

A Re-Analysis of [±Syllabic] Assignment in Kitlope Haisla

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1. Introduction

In a forthcoming grammar and dictionary of Haisla, a North Wakashan language (Lincoln and Rath, to appear), John Rath proposes the phonemic inventory given in (1) for the Kitlope dialect. What is noteworthy about this inventory is that the primary opposition is one between resonants and non-resonants (or sonorants and obstruents) rather than between consonants and vowels. Whether a segment is a "vowel" (or more properly, whether it has the feature specification [+syllabic], since Haisla resonants can be syllabic) or whether it is a "consonant" (i.e. has the feature specification [-syllabic]), since non-consonantal segments in Haisla can be non-syllabic) is entirely predictable, and hence the feature [±syllabic] is not a distinctive property of underlying forms. In fact, each of the resonants has both [+syll] and [-syll] realizations depending on its position in a word: for consonantal resonants (where "consonantal" is used here strictly in its articulatory sense, i.e. a sound produced with an obstruction in the oral cavity), the [+syll] allophones are syllabic nasals and laterals, while the [-syll] allophones are the usual nasal or lateral consonants; for non-consonantal resonants, the [+syll] allophones are vowels while the [-syll] allophones are glides or the glottal stop. This is illustrated in the table given in (2). Phonetically, non-syllabic /h/ is [h], i.e. breathy vibration of the vocal cords, so its grouping as the non-syllabic counterpart of [a] is quite plausible; non-syllabic /h/ is phonetically the glottal stop [ʔ]. Whether a given segment is [±syllabic] determines not only its own pronunciation but is also crucial in determining the placement of various epenthetic (or "anaptyctic") vowels of predictable quality within a string.

Along with the inventory given in (1), Rath also proposes a series of rules, or rather an algorithm, for determining the [±syllabic] status of a segment. Obstruents and word-initial resonants are always [-syll] and plain resonants between obstruents are always [+syll], but the situation is more complex when there is a string of plain resonants or when glottalized resonants are involved. For plain resonants, the algorithm can be paraphrased as follows: In any string of consecutive plain resonants, count the number of segments excluding a word-initial one. If the number is odd, make the first resonant [+syll] and the second [-syll], and then continue to alternate values to the end of the string. If the number is even, make the first two [+syll], then the third [-syll] and continue alternating to the end of the string. If, however, a word contains at least one h in a string of consecutive resonants which has received the value [-syll] as a result of these first two steps, start over again, this time dividing the string into sub-strings bounded by the first (or last) resonant and any of the h's. Count the number of resonants in these sub-strings (including the h for each sub-string) and re-assign values of [±syll] as above. This is illustrated in (3), where the values of [±syll] are given for word-internal strings of resonants (the "phonetic" output here is actually the "semi-phonemic" transcription of Rath, prior to the insertion of epenthetic vowels; I have retained the marking of distinctive accent with '˘' on plain resonants; no glosses are given for these items in Lincoln and Rath pending the completion of the dictionary).

- (3) Odd: /t p w y h̄ l h/
- + - + - +
- [t p u y a l a]
- Even: /k̄ y g h w l m m h l h̄ s/
- + + - + - + - +
- [k̄ i g a u l m m a l a s]

(1)

	Obstruents		Resonants	
	Plosives	Fricatives	Plain	Glottalized
Labial	p	ɸ	m	m̄
Alveolar	t	t̄	n	n̄
Alveolar Affricate	c	c̄		
Alveolar Lateral	ʎ	k̄	l	l̄
Palato-Velar	g	k̄	y	ȳ
Labialized Velar	gʷ	k̄ʷ	w	w̄
Uvular	q	q̄		
Labialized Uvular	qʷ	q̄ʷ		
Laryngeal			h	h̄

(2)

Underlying	[+syll]	[-syll]
m	m̥	m
,m	,m̥	,m
n	n̥	n
,n	,n̥	,n
l	l̥	l
,l	,l̥	,l
y	i	y
,y	,i	,y
w	u	w
,w	,u	,w
h	a	h
,h	,a	,h

(3), cont.

One [-syll] h:	/m y h̥ n y x̥w/
Initial assignment:	+ - + - +
Re-assignments:	+ +
	+ + - +
	[m i̥ ã i n i x̥w]
Two [-syll] h's:	/č y n h w h̥ w l m/
Initial assignment:	+ + - + - + - +
Re-assignments:	+ - +
	+ - +
	+ - +
	[č i n a w ã u l m]

In the above rules Rath also makes use of the elements /:/ and /ə/. The former is a reduplication boundary; exactly where and when this boundary is inserted is unclear, but any resonant which directly follows it behaves as if it were word-initial. /ə/ is an element of dubious status which seems to be an exceptionally unpredictable, and hence non-epenthetic, vowel, whose occurrence is in some way related to morpheme boundaries. In any case, when it is present in the underlying form of a word it behaves like any other plain resonant with respect to the algorithm given above and in fact never fails to receive the value [+syll].

For glottalized resonants, Rath provides a more haphazard collection of environments for determining the [tsyll] values. It is stated that a glottalized resonant is [-syll] if it is any of the following: word-initial, preceded by a [+syll] resonant (or /ə/), or followed by an obstruent and preceded by either a replica of the word-initial segment or any plain or glottalized plosive other than /d/. Elsewhere it is [+syll]. Even this list does not cover all the cases, however, and exceptionally [-syll] glottalized resonants must be marked with the juncture /./ between them and the preceding obstruent, with the stipulation that any glottalized resonant following /./ is [-syll].

2. An Assessment

Considering for the moment only the algorithm pertaining to strings of plain resonants, several things can be said about Rath's proposals:

a) The rules are quite unorthodox and awkward to carry out: the counting of segments and crucial reference to odd and even numbers, and the necessity to repeat the procedure several times over when /h/ is involved render the process more like working out a mathematical formula than describing the behavior of a natural language. To be sure, systems of comparable complexity and of a quite similar nature (often involving at least superficial reference to odd- and even-numbered segments) can be encountered most notably in the description of stress systems. Nevertheless, these are all reducible to more conventional processes and notations; the algorithm put forward by Rath should preferably not be allowed to stand as is, but either be abandoned or subject to a more standard formalization.

b) Unusual as Rath's system may be, it works flawlessly in virtually all cases; furthermore, the underlying inventory which such a system affords is very appealing in its symmetry and straightforwardness. This suggests that there is a true generalization to be captured here-- namely that the language does not operate on an underlying distinction of consonants and vowels-- and that if at all possible this generalization should be preserved through a reformulation of the algorithm.

c) Rath's rules are not hopelessly bizarre or unnatural, but do have a regularity or order to them, albeit a somewhat inaccessible one. After all, the algorithm does not say something like: make every third resonant in a word that has two or more

fricatives [+syll]; otherwise, or if preceded by resonants in multiples of five, make [+syll] every resonant whose position from the penultimate resonant is a prime number! Rather, the central concepts in the algorithm are position relative to a boundary or obstruent, and an alternation of [+syll] across a string; the reference to odd and even numbers of segments is in fact most likely a by-product of where in a word this alternation is construed to originate. This suggests that most of the patterns expressed in the algorithm are genuine and can be maintained in a reformulation.

d) In spite of its unconventional appearance, the algorithm captures an idea which is in fact completely in line with current hypotheses about the syllable, namely that the feature [+syllabic] is different from other phonological features by having its value almost entirely determined by context and hence should be eliminated from phonological representations. Recent theories (e.g. Kaye and Lowenstamm 1981) suggest that the syllable be represented as a branching hierarchical unit, with syllabicity of individual segments then defined on the basis of position within that branching structure. Clearly it is of interest to bring the generalizations uncovered by Rath's system more into line with a standard formalization so that they may be compared with such an approach. In this paper no direct assessment of the possibilities of a non-linear analysis will be made; instead, a conventional segmental solution will be detailed as a necessary first step in the analysis of this language.

The focus of the reformulations to be presented in this paper will be the algorithm describing the realization of plain resonants. Preferably, of course, the rule(s) relating to the [+syll] value of glottalized resonants should be simplified as well; although the results will be more mixed, this will also be attempted in the analysis that follows. Ideally, too, the status of such questionable elements as /ə/ and /./ (and to a lesser extent, /:/) should be re-evaluated in the hope of eliminating them or incorporating them more smoothly into the phonemic system. In the case of /./ this will be possible with respect to the role it plays in the realization of glottalized resonants. However, items such as schwa and the reduplication boundary cannot at this point be improved upon and will simply be accepted as a necessary component of underlying forms.

3. An Alternate Analysis

3.1. Observations

As a prerequisite to reformulating Rath's algorithm we can state a number of observations about the [+syll] values of segments based entirely on the configuration of surface (= "semi-phonemic") strings. In some cases these observations will be identical to generalizations embodied in Rath's rules; in other cases they will be the same generalizations but seen from a different perspective, while still others will be entirely new observations. First of all, it is possible to recognize both a paradigmatic and a syntagmatic predictability to the feature [+syll] in Kitlope Haisla. Paradigmatically, there seems to be a more "basic" value of [+syll] for a given segment and this is predictable from its other feature specifications; moreover, this "basic" value cuts across the traditional distinction of "consonants" and "vowels" and thus is not simply a roundabout way of recognizing such an underlying opposition. Obstruents are always [-syll]; plain resonants are [+syll] in more environments than they are [-syll]; and glottalized resonants are [-syll] more often than they are [+syll]. Furthermore, non-initial /h/ is always [+syll].

Syntagmatically, one can recognize for plain resonants a predictability based on "absolute" position, i.e. not relative to any other plain resonant, and a predictability based on relative position with respect to other plain resonants. In absolute position: Word-initial resonants (and those after the reduplication boundary) are always [-syll]; before or after an obstruent, a plain resonant is always [+syll]; and word-final plain resonants are always [+syll]. Stating these differently, in a

string of plain resonants preceded by an obstruent, the first and last ones will always be [+syll].

Position relative to other resonants: a plain resonant will always have the opposite value of [+syll] from the segment following it, creating an alternating pattern from the last (which will always be [+syll]). *h* and glottalized resonants do not follow this alternation within a string: the former is always [+syll] and the latter are always [-syll].

Concerning glottalized resonants more specifically: they are [+syll] in basically two environments: a) Following /d/, an apparent idiosyncrasy also recognized in Rath's algorithm; and b) After an obstruent if (i) a [+syll] segment follows and (ii) either the preceding obstruent is word-initial or the following [+syll] segment is stressed.

3.2. Rule Formulations

In the following formulations, use will be made of the glottal width features proposed by Halle and Stevens (1971) and discussed in Iverson (1983). The table in (4) gives the values for these features based on the phonetic descriptions provided in Lincoln and Rath, along with values for [+sonorant] and [+consonantal]. The '+' values of the non-glottal glottalized resonants in the last row are enclosed in parentheses because, while this value may be the most appropriate for the symmetry of the system (i.e. these segments are voiced like their non-glottalized counterparts), there is an articulatory constraint proposed by Iverson (1983) that [+constricted glottis] implies [-slack vocal cords]. No instrumental data are available for Haisla, and the situation is complicated by the fact that glottalized resonants are usually phonetically realized as various sequences of resonant and glottal stop. In any case, these particular values are not crucial to the analysis. What the glottal width features do allow is the grouping together as natural classes sounds which seem to behave together in Kitlope Haisla, and the singling out of segments which behave exceptionally.

Thus, the glottal and glottalized segments /h, ɦ, ʱ, ʲ, ʷ/, which are together immune to the alternating [+syll] pattern, are easily defined as [+son, spread gl., -aconstr. gl.], i.e. those segments with opposite values for spread and constricted glottis. Alternately, non-glottal and non-glottalized resonants can be defined as [+son, spread gl., constr. gl.]. The glottalized resonants /ɦ, ʱ, ʲ, ʷ/ are defined as [+son, +constr. gl.], while /h/ = [+son, +spread gl.] and /ɦ/ = [+son, +stiff v.c.]. While it would be possible to group these segments and write rules using other features, the glottal width features seem to target the properties of laryngeal activity which are central to the sound system of Haisla. Incidentally, the feature [+cons] is included here because it appears to be crucial when determining the realization of glottalized resonants to know whether a segment is produced with an obstruction in the oral cavity ([+cons] = /m, n, l, ɱ, ɳ, ɺ/) or not ([-cons] = /y, w, h, ɦ, ʲ, ʷ, ɦ/); this feature has nothing to do with the "consonantal" or "vocalic" quality of a segment covered by the feature [+syll].

Five rules will be proposed here to account for the [+syll] values of all segments in Kitlope Haisla; they apply in the order presented. In the Appendix are given the derivations using these rules of nearly 130 items taken from the grammar section of Lincoln and Rath's dictionary; these represent all items given in the first few pages and the most interesting and contentious examples from later pages. All later items not included in this Appendix follow these rules without exception. In the next few paragraphs, the numbers next to the example items refer to the consecutive numbering of these items in the Appendix.

e	+	-	-	-	+	e
β	-	+	-	+	-	β
p	-	+	+	-	-	p
b	-	+	-	-	+	b
h=[ʔ]	+	-	-	-	-	h=[ʔ]
w	+	-	-	-	+	w
y	+	-	-	-	+	y
i	+	+	-	-	+	i
n	+	+	-	-	+	n
m	+	+	-	-	+	m
h=[f]	+	-	+	-	+	h=[f]
w	+	-	-	-	+	w
y	+	-	-	-	+	y
l	+	+	-	-	+	l
n	+	+	-	-	+	n
m	+	+	-	-	+	m

sonorant
consonantal

spread glottis
constricted glottis
stiff vocal cords
slack vocal cords

1. a. [-son] → [-syll]

b. $\begin{bmatrix} +\text{son} \\ \text{aconstr. gl.} \end{bmatrix} \rightarrow [-\text{asyll}]$

These two rules express the generalizations of paradigmatic predictability made earlier. They assign obstruents the value [-syll] and sonorants the value of [+syll] opposite to their value of [+constr. gl.]: that is, [+constr. gl.] (glottalized) resonants will be [-syll], [-constr. gl.] (plain) resonants will be [+syll]. These rules are to be interpreted as filling in the values for a feature which is unspecified in underlying representations (see Kiparsky (1982) on earlier objections to unspecified features). For some items these rules will derive the surface form directly (where once again "surface" is used here to refer to the "semi-phonemic", pre-epenthetic stage); in the following items, the line of pluses and minuses represents the values of [+syll] assigned by this rule:

(5) 4./s m s/ 25./n t:n λ y t/ 93./t h t y t m h/
 - + - - - - + - - + - + - + - +
 [s m s] [n t:n λ i t] [t a t i t m h a]

2. $\begin{bmatrix} +\text{son} \\ \text{aspread gl.} \\ \text{aconstr. gl.} \end{bmatrix} \rightarrow [\beta\text{syll}] / ____ [-\beta\text{syll}]$

This rule assigns any resonant except /h/ and the glottalized resonants a value of [+syll] opposite to the segment following it; it is to be applied iteratively right-to-left. Word-final resonants will receive the value [+syll] by Rule 1, and will serve as the starting point of this rule; it applies vacuously to resonants before obstruents (where the latter are assigned [-syll] by Rule 1), and thus accounts for the fact that the last plain resonant in a sequence of any length is [+syll]. By excluding h, the need to re-apply the procedure as in Rath's algorithm is eliminated. The application of this rule is illustrated in (6).

(6) 11./d h l y n y x/ 15./k y g h w l m m h l h s/ 21./t y n h w h w l m/
 1: - + + + + - 1: - + - + + + + + - 1: - + + + + + + +
 2: - + - + - - 2: - + - + - + - + - 2: - + - + - + - +
 [d a l i n y x] [k i g a u l m m a l a s] [t i n a w a u l m]

The only exceptions to this rule are 119.[hpg'ayq] and 120.[k'uup'ala] which would be *[hpg'ayq] and *[k'uup'ala] after its application. However, Rath's algorithm would also predict these ill-formed outputs, and he states that they represent idiosyncratic violations of the otherwise steadfast constraint that three syllabic resonants cannot occur in a row unless the middle one is [a] </h/ (a result of the fact that Rule 2 does not affect /h/).

3. [+son] → [-syll] / # ____

This rule makes any resonant which is word-initial [-syll], in particular those which received the value [+syll] by the preceding rule. In this and subsequent rules, use of the word boundary symbol '#' should be understood as also referring to the reduplication boundary ':'. It is most likely possible to eliminate the need to make separate reference to the reduplication boundary each time by stipulating that [+syll] assignment applies before reduplication (when the segment preceded by /:/ would be word-initial) and then applies again to the reduplicated portion.

$$4. \left[\begin{array}{l} +\text{son} \\ -\text{constr. gl.} \end{array} \right] \rightarrow [+syll] / [-syll] \text{ ______}$$

Any non-glottalized resonant becomes [+syll] after a [-syll] segment, whether that preceding segment is a sonorant or an obstruent. This rule may be fed by the preceding rule, as in items 56 and 97 below, or apply independently, as in 20 (where n/a = not applicable).

(7)	20./h w y n h̄ w̄ y w h/	56./y w w t/	97./h n w l̄ l̄ h̄/
	1. + + + + + - + +	+ + + -	+ + + - + +
	2. - + - + - + - - +	+ - - -	+ - - - +
	3. n/a	- - + -	- - + - +
	4. - + - + - + + +	- + + -	- + + + +
	[w a w i n à u ȳ u a]	[y u u t]	[h p u l̄ l̄ à]

$$5. \left[\begin{array}{l} +\text{son} \\ +\text{constr. gl.} \\ <-\text{stiff v.c.}> \end{array} \right] \rightarrow [+syll] / \left\{ \begin{array}{l} \# \\ < \left[\begin{array}{l} +\text{son} \\ +\text{cons} \end{array} \right] > \\ d \\ <[-syll] \text{ ______ } ([+syll]) [+stress]> \end{array} \right\} [-syll] \text{ ______ } [+syll]$$

This rule stipulates when glottalized resonants can become [+syll]; although it is complex, it does reduce the number of environments which Rath must specify while capturing some essential patterns, and eliminates entirely the need for the juncture /./ to mark apparently exceptional non-syllabic glottalized resonants. This rule states first of all that in order for a glottalized resonant to become syllabic, it must minimally be preceded by a [-syll] segment and followed by another [+syll] segment-- this stipulation in fact covers a great many of the cases where Rath is forced to use /./ Compare 34./λhxλws/ + [λaxλws] (Rath's /λhxλ.w̄s/) with 41./pwh/ + [pua]. Any glottalized resonant will become syllabic if the preceding [-syll] segment is word-initial-- see items 42, 89, 125, 129 (/h̄/); 44, 45 (/l̄/); 76, 77, 126 (/y/); 41, 79, 127 (/w̄/); 81, 82, 83, 84, 121, 122 (/h̄/). Also, any glottalized resonant will become [+syll] if preceded by /d/: see items 48, 106 (/m/); 50 (/w̄/); 86 (/h̄/). Furthermore, if the glottalized resonant is not /h̄/, there are a couple more environments in which it can become [+syll]. This is indicated in the use of angled brackets in the formulation, where [-stiff v.c.] defines /m̄, n̄, l̄, ȳ, w̄/ and excludes /h̄/. These environments are: If the preceding [-syll] segment follows a [+cons] resonant, i.e. any of /m, n, l/ + [p, q, j] and crucially not /y, w, h/ + [i, u, a]. Compare 107./d̄hx̄m̄ah̄l̄hs/ + [d̄ax̄m̄opalas] with 68./t̄hx̄m̄hx̄wh̄l̄h/ + [t̄ax̄m̄ax̄uala] (not *[t̄ax̄m̄ax̄uala]) (also 98, 114), and 123./l̄l̄k̄ȳh/ + [l̄l̄kia] with 113./h̄t̄w̄h̄th̄lh/ + [k̄at̄watala] (not *[k̄at̄uatala]). That /h̄/ is excluded can be seen in 79./λ̄w̄l̄x̄hyd/ + [λ̄ūl̄x̄hid] (not *[λ̄ūl̄x̄aid]) and 103./d̄hx̄h̄l̄sh/ + [d̄p̄x̄h̄lsa] (not *[d̄p̄x̄h̄lsa]) where the preceding [-syll] is preceded by a [+cons] resonant but /h̄/ does not become syllabic. (For complete derivations of all these items, see the Appendix.) The only exception to this rule is 78./k̄ȳk̄ȳnx/ + [k̄ȳk̄ȳlx̄] where /ȳ/ has become syllabic even though the preceding obstruent is neither word-initial nor preceded by a [+son, +cons] segment. Although this item looks very much like a reduplicated form, i.e. of the shape /k̄ȳ:k̄ȳnx/ (in which case it would no longer constitute an exception), there is apparently no reduplication boundary in this word (Rath, personal communication) and it must therefore be marked as not undergoing Rule 5.

The second environment where glottalized resonants other than /h̄/ may become syllabic is when a stressed resonant follows. This is illustrated by 80./p̄ȳh̄x̄ȳ/ + [p̄l̄ax̄ci] and 75./mh̄m̄ȳ/ + [m̄ax̄l̄t̄]. The latter example shows that this applies even when a non-consonantal resonant precedes the previous [-syll] segment, while the former shows that even when two obstruents precede the resonant it may become syllabic-- compare 31./bk̄m̄nȳx̄/ + [bk̄m̄p̄lx̄/ where /m̄/ is preceded by two obstruents and remains [-syll]. (See also 32, 101, and 102 for the exemption of /h̄/ in these environments.) Item 43./zhzwh̄/ + [zazuq̄a] (the only item in the corpus where a glottalized resonant is followed by a [+syll] glottalized resonant) shows this rule applies iteratively and that there may be an intervening segment between the stressed resonant and the glottalized resonant.

This rule is fed by the preceding rule, which can serve to make the following segment [+syll] and thereby satisfy its structural description, as in the derivation of 89:

(8)	89./w̄ n̄ ȳ ȳ w̄/
	1. - - + + -
	2. - - - + -
	3. n/a
	4. - - + + -
	5. - + + + -
	[w̄ n̄ i i λ]

4. A Look Ahead

A fairly simple segmental alternative to a complex algorithm for determining the syllabic status of sonorants and obstruents in Kitlope Haisla has been presented in this paper. Although this account is satisfactory in and of itself, current theoretical approaches would press for an alternate analysis that would eliminate the feature [*syllabic] entirely. Given the resemblance of this system to the algorithms found in stress rules, handled within the theory of metrical phonology with hierarchical tree structures, one would expect that such an approach is in fact feasible and indeed that the data should lend itself quite well to such a treatment. However, preliminary investigation into this area reveals that it may not be so straightforward. Kiparsky (1981) proposes an algorithm for constructing syllable trees which is loosely based on the principles and constraints employed in constructing stress trees (as in e.g. Hayes 1981); however, even if this algorithm worked without a hitch for other languages, it does not at present appear possible to extend its operation to the segmental distinctions required in Kitlope Haisla. More promising is an algorithm elaborated in Walli (to appear); this has not been formalized, however, and does not seem to be able to be brought in line with the broader principles of metrical phonology. The merit of applying it to the case of Haisla, therefore, is doubtful, since what would be desired in so doing is a more "standard" (in terms of current non-linear theories) approach. For now the analysis offered in this paper can simply be viewed as a starting point for further research.

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Appendix

The following pages present the application of the five rules given in this paper to the majority of items found in the grammar portion of Lincoln and Rath's Haisla dictionary. The first line of each item is the underlying form and the last is the "phonetic" or semi-phonemic form. The five intervening rows of pluses and minuses represent the values of [syllabic] assigned by each of the five rules in the order given in the paper. n/a = not applicable or applies vacuously. The first 45 items are from pages 7-8 in Lincoln and Rath; for subsequent items the numeral in parentheses indicates its page number.

1. h y m h s
 +- - + -
 + - - + -
 - - - + -
 - + - + -
 n/a
 h l m a s

2. p s d h l h y l e k^w
 - - - + + + + + -
 - - - + - + + - + -
 n/a
 n/a
 n/a
 p s d a l a i l e k^w

3. n l y t
 - - + -
 n/a
 n/a
 n/a
 n/a
 n l i t

4. s m s
 - + -
 n/a
 n/a
 n/a
 n/a
 s m s

5. n y h l h
 + + + + +
 + - + - +
 - - + - +
 - + + - +
 n/a
 n i a l a

6. n y h l h
 - + + + +
 - - + - +
 n/a
 - + + - +
 n/a
 n i a l a

7. m x h
 + - +
 n/a
 - - +
 n/a
 n/a
 m x a

8. m y : m x h
 + + + - +
 + - + - +
 - - - - +
 - + + - +
 n/a
 m i : m x a

9. n w y m
 + + + +
 - + - +
 n/a
 n/a
 n/a
 n u y m

10. t p w y h l h
 - - + + + + +
 - - + - + - +
 n/a
 n/a
 n/a
 t p u y a l a

11. d h l y n y x^w
 - + + + + + -
 - + - + - + -
 n/a
 n/a
 n/a
 d a l i n i x^w

12. c y m h n y n w k^w
 - + + + + + + -
 - + - + - + - + -
 n/a
 n/a
 n/a
 c i m a n i n u k^w

13. d n m
 - + +
 - - +
 n/a
 - + +
 n/a
 d n m

14. d n w y h l h
 - + + + + + +
 - - + - + - +
 n/a
 - + + - + - +
 n/a
 d n u y a l a

15. k y g h w l m m h l h s
 - + - + + + + + + + -
 - + - + + - + - + - + -
 n/a
 n/a
 n/a
 k i g a u l m m a l a s

16. t m h y
 - + + +
 - - + +
 n/a
 - + + +
 n/a
 t m a i

17. m y h y n y x^w
 + + + + + + -
 - + - + - + -
 - - + + - + -
 - + + + - + -
 n/a
 m i a i n i x^w

18. h n w w h y
 - + + + + +
 - - + - + +
 n/a
 - + + - + +
 n/a
 h n u w a i

19. t p y n h y
 - - + + + +
 - - + - + +
 n/a
 n/a
 n/a
 t p i n a i

20. w h w y n h w y w h
 + + + + + + + - + +
 - + - + - + + - - +
 n/a
 - + - + - + + - + +
 n/a
 w a w i n a u y u a

21. c y n h w h w l m
 - + + + + + + + + +
 - + - + - + + - + +
 n/a
 n/a
 n/a
 c i n a w a u l m

22. c w c w e z w h
 - + - + + - + + +
 - + - - + - - + +
 n/a
 - + - + + - + + +
 n/a
 c u c u e z u a

23. c w y e k^w
 - + + + -
 - + - + -
 n/a
 n/a
 n/a
 c u y e k^w

24. k h g l y l e k^w
 - + - + + + + -
 - + - - + - + - +
 n/a
 - + - + + - + - +
 n/a
 k a g l l e k^w

25. ḥ t: n̄ l y t̄
 - - - - t -
 n/a
 n/a
 n/a
 n/a
 ḥ t: n̄ l i t̄

26. c h w̄ ȳ l̄ ə k̄
 - + + + + -
 - t - t - t -
 n/a
 n/a
 n/a
 c a w̄ l̄ l̄ ə k̄

27. p̄ h̄ p̄ ȳ w̄ ḥ
 - + - + - t
 n/a
 n/a
 n/a
 n/a
 p̄ a p̄ i w̄ à

28. b̄ ḥ ḡ^w h̄ n̄ x̄^w
 - t - t - -
 n/a
 n/a
 n/a
 n/a
 b̄ à ḡ^w ā ḥ x̄^w

29. l̄ ḥ h̄ w̄ ȳ s
 t + t - t -
 - t + - t -
 n/a
 n/a
 n/a
 l̄ à ā w̄ i s

30. k̄ ḥ l̄ ə n̄ h̄ k̄ l̄ h̄
 - + + - t - + +
 - t - t - t - +
 n/a
 - t - t - t - +
 n/a
 k̄ à l̄ ə n̄ a k̄ l̄ a

31. b̄ k̄^w s̄ m̄ n̄ ȳ x̄^w
 - - - - t + -
 - - - - t -
 n/a
 - - - - t + -
 n/a
 b̄ k̄^w s̄ m̄ ṛ i x̄^w

32. b̄ k̄^w s̄ ḥ ḥ n̄ h̄ t̄
 - - - - t + -
 - - - - t - t -
 n/a
 n/a
 n/a
 b̄ k̄^w s̄ ḥ à n̄ a t̄

33. l̄ ḥ q̄ z w d w̄ s
 t + - - t - - -
 - t - - t - - -
 n/a
 n/a
 n/a
 l̄ à q̄ z u d w̄ s

34. λ h x λ w̄ s
 - t - - - -
 n/a
 n/a
 n/a
 n/a
 λ a x λ w̄ s

35. λ h w̄ s
 - t - -
 n/a
 n/a
 n/a
 n/a
 λ a w̄ s

36. w̄ ȳ: w̄ l̄ x̄ ḥ ȳ d
 t + t - - - t -
 t - t - - - t -
 - - - - t -
 - t - - - - t -
 n/a
 w̄ i: w̄ l̄ x̄ ḥ i d

37. w̄ ȳ l̄ x̄ ḥ ȳ d
 t + - - - t -
 - t - - - t -
 n/a
 n/a
 n/a
 w̄ l̄ l̄ x̄ ḥ i d

38. ḥ l̄ z w̄ s
 - t - - - -
 n/a
 n/a
 n/a
 p̄ a
 ḥ l̄ z w̄ s

39. h̄ h̄ x̄ ḡ w̄ s
 t + - - - -
 - t - - - -
 n/a
 n/a
 n/a
 h̄ a x̄ ḡ w̄ s

40. ḥ h̄ c̄ w̄ s
 - t - - - -
 n/a
 n/a
 n/a
 n/a
 w̄ a c̄ w̄ s

41. p̄ w̄ h̄
 - - t
 n/a
 n/a
 n/a
 - t +
 p̄ u a

42. w̄ ḥ n̄ ȳ s
 - - t -
 n/a
 n/a
 n/a
 n/a
 - t + -
 w̄ ṛ i s

43. z h z w̄ ḥ ḥ
 - t - - - t
 n/a
 n/a
 n/a
 - t - t t t
 z a z u ṛ à

44. w̄ l̄ ȳ l̄ ḥ s
 t - t + t -
 t - t - t -
 - t - t -
 n/a
 - - - - -
 w̄ l̄ i l̄ à s

45. w̄ ȳ: w̄ l̄ ȳ l̄ ḥ s
 t + t - t + t -
 t - t - t - t -
 - - - t - t -
 - t - t - t -
 - t - t - t -
 w̄ i: w̄ l̄ i l̄ à s

46. t̄ k̄ s
 (9) - - -
 n/a
 n/a
 n/a
 n/a
 n/a
 t̄ k̄ s

47. x̄ l̄ p̄ b̄ t̄ w̄ d̄
 (10) - t - - - t -
 n/a
 n/a
 n/a
 n/a
 x̄ l̄ p̄ b̄ t̄ u d̄

48. k̄ ḥ t̄ d̄ ḥ
 (10) - t - - - t
 n/a
 n/a
 n/a
 n/a
 - t - - t +
 k̄ à t̄ d̄ ḥ a

49. m t s d w h l h
 (10) + - - - + + + +
 + - - - - + - +
 - - - - - + - +
 - - - - + + - +
 n/a
 m t s d u à l a

55. c h y h s l
 (11) - + - + - -
 n/a
 n/a
 n/a
 n/a
 c a y a s l

50. q w t s d w y z
 (10) - + - - - + - -
 n/a
 n/a
 n/a
 - + - - - + + -
 q u t s d u i z

56. y w w t
 (12) + + + -
 + - + -
 - - + -
 - + + -
 n/a
 y u u t

51. k l s s w
 (10) - + - - +
 n/a
 n/a
 n/a
 n/a
 k l s s u

57. w h w x k h w h
 (12) - + - - - + + -
 - + - - - + - +
 n/a
 n/a
 n/a
 w a w x k a w a

52. m w z y z z y s d w n t
 (11) + + - + - - + - - + - +
 - + - + - - + - - - + -
 n/a
 - + - + - - + - - + - +
 n/a
 m u z i z i s d u n t

58. w y h c h
 (13) + + + - +
 + - + - +
 - - + - +
 - + + - +
 n/a
 w i n c a

53. k l x s m d
 (11) - + - - + -
 n/a
 n/a
 n/a
 n/a
 k l x s m d

59. k h w e n w
 (14) - + + + + +
 - + - + - +
 n/a
 n/a
 n/a
 k a w e n u

54. h l z
 (11) - + -
 n/a
 n/a
 n/a
 n/a
 h l z

60. x h l e n h k l h
 (15) - + + + - + - + +
 - + - + - + - + - +
 n/a
 - + - + - + - + +
 n/a
 x a l e n a k l a

61. y y y p h
 (15) + + + - +
 + - + - +
 - - - - +
 - + - - -
 n/a
 y i y p a

67. t h x m x y n h l h
 (18) - + - - - + + + + +
 - + - - - + - + - +
 n/a
 n/a
 n/a
 t a x m x i n a l a

62. y y y l y z
 (16) - + - + + -
 - + - - + -
 n/a
 - + - + + -
 n/a
 y i y l z

68. t h x m h x w h l h
 (18) - + - - - + + + + +
 - + - - - + - + - +
 n/a
 - + - - - + + + - +
 n/a
 t a x m a x u a l a

63. t h w n m
 (16) - + - + +
 - + - - +
 n/a
 - + - + +
 n/a
 t a w n m

69. p l l n h k l h
 (19) - + + - + - + +
 - - + - + - - +
 n/a
 - + + - + - + +
 n/a
 p l l n a k l a

64. x k h q m y l h
 (16) - - + - + - + +
 - - + - - - - +
 n/a
 - - + - + - + +
 n/a
 x k a q m y l a

70. t m h y y w d
 (19) - + + + - + -
 - - + + - + -
 n/a
 - + + + - + -
 n/a
 t m a i y u d

65. b w t l h h l h
 (16) - + - + + - + +
 - + - - + - - +
 n/a
 - + - + + - + +
 n/a
 b u t l a h l a

71. t m h y
 (19) - + + +
 - - + +
 n/a
 - + + +
 n/a
 t m a i

66. h y w h l h
 (16) + + + - + +
 - + - - - + +
 - - + - - +
 - + - + + +
 n/a
 h i u h l a

72. c m c m g m h
 (20) - + - + - + + +
 - + - + - - + +
 n/a
 - + - + - + + +
 n/a
 c m c m g m a

73. w h h
(24) + + +
- + +
n/a
n/a
n/a
w a a

74. q̇ h h t h w ḣ ṗ
(24) - + + - + + + -
- + + - + - + -
n/a
n/a
q̇/a
q a a t a w à ṗ

75. m h ṫ ṁ ẏ ṫ
(25) + + - - + -
- + - - + -
n/a
n/a
- + - + + -
m a ṫ ṁ i̇ ṫ

76. k̇ ẏ l̇ ġ ṡ
(26) - - + - -
n/a
n/a
n/a
- + + - -
k̇ i̇ l̇ ġ ṡ

77. k̇ ẏ ẏ ṡ ḃ ḣ k̇
(26) - - + - - + -
n/a
n/a
n/a
- + + - - + -
k̇ i̇ l̇ i̇ ṡ ḃ ȧ k̇

78. k̇ ẏ k̇ ẏ ṅ ẋ
(26) - + - - + -
n/a
n/a
n/a
n/a
*k̇ i̇ k̇ ẏ ṅ ẋ
reduplication boundary?

79. λ ẇ l̇ ẋ ḣ ẏ ḋ
(26) - - + - - + -
n/a
n/a
n/a
- + + - - + -
λ u̇ l̇ ẋ ḣ i̇ ḋ

80. λ ṗ ẏ ḣ ẋ ċ ẏ
(26) - - - + - - + -
n/a
n/a
n/a
- - + + - - + -
λ ṗ i̇ à̇ ẋ ċ i̇

81. ṗ ḣ ẏ l̇ ə̇ k̇
(26) - - + + + -
- - + - - + -
n/a
n/a
n/a
- + + - - + -
ṗ à̇ i̇ l̇ ə̇ k̇

82. l̇ ḣ ḣ ẏ ẋ
(26) + - + + -
n/a
- - + + -
n/a
- + + + -
l̇ à̇ ȧ i̇ ẋ

83. k̇ ḣ ẏ l̇ ṁ
(26) - - + + +
- - + - - +
n/a
n/a
- + + - - +
k̇ ȧ l̇ l̇ ṁ

84. k̇ ḣ ḣ
(26) - - +
n/a
n/a
n/a
n/a
- + +
k̇ ȧ ȧ

85. m ḣ ḣ ṁ ẇ k̇
(27) + + - + + -
- + - - + -
n/a
- + - + + -
n/a
m a ḣ ṁ u̇ k̇

86. k̇ ḣ ṡ ḋ ḣ ẏ ṡ
(28) - + - - - + -
n/a
n/a
n/a
n/a
- + - - + + -
k̇ ȧ ṡ ḋ ȧ i̇ ṡ

87. ċ ṁ ṁ
(28) - + +
- - +
n/a
n/a
- + +
n/a
ċ ṁ ṁ

88. ṗ l̇ l̇
(28) - + +
- - +
n/a
- + +
n/a
ṗ l̇ l̇

89. ẇ ṅ ẏ ẏ ẋ
(28) - - + + -
- - - + -
n/a
- - + + -
- + + + -
ẇ ṅ i̇ i̇ ẋ

90. ċ l̇ ṁ ṁ ḣ
(28) - + + + +
- - + - +
n/a
- + + - +
n/a
ċ l̇ ṁ ṁ ȧ

91. m w w h w s
(28) + + + + + -
- + - + + -
n/a
n/a
n/a
m u w à u s

92. h w w k̇
(29) + + + -
+ - + -
n/a
- - + -
- + + -
n/a
h u u k̇

93. ṫ ḣ ṫ ẏ ṫ ṁ ṁ ḣ
(29) - + - + - + -
n/a
n/a
n/a
n/a
ṫ ȧ ṫ i̇ ṫ ṁ ȧ

94. ṡ ḣ ṡ ṁ ṁ ṅ ẏ ẋ
(29) - + - + - + + -
- + - + - + -
n/a
- + - + - + + -
n/a
ṡ ȧ ṡ ṁ ṁ ṅ i̇ ẋ

95. ṅ ḣ ḣ ṅ ḣ l̇ ḣ q̇ l̇ ḣ
(29) - + - + + + - + +
- + - - + - + - - + +
n/a
- + - + + - + - + +
n/a
n a ḣ ṅ ȧ l a q̇ l̇ a

96. ġ ẏ ṅ ṅ
(30) - + + +
- + - +
n/a
n/a
n/a
ġ i̇ ṅ ṅ

97. h n w í l h
(30) + + + - + +
+ - + - - +
- - + - - +
- + + - + +
n/a
h n u í l à

98. t h x^w m y' h l h
(30) - + - - + - + +
- + - - + - + - +
n/a
n/a
n/a
t à x^w m y' a l a

99. w h x: w y s
(30) - + - - + +
- + - - + -
n/a
- + - - + + -
n/a
w à x: w u i s

100. h y x: h k h
(31) - + - - - +
n/a
n/a
n/a
n/a
h l x: h k a

101. x s h n
(32) - - - +
n/a
n/a
n/a
n/a
x s h n

102. x x h h y s h
(32) - - - + + - +
n/a
n/a
n/a
n/a
x x h à i s a

103. d h x h l s h
(32) - + - - + - +
n/a
n/a
n/a
n/a
d h x h l s a

104. d w x^w h h l h
(32) - + - - + - + +
- + - - + - + - +
n/a
- + - - + - + +
n/a
d u x^w h a l l a

105. d h w m
(33) - + + +
- + - +
n/a
n/a
n/a
d à w m

106. d h x^w d m h
(33) - + - - - +
n/a
n/a
n/a
n/a
- + - - + +
d à x^w d m a

107. d h x^w m g m h l h s
(33) - + - + - - + + + -
- + - + - - + - + -
n/a
n/a
n/a
- + - + - + + - + -
d à x^w m g m a l a s

108. c w y e k^w
(34) - + + + -
- + - + -
n/a
n/a
n/a
c u y e k^w

109. c w c y e k^w
- + - + + -
- + - - + -
n/a
- + - + + -
n/a
c u c i e k^w

110. c w c w e z w h
- + - + + - + +
- + - - + - - +
n/a
- + - + + - + +
n/a
c u c u e z u à

111. k y k w e n w x m
- + - + + + + - +
- + - - + - + - +
n/a
- + - + + - + - +
n/a
k i k u e n u l m

112. m n s: m n c m h
- + - - + - + +
- + - - + - - +
n/a
- + - - + - + +
n/a
m n s: m n c m a

113. x h t w h t h l h
- + - - + - + + +
- + - - + - + - +
n/a
n/a
n/a
x a t w a t a l a

114. t h x^w m h l h
- + - - + + + +
- + - - + - + - +
n/a
n/a
n/a
t à x^w m a l a

115. c y s h y d
- + - - + -
n/a
n/a
n/a
n/a
c l s h i d

116. q^w m k s y w y s d h w d k h l h
- + - - + + + - + + + +
- + - - + - + - + + - + - +
n/a
n/a
n/a
q^w m k s i w i s d a u d k a l a

117. d y y s b w d
- + + - - + -
- + - - + - + -
n/a
- + + - - + -
n/a
d i l s b u d

118. h w b h y l h y h x y
- + - + + - + + + - +
- + - + + - + - + - +
n/a
n/a
n/a
h u b a i l a y a x i

119. h n g^w h y n
- + - + + +
- + - + - +
n/a
n/a
n/a
h n g^w a y n

120. k w w n p h l h
- + + + - + + +
- + - + - + - +
n/a
n/a
n/a
k u w n p a l a

121. l ḣ ḣ y λ m
 (40) + - + + - +
 n/a
 - - + + - +
 n/a
 - + + + - +
 l ā a i λ ṁ

127. λ ẇ l h
 (44) - - - + +
 - - - +
 n/a
 - - + +
 - + + +
 λ ū l̇ a

122. g ẇ ḣ λ h
 (40) - - + - +
 n/a
 n/a
 n/a
 - + + - +
 g ū a λ a

128. t s ẇ ṫ ṫ ẏ ṫ h
 (45) - - - - - + - +
 n/a
 n/a
 n/a
 n/a
 n/a
 t s ẇ ṫ ṫ l̇ ṫ a

123. ṫ l̇ k̇ ẏ h
 (40) - + - - +
 n/a
 n/a
 n/a
 - + - + +
 ṫ l̇ k̇ l̇ a

129. q ṅ y
 (50) - - - +
 n/a
 n/a
 n/a
 - + +
 q ṅ i

124. m y h
 (41) + + +
 + - +
 - - +
 - + +
 n/a
 m i a

125. ṗ ḣ l̇ ḣ s#q ṅ y k#h h
 (42) - + + + - - - + - + +
 - + - + - - - + - - +
 n/a
 n/a
 - + - + - - + + - - +
 ṗ a l̇ a s q ṅ i k h a

126. s ẏ h
 (44) - - +
 n/a
 n/a
 n/a
 - + +
 s i a