Condition places a limitation on the search for the more salient coda.

(24)	/palp+ko/	Cluster Cond	Parse-Pl	Contiguity
	\$pal<p>ko	√	*	√
	pa<l>pko	*!	√	*
	/palp+ta/			
	pal<p>ta	√	*	√
	\$pa<l>pta	√	√	*

However, this effect of the cluster condition seems to only hold for /IC/ clusters in verbs. We leave expression of this limitation in OT terms for future research.

### Notes

\*Earlier versions of this paper were read at MIT and the Universities of Iowa, Connecticut, Barcelona (Autònoma), Rutgers, and Seoul National. I thank the audiences for their comments and criticism. Special thanks to Thomas Green for very helpful discussion at the earliest stages of this research as well as to Judy Baek and Morris Halle.

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