



# Ultrasounding It Out

## Speech visualization in language-learning research

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# Acknowledgments

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- SENĆOŦEN language community, in particular late Ray Sam and late Ivan Morris Sr.
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# Introductions

- **Presenters:**

- Sonya Bird (Associate Professor, UVic)
- Heather Bliss (Banting post-doctoral fellow, UVic; Adjunct Professor, UBC)
- Tess Nolan (PhD student, UVic)

- **Research program:** Ultrasound imaging as a visualization tool for documenting + teaching and learning pronunciation in the context of Indigenous language revitalization



# Speech visualization and pronunciation



Video credit: UBC Communications

# Outline

1. Introduction to ultrasound imaging in speech research (30 minutes)
  - Documenting the sounds of Blackfoot and SENĆOŦEN
  - Exploring the benefits of speech visualization in teaching and learning (Indigenous) languages
2. Mini experimental study: Interactive ultrasound session (20 minutes)
  - French /u/ vs. /y/
3. Discussion: questions and comments (10 minutes)



Ultrasound imaging in  
speech research

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# Documenting the sounds of Blackfoot

- ~ 5600 speakers
- Few (if any) children acquiring Blackfoot as a first language
- Dialectal variation
  - 4 dialects: Siksika, Kainai, Piikani, Blackfeet
- Generational variation
  - “New Blackfoot” versus “Old Blackfoot”
  - Younger speakers (born in 1940s or later) speak a different variety than older speakers



# Blackfoot soundless vowels

- At the ends of many words, there is a vowel (*a* or *i*) that is challenging for learners and non-speakers to perceive

oma si'káána

'the blanket (here)'

omi si'kááni

'the blanket (there)'

Noreen Breaker:

*"It's there, but it's silent. You can't leave it out."*



# Research questions

- What are the phonetic properties of “soundless” vowels?
- ***Are they really there?***
- What variation is there amongst speakers?
  - Do younger speakers (still) produce soundless vowels, and if so, is their pronunciation different from that of older speakers?
  - Do older speakers produce them as soundless, or is soundlessness a result of language change / language loss?

# Methods

- Simultaneous recordings of ultrasound (tongue), video (lips), and audio for speakers
  - Two dialects; Age range = 53-81 yo
- (~40 tokens for each speaker)
- Analysed the point in each recording where the vowel is predicted to appear



# Results

- No acoustic evidence of the vowels for any speaker
  - Corroborated by a perception experiment with a Blackfoot listener (Gick et al. 2012)
- Vowels are distinguished articulatorily
  - Ultrasound: different tongue heights for a and i vowels
  - Video: different aperture for a and i vowels
- There is subtle variation in the articulatory properties of vowels across speakers, but not corresponding with dialect or age (Bliss & Gick 2017)
- “New Blackfoot” and “Old Blackfoot” speakers produce soundless vowels
  - This is a property of the language that is considered important in language learning

# Documenting the sounds of SENĆOŦEN

- Language of the W̱SÁNEĆ people
- Very few L1 speaking elders (< 5)
- Vibrant language revitalization program
  - Adult L2 speakers of different generations and fluency levels
  - Child L2 speakers (immersion programming)
  - Adult L2 speakers starting to raise their kids in SENĆOŦEN



Map: <http://www.vipirg.ca/>

# Documenting the sounds of SENĆŦEN

- Coast Salish languages are among the most complex in the world in terms of their sound structure

	Labial	Dental	Alveolar	Lateral	Post-alveolar	Velar	Uvular	Glottal
Stops	p p'		t t'			(k) k <sup>w</sup> k' <sup>w</sup>	q q' q <sup>w</sup> q' <sup>w</sup>	ʔ
Affricates		t <sup>θ</sup>			č č'			
Fricatives		θ	s	ɬ	š	x <sup>w</sup>	x̣ x̣ <sup>w</sup>	h
Nasals	m m'		n n'				ŋ ŋ'	
Resonants				l l'	j j'	w w'		

# Back of the mouth sounds

- velar /k/ vs. uvular /q/
  - ƷELEN [qʷələn] ‘ear’ vs. ǾELEN [kʷələn] ‘airplane’
  - /q/ difficult to perceive and produce for learners (whose first language is English)
  - Concern among SENĆOŦEN-speaking community that the /k/ ~ /q/ contrast is being lost, under the influence of English (Bird & Kell 2017)
- /qi/ ~ /iq/
  - Particularly difficult to articulate because /i/ and /q/ require conflicting positions of the tongue
  - Different strategies can be used to pronounce these sounds (Bird 2018)
    - Elders use a range of strategies, all of which maintain the /q/ ~ /k/ contrast
    - Learners tend to use a single strategy: /q/ → [k]

# Research questions and methods

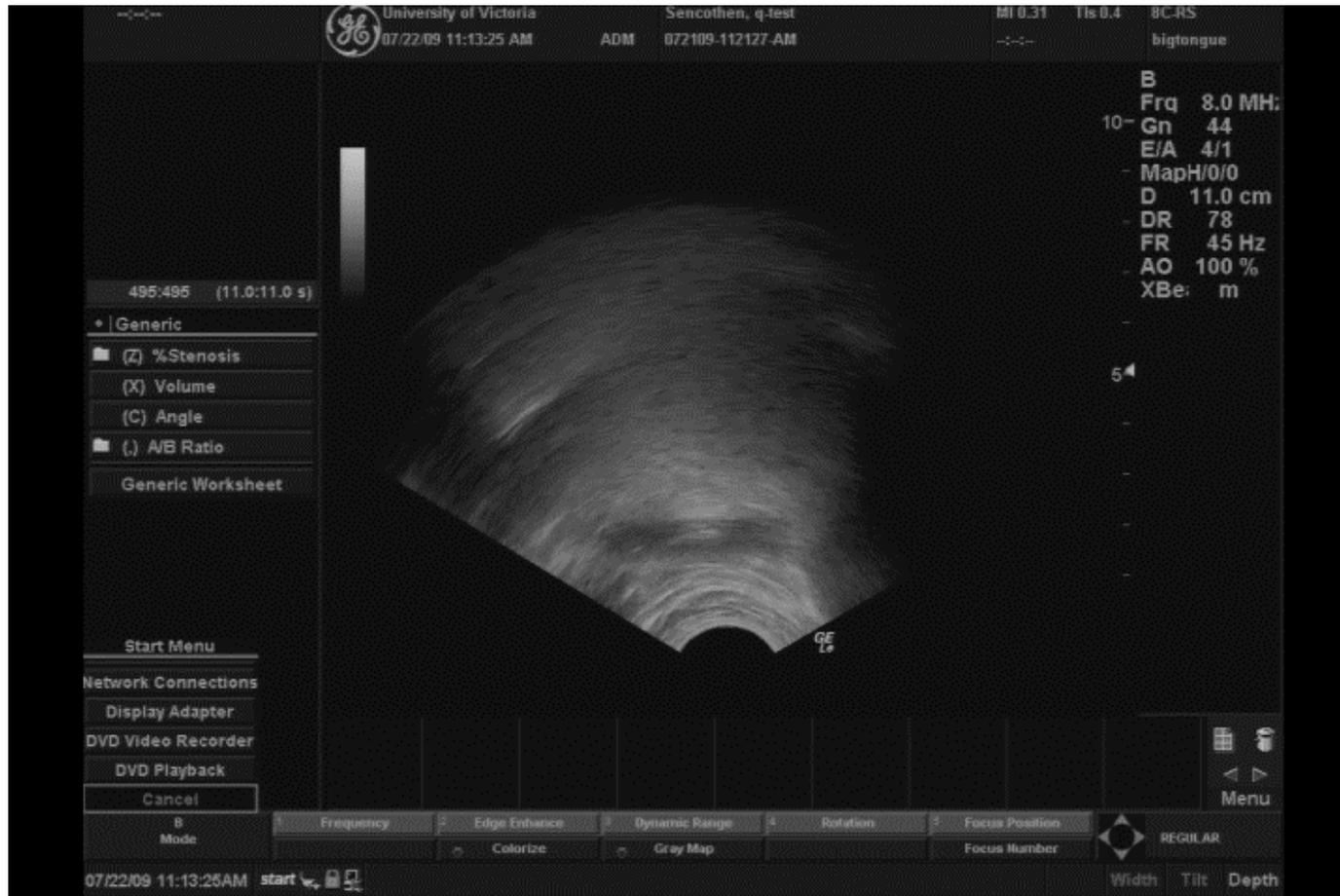
- Research question (Bird 2012)
  - What strategy/strategies do Elders use to pronounce /qi/ and /iq/ sequences?
- Methods
  - Recording words with the target /iq/ and /qi/, using ultrasound
  - Analysis of tongue movement during the target sounds/sequences



# Documenting the sounds of SENĆOŦEN



- Lightbulb moment: “tongue rolling”



# From documentation to teaching and learning

- Indigenous language revitalization and reclamation in Canada  
PENÁĆ (2017): “I read and write the language often, but speaking the language is the standard by which to measure language revitalization” (p. 32)
- At the centre of the movement: Adult second language (L2) learners  
PENÁĆ (2017) “In the course of learning from our elders, I have always wanted to honour them. I cherished them and hoped to see them smile, knowing they were assured that we were carrying the language forward and that the language was going to be safe with us.” (p. 60)
  - Intelligibility and comprehensibility (Derwing & Munro 2009) are not enough

# From documentation to teaching and learning

- The challenge

Mclvor (2015) “... many of our people struggle with accessing successful, research-based, meaningful, and useful learning experiences as adult learners in order to become proficient speakers of our languages. The rise of, and need for, effective Indigenous adult language learning approaches is a relatively new societal phenomenon” (p. 38)

- Documentation works feeds directly into pedagogical work

- Step 1: documenting phonetic structures
- Step 2: developing and assessing methods for teaching phonetic structures
  - Our focus: speech visualization

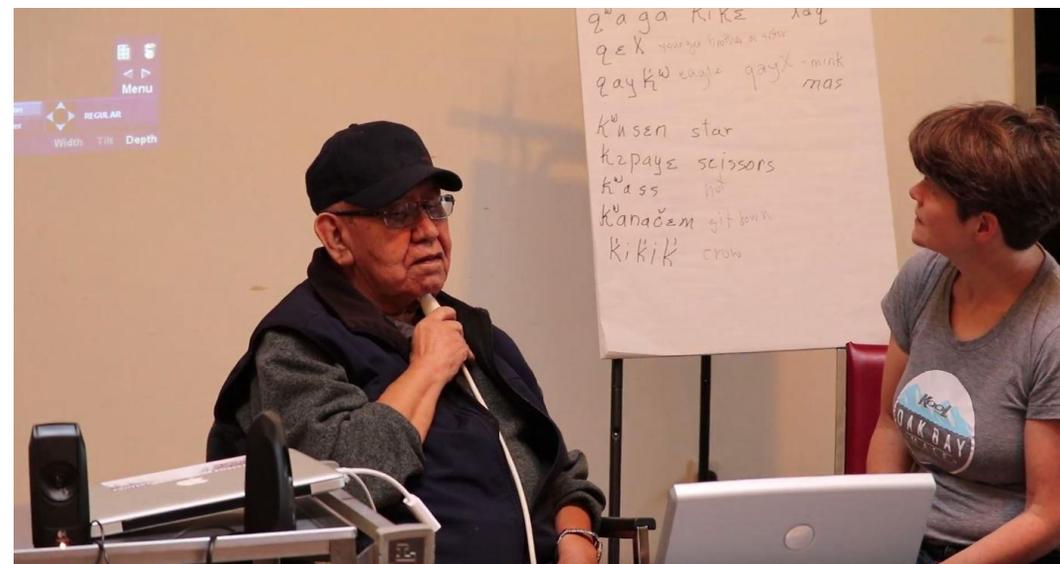
# Ultrasound in pronunciation teaching and learning

- Ultrasound in speech research
  - Long history of US in phonetic research and speech therapy
  - Much shorter history in pronunciation teaching and learning
- Ultrasound in pronunciation teaching and learning
  - No studies comparing US with other methods (to our knowledge)
  - Studies tend to be focused on a small number of learners (10 or fewer) acquiring a small number of segments (e.g., English /r ~ l/; vowels)
  - Literature review: Bliss, Abel, & Gick (to appear) + <http://enunciate.arts.ubc.ca/research-and-case-studies/other-research/>
- Ultrasound in Indigenous language revitalization
  - Bliss, Bird, Burton, Cooper & Gick (to appear). Seeing Speech. *Language Documentation & Conservation*.

# Ultrasound in pronunciation teaching and learning

- Research questions
  - Does speech visualization help in learning pronunciation?
    - If so, over what time frame? (short-term vs. long-term benefits)
  - What are the best settings for doing speech visualization work?
    - Classroom vs. one-on-one
    - Receptive (passive) vs. interactive
- Methods
  - Quantitative research: Pre-test + training + post-test
    - Acoustic analysis (pre- vs. post-training)
    - Articulatory analysis (pre- vs. post-training)
    - Native speaker judgements (pre- vs. post-training)
  - Qualitative research: learner reflections

# Play time: Speech visualization and language learning



# French /u/ vs. /y/

- Mock mini-experiment
- Structure of the study
  - Pre-test – recorded in Praat ([www.praat.org](http://www.praat.org))
    - Description of L2 pronunciation
    - Baseline for potential improvement
  - Training
    - One-on-one US session with a fluent speaker (alternative: pre-recorded videos)
    - (Possible other conditions: auditory-only training; no training)
  - Post-test – also recorded in Praat
    - Comparison to pre-test: assessment of improvement
- Methods = qualitative: self-reflection, listener judgments (alternative: quantitative: acoustics, articulation)

# Pre-test

French	IPA	English
bout	[bu]	end
but	[by]	goal
pou	[pu]	(head) louse
pu	[py]	was able to

# Training

French	IPA	English
bout	[bu]	end
but	[by]	goal
vous	[vu]	you (pl)
vu	[vy]	seen
nous	[nu]	we
nu	[ny]	naked
loup	[lu]	wolf
lu	[ly]	read (past)
roue	[ru]	wheel
rue	[ry]	street
voulu	[vuly]	wanted

# Post-test

French	IPA	English
bout	[bu]	end
but	[by]	goal
pou	[pu]	(head) louse
pu	[py]	was able to

- Listener judgments (close your eyes!)
- Self-reflection: engagement, motivation, confidence

# Discussion

- Appropriate target sounds/sequences
- Ways of adding complexity
  - Different segmental and prosodic contexts; sound sequences
  - Different ways of assessing value of speech visualization
- Other considerations

# Summing up

- Ultrasound imaging has intuitive appeal to learners
- It is entirely feasible
  - Doesn't need to be invasive
  - Can be done in a variety of settings
  - Doesn't necessarily require complex articulatory data analysis
- More studies are needed to show what its benefits are
  - Comparative (US vs. other visualization methods)
  - Classroom studies (e.g., beyond single participant)
  - Local (particular articulations) vs. global (awareness and motivation)

# HÍSKWE, Nitsikó'tahsi'taki, Thank you



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Slides will be posted to:

<https://enunciate.arts.ubc.ca/research-and-case-studies/team-research/>

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