Phonetic vs. phonological rounding in Athabaskan languages

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Phonetics vs. phonology

- *Phonetic* vs. *phonological*
  - coarticulation
  - assimilation
- Language-internal acoustic evidence
  - variability
  - uniformity
  - interpolation
  - clear target
- A comparative approach
Study languages

• Deg Xinag
• Babine-Witsuwit’en
Overview

• Rounding Assimilation in Deg Xinag
  – acoustic, video evidence
• Lack of Rounding Assimilation in Babine-Witsuwit’en
• Why (and how) Deg Xinag has developed Rounding Assimilation
C Rounding in Athabaskan

• Secondary articulation
  – velar+[w]: e.g. Babine-Witsuwit’en [kʷa] ‘again’

• C[w] cluster
  – e.g. Tsek’ene [kweh] ‘crater, cave’ [ʔwèdèʔ] ‘always’, [ʔəjwèʔ] ‘scent’

• Neither secondary articulation nor cluster
  – e.g. Koyukon
Deg Xinag

- Stem-initial consonants

<table>
<thead>
<tr>
<th>p pʰ</th>
<th>t tʰ t’</th>
<th>k kʰ k’</th>
<th>q qʰ q’</th>
<th>?</th>
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<tbody>
<tr>
<td>tθ tθʰ tθ’</td>
<td>ts tsʰ ts’</td>
<td>ts tsʰ ts’</td>
<td>tʃ tʃʰ tʃ’</td>
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<tr>
<td>tɬ tɬʰ tɬ’</td>
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<td>θ ơ</td>
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<td>v</td>
<td>j</td>
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</tbody>
</table>
Vowels

- Rounding contrast in reduced vowels

\[
\begin{array}{ccc}
\text{full} & \text{reduced} & \text{full} \\
\mathbf{\theta} & \mathbf{\varepsilon} & \mathbf{\theta} \\
\mathbf{\alpha} & \mathbf{\varepsilon} & \mathbf{\theta} \\
\end{array}
\]

- Acoustic study (Hargus 2010)
  - /\mathbf{\theta}/ \rightarrow [\mathbf{\tilde{\theta}}] adjacent to uvular
  - [e o \mathbf{\tilde{\theta}}] lower-mid: [\varepsilon \mathbf{\varepsilon} \mathbf{\tilde{\theta}}]
“lazy lips”

- Rounding Assimilation
  
  /ə/ → [õ] / ___ {uvular, laryngeal} {õ, o}

- Alternations in imperfective prefix /ə/-. Some imperfective forms of ‘chew’:
  
  /k-ə-q’ōts/ [kõ'q’ōts] 'he/she is chewing’
  /k-ə-s-q’ōts/ [kəs'q’ōts] ‘I’m chewing’
  /k-χ-ə-q’ōts/ [kəχõ'q’ōts] ‘they’re chewing’
Rounding Assimilation in Deg Xinag linguistics

- Not mentioned in Krauss 1962
- Kari 1978 *yixunh* [jŏχŏŋ] ‘you (pl.)’ (<i> = /ə/, <u> = /õ/)
- Rock 1998 *Niq’ołonh Chux Deg Ghihoł*: *The Big Woman Was Walking Along* [nŏq’ołon̥]~[nq’ołon̥], [kŏhoñ]
- But *<yidoghot>* ‘he shakes it’ (Kari 1976-1977: 178) for [jĕdŏkot]
[ləq’oɬ] ‘white (object)’
Questions about Rounding Assimilation

• Phonetic?
  – F2 lowering increases towards uvular

• Phonological?
  – not rate-dependent
  – occurs even without surface round trigger
Not rate dependent

- \[\text{the } \ddot{\text{o}}\ddot{\text{q}}^\text{ho}_\text{h}] \quad \text{‘there is water (in container)’}
  - \[\text{the } \ddot{\text{o}}\ddot{\text{q}}^\text{ho}_\text{h}] \text{ (LH)} \quad \text{(discourse)}

Counter-bled by o-Unrounding

- A sentence from *Yixgitsiy Dranh Itltsenh Dong* (Raven made light long ago), recorded by AJ
  
  Vanhtoni\text{y} \quad \text{nigughun’} \quad \text{getiy} \quad \text{vugho’} [\nu\ddot{\text{o}}\ddot{\text{v}}\ddot{\text{a}}?] \quad \text{dengath.}

  ruff \quad \text{wolf} \quad \text{really} \quad \text{its fur} \quad \text{it’s long}

  ‘It had a wolf ruff with very long fur.’
An acoustic study of Rounding Assimilation

• If DX has Rounding Assimilation, how far into vowel does it extend? Are derived round vowels as round as underlying reduced round vowels in prefixes?

• …lips ‘relatively close and protruded (small lip-opening area)…F1+F2+F3 lower than with a larger lip-opening and the same tongue articulation.’ (Fant 1962)

• /ə/ vs. /õ/ in Hargus 2010: /õ/ significantly lower in normalized F2, higher in normalized F1 than /ə/
Predictions concerning rounding contrasts among reduced vowels in Deg Xinag

a) ōQ{ő,o} vs. eQ{e,a}: ŏ predicted to have significantly lower F2 (Q = uvular)
b) ōH{ő,o} vs. eH{e,a}: ŏ predicted to have significantly lower F2 (H = {ʔ, h})
c) ōQ{ő,o} vs. ŏH{ő,o}: predicted not to differ in F2
d) ōQ{ő,o} vs. eK{ő,o}: ŏ predicted to have significantly lower F2
e) ōQ{ő,o} vs. eCQ{ő,o}, for C = alveolar: ŏ predicted to have significantly lower F2, higher F1
f) ōQ{ő,o} vs. perambulative /q’ő/-: predicted not to differ in F2
Methods

- Word list recording
- $F_1$, $F_2$, $F_3$ measured at vowel midpoint and 75% of vowel duration
• 5 speakers, 3 male and 2 female
• Place of articulation of Cs immediately preceding and following target vowel balanced (no labial Cs)
• 9-15 comparison pairs per speaker per experiment
• Two repetitions elicited, generally only one measured (loudest)
• F1, F2 reported here (not normalized, as in Hargus 2010)
• Repeated-measures ANOVA for group
• Factorial ANOVA for each individual
(a) effect of round vs. unround vowel, intervening uvular

\[ \ddot{o}Q\{\ddot{o},\ddot{o}\} \text{ vs. } \dddot{e}Q\{\dddot{e},\dddot{e}\} : [\ddot{o}] \text{ predicted to have significantly lower F2 (}Q = \text{ uvular)} \]

✓ (group) F2 only; \( p = .0009 \) (50%), \( p < .0001 \) (75%)
F2 means

- Female and male F2 means for different conditions.

- Statistical significance indicated by p-values: p < .0001 and p = .0009.
[sōq’ōθ] ‘my neck’

- [sō]- (50%)
- [sō]- (75%)
- [q’ōθ]

1 video frame (29 ms.) advance

(frontal and sagittal views are 2 different productions)
[səqʰaʔ] ‘my foot’

- [sə]- (50%)  [sə]- (75%)  [qʰaʔ]

(frontal and sagittal views are 2 different productions)
Is Rounding Assimilation neutralizing?

d) ōQ{ŏ,o} vs. perambulative /q’ŏ/-: predicted not to differ in F2

Rounding Assimilation perambulative

<table>
<thead>
<tr>
<th>l  ō  q’</th>
<th>q’  ō  t^h</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% 75%</td>
<td>25% 50%</td>
</tr>
</tbody>
</table>
• no significant F1 differences
• F2
  – significantly lower at 75% in RA context ($p = .0148$) (before uvular) than at 25% in perambulative context (after uvular)
Effect of intervening uvular vs. velar

• Triggering consonants: uvulars, laryngeals
• Blocking consonants: all other places
[kəson] ‘I’m eating’

[kə]- (50%)  [kə]- (75%)  [son]

(frontal and sagittal views are 2 different productions)
Velars

appear to block Rounding Assimilation

(d) ŏQ{õ,o} vs. ɐK{õ,o}: [õ] predicted to have significantly lower F2

– √ F2, p = .0023 (50%), = .0006 (75%)
– F1, p = .0104 (50%), = .0009 (75%)
F1 means

![Bar chart showing F1 means for different categories: uvular, V50, uvular, V75, velar, V50, velar, V75. The chart compares male and female participants with p-values provided for significant differences.]

- uvular, V50
- uvular, V75
- velar, V50
- velar, V75

- For uvular, V50 and uvular, V75, the p-value is 0.0104.
- For velar, V50 and velar, V75, the p-value is 0.0009.
F2 means

![Bar chart showing F2 means for uvular and velar positions with male and female data.]

- **F2 (Hz)**: The x-axis represents F2 frequency in Hz, ranging from 0 to 1800 Hz.
- **uvular, V50** and **uvular, V75**
- **velar, V50**
- **velar, V75**

The chart illustrates the F2 means for different phonetic positions (uvular and velar) and subcategories (V50 and V75) for both female and male participants.

- **p = .0023** indicates a statistically significant difference.
- **p = .0006** indicates another statistically significant difference.

The graph shows the mean F2 values with error bars, indicating the variability or standard error of the mean.
• [səŋʊŋ] ‘my mother’

[sə-] (50%)     [sə-] (75%)     [ŋʊŋ]

(frontal and sagittal views are 2 different productions)
Deg Xinag discussion

• Support for Rounding Assimilation
  – significantly lower F2 before a round vowel (intervening uvular, laryngeal)
    • even at vowel midpoint
    • F2 as low as underlying reduced rounded vowel, even lower at 75%
Consonant effects

• Rounding Assimilation takes place across a single uvular or laryngeal C
• RA blocked by all other places of articulation
  – alveolars
  – velars
  – [v]
[χəvοn] ‘their mother’

(frontal and sagittal views are 2 different productions)
## Effect of uvulars on vowel quality

<table>
<thead>
<tr>
<th>Language</th>
<th>Reference</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babine-Witsuwit’en</td>
<td>Story 1984</td>
<td>Auditory</td>
<td>Proto-Athabaskan high vowels lower to mid before uvulars</td>
</tr>
<tr>
<td>Quechua (e.g. Cuzco dialect)</td>
<td>Rose 1950</td>
<td>Auditory</td>
<td>*[qi], *[iq] ([qe], [eq] only), *[qu], *[uq] ([qo], [oq] only)</td>
</tr>
<tr>
<td>Deg Xinag</td>
<td>Hargus 2010</td>
<td>Acoustic</td>
<td>Preceding/following uvulars raise F1, lower F2; greater effect of uvular following vowel</td>
</tr>
<tr>
<td>Palestinian Arabic</td>
<td>Card 1983</td>
<td>Acoustic</td>
<td>Lowered F2</td>
</tr>
<tr>
<td>Jordanian Arabic</td>
<td>Zawaydeh 1997</td>
<td>Acoustic</td>
<td>Lowered F2, raised F1</td>
</tr>
<tr>
<td>Moses-Columbian, Coeur D’Alene (Interior Salish)</td>
<td>Bessell 1998b, Bessell 1998a</td>
<td>Acoustic</td>
<td>Lowered F2, raised F1</td>
</tr>
<tr>
<td>Klallam</td>
<td>Montler 1998</td>
<td>Acoustic</td>
<td>No effect</td>
</tr>
<tr>
<td>Nuuchahnulth</td>
<td>Wilson 2007</td>
<td>Auditory, Acoustic</td>
<td>Preceding uvular raises F1 of /i/ but not /a/, /u/ (F2 not reported)</td>
</tr>
</tbody>
</table>
Uvulars and labials

• Card 1983: ‘it is interesting to note that emphasis and labialization both cause lowered second formants’

• Cairo Egyptian Arabic (Lehn 1963). articulation of emphatic Cs ‘is defined by the cooccurrence of the first and one or more others of the following articulatory features: … (3) slight lip protrusion or rounding (labialization), …’

• Jakobson, Fant, and Halle 1976: ‘peoples who have no pharyngealized consonants in their mother tongue, as for instance, the Bantus and the Uzbeks, substitute labialized articulations for the corresponding pharyngealized consonants of Arabic words’
Uvulars and Rounding Harmony

- Blocking/triggering Cs in RH
  - Kaun 2004 survey of doesn’t mention
  - Labials block RH in Nawuri (Casali 1995)
- Why don’t uvulars come up in Rounding Harmony lit?
  - Uvulars areally limited (Maddieson 2005)
  - Rounding Harmony also rare
Deg Xinag summary

• Rounding Assimilation as a phonological process
  – applies even in slow speech
  – applies even without surface round trigger (AJ)
  – lack of variability (F2 lowering in uvular and laryngeal contexts, \( p < .0001 \) for each individual)
  – neutralizing (difs with perambulative prefix are predictable from position of uvular C)
Still…

• Are there any Ig-independent aspects of DX Rounding Assimilation?
• If a language has /ə/-Q-round vowel, can we expect anything like RA?
• Enter Babine-Witsuwit’en
Babine-Witsuwit’en

- Consonants
  - p p’
  - t tʰ t’
  - c ch c’
  - k w kʰ w’
  - q qʰ q’
  - ts tsʰ ts’
  - tl tlʰ tl’
  - s z ç
  - h
  - m n
  - w l j

- Vowels
  - full: i e ε
  - reduced: η
  - full: u o a
Babine-Witsuwit’en vs. Deg Xinag

- B-W has innovative ‘fortis’ vs. ‘lenis’ C classes, affect quality (mostly F1) of following V (Story 1984, Hargus 2007)
  - fortis:  ejectives, ?, vls aspirates, vls fricatives
  - lenis:  vls unaspirates, vd fricatives, sonorants
Questions about B-W

• Perhaps Babine-Witsuwit’en has something like Deg Xinag Rounding Assimilation on a subphonemic level and fieldworkers like myself have trained themselves not to hear it because rounding is not contrastive in the reduced vowels.
  
  – [seqʰoj] ‘he/she vomited’
  – [təquez] ‘it’s friable’

\[
\begin{align*}
  a) \quad & \text{əQ{u,o} vs. əQə: predicted not to differ in F2} \\
  b) \quad & \text{əKʷə vs. əQə: F2 before labio-velar predicted not to be significantly lower than before uvular}
\end{align*}
\]
Methods

• Word list recording
• C before target vowel
  – Place controlled for (alveolar)
  – ‘Fortis’ vs. ‘lenis’ balanced
• 9 speakers (5 female, 4 male)
• 10-15 comparison pairs per speaker
F2 results

- n.s. (group)

individuals: 1 speaker has DX pattern (p = .0407 at 75%)
F1 results

- F1 significantly lower before round vowels

F1 n.s. at individual level
The likely culprit is fortis vs. lenis class of following uvular:

\[\text{[sə̝qʰj]} \quad \text{[sə̝qəs]} \quad \text{[tə̝quz]} \quad \text{[ɬə̝qʰət]}\]
• Lip positions on the vowels of [sə𝑞ʰ𝑜𝑗] ‘he/she vomited’
  [sə] (50%)  [sə] (75%)  [qʰ𝑜𝑗]

(frontal and sagittal views are 2 different productions)
Lip positions on the vowels of [ɬəqʰət] ‘he/she is clapping’

[ɬə] (50%)  [ɬə] (75%)  [qʰət]

(frontal and sagittal views are 2 different productions)
Babine-Witsuwit’en discussion

• Lacks F2 lowering seen in DX Rounding Assimilation
  – except one speaker, at 75% of vowel duration
Why does Deg Xinag have Rounding Assimilation while Babine-Witsuwit’en does not?

• Dorsal consonants
  – Deg Xinag: /k q/
  – Witsuwit’en: /c k^w q/

• F2 lowering on preceding vowel makes it easier to distinguish uvulars and velars (next to round vowels)
A possible scenario for historical change

- Proto-Athabaskan (much work by Jeff Leer)

- Pre-Proto-Athabaskan ("a more hypothetically reconstructed stage of the language previous to certain important phonological and structural changes", Leer 1979)

<table>
<thead>
<tr>
<th>PA</th>
<th>*/ʊq/</th>
<th>*/qʊ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPA</td>
<td>*/əq^w/</td>
<td>*/q^wə/</td>
</tr>
</tbody>
</table>
Another look at Proto-Athabaskan

<table>
<thead>
<tr>
<th>PPA</th>
<th>*/əqʷ/</th>
<th>*/qʷə/</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>*ʊq [ʊqʷ]</td>
<td>*qʊ [qʷə]~[qʊ]</td>
</tr>
</tbody>
</table>
Development of PA *qʊ in Babine-Witsuwit’en

PA

*ᵻq
[ᵻqʷ]

*nə-t-tᵻq’
‘become crammed…’

*ᵻq
[ᵻqʷə]~[ᵻq]

B-W

/əkʷ/

[kʷə]/

[ᵻkʷ]/[ᵻkʷ]

[niztᵻqʷ]
‘it’s spherical’

[kʰwən]
‘fire’
• /tətɪhəkʷ/ ‘it’s wet’ (female speaker LM)
How Deg Xinag developed Rounding Assimilation

PPA  */əqʷ/  */qʷə/

PA  *ʊq  *qʊ

DX  [ʊqʷ]  [qʷə]~[qʊ]

[ʊq]  [qʊ]  [ʊqʊ]

(RA)

*- [tɬʊq’] ‘laugh’  *qʰʊn’ ‘fire’
-[tɬq]  [qʰoŋ’]  [səqʰoŋ’]

‘laugh’  ‘fire’  ‘my fire’
Conclusions

• Lip rounding exists before uvular+round vowel in Deg Xinag, probably to enhance velar-uvular contrast

• Comparison with Babine-Witsuwit’en
  – helps separate phonological and phonetic aspects of DX Rounding Assimilation
  – provides insights into how RA may have developed in DX
Thanks to

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  – for comments
- Russell Hugo
  – for assistance with video
Thanks to Witsuwit’en speakers
Thanks to Deg Xinag speakers