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The four-way laryngeal contrast in Bengali IDS and beyond

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Introduction

- Bengali four-way laryngeal contrast – primary acoustic cues unclear

category	segments	example
T	[p, t̪, tɕ, ʈ, k]	t̪ana *drawn*
Th	[t̪ʰ, tɕʰ, ʈʰ, kʰ]	t̪ʰana *police station*
D	[b, d̪, dʑ, ɖ, g]	d̪ana *grain*
Dh	[bʱ, d̪ʱ, dʑʱ, ɖʱ, gʱ]	d̪ʱana *paddy*

- Infant Directed Speech (IDS) - slower, hyper-articulated, breathier

cue	contrast	register
Lead VOT	Dh = D > Th = T	Longer
Lag VOT	Dh ≥ Th > T ≥ D	Longer
Cf0	T > Th > D > Dh	Higher
H1*-H2*	Dh > Th > T = D	Higher

Questions

- What can IDS tell us about the primary cues to the Bengali contrast?
- What can the Bengali contrast tell us about voicing distinctions more generally?

Methods

- Recordings of 10 native speakers of Bangladeshi Bengali
- VOT measured in Praat; H1*-H2*, Cf0 in Voicesauce
- Bayesian linear models in `brms`, multinomial logit regression in `upg` in R

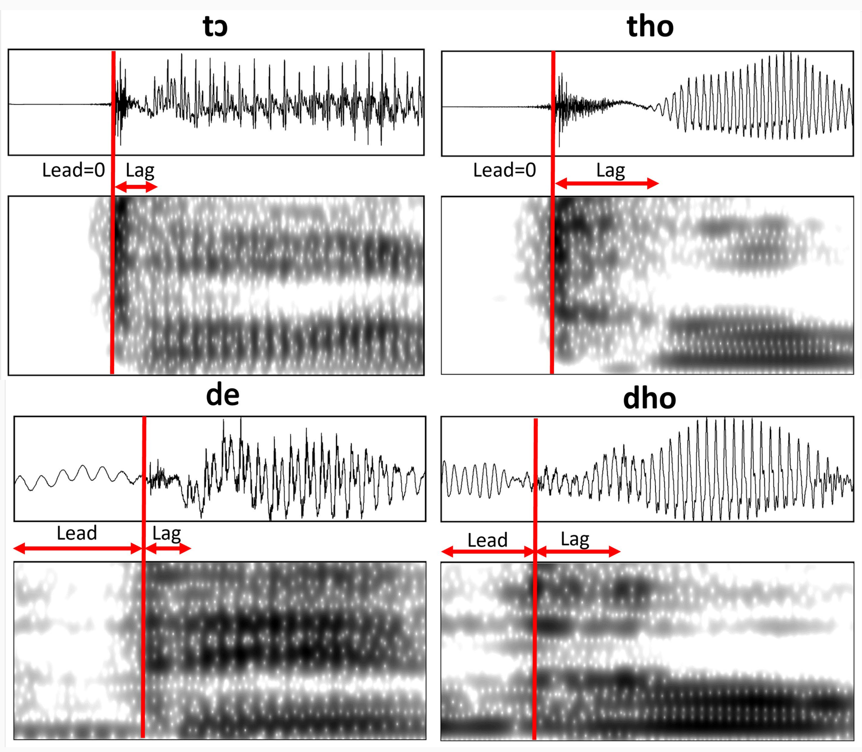

Fig 1: Acoustic measurements of lead and lag VOT

Number of tokens in the analyses -

	lead, lag VOT	Cf0, H1*-H2*
T	2999	1804
Th	403	403
D	1429	1410
Dh	453	435

Results

Lead and lag VOT optimal cues

cue	contrast	register
Lead VOT	Dh = D > Th = T	Longer in D
Lag VOT	Dh = Th > T > D	No difference
Cf0	Th > Dh > T > D	Higher
H1*-H2*	Dh > Th > T = D	No difference

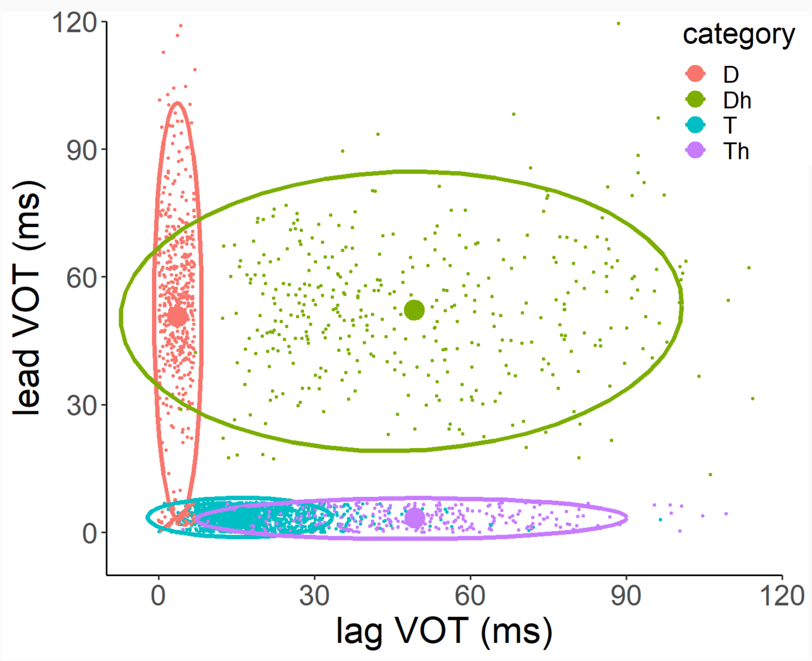

Fig 2: Lead vs lag VOT across registers

predictors	accuracy
lead, lag, Cf0, H1*-H2*	93.36%
lead, lag, Cf0	93.29%
lead, lag, H1*-H2*	93.36%
lead, Cf0, H1*-H2*	78.78% !
lag, Cf0, H1*-H2*	68.2% !
lead, lag	**93.08%**

Discussion

- Languages like Bengali may fold the acoustic VOT continuum to yield more contrasts.
- Follows from Lindblom & Maddieson (1988) - fill basic phonetic space and then make space more complex by adding dimensions.

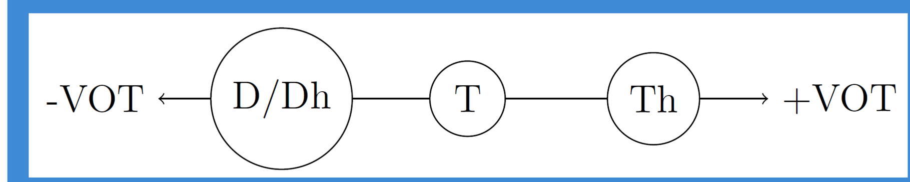

Fig 3: 1D acoustic VOT

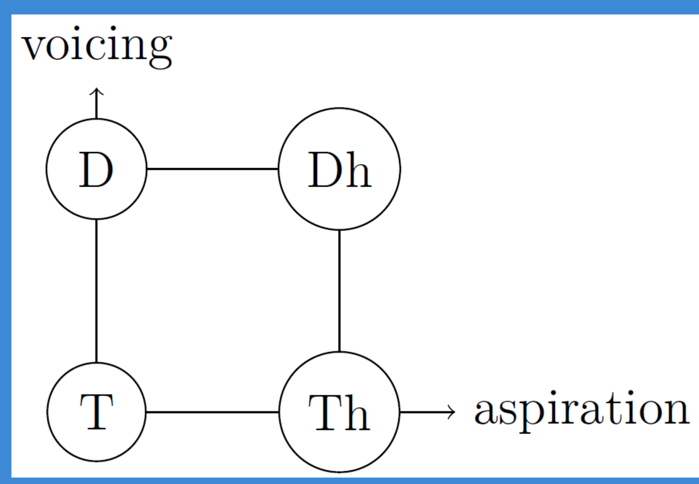

Fig 4: 2D auditory VOT

What about 3-way contrasts?

Survey of all languages with 3-way VOT contrast from UPSID

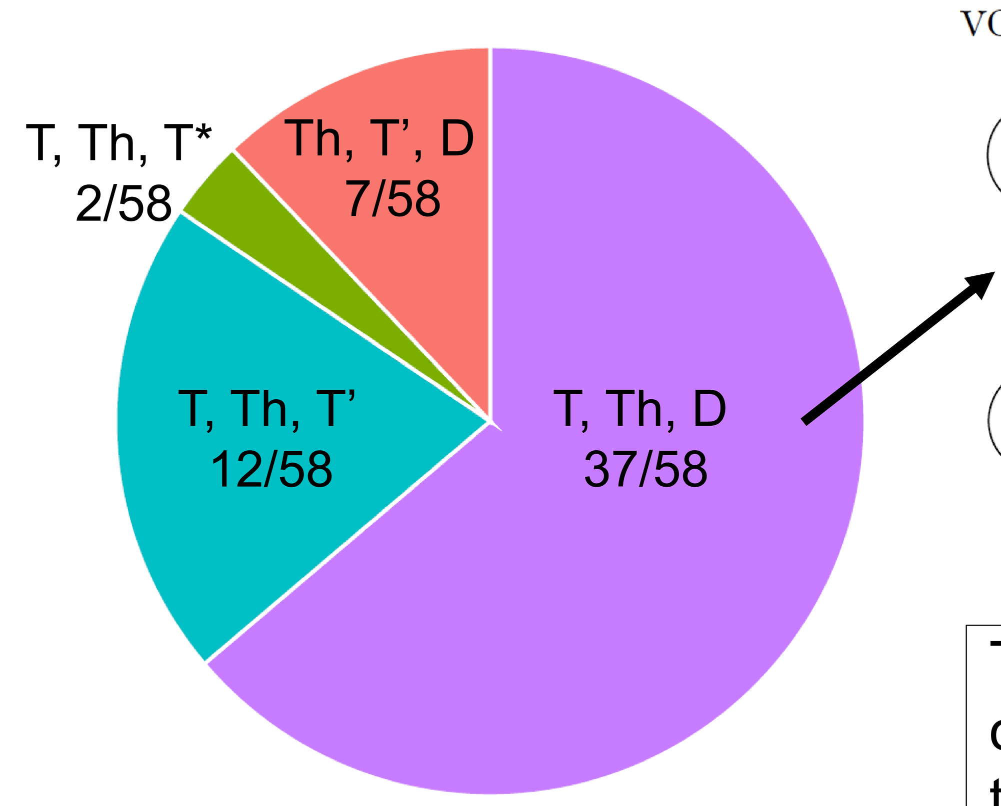

Fig 5: The distribution of 3-way languages in UPSID

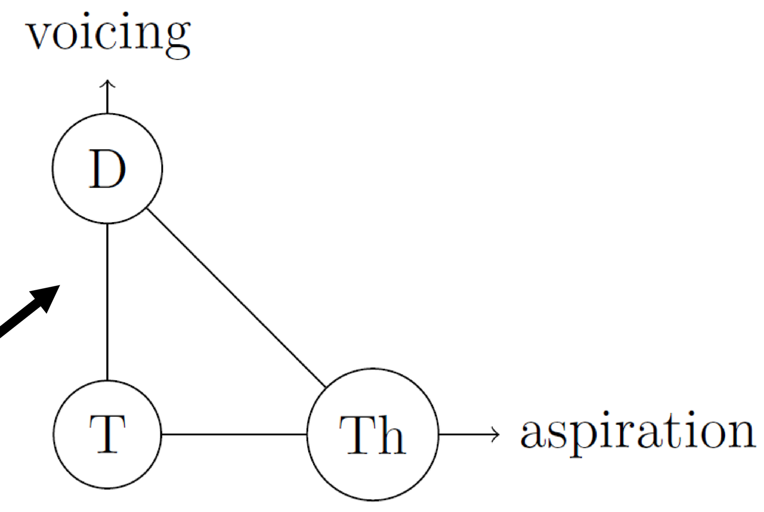

Fig 6: The VOT space in 3-way languages like Thai

This triangular organization comparable to the optimally dispersed [a-i-u] vowel space.

- If the T-Th-D contrast is optimally dispersed along a continuum, why are T-Th (e.g., English) and D-T (e.g., Spanish) more common than the optimally dispersed D-Th (e.g., Swedish, some Arabic)?
- Languages like Yemba and Yerevan Armenian also problematic.

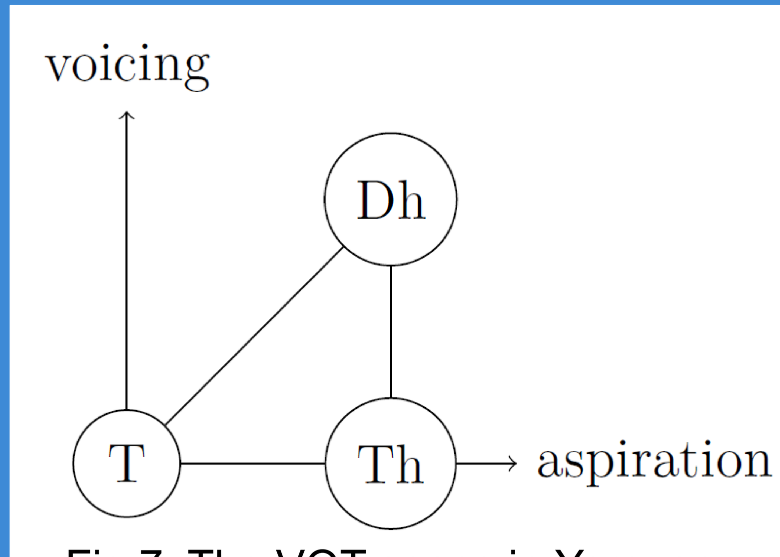

Fig 7: The VOT space in Yerevan Armenian

- The Bengali contrast is best captured by two-dimensional VOT with aspiration and voicing as separate cues.
- VOT is not a single acoustic cue – 1D VOT is a useful proxy for describing laryngeal contrasts.
- The principles of dispersion that govern vowel spaces also govern stop spaces.
- Future work – principled dispersive behavior within consonant classes rather than in entire consonant inventories.

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