



## Introduction

- **Question:** How do different systems of phonological contrast affect patterns of phonetic variation?
- ▶ **Potential hypothesis:** Systems with more phonological contrasts should exhibit less within-category variation than systems with fewer contrasts (Lindblom, 1986).
  - Hypothesis: Variation predicted by *number of phonemes in an inventory*.
- ▶ **But phonological contrasts are not unidimensional in phonetic space**
  - Issues with quantifying within-category variation: What are the relevant phonetic dimensions? What counts as a “system”?
- ▶ **Proposal:** We only expect less variation along the particular *phonetic dimensions* that realize additional contrasts.

## Case study: Hindi and English stop consonants

- ▶ Hindi has four contrasting stops at each place of articulation; English has two.

Hindi velar stops:	/g/	/g <sup>h</sup> /	/k/	/k <sup>h</sup> /
English velar stops:	/g/		/k/	

- ▶ If variation is predicted by **number of phonemes in an inventory**, we might expect Hindi speakers to constrain variation on all dimensions, including lag time.
  - Hindi /k<sup>h</sup>/ should vary less than English /k<sup>h</sup>/ in voiceless lag time.
- ▶ If variation is predicted by **additional contrast along a single dimension**, Hindi speakers will only exhibit less variation along phonetic dimensions which distinguish additional contrasts relative to English.
  - Hindi /k/ and /g/ should vary less than English /g/ in voicing.

### Phonetic dimensions in Hindi and English stops

	Hindi		English	
	unaspirated	aspirated	unaspirated	aspirated
voiceless	/k/	/k <sup>h</sup> /	voiceless	/k/
(pre)voiced	/g/	/g <sup>h</sup> /	(pre)voiced	/g/

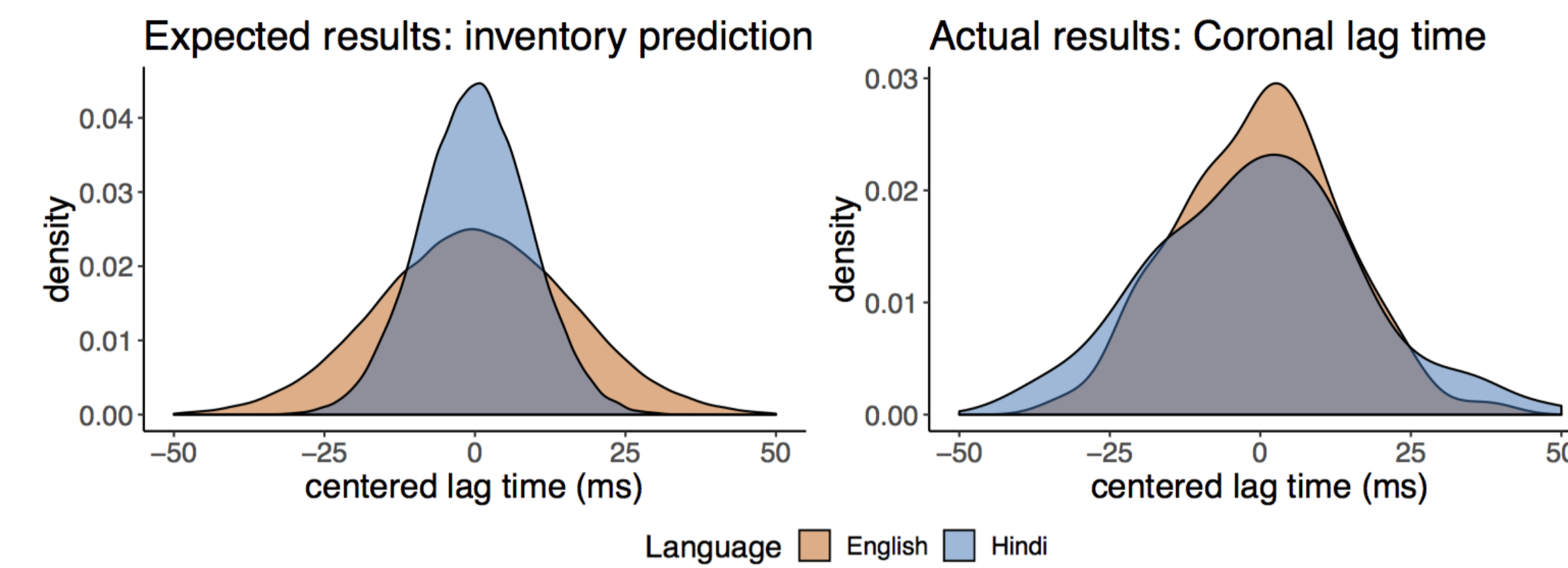
- ▶ No difference expected in voiceless lag time (positive VOT) because the space of contrasts is the same in both languages.
- ▶ Difference expected in prevoicing because Hindi has additional voicing contrasts relative to English (Kagaya et al., 1975).

## The Experiment

- ▶ Production task. Native speakers of each language read CVC words where first consonant was a stop followed by [i a u].
- ▶ 14 Hindi speakers and 9 English speakers recorded; 7 of each analyzed after exclusions.
- ▶ Carrier phrases: Say X again; Dohara X doharao.

## Results: No difference in lag time variation

All graphing and analysis done in R (R Core Team, 2013; Wickham, 2009).



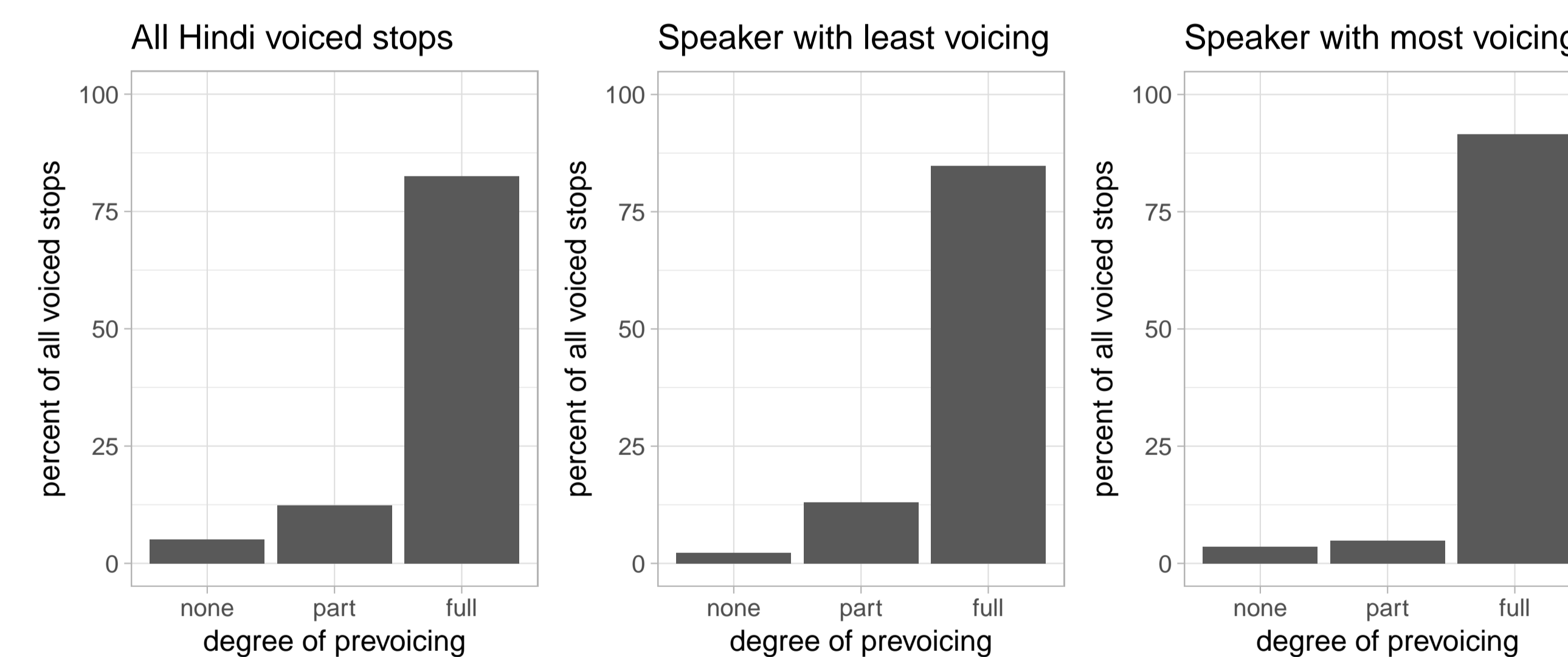
### Why are Hindi speakers just as variable as English speakers?

(Levene's Test for homogeneity of variance not significant.)

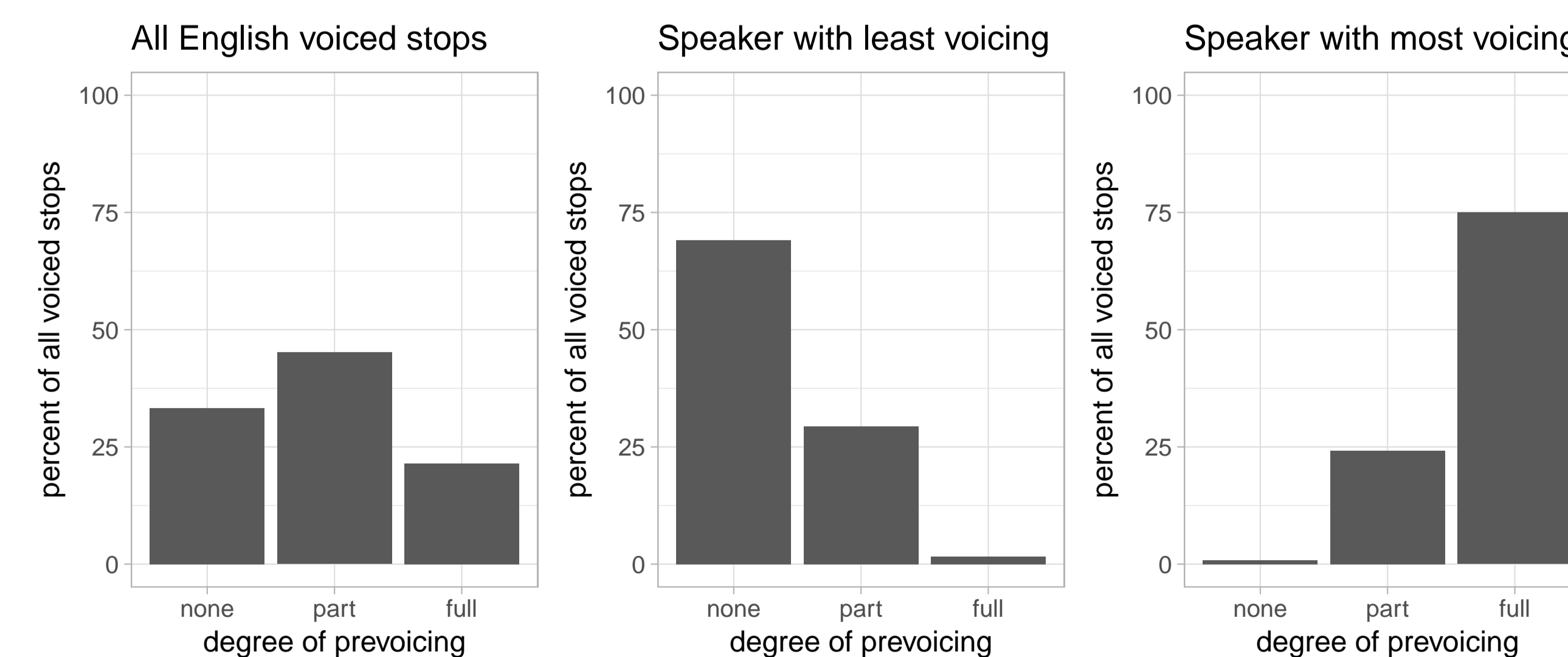
- ▶ Voiceless lag time realizes one contrast in both languages, no difference expected.
- ▶ Additional evidence for understanding prevoicing and lag as separate dimensions (Mikuteit & Reetz, 2007)

## Results: Prevoicing variation differs

### Voicing in Hindi voiced stops



### Voicing in English voiced stops

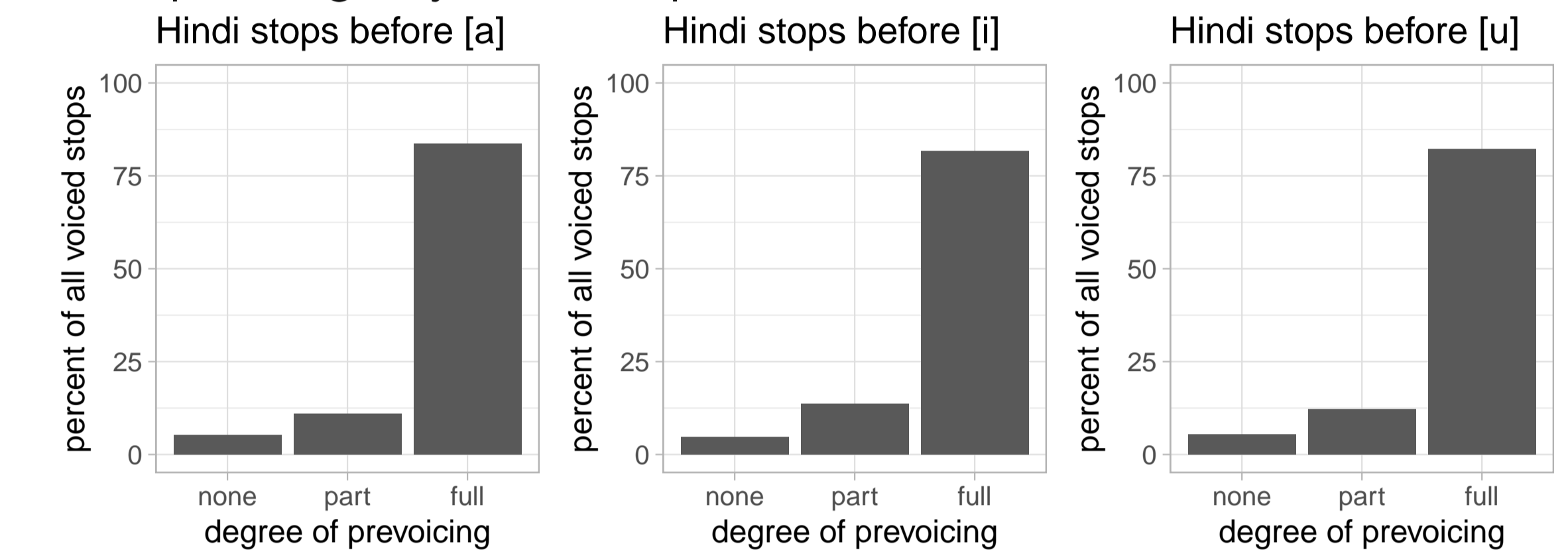


- ▶ **Main result:** English stops /b d g/ vary more within- and between-speakers in production of prevoicing.

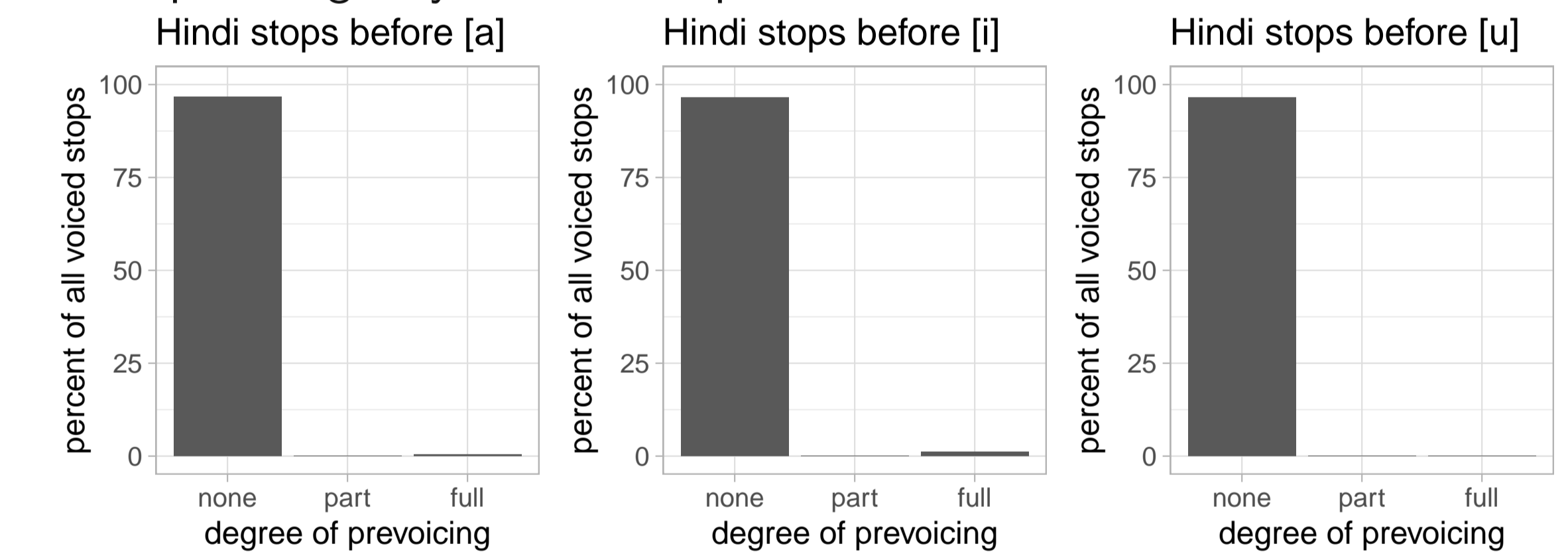
## Even non-contrastive variation is systematic

- ▶ The phonological system of English allows more prevoicing variation without threatening the maintenance of contrast.
  - Even though the variation is not contrastive, it is still structured by context.
- ▶ Previous studies have reported more prevoicing before high vowels, citing an articulatory explanation (Smith, 1975).
  - This pattern emerges in English, but not Hindi.

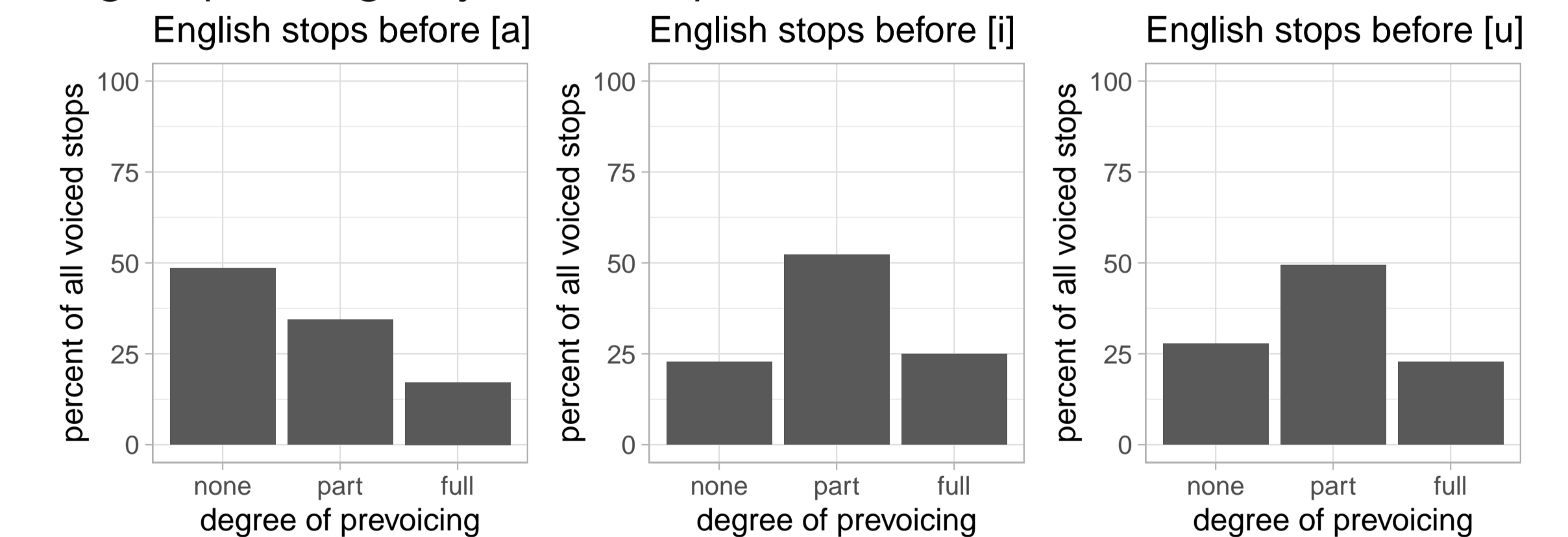
### Hindi phonologically voiced stops:



### Hindi phonologically voiceless stops:



### English phonologically voiced stops:



## Discussion and conclusion

- ▶ **Main result:** Patterns of variation are language-specific and relative differences can be predicted by how phonological contrasts are implemented.
- ▶ The mathematically intuitive “larger inventory = less variation” hypothesis is not trivially true. We have to acknowledge how contrasts are realized in phonetic space.
- ▶ Non-contrastive structure emerges when the contrastive structure allows variability.
- ▶ **Future work:** Comparing non-contrastive to contrastive phonetic dimensions in the same language. Statistical difficulty of comparing across dimensions/units.