Vowel quality and duration in Deg Xinag

Sharon Hargus
Dept. of Linguistics (Linguistic Phonetics Lab), University of Washington, Seattle
sharon@u.washington.edu

CAA Vancouver 2008 / ACA Vancouver 2008
Deg Xinag language

- Athabaskan family
- Spoken in western Alaska
- Moribund; 7 speakers left

Deg Xinag, a.k.a. Deg Hit’an

Vowel inventory

• Krauss 1962

• Unusual absence of high vowel phonemes
  – What about [u]?
    • auditory impression: [õ]
    • restricted in distribution, only occurs adjacent to uvulars

Krauss, Michael (1962) “Ingalik.” Alaska Native Language Center, UAF, Ms.
Consonant places of articulation in DX

- **Labial** (fricative, nasals)
- **Interdental** (affricates, fricatives)
- **Alveolar** (oral and nasal stops, sibilant affricates and fricatives, lateral affricates and fricatives)
- **Retroflex** (sibilant affricates and fricatives)
- **Palato-alveolar** (affricates, fricative)
- **Palatal** (glides)
- **Velar** (oral, nasal stops)
- **Uvular** (stops, fricatives)
- **Glottal** (stop, fricative)
Research questions

• (preliminary to a study of vowel overlap in 3 dimensions, cf. Morrison 2007)
• What are the spectral properties of the Deg Xinag vowels?
  – What are effects of retroflexion, uvular place?
• Which vowels are significantly different in duration?

Method
Participants

- 8 adult native speakers (3 male, 5 female)
- Ages
  - apx. 68-76 at time of recording
  - 3 speakers now deceased
- All bilingual in English
  - varying oral proficiency
  - minimal written proficiency for all but 3 speakers
Recordings

• Recording equipment
  – professional CD recorder or compact flash recorder
  – AT 4041 microphone

• Sampling rate
  – recorded at 44,100 Hz
  – downsampling to 11,025 for analysis

• Four repetitions; sets of repetitions recorded in random order

• Vowel duration word list
  – Sentence context, presented in local orthography
    • chenh ______ didaghsne’ “I said _____ again”
      again ______ I said
  – Two consonantal contexts
    • vls. unasp. alveolar stop___ vls. unasp. alveolar stop or affricate
    • vls. unasp. uvular stop ___ vls. unasp. alveolar stop or affricate
Vowel quality word list

- Words recorded in isolation
  - except for some words taken from vowel duration word list
- Five consonantal contexts
  1. Alveolar ___ alveolar
  2. Alveolar ___ retroflex
  3. Retroflex ___ alveolar
  4. Uvular ___ alveolar
  5. Alveolar ___ uvular

- Justification for retroflex: Proto-Athabaskan vowels > centralized monophthongs or diphthongs in Upper Tanana before retroflex consonants (Tuttle and Lovick 2008)
- Justification for uvular: /ʊ/ only occurs adjacent to a uvular consonant in DX

Acoustic analysis

- **Vowel quality**
  - Praat (version 4.3.27)
  - Lowest four formants measured at steady-state
    - Maximum Formant settings
      - 5000 Hz for men
      - 5500 Hz for women

- **Vowel duration**
  - Multi-Speech 2.5
  - Duration measured between tags at onset and offset of F2
Statistical analysis

• Repeated measures ANOVA
  – Vowel duration studies
    • Independent variable: Vowel
    • Dependent variable: each speaker’s mean vowel duration
  – Vowel quality studies
    • Independent variable: Vowel
    • Dependent variable: each speaker’s mean log-normalized F1 and F2 (Nearey 1978, 1989)

• Post hoc analysis: Bonferroni/Dunn

• Alpha level: .05

Results
Spectral properties of vowels

• Sample vowel plots on following slides generated with PlotFormants
  – F2 (horizontal axis) x F1 (vertical axis) (Bark scale)
  – Large symbols plotted at means
  – Ovals show 2 standard deviations
  – Same speaker, HM (female)

• Repeated measures ANOVA results
• Alveolar ___ alveolar
  – Note relatively low F1 and high F2 for /ə/ ( [ɪ]-like)

Speaker HM
  [ntataʔ] ‘when (in the future)?’
  [təGəted] ‘eel’
  [taˈtədə] ‘red-necked grebe’
  [ŋətət] ‘downriver (at place)’

• Post hoc results
  • Normalized F1
    -- All vowel pairs significantly different except /e o/
  • Normalized F2
    -- All vowel pairs significantly different except /e ə/
• **Retroflex alveolar**
  - Note absence of fronting and raising of /ə/ in this context

  ![F2](image)

  ![F1](image)

  **Speaker HM**
  - [t$\text{ʃ}^\text{h}a\text{ɪ}t\theta\text{̣}^\text{t}e\text{t}]$ ‘kashim’
  - [t$\text{ʃ}e\text{d}$] ‘seldom’
  - [k$\chi\text{ət}\text{ʃ}^\text{ʊ}\text{t}e\text{t}]$ ‘they’re lying down’
  - [v$\text{ʊt}\text{ʃ}^\text{ʊ}\text{d}$] ‘his shin’

• **Post hoc results**
  • Normalized F1
    -- All vowel pairs significantly different except /e ə/, /e ə/, /ə o/
  • Normalized F2
    -- All vowel pairs significantly different
• Alveolar___retroflex
  – Note centralization of all vowels

F1

-300  -200  -100  0  100  200  300 Hz

Speaker HM

[ˈvətadʐ] ‘his younger sister’
[ˈletʂ’aʔ] ‘female dog’
[ðətɬətʂ] ‘he urinated’
[ˈvəjoɾts’aʔ] ‘his daughter-in-law’

• Post hoc results
  • Normalized F1
    -- All vowel pairs significantly different
      except /e o/, /e ə/, /ə o/
  • Normalized F2
    -- All vowel pairs significantly different
      except /a o/, /e ə/
• **Uvular–alveolar**
  
  - Note more compressed vowel space, more variability
  - /əː/: relatively high F1 ([ʌ]-like)
  - /ʊː/: spectral overlap with /o/ and /ɔ/
• **Alveolar-uvular**
  
  – /ə/: relatively high F1 (impressionistically [ʌ] in this context)
  
  – /o/: relatively high F1, spectral overlap with /o/

---

**Post hoc results**

**Normalized F1**

-- All vowel pairs significantly different except /a ə/, /e o/, /e ʊ/, /o ʊ/

**Normalized F2**

-- All vowel pairs significantly different except /o ʊ/

---

Speaker HM

- [tʰaG] ‘no good’
- [tʰeqo] ‘puppy’
- [kətʰaq] ‘one’
- [qʰθtʰæselo] ‘I have a cold’
- [tʰtʰo] ‘it’s baggy’
# Spectral properties summary

<table>
<thead>
<tr>
<th></th>
<th>__alveolar</th>
<th>__retroflex</th>
<th>__uvular</th>
</tr>
</thead>
<tbody>
<tr>
<td>alveolar__</td>
<td>G1: $e = o$</td>
<td>G1: $e = o, e = \partial, o = o$</td>
<td>G1: $a = o, e = o$</td>
</tr>
<tr>
<td></td>
<td>G2: $e = \partial$</td>
<td>G2: $a = o, e = \partial$</td>
<td>G2: $o = o$</td>
</tr>
<tr>
<td>retroflex__</td>
<td>G1: $e = o, e = \partial, \partial = o$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>G2: $a = o$</td>
<td></td>
</tr>
<tr>
<td>uvular__</td>
<td>G1: $e = o, e = \mathring{u}, \mathring{u} = o$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G2: $a = \partial$</td>
<td>G2: $o = \mathring{u}$</td>
<td></td>
</tr>
</tbody>
</table>

G1 = normalized F1; G2 = normalized F2

‘=’: ‘not significantly different’
Spectral trends in Deg Xinag vowels

• Fewer significant differences before retroflex consonants than after
  – no significant differences in normalized F1 or F2 for /e ə/

• Fewer significant differences before uvular consonants than after
  – no significant differences in normalized F1 or F2 for /o ʊ/
Vowel duration studies

• Next slides present data averaged across 8 speakers
• In tables, ( ) represents one standard deviation
• In bar graphs, error bars represent one standard deviation
• Alveolar ___ alveolar

• Significant differences in length ($F[7,21] = 21.455$, $p < .0001$)
  – /ə/ significantly shorter than each of /e o a/ ($p < .0001$)
  – /e o a/ do not differ in length from each other

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Duration (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>.168 (.0154)</td>
</tr>
<tr>
<td>e</td>
<td>.150 (.0278)</td>
</tr>
<tr>
<td>ə</td>
<td>.077 (.0080)</td>
</tr>
<tr>
<td>o</td>
<td>.176 (.0140)</td>
</tr>
</tbody>
</table>
• Uvular ___ alveolar

![Bar chart showing duration of vowels](image)

<table>
<thead>
<tr>
<th>Vowel</th>
<th>a</th>
<th>e</th>
<th>ə</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.203 (.0169)</td>
<td>.178 (.0195)</td>
<td>.105 (.0127)</td>
<td>.191 (.0089)</td>
<td>.088 (.0108)</td>
</tr>
</tbody>
</table>

• Significant differences in length ($F[7,28] = 34.633, p < .0001$)
  – Each of /ə ʊ/ significantly shorter than each of /e o a/ ($p < .0001$)
  – /e o a/ do not differ in length from each other
  – /ə ʊ/ do not differ in length from each other
Points of interest in Deg Xinag vowel system
Centralization of DX vowels before retroflex

- Cf. sound change in Upper Tanana
  - PA *a:, ə > UT /ɤ/
  - *e: __ ʂ > /ia/
  - *u: > /io/

Vowel duration

• Deg Xinag
  – Three long vowels: /e a o/
  – Two short vowels: /ə ʊ/

• Cf. other Athabaskan languages
  – Tsek’ene (Hargus in prep.)
    • long vowels: /e a o u/
    • short vowels: /ə ɪ ʊ/
  – Witsuwit’en (Hargus 2007)
    • long vowels: /i e ɛ a o u/
    • short vowel: /ə/

• Support durational differences between PA ‘full’ vs. ‘reduced’ vowels

Vancouver: UBC Press.
Hargus, Sharon (in prep.) Kwadacha (Fort Ware Sekani) Grammar. Seattle, Ms.
No high vowel phonemes in DX

- /ʊ/ not a high vowel
  - Spectral overlap between DX /ʊ o/
  - Durational differences may crucially distinguish these vowels, particularly before uvulars
- DX uniquely without high vowels in Athabaskan?
History of DX vowel system

- Leer 1979: “counter-clockwise” rotation of PA ‘full’ (long) vowels > DX

*ɪː* \[\sim \text{æ}\] \*\text{u}*

Leer, Jeff (1979) Proto-Athabaskan Verb Stem Variation: I. Phonology. Fairbanks: Alaska Native Language Center, UAF.
Acknowledgements

• Deg Xinag speakers Phillip Arrow, Edna Deacon, James Dementi, Raymond Dutchman, Lucy Hamilton, the late Katherine Hamilton, Alta Jerue, and Hannah Maillelle

• Funding provided by the U.S. National Science Foundation (OPP-0137483 and DEL-0651853)

• RA Julia Miller (helped prepare sound files for measurement)

• Comments from
  – Rob Hagiwara, University of Manitoba
  – Members of the UW Linguistic Phonetics Lab (Richard Wright, director)

These slides will be posted at http://faculty.washington.edu/sharon/