Using acoustics to resolve place controversies in Deg Xinag fricatives

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Deg Xinag language

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

Deg Xinag, a.k.a.
Deg Hit'an

Map based on Krauss, Michael (1974) "Native Peoples and Languages of Alaska". Fairbanks: Alaska Native Language Center, UAF

Consonant inventory

stops			d t t^h t’			g k k^h k’	G q q^h q’	ʔ
affricates								
lateral release			dl $tɬ$ $tɬ^h$ $tɬ$’					
other release		dð tθ $tθ^h$ tθ’	dz ts ts^h ts’	dʐ tʂ $tʂ^h$ tʂ’	ʤ ʧ $ʧ^h$ ʧ’			
fricatives			$lɬ$					
		ð θ	z s	ʐ ʂ	ʃ		ʁ χ	h
sonorants	m m’		n $n̥$ n’			ŋ $ŋ̥$ ŋ’		
	v(~w)				j $j̥$ j’			

- Note 7 voiceless fricatives (also [ç] = /j̥/)
- Unusual (for Ath.) 4-way phonation contrast among stops (but common in Alaska). Voiced (innovative) mainly restricted to word-final position; e.g. [ts’əd] “blanket” (cf. [ɬət] “smoke”).
- Voiceless and laryngealized sonorants mainly restricted to word-final position

/χ/ vs. /h/

- Contrast in stem-initial position
  - – [genoχa] ‘you (pl.) will pick (berries)’
  - – [genoha] ‘he/she will pick (berries)’

  - – [enoχəɬ] ‘you (pl.) will camp’
  - – [enohəɬ] ‘he/she will camp’

Speaker ED

Verb prefixes

- Limited contrast between /χ/ and /h/
- Linguists have variously transcribed /χ/ <x> or /h/ <h> in verb prefixes, even in names for the language!
  - Deg Hit'an (Krauss 1974) (lit. "people of this area")
    - *χʊ- areal (Leer 2000)
  - Deg Xinag (Kari 1978) (lit. "this language")
    - *χənəgʲ "language" (Story 1984), < *qə-nə-(h)e:xʲ, -(h)aʔ (Krauss and Leer 1981)

Kari, James (1978) *Deg Xinag: Ingalik Noun Dictionary (Preliminary)*. Fairbanks: ANLC.

Krauss, Michael and Jeff Leer (1981) *Athabaskan, Eyak and Tlingit Sonorants*. Fairbanks: ANLC.

Leer, Jeff (2000) The Negative/Irrealis Category in Athabaskan-Eyak-Tlingit. In Theodore Fernald and Paul Platero, eds. The Athabaskan Languages: Perspectives on a Native American Language Family. Oxford: OUP. 51-72.

Story, Gillian (1984) *Babine and Carrier Phonology: A historically oriented study*. Arlington: SIL.

Acoustic differences between DX /χ/, /h/

- /χ/ and /h/ in stems (Wright, Hargus, and Miller 2005)
  - Significantly different in skew and kurtosis
  - Not significantly different in center of gravity, lowest spectral peak, or standard deviation
  - ➢ /χ/ and /h/ differ in relatively few spectral measures
- Given limited contrast possibilities in prefixes, /χ/ and /h/ might be confusable

Wright, Hargus and Miller (2005) An acoustic study of Deg Xinag fricatives. *JASA* 117: 2491

Research question

- What is the identity of the prefixal fricative ("x")?
  - Does "x" pattern with /χ/ or with /h/?

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

Word list recordings

- [χ], [h], "x" lexical sets
  - [χot] 'slowly'
  - [ʁʊhoɬ] 'he/she is walking'
  - ["x"otəɬ] 'they're walking'

Speaker ED

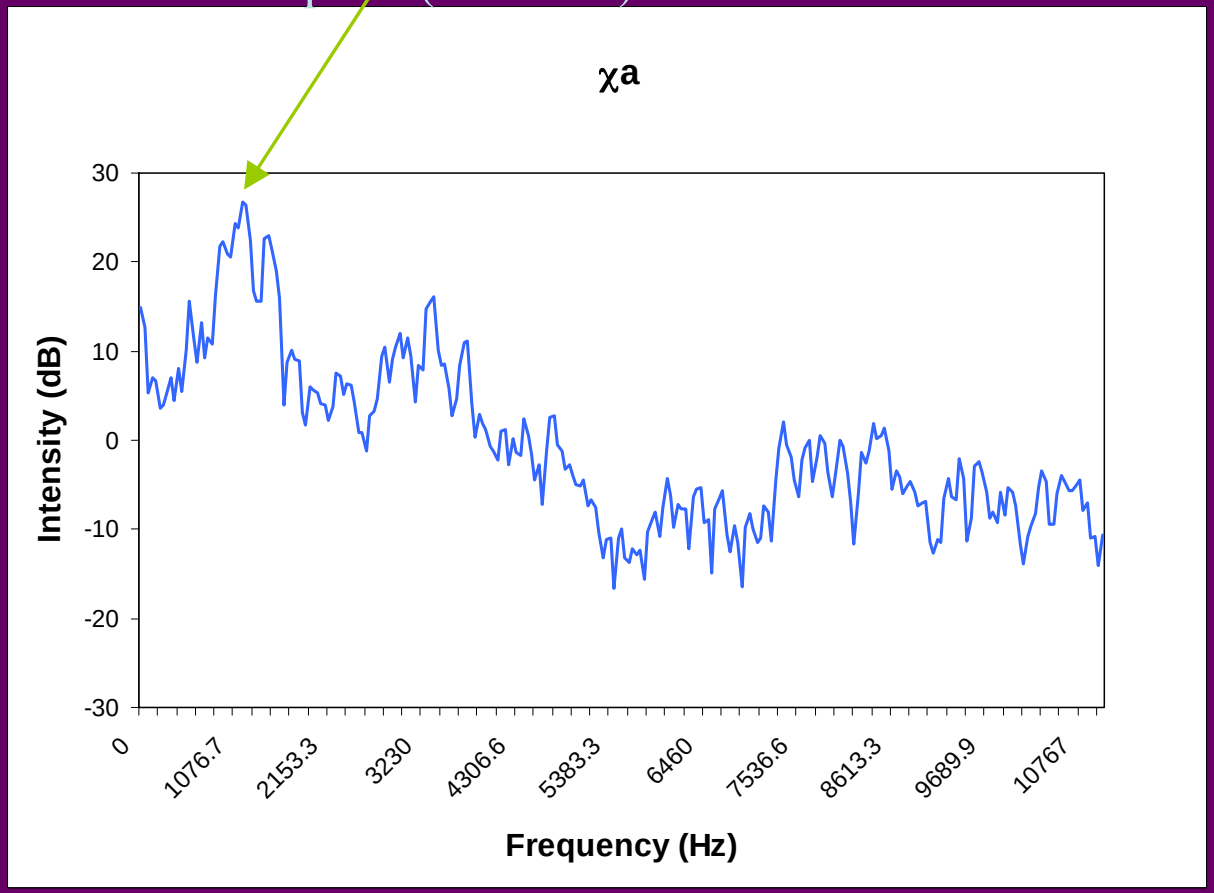
- Two vocalic contexts (__ rounded vs. unrounded V)
- Two lexical sets per context
- Four repetitions elicited; sets of repetitions recorded in random order
- Recording equipment
  - professional CD recorder or compact flash recorder
  - Shure SM-10 head-mounted microphone
- Sampling rate
  - recorded at 44,100 Hz
  - downsampled to 22,050 for analysis

Acoustic analysis

- Praat (version 4.3.27 and previous)
  - Spectral moments (center of gravity, standard deviation, skew and kurtosis) (30 ms. window at midpoint)
  - Intensity (dB) (25 ms. window at midpoint)
- Multi-Speech (2.5 and previous)
  - lowest main spectral peak (512-point FFT spectra, 25 ms. window at midpoint)

Lowest main peak

- Graph of averaged FFT output
- [χa] 'grease, gasoline'
  - lowest main peak (1206 Hz)



[χa]1
[χa]2
[χa]3
[χa]4

Statistical analysis

- Repeated measures ANOVA
  - Independent variables
    - fricative Place
    - vowel Rounding
  - Dependent variable
    - each speaker's mean center of gravity, standard deviation, skew, kurtosis, lowest main peak, intensity
  - Post hoc analysis: Bonferroni/Dunn
  - Alpha level = .05

Results

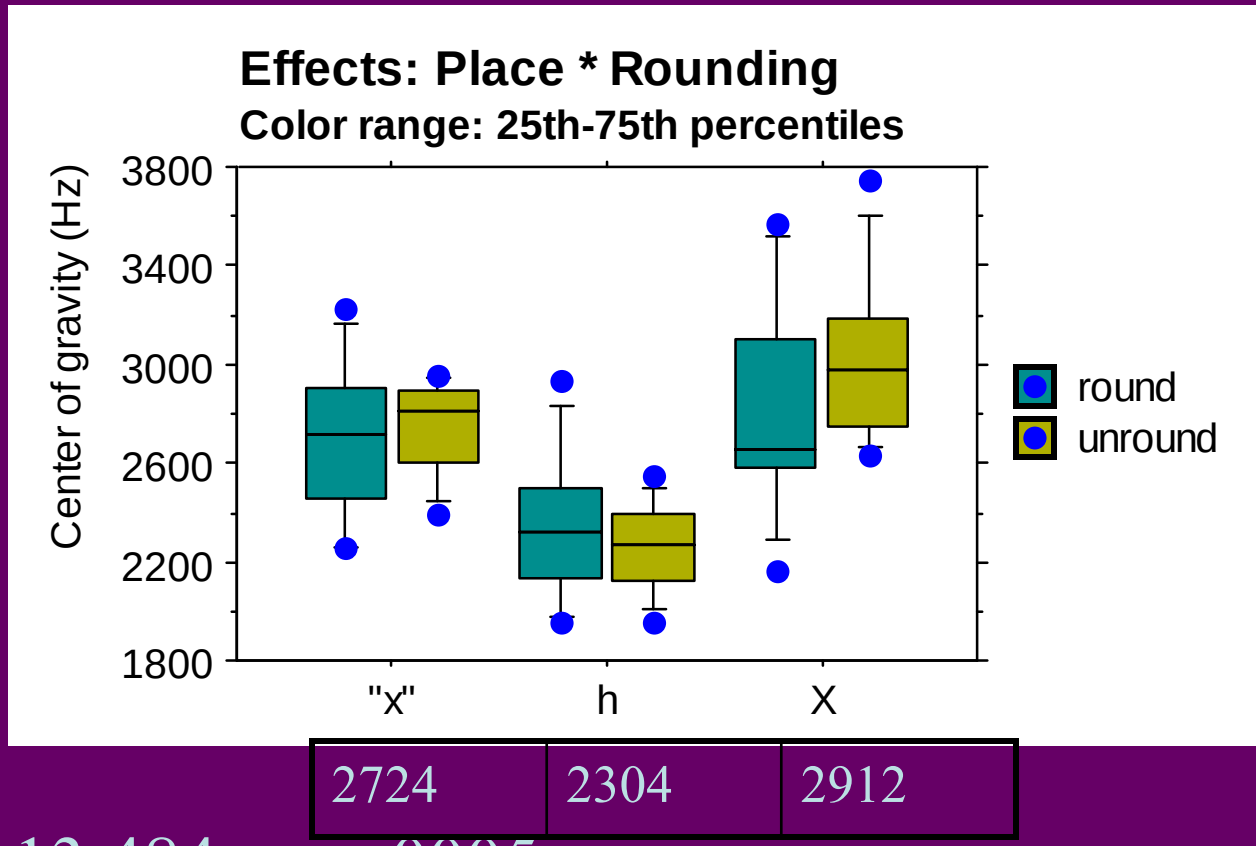
Results overview

- Repeated measures ANOVA: significant Place effects for 3 of 6 measures
  - Center of gravity
  - Kurtosis
  - Intensity
- Bonferroni/Dunn
  - "x" patterns with [χ] (center of gravity and kurtosis)
  - "x" patterns with [h] (intensity)

Significant spectral differences

- Center of gravity

➢ "x" = [χ]

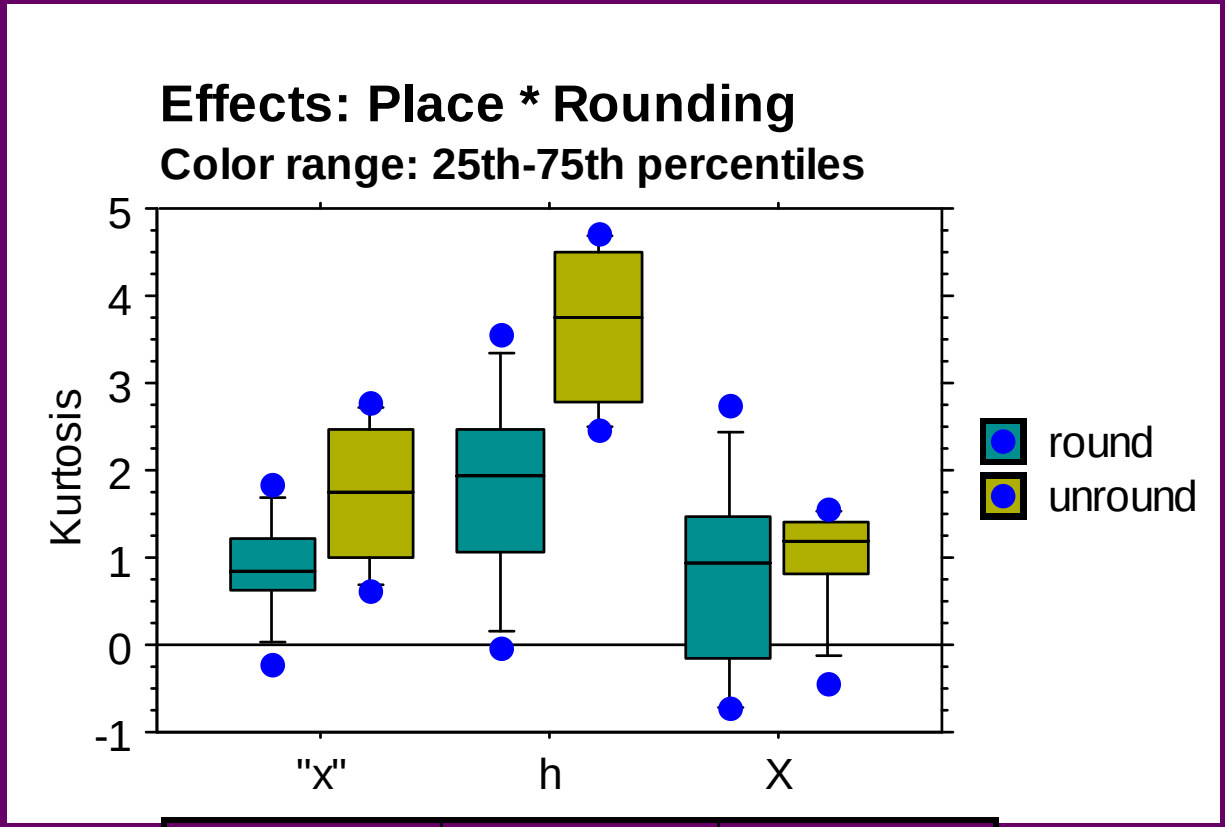


2724	2304	2912

- Place: F[2,14] = 13.484, p = .0005
- Rounding: n.s.
- No significant interaction effect

Significant spectral differences

- Kurtosis



1.2995	2.733	.9065

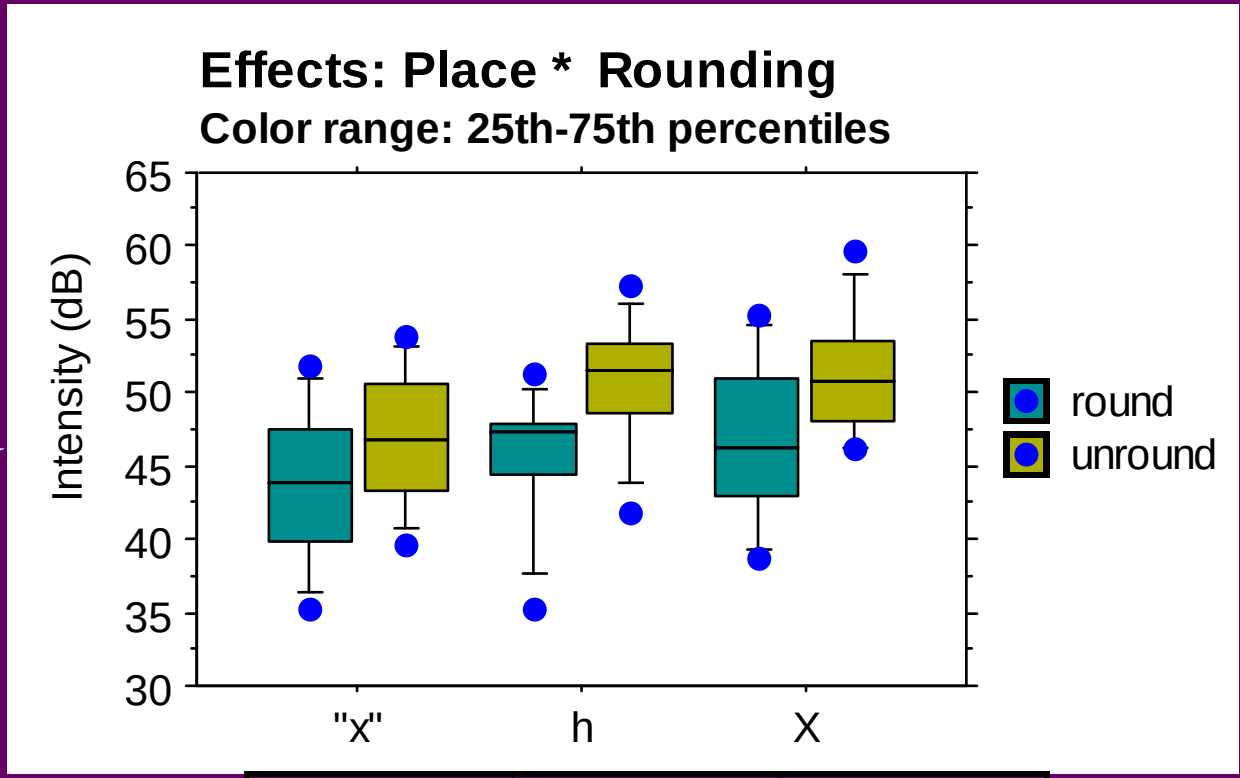
➢ "x" = [χ]

- Place: F[2,14] = 26.628, p < .0001
- Rounding: F[1,14] = 36.498, p = .0006
- No significant interaction effect

Significant intensity differences

- Intensity

➢ “x” = /h/ (and /h/ = /χ/)



45.3	48.2	49.1

– Place, F[2,14] = 4.797, p = .0259
– Rounding: F[1,14] = 23.488, p = .0019
– No significant interaction effect

Discussion

What is “x”?

- In terms of spectral properties, more like /χ/ than /h/
  - center of gravity
    - /χ/, “x” higher
    - /h/ lower
  - kurtosis
    - /χ/, “x” more diffuse
    - /h/ more peaked

- In terms of intensity, “x” more like /h/ than /χ/
  - “x” < /h/ < /χ/
- But intensity does not neatly divide the 3 fricatives into 2 classes in DX. Bonferroni/Dunn patterns of significance
  - “x” = /h/
  - /h/ = /χ/
  - “x” ≠ /χ/

Why does "x" pattern with /h/, not /χ/, for intensity?

- DX "x" occurs only in prefixes
- Prefixes are widely reported unstressed in Ath languages (Rice and Hargus 2005)
- Unstressed vowels in Witsuwit'en and Tsek'ene have less intensity than stressed vowels (Hargus 2005)
- Stem-initial stops and nasals in San Carlos Apache are longer than prefix nasals (Tuttle 2005)

➢ DX "x" probably relatively quiet because unstressed

Rice, Keren and Sharon Hargus (2005) Introduction. In Sharon Hargus and Keren Rice (eds.) *Athabaskan Prosody*. Amsterdam: John Benjamins.

Hargus, Sharon (2005) Prosody in two Athabaskan languages of Northern B.C. In Hargus and Rice, eds., 393-423.

Tuttle, Siri (2005) Duration, intonation and prominence in Apache. In Hargus and Rice, eds., 319-344.

Distributional restrictions on /χ h "x"/

	prefixes		stems	
	__V	V__	__V	V__
/χ/		X	X	X
/h/	X		X	
"x"	X			

= Contexts represented on our word list

- [genoχa] /g-e-n-o-ʊχ-ha/ 'you (pl.) will pick (berries)'
  unspO-fut-'pick'-fut-2pS-'pick'
- [genoha] /g-e-n-o-ha/ 'he/she will pick (berries)'
  unspO-fut-'pick'-fut-'pick'

Consequences of lack of contrast

- Lack of contrast between prefixal “x” and /h χ/
  - In fact, prefixal “x” conjunct prefixes only; prefixal /h/ disjunct prefixes only
  - ➢ Decreased functional load on “x”
  - ➢ Increased variability and reduction (Lindblom 1990)

Lindblom, Bjorn (1990) Explaining phonetic variation: a sketch of the H&H theory. In Hardcastle, William J. and Alain Marchal (eds.) Speech Production and Speech Modeling. Dordrecht: Kluwer Academic Publishers. pp. 403-439

An analogous situation

- DX lateral affricate phonation contrasts (Hargus 2008)
  - Stem-initial /tɬ tɬʰ tɬ’/
  - Stem-final /tɬ dl/
- Verb prefixes
  - Single lateral affricate [tɬ]~[tɬ’]~[dl]
  - < Proto-Athabaskan *s-ɬ
  - Fortition in word-initial position [tɬ’] (all 3 speakers)
  - Elsewhere, prevocalically [tɬ’] (2 speakers), [tɬ] (1 speaker)
- Given lack of contrast, prosody and/or position can shape articulation

Hargus, Sharon (2008) ‘Deg Xinag lateral affricates: Phonetic and historical perspectives.’ Poster presented at SSILA, Chicago.

Other cases of lenition of prefixal *χ

PA	3pS *χ- (Leer 2000)	areal *χʊ- (Leer 2005)
Koyukon	χʊ-	χʊ-
Deg Xinag	χ-	χ-
Ahtna	$_{syll}$[q^{h}-, h-]$_{syll}$	χu-
Witsuwit'en	h-	ho/w-
Tsek'ene	ɣ-	w-
Slave	k^{h}~k-	ko-
Navajo	h- seriative	ho-

Leer, Jeff (2005) How stress shapes the stem-suffix complex in Athabaskan. In Hargus and Rice (eds.) *Athabaskan Prosody*. Amsterdam: John Benjamins. 278-318.

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