Measuring the VOT of Blackfoot oral stops

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Background: Blackfoot spellings and the lack of phonetic documentation

- Several details of IPA-based Blackfoot orthography (Frantz 1978, 1993, 2017) are counterintuitive for intuitions based on English (Genee 2020).
- Spelling of oral stops has many variations.
- Anecdotal impression that informal spellings with <b, d, g> contribute to "overvoicing" to produce stops sounding like true English-style "voiced" short lag VOT stops, resulting in non-native-like pronunciations in L2 learners.
- Need better analysis to improve pronunciation training.

Background: Blackfoot spellings and the lack of phonetic documentation

IPA	Standard	Informal	Example
/p/	**p**	**p**	*ghit dawk ksou wa doo**p*** (for *kitáaksowatoo'**p**a*) 'you (SG) will drink it'
		b	***b**ee dah* (for ***p**íítaa*) 'eagle'
		bh	
/t/	**t**	**t**	*goo**t** **t**sis* (for ko'***t**sísi*) 'your (SG) hand'
		d	*nimah **d**awk simm* (for *nimáá**t**aaksimi*) 'I will not drink'
		dh	
/k/	**k**	**k**	*aw **k**aa **k**is sim mii* (for *a**k**áá**k**simiwa*) 's/he finished drinking'
		ck	*nee tsee tsi**ck** **gh**in* (for *niitsítsi**k**in*) 'moccasin'
		g	***g**aas* (for ***k**aaáhsa*) 'your (SG) grandparent'
		gh	*ah **gh**ee* (for *aa**k**íí*) 'woman'

Outline

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Introduction

- Unlike English (**p**ea vs. **b**ee, **t**in vs **d**in, **c**ap vs. **g**ap), voicing is not distinctive in Blackfoot (Frantz 2017).
- Blackfoot stops are generally described as voiceless unaspirated (Frantz 2017).
- Blackfoot stops are often perceived as voiced in environments where English would have aspiration (Genee & Junker 2018; Genee 2020).

Introduction

Typical English VOT values:

- /p/ /t/ /k/ “long lag”: >30ms
- /b/ /d/ /g/ “short lag”: <15ms

Common linguistic correlations:

- Longer VOT values for more posterior point of contact
- Longer VOT values for following high vowels

Common non-linguistic correlations:

- Mixed evidence for effect of gender
- Mixed evidence for effect of age

(Byrd 1993; Cho & Ladefoged 1999; Lieberman & Blumstein 1988; Lisker & Abramson 1964; Neary & Rochet 1994; Yao 2007)

Research questions

- What are mean VOT values of /p t k/ in the speech of fluent Blackfoot speakers in relevant phonetic environments?
- How do Blackfoot VOT values compare with the usual VOT of English oral stops?
- Do Blackfoot VOT patterns vary with speakers' demographics?

Methods: Participants

- 18 fluent speakers of Kainai and Siksika dialects
- Age range 34-100 with a mean age of 60.2
- 10 female speakers aged 34-72 with a mean age of 55
- 8 male speakers aged 49-100 with a mean age of 66.75.
- 14 speakers self-identified as L1=Blackfoot
- 4 speakers self-identified as L1=Blackfoot + English

Methods: Participants

Speaker code	Gender	Age	Dialect: K(ainai) or S(iksika)	Self-reported L1: B(lackfoot) and/or E(nglish)	Data: P(ictures) and/or T(ranslations)
01	F	56	K	B+E	P+T
02	M	77	K	B	P+T
03	F	61	K	B	P+T
04	M	64	K	B	P+T
05	M	63	S	B	P+T
07	M	57	K	B	P+T
08	F	34	K	B+E	P+T
09	M	49	K	B+E	P
10	F	58	K	B	T
11	F	34	K	B+E	P+T
12	M	69	K	B	P+T
13	M	55	K	B	P+T
14	F	60	K	B	P+T
15	F	59	K	B	P+T
16	F	72	S	B	P
17	M	100	K	B	T
19	F	69	K	B	P+T
20	F	47	K	B	P+T

Methods: Data collection

- Speakers were recorded in the Blackfoot Language Resources lab or in their own home by student fieldworkers.
- Recordings were made with Edirol R-09HR recorder and Nexxtech omnidirectional lapel microphone to wave files with a sampling rate of 44,1 kHz and bit depth of 24.
- Preselected stimuli to elicit non-geminate oral stops in word-initial and word-medial position followed by short/long and stressed/unstressed monophthongs.

Methods: Stimuli

environment	example
#_V	**pa**nokáínattsi ‘paper’
#_VV	**paa**pó’sin ‘lightning, electricity’
#_V́	**pá**kkii’p ‘chokecherry’
#_V́V́	**p**íítaa ‘eagle’
(V)V_V	**áápo**tskina ‘cow’
(V)V_VV	**áápii**kayi ‘skunk’
(V)V_V́	**apá**ni ‘butterfly’
(V)V_V́V́	ssp**opíí** ‘turtle’
C_V	**sspo**píí ‘turtle’
C_VV	apái**hpii**soká’sim ‘skirt’
C_V́	**sspá**tsiko ‘sand’
C_V́V́	aam**skáá**poohtsi ‘south’

Methods: Stimuli

- Two tasks:
  - picture naming
  - English-to-Blackfoot phrase translation
- Speakers were asked to say each target three times with a short pause in between
- Second item was generally used for analysis

Methods: Picture naming task

Target: ***p****íí****t****aa* ‘eagle’

Methods: Translation task

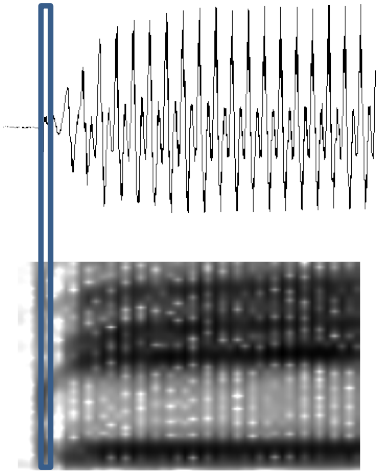
Help us!

Target: *Isspómmokinnaan!*

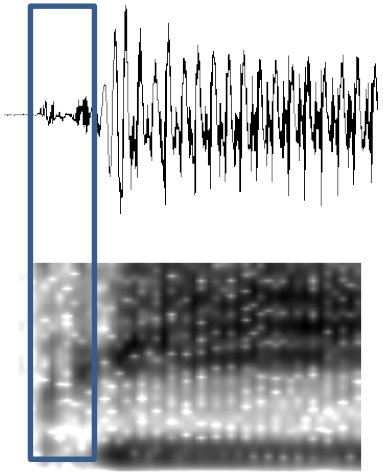
Methods: Data analysis

- VOT values extracted using Praat (Boersma & Weenink 2019).
- VOT measured by subtracting the time value of voice onset from that of the burst.

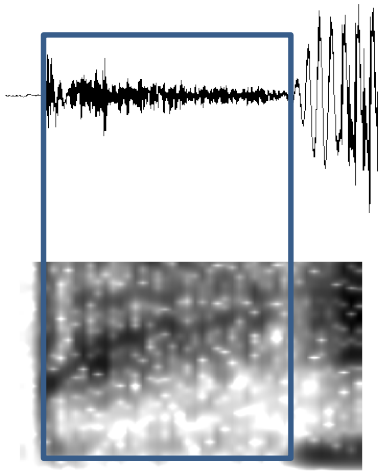
English /bi/ “bee”



Blackfoot /piit/



English /pik/ “peak”



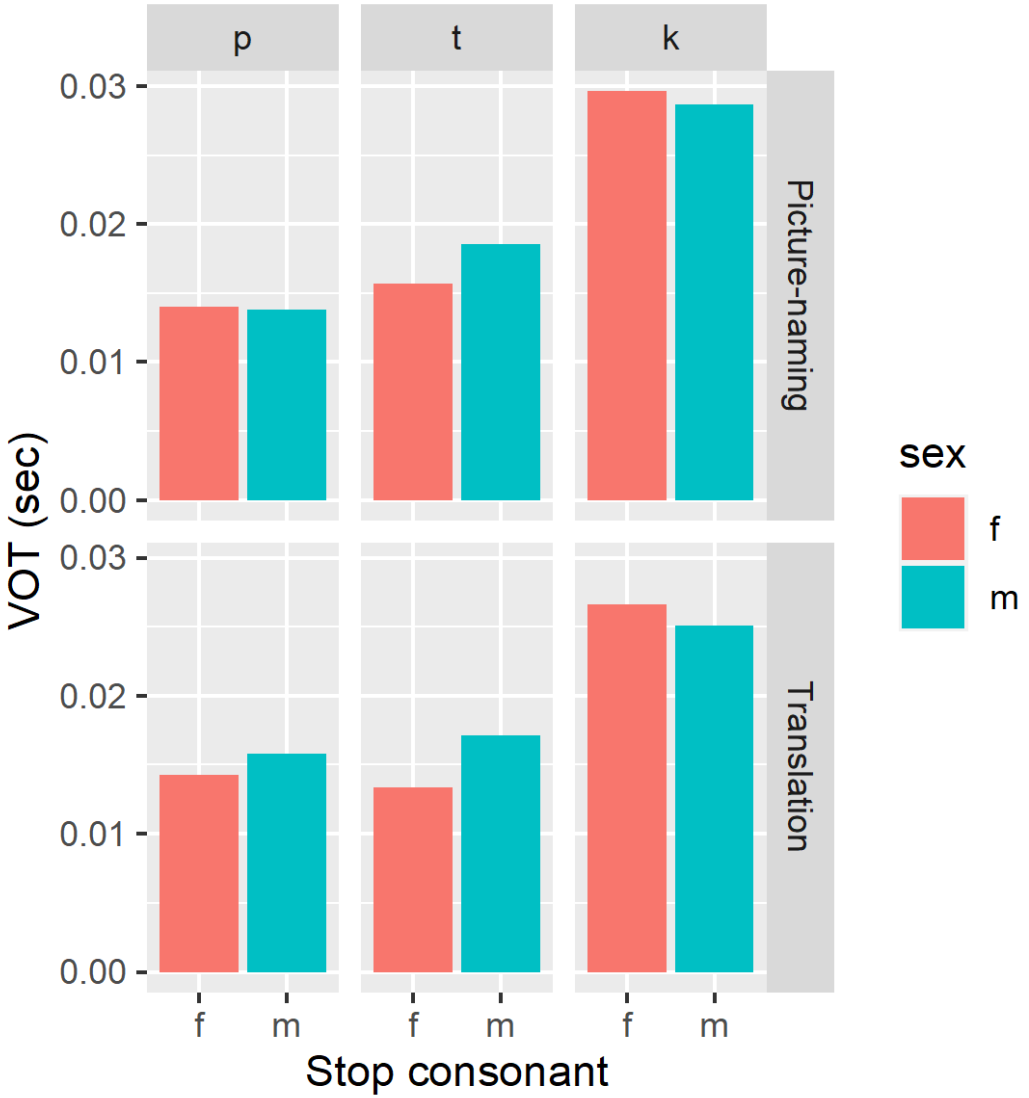
Results: Effect of phonological environment

- Linear mixed effects models
- Random factor: individual speaker
- Fixed factors
  - target stop: /p/, /t/ or /k/
  - the following vowel: /a/, /i/, or /u/
  - Task: picture naming vs. translation
  - Speaker's sex: male vs. female

Results: Effect of phonological environment

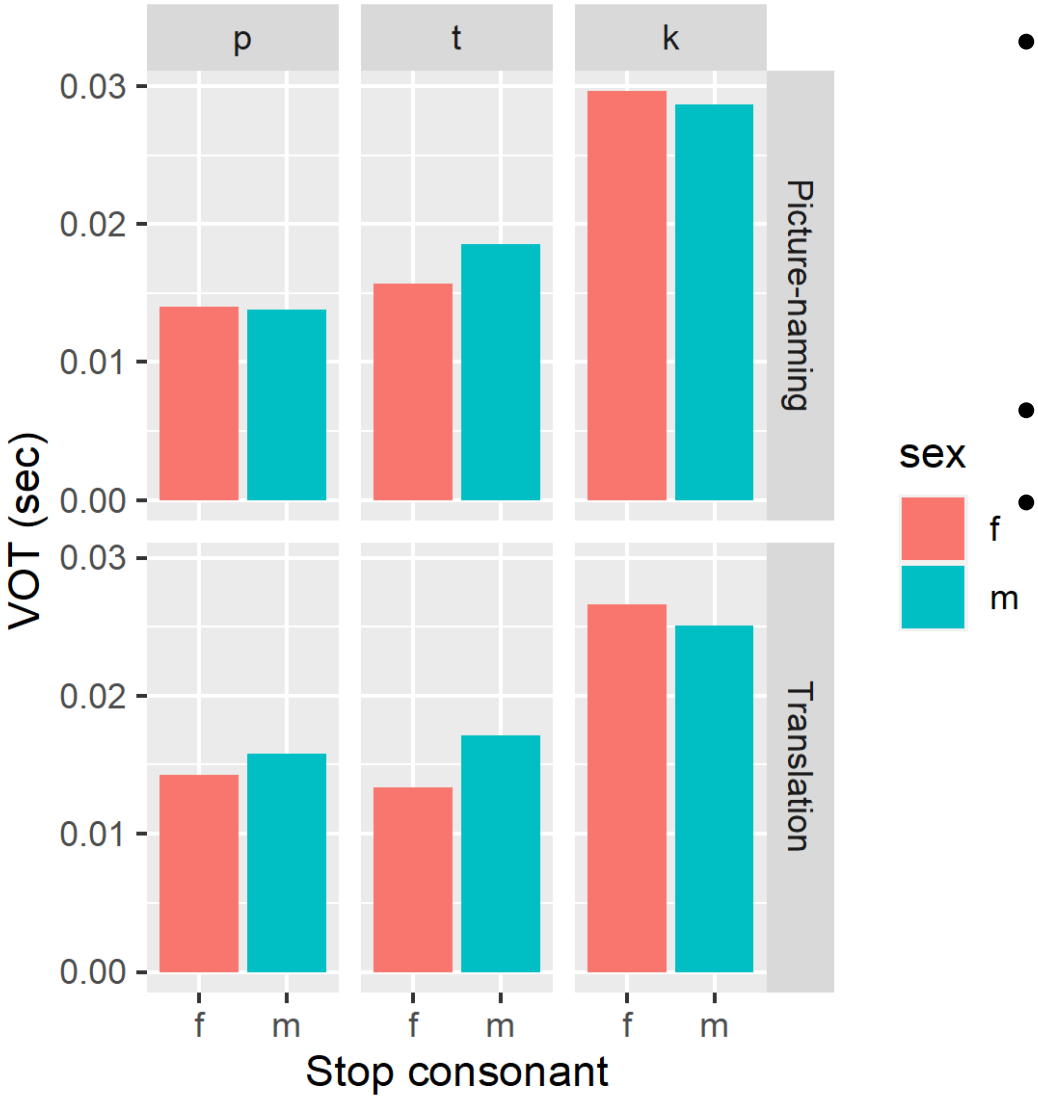
- Linear mixed effects models
- Random factor: individual speaker
- Fixed factors
  - target stop: /p/, /t/ or /k/
  - the following vowel: /a/, /i/, or /u/
  - Stress pattern of the following vowel: stressed vs. unstressed
  - Length of the following vowel: long vs. short

Results: effect of sex, task, and target



- No effect of task.
- No effect of sex.
- Significant VOT difference between /p/, /t/, and /k/.

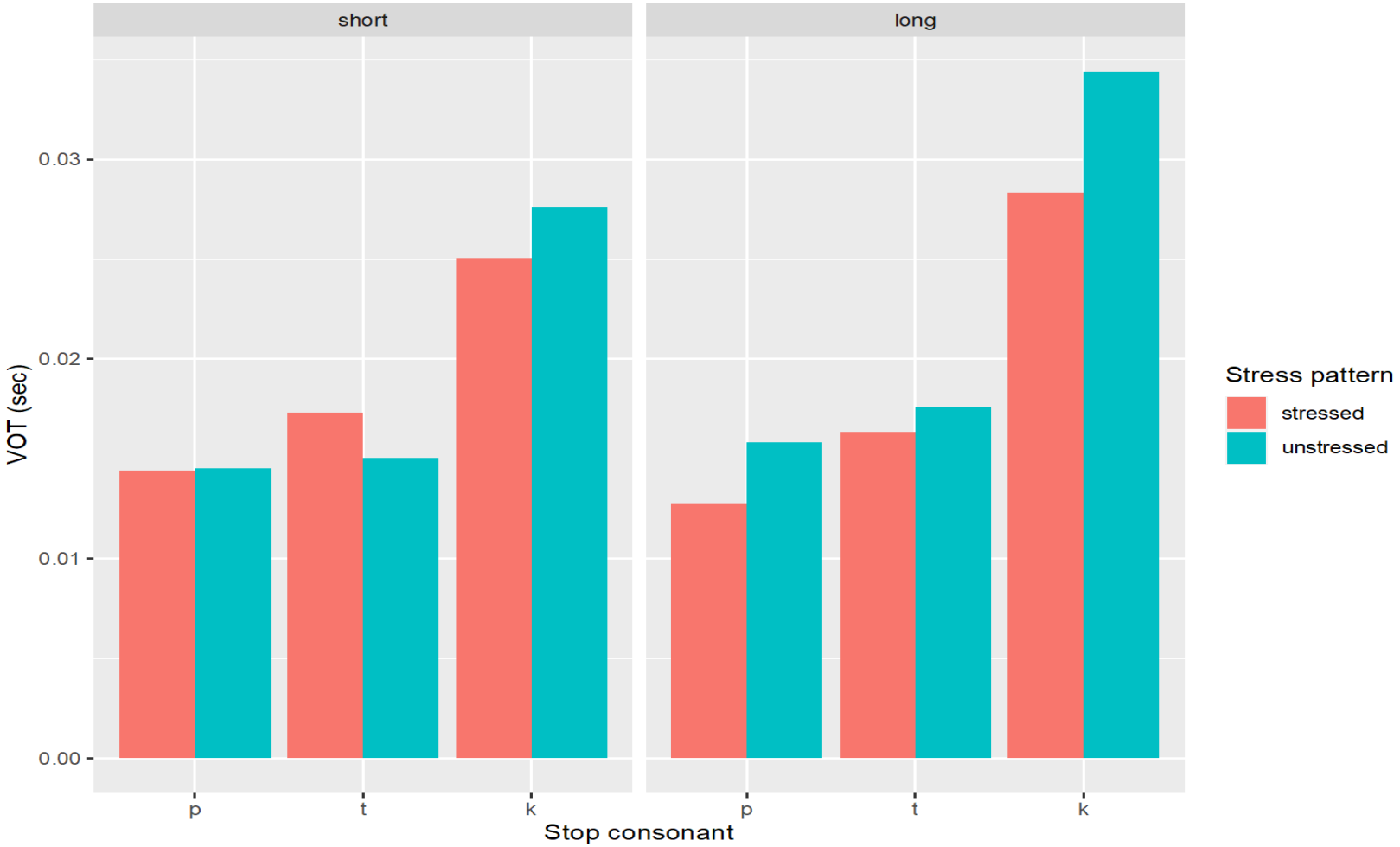
Results: effect of sex, task, and target



- Mean values of VOT:
  - /p/: 14.6 ms
  - /t/: 16.1 ms
  - /k/: 27.8 ms
- In comparison to English
- (Klatt, 1975)

Voiced stops	VOT (ms)	Voiceless stops	VOT (ms)
/b/	11	/p/	47
/d/	17	/t/	65
/g/	27	/k/	70

Results: effect of length and stress pattern of the following vowel

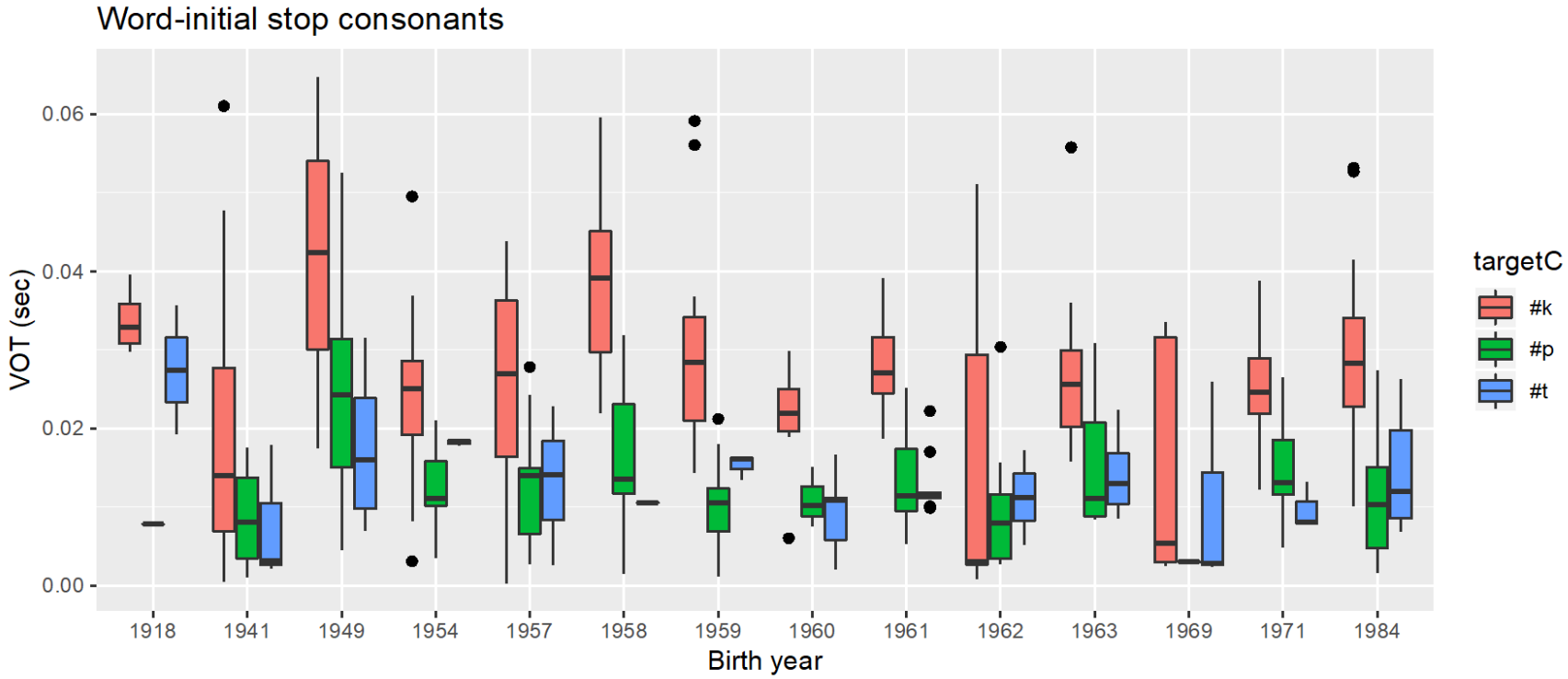


Results: effect of length and stress pattern of the following vowel

- No consistent effect of stress across the three targets when followed by short vowels.
- Stressed vowels have shorter VOT values than unstressed vowels when they are long vowels following stop consonants.
- Significant interaction between vowel length and stress pattern (p=0.002)

Results: Effect of demographic factors

- A negative correlation was found between the VOT values of word-initial /t/ and speakers' age.



Discussion/conclusion

- VOT values for Blackfoot stops lean towards the corresponding English voiced stops.
- VOT values for Blackfoot stops conform to the cross-linguistic tendency for longer VOT in more posterior positions.
- Language-specific effects of stress and vowel length were found in the Blackfoot language.

Discussion/Conclusion

- No effect was found for task type.
- No clear difference in VOT on speakers' sex was found.
- The small generational difference in VOT for /t/ warrants further investigation.
- Future research should investigate possible effect of dialect.

Thank you!

Questions?

Comments?