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# 1 Background

## 1.1 Basic Facts about Bella Coola

- Native name for the language: Nuxalk [nuˈχalk].
- Isolate within the Salish family; also northernmost and most divergent member.
- The town of Bella Coola, where the language is centered, is on the central coast of British Columbia (∼400 mi NNW of Seattle).
- Severely endangered – less than 20 native speakers.
  - 16 elders listed as contributors on First Voices site.[1]
  - Language is being archived by community with First Voices, but no serious language documentation effort is being undertaken.
  - Language is taught in the tribal school in Bella Coola, BC.
- Long term contact with Heiltsuk (Northern Wakashan).
  - Beck (2000:170) notes that Nuxalk tends to converge towards Northern Wakashan grammatical structures and features.
  - Because the Nuxalk viewed the Heiltsuk, who lived on the coast, as more prestigious, "it was more common for the Bella Coola to learn Heiltsuk than the other way around."
  - "Phonologically, Bella Coola resembles Heiltsuk in such features as the absence of phonemic schwa and the frequent use of resonants as syllabic nuclei–features not unknown, but less widely attested in other Salishan languages (cf. Czaykowska-Higgins and Kinkade 1997:16)."
- Descriptive sources include: Newman (1947, 1969, 1971); Nater (1984, 1990); Davis and Saunders (1997).
- Relied most on Nater (1984, 1990) since they are both recent and comprehensive.

## 1.2 Linguistic Characteristics

- Nuxalk is famous for having long strings of segments composed only of obstruents:

(1) xɬpˈχʷɬtɬpɬɬs

| xɬ- | pˈχʷɬt- | ɬp- | ɬɬ- | s |
|---|---|---|---|---|
| to.have/possess | bunchberry | tree/plant | PLUP | POSS |

He had had in his possession a bunchberry plant (Bagemihl 1998:74, Nater 1984:5).

[1] http://www.firstvoices.com/en/Nuxalk/welcome

- Nuxalk Phonemic Inventory:

| | LAB | ALV | ALV AFFRIC | LAT | VEL | | VEL LABLZD | UVU | UVU LABLZD | GLOT |
|---|---|---|---|---|---|---|---|---|---|---|
| PLAIN STOP | p | t | t͡s | | k | | $k^w$ | q | $q^w$ | ʔ |
| EJECTIVE | p’ | t’ | t͡s’ | t͡ɬ | k’ | | $k’^w$ | q’ | $q’^w$ | |
| FRICATIVE | | s | | ɬ | x | | $x^w$ | χ | $χ^w$ | (h) |
| RESONANT | m | n | | l | j | | w | | | |
| SYLLABIC RES. | m̩ | n̩ | | l̩ | i | a | u | | | |

- 23 consonants (C)
  5 sonorant/resonant consonants (R; l, m, n, j, w)
  3 vowels (V)
- Syllabicity of /l, m, n/ is not entirely predictable (Nater 1984:14) ∴ Following Nater (1984), I treat these syllabic variants as separate phonemes (for now).
- ***Main Question****: How should Nuxalk words be syllabified?*

# 2 Previous Accounts of Nuxalk Syllabification

1. Newman (1947:132): “[t]here are no syllables in Bella Coola [...].”
2. Hockett (1955) (described as quoted by Bagemihl 1991:591): “[...] each segment of an obstruent-only word comprises its own syllable” but those segments aren’t syllabic, per se, in the same sense of vowels.
3. Greenberg (1962): Exhaustive syllabification; peaks = sonorants, non-lateral fricatives, /t/, /t͡s/.
4. Hoard (1978:67-71): Exhaustive syllabification; the release noise of any obstruent can be used as syllabic peak; simple syllables with one onset and/or one coda C; plain obstruent plus fricative = σ; fricative plus fricative and labialized non-ejective stop plus fricative often form syllables.
5. Nater (1984): No position expounded.
6. Bagemihl (1991, 1998): Reduplication shows limited syllabification to maximal CRVVC template.

- Reduplication patterns used by Bagemihl (1991:598,618-9) to justify CRVVC syllable

  (2) CVC : yałk- → yałyałk-
  “do too much” → do too much (CONT)

  (3) V: : ʔ um- → ʔuːmʔ um-
  “go out of enclosed space” → “go out [...] (CONT)”

  (4) CRV : p’wi → ʔu-p’wi-j (glide/vowel alternation of [w] & [u])

- Unsyllabified segments escape Stray Erasure by linking to the mora they start with per the theory advanced in Hyman (1985). Bagemihl (1991) calls this Moraic Licensing and argues that it follows as an extension of Itô’s (1986) Prosodic Licensing.
- Cook (1994) argues against the need for Moraic Licensing, and instead claims that Stray Erasure does not exist in Nuxalk.
- ***My Claim****: Nuxalk uses a more refined sonority hierarchy, influenced by the idea of “audibility,” to exhaustively syllabify all words in the language, including obstruent-only words.*

# 3 New Analysis of Nuxalk Syllabification

## 3.1 Guiding Ideas

- Via The Emergence of The Unmarked (TETU) "reduplication often copies an unmarked subset of what a language may allow with regard to prosodic and featural structures" and "thus Bagemihl's argument that the only possible syllable structure of Nuxalk is [the one] seen in reduplication is not completely convincing" (Carlson 1997:26).

- I propose using an elaborated version of the sonority hierarchy to redefine which segments can function as syllable peaks.

- Reduplication must copy a syllable with a peak characterized by *laminar* airflow, but syllables may also use a segment with enough *turbulent* airflow as a syllable peak since turbulent airflow is highly audible.

- Definitions:
  **Audibility**: Property of a segment corresponding to amount of high-frequency (above about $\sim$3000 Hz) frication noise associated with it.
  **Laminar airflow**: Airflow which occurs when air particles move on a smooth, easily predictable, forward path through a channel (Johnson 2003:121,128; sonorants and vowels have laminar airflow).
  **Turbulent airflow**: Airflow which occurs when air particles move generally forward, but are hampered from moving smoothly by some obstruction, which creates small eddies (Johnson 2003:121; fricatives and stop releases have turbulent airflow).

- Since Nuxalk has no voiced consonants other than the sonorants/resonants, it is possible to leave out the formal feature [$\pm$sonorant] in this analysis and replace it with [$\pm$voice]. This allows the Nuxalk sonority hierarchy to be defined in terms of instrumentally measurable properties (voicing and amount or kind of airflow), which assuages one of the objections to sonority hierarchies raised in Ohala (1997).

## 3.2 Data

- 126 obstruent-only words listed in Nater (1990)

- 115 (91%) contain at least one fricative. $\therefore$ It seems optimal to have a highly audible segment if there is no sonorant segment. From this, I draw the conclusion that airflow type is important.

- Because airflow type seems to be important in Nuxalk, I define affricates as fricatives rather than stops (contra Steriade 1989).

- Of the remaining 11 obstruent-only, fricative-less words, all contain either an ejective (glottalized) or labialized consonant.

  $\longrightarrow$ One need not allow plain stops to be syllable nuclei! This means that even exhaustive syllabification is still restrictive in Nuxalk.

(5) 11 Obstruent-Only, Fricative-Less Words in Nuxalk

| | *Word* | *Gloss* | *Nater (1990)* | *Available Online via FPCF (2009)* |
|---|---|---|---|---|
| 1. | k$^{w}$'p | right, straight | p. 53 | |
| 2. | k$^{w}$'pt | become saturated with water | 54 | |
| 3. | q$^{w}$t | crooked | 98 | Y |
| 4. | q$^{w}$'p | bare, empty | 99 | |
| 5. | tk$^{w}$ | dirty | 127 | |
| 6. | tk$^{w}$' | to dig something up | 127 | |
| 7. | tk' | sticky | 127 | |
| 8. | tq$^{w}$' | to remove fur from hide; lift/hold sth up | 134 | |
| 9. | tq' | to arrive by boat, land alongshore | 134 | Y |
| 10. | t'k$^{w}$ | to bleed | 146 | Y |
| 11. | t'q | to stick, paste something | 146 | |

- *Impressionistically*, release noise for labialized consonants seems longer than that for ejectives in number 10. *t'k$^{w}$* "to bleed." However, recording was from second-language speaker.
  $\longrightarrow$ Need high quality field recordings for phonetic analysis!

- Assume that labialization is more optimal than glottalization (for now) for making a segment function as a syllable peak.

- Pattern that emerges from lexicon is the following refined Nuxalk sonority hierarchy:

  Vowels [−cons,+son] $\gg$ Sonorants [+cons,+son] $\gg$ $\leftarrow$ Laminar
  Fricatives [−son,+cont] $\gg$ Lab'zed C's [−son,+round] $\gg$ Ejectives [+cg] $\gg$ $\leftarrow$ Turbulent
  Plain Stops [−cont] $\leftarrow \varnothing$

# 4 Formal Implementation in Optimality Theory

- Carlson's (1997) account of Nuxalk reduplication in OT (Prince and Smolensky 1993) uses TETU.

- Assume, broadly, then: FAITH-IO $\gg$ MARKEDNESS $\gg$ FAITH-BR; since I will not formally account for reduplication here, I'll disregard FAITH-BR.

- FAITH-IO is undominated.

- Implement refined Nuxalk sonority hierarchy using PEAK constraints (Prince and Smolensky 1993, Carlson 1997:2)

- My formal definition of PEAK (*P/*X*) constraints:
  Assess one violation for each segment which has the characteristic of feature *X* and which depends on that feature to function as a syllable peak in the candidate form being evaluated.

- These peak constraints are ranked such that the constraint militating against the optimal syllable peak is ranked low while the constraint militating against a very bad syllable peak (like a plain stop) is ranked high, immediately below FAITH-IO

  FAITH-IO $\gg$ PEAK =

  FAITH-IO $\gg$ *P/[−cont] $\gg$ *P/[+cg] $\gg$ *P/[−son,+rnd] $\gg$ *P/[−son,+cont] $\gg$ *P/[+son,+cons] $\gg$ *P/[+son,−cons]

- Using Bagemihl's proposed syllable template (CRVVC) and (by extension) reduplication patterns as evidence, onsets are preferable to codas, so *CODA operates and assesses one violation for each segment appearing in a syllable coda. However, since codas seem to exist, *CODA is ranked below PEAK constraints.

  FAITH-IO $\gg$ PEAK $\gg$ *CODA =

  FAITH-IO $\gg$ *P/[−cont] $\gg$ *P/[+cg] $\gg$ *P/[−son,+rnd] $\gg$ *P/[−son,+cont] $\gg$ *P/[+son,+cons] $\gg$ *P/[+son,−cons] $\gg$ *CODA

- In order to make sure that sonorant consonants are syllabified properly where they are not underlying, the constraint *COMPLEX is in operation. *COMPLEX assigns one violation for each syllable component in the set {onset, nucleus, coda} that is composed of more than one segment.

- *COMPLEX is ranked at the boundary between the PEAK constraint militating against plain stops and the rest of the PEAK constraints in order to ensure that small syllables are built rather than having their segments (most often obstruents) syllabified into complex onsets and codas. Note that the boundary at which *COMPLEX is placed is the boundary between segments that can function as peaks and those that cannot (plain stops).

- The following is the final constraint ranking for syllabification in Nuxalk.

  FAITH-IO $\gg$ *P/[−cont] $\gg$ *COMPLEX $\gg$ *P/[+cg] $\gg$ *P/[−son,+rnd] $\gg$ *P/[−son,+cont] $\gg$ P/[+son,+cons] $\gg$ *P/[+son,−cons] $\gg$ *CODA

# 5 Example Tableaux

(6) *nustpaaqlajx* "to have a freckle on one's chin" (Nater 1990:4)

| /nustpaaqlajx/ | FAITH-IO | *P/[−cont] | *COMPLEX | *P/[+cg] | *P/[−son, +rnd] | *P/[−son, +cont] | *P/[+son, +cons] | *P/[+son, −cons] | *CODA |
|---|---|---|---|---|---|---|---|---|---|
| ☞ nu.st.paaq.laj.x | | | | | | 2 | | 3 | 3 |
| nus.tə.paaq.lajx | 1! | | 1 | | | 1 | | 4 | 4 |
| nus.t.paaq.lajx | | 1! | 1 | | | 1 | | 3 | 4 |
| nus.tpaaq.lajx | | | 2! | | | 2 | | 3 | 4 |
| nust.paaq.lajx | | | 2! | | | 2 | | 3 | 5 |
| nus.tpaaq.laj.x | | | 1! | | 1 | 1 | | 3 | 3 |

(7) *t͡s'klaktᵂ'p* "ten fathoms" (Bagemihl 1998:74)

| /t͡s'klaktᵂ'p/ | FAITH-IO | *P/[−cont] | *COMPLEX | *P/[+cg] | *P/[−son, +rnd] | *P/[−son, +cont] | *P/[+son, +cons] | *P/[+son, −cons] | *CODA |
|---|---|---|---|---|---|---|---|---|---|
| ☞ t͡s'k.lak.tkᵂ'p | | | | | 1 | 1 | | 1 | 3 |
| t͡s'ək.lak.tkᵂ'p | 1! | | | | 1 | | | 2 | 3 |
| t͡s'k.lak.tkᵂ'.p | | 1! | | | 1 | 1 | | 1 | 2 |
| t͡s'klak.tkᵂ'p | | | 1! | | 1 | | | 1 | 2 |

(8) *kᵂ'pt* "become saturated with water" (Nater 1990:54; $X_N$ = X is syllable nucleus)

| /kᵂ'pt/ | FAITH-IO | *P/[−cont] | *COMPLEX | *P/[+cg] | *P/[−son, +rnd] | *P/[−son, +cont] | *P/[+son, +cons] | *P/[+son, −cons] | *CODA |
|---|---|---|---|---|---|---|---|---|---|
| ☞ $k^w'_N pt$ | | | 1 | | 1 | | | | 2 |
| $k^w'.p_N t$ | | 1! | | | 1 | | | | 1 |
| $k^w'.pt_N$ | | 1! | | | 1 | | | | |
| $k^w'p_N t$ | | 1! | | | | | | | 1 |
| $k^w'pt_N$ | | 1! | 1 | | | | | | |

(9) *xɬp'χʷɬtɬpɬɬs* "he had had in his possession a bunchberry plant" (Bagemihl 1998:74)

| /xɬp'χʷɬtɬpɬɬs/ | FAITH-IO | *P/[−cont] | *COMPLEX | *P/[+cg] | *P/[−son, +rnd] | *P/[−son, +cont] | *P/[+son, +cons] | *P/[+son, −cons] | *CODA |
|---|---|---|---|---|---|---|---|---|---|
| ☞ xɬp'.χʷɬ$_N$.tɬ.pɬɬs | | | | | | 4 | | | 2 |
| xɬp'.χʷɬ$_N$.tɬ.pɬɬ | 1! | | | | | 4 | | | 1 |
| xɬp'.χʷɬ$_N$.t.ɬ.pɬɬs | | 1! | | | | 4 | | | 2 |
| xɬ$_N$p'χʷ.ɬ.tɬ.pɬɬs | | | 1! | | | 4 | | | 3 |
| xɬ.p'.χʷɬ$_N$.tɬ.pɬɬs | | | | 1! | | 4 | | | 1 |
| xɬp'.χʷ$_N$ɬ.tɬ.pɬɬs | | | | | 1! | 3 | | | 3 |
| xɬp'.χʷ$_N$ɬ.tɬ.pɬɬs | | | | | | 4 | | | 3! |

- Note that in the final candidate, the segment /χʷ/ is evaluated as a peak by its feature [+continuant] while in the second-to-last candidate, the segment /χʷ/ is instead evaluated by its [+round] feature.
- If the PEAK constraints were not formulated such that only the feature being used to define a segment as a syllable peak is evaluated, then the PEAK constraints would always rule out a fricative like /χʷ/ since it is rounded.

# 6 Stress in Nuxalk

- Stress is not phonemically distinctive in Nuxalk, but is still phonetically realized.
- Nater (1984:27) claims that stress "is of a dynamic-tonal nature." This suggests that the primary acoustic correlate of stress is high pitch and that Nuxalk may possess either a tonal system or a mixed stress and tone system.
- Heiltsuk developed high tone in positions which were historically stressed (Wilson 1987).
- Heavy contact with Heiltsuk could have prompted this development or at least a trajectory toward it.
- While stress is marked with a high-tone, phonemically doubled vowels are marked with a rising-falling contour tone. This can coexist with stress.
- Phonetically doubled vowels do *not* exhibit this contour. Thus, while the stress/tone system is not used to make phonemic distinctions, it seems to be sensitive to the phonology of the language.
- Stress falls on vowels and sonorant consonants that function as syllable peaks, but not generally on other consonants.
- Anecdotally, Ross Saunders noticed a regular placement of stress in longer obstruent only words (Tom Perry, p.c.).

# 7 Summary

- The idea of TETU suggests that the syllables identified by Bagemihl (1991) may not be the only ones in the language (Carlson 1997:26).
- Because most words have some type of sonorant, these act as the peaks for most syllables.

- Approximately 126 words do not have sonorant sounds, but 115 (91%) of these have fricatives, and all the remaining 11 words have either labialization or glottalization. This forms the basis of a refined sonority hierarchy for Nuxalk.
- Refining the sonority hierarchy allows us to exhaustively syllabify Nuxalk words. The basis for refining this hierarchy is broadly phonetic, and I assume that this basis is reflected in the lexicon.
- The constraint ranking advocated in the tableaux produces exhaustive syllabification and prevents intra-syllabic consonant clusters as much as possible.

# 8 Conclusion

## 8.1 Future Work

- Future work should gather precise phonetic data on the properties of each segment in Nuxalk. That way, we can be more sure about the role of specific segmental characteristics like labialization and glottalization.
- Future work should also comprehensively describe the stress system of Nuxalk since only a sketch is provided in Nater (1984:27). The placement of stress in obstruent-only words would enrich our understanding of syllabification in Nuxalk.

## 8.2 Discussion

- Exhaustive syllabification in Nuxalk does not use plain stops as syllable nuclei. This system is thus more restrictive than that advocated for dialects of Berber (Dell and Elmedlaoui 1985, 1988), and it is more restrictive than the systems devised for Nuxalk by Hockett (1955), Greenberg (1962), and Hoard (1978).
- The account advanced here does not need to appeal to Moraic Licensing (Bagemihl 1991, 1998) nor does it need to posit the non-existence of Stray Erasure in Nuxalk (Cook 1994).
- This analysis advocates for a more nuanced understanding of sonority and "audibility" and their roles in syllabification in languages with long strings of obstruents.
- Because syllabification can be exhaustive in Nuxalk, Nuxalk may not pose a challenge to the proposed universality of the syllable after all.

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