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ROBERT FUCHS

EMPIRICAL RESEARCH ON PHONOLOGICAL NUANCES: ISSUES AND METHODS – WITH A FOCUS ON SPEECH RHYTHM

4th Conference of the Association of Phoneticians and Phonologists in Nigeria

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OVERVIEW

- What speech rhythm is: **A definition**
- How it can be measured: **Rhythm metrics**
- How I measured it: **Indian English**
- How it can also be measured: **New metrics**
- Broadening the focus: **Other World Englishes**

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OVERVIEW

- Particular focus on ‘how to do research’ – **methodological issues and challenges**
- Addressing in particular **younger researchers**
- Final part: Where to go from here – **opportunities for further research**

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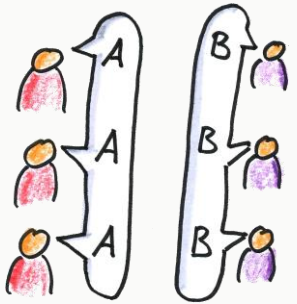
WHAT IS SPEECH RHYTHM?



- Were you aware of the term ‘speech rhythm‘ before this talk?
- Do you think you could give a brief explanation?

- Survey: www.bit.ly/3wRzCxz

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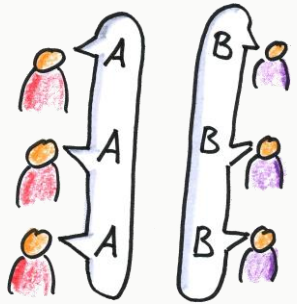
WHAT IS SPEECH RHYTHM?



- **Stress-timed** languages with an uneven rhythm (English, German) vs. **syllable-timed** languages with an even rhythm (Spanish, French)
  (Abercrombie 1967; Pike 1945) – *rhythm classes*
- Also: **varieties** - British/American English (= Inner Circle) vs. Indian, Singapore, Nigerian English (= Outer Circle)
- **Research question**: Is Indian English (IndE) more syllable-timed than British English (BrE)?

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WHAT IS SPEECH RHYTHM?

- Definition of speech rhythm is controversial
- Two most widely used definitions:
  - Duration (Low 1998; Low et al. 2000; Ramus et al. 1999)
  - Prominence

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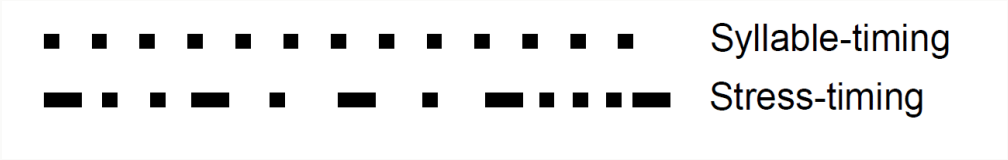
RHYTHM AND VARIABILITY



- Syllable-timing:
  Durations of syllables/vowels **relatively similar** to each other
- Stress-timing:
  Durations **relatively dissimilar** to each other
- *Scalar concept of rhythm, not rhythm classes*

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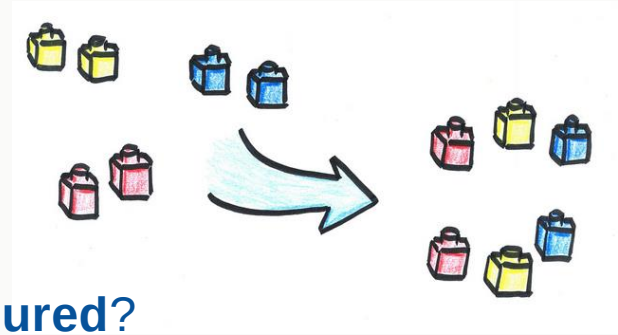
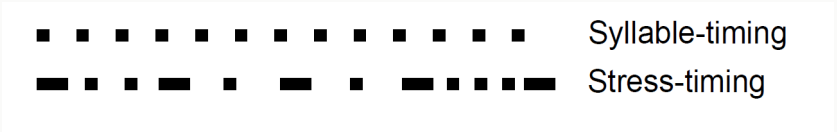
RHYTHM AND VARIABILITY



- How can durational variability be **measured**?
  - Standard deviation of durations of vocalic intervals → ΔV
  - Normalised for speech rate → VarcoV = SD(V) / mean(V)
  - Normalised pairwise variability index → nPVI-V

$$= 100 \times \frac{\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right|}{m-1}$$



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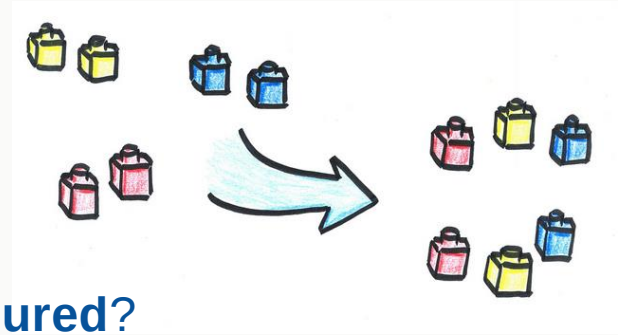
RHYTHM AND VARIABILITY



- How can durational variability be **measured**?
  - Standard deviation of durations of vocalic intervals → ΔV
  - Normalised for speech rate → VarcoV = SD(V) / mean(V)
  - Normalised pairwise variability index → nPVI-V
- Can also be applied to **syllables** (and **consonantal intervals**)

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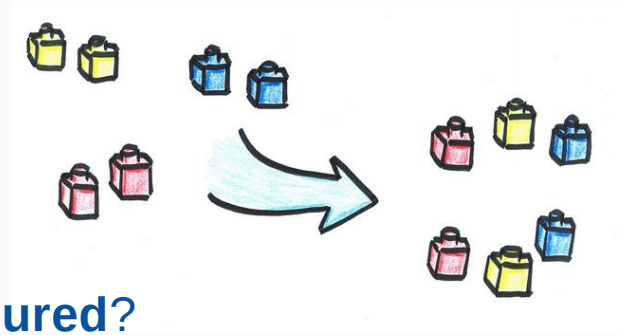
RHYTHM AND VARIABILITY



- How can durational variability be **measured**?
  - Standard deviation of durations of vocalic intervals → ΔV
  - Normalised for speech rate → VarcoV = SD(V) / mean(V)
  - Normalised pairwise variability index → nPVI-V
- Stress-timed languages have more/longer consonant clusters
  -> less time taken up by vowels (percentage of vowel duration over total utterance duration) → **%V**

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RESEARCH QUESTION

- **Research question**: Is Indian English (IndE) more syllable-timed than British English (BrE)?
- Widespread claim that IndE is syllable-timed or more syllable-timed than BrE (historical cross-linguistic influence/substrate transfer)

  (Masica 1972: 8; Trudgill and Hannah 2002: 130; Gargesh 2004: 1001; Hickey 2004: 545; Lange 2009; Sailaja 2009: 34, 2010, 2012)
- No substantial empirical evidence
- Study takes into account production and perception

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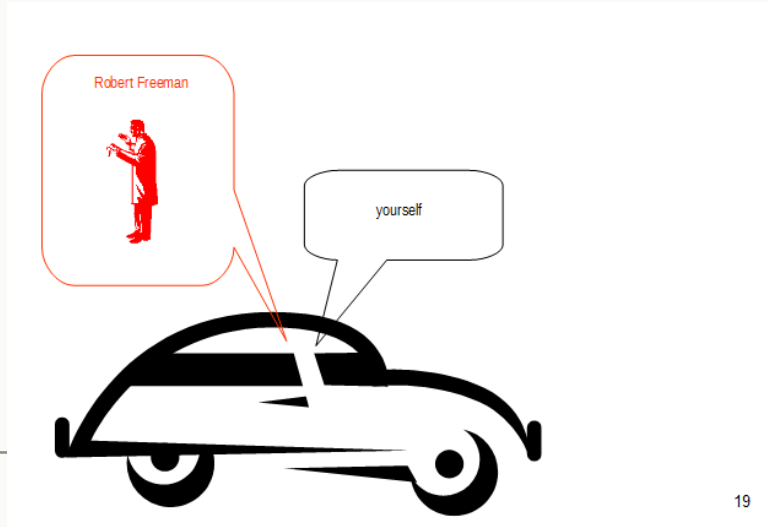
DATA: INSTRUMENTS

- No speech corpus for IndE
- Record Indian and British speakers?
- Use existing recordings of British speakers (DyViS; Nolan et al. 2006) and use the same materials with Indian speakers

DATA

- Reading passage and structured interview from BrE and IndE speakers
- Structured interview: Simulated 'police interview'



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LISTENING EXAMPLE

- Q: Which route did you take in the car that evening?
  A: Well I took ehm route from Boyd street, I came to the highway again, A 40, and I took a turn and I went to sixter's - sister's house at Dixon

- Q: Are you sure you didn't take a longer route?
  A: No, that's the shortest route and I had to be there in half an hour, so, yeah

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LISTENING EXAMPLE

- (Q: Did you have someone with you in the car?
  A: No I didn’t)
- Q: We have CCTV footage that you had someone with you in the car that evening
  A: No I did not. You must be mistaken, I was travelling alone

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DATA: INSTRUMENTS

- Read and spontaneous speech
- Former likely to elicit standard speech, the latter more colloquial speech (speakers distracted by task in role play)
- Read speech (392 words) and spontaneous speech (structured interview, > 5 mins.):
  Transcribed and segmented

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DATA: INSTRUMENTS

- Forced **phonemic alignment**: phoneme boundaries
  (HTK; at the time only on Linux, so used via command line in Cygwin on Windows, ‘simulating’ a Linux environment)
- **Manual correction** of phoneme boundaries:
  Time-consuming and not trivial
  (easy at boundaries of plosives, hard at V-approx. boundaries)
  (Wiget et al. 2010: 1562, Machač and Skarnitzl 2009)

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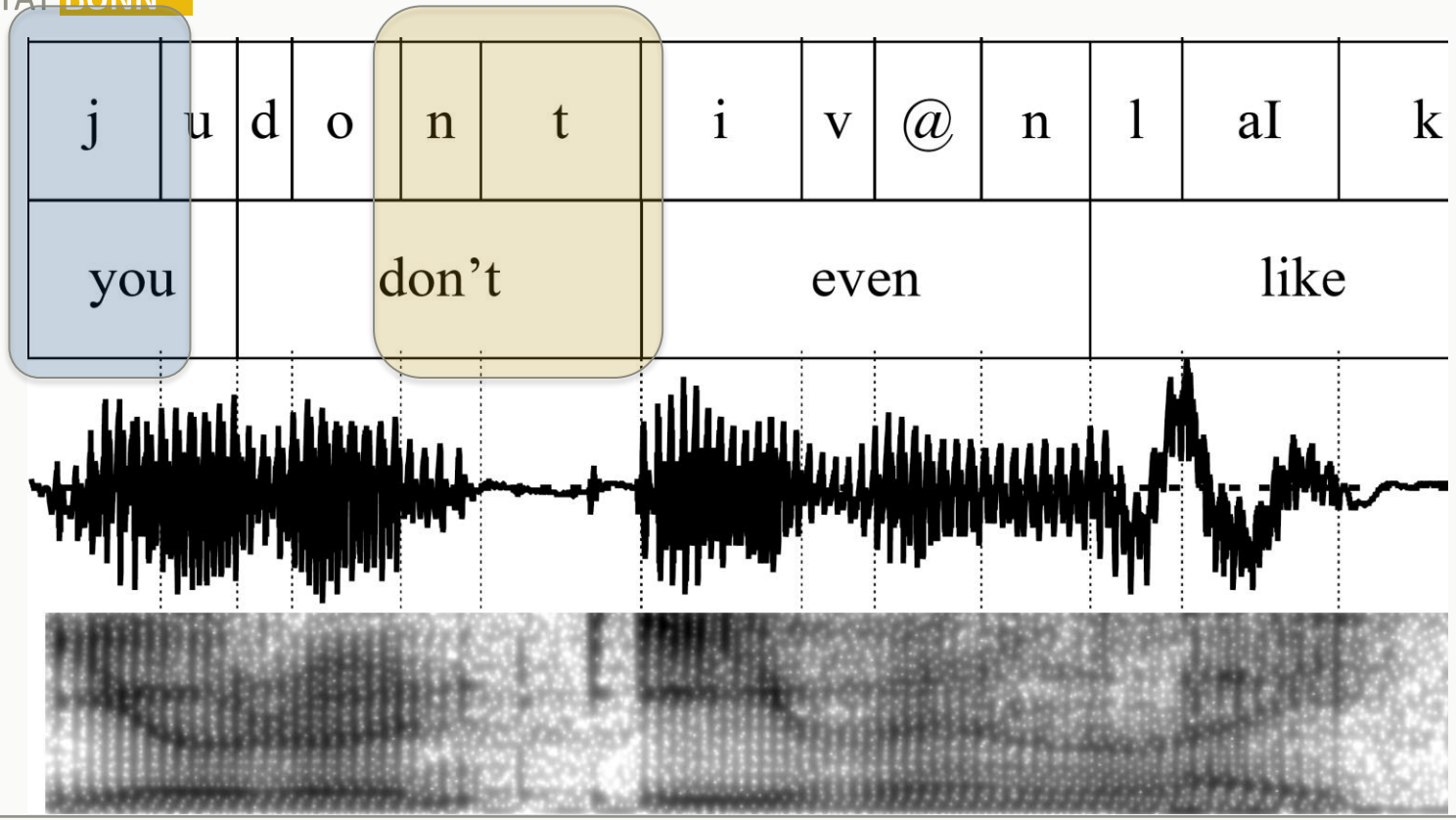
SEGMENTATION: LONG AND SHORT TRANSITIONS



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DATA: INSTRUMENTS

- Forced phonemic alignment: phoneme boundaries
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- Manual correction of phoneme boundaries: Time-consuming and not trivial (easy at boundaries of plosives, hard at V-approx. boundaries) (Wiget et al. 2010: 1562, Machač and Skarnitzl 2009)
- Remove hesitations
- Syllable boundaries (Maximum Onset Principle): Praat script and manual correction

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DATA: SPEAKERS

- **Aim**: Analyse emerging standard IndE
- **Two approaches** to eliciting standard speech
  1) Define standard and select speakers on that basis
  2) Select educated/elite speakers and define standard based on their usage
     - Backdrop: History of standardisation of European languages
     - Rationale of the ICE project

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DATA: SPEAKERS

- Representative of standard(ising) IndE and BrE
- Criteria
  - English-medium educated
  - University education
- **20 speakers of educated/standard IndE** (L1 Hindi, Bengali, Telugu, Malayalam), 10 speakers of BrE
- Definition of L1 based on sociolinguistic interview

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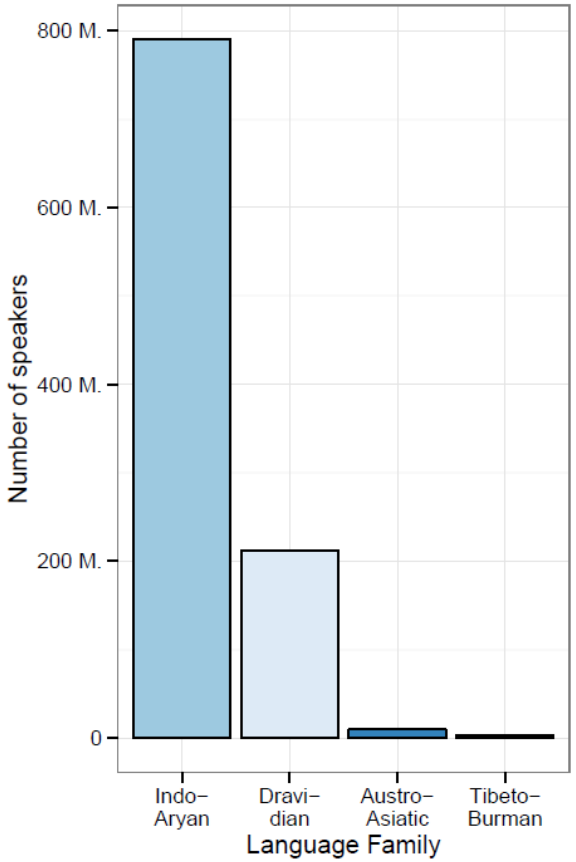
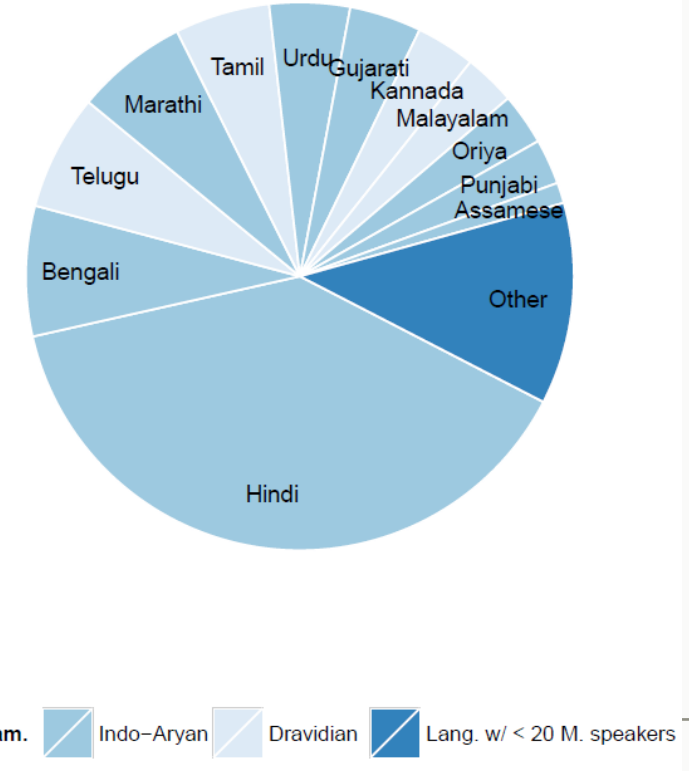
INDIAN LANGUAGES





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DATA

- Read speech (392 words) and spontaneous speech (structured interview, >5 mins.):
  Transcribed and segmented
- **20 speakers of educated IndE** (L1 Hindi, Bengali, Telugu, Malayalam), 10 speakers of BrE (Nolan et al. 2006)
- Representative of standard(ising) IndE and BrE
- Recordings usually pm and headmounted microphone

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DATA: INSTRUMENTS

- Extraction of data from annotations with Praat script
- Computation of rhythm metrics in R
  - Calculate metrics for each stretch of speech
  - Mean for each speaker and speaking style
  - T-tests
- Problems
  - R code not very clean and not shareable – should've done better from the start
  - Mixed effects regression model might be better

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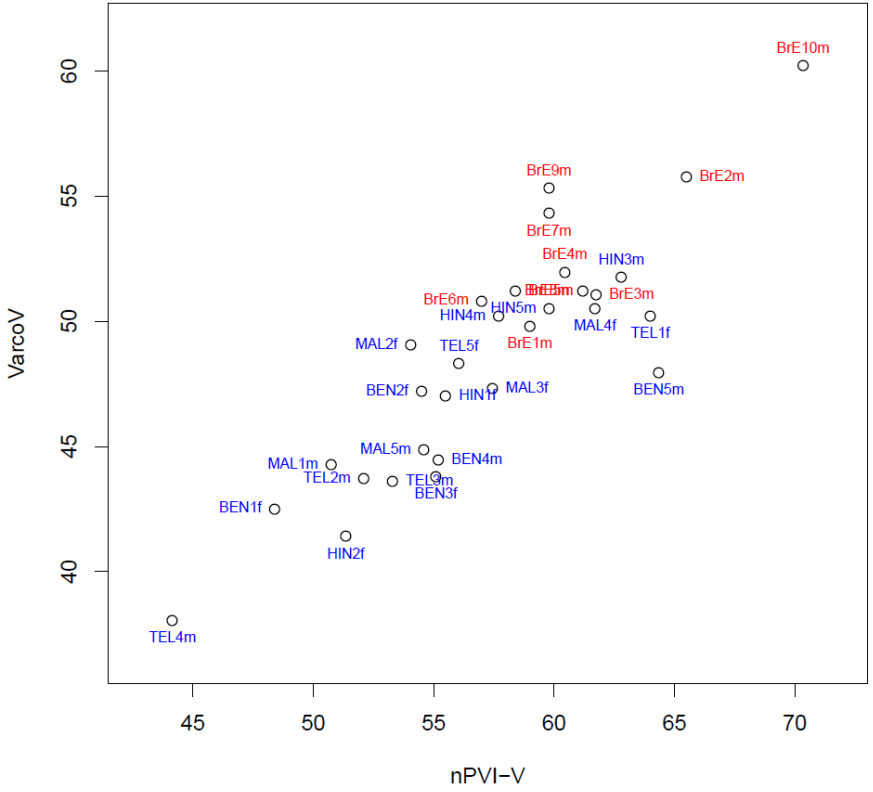
RESULTS: IndE MORE SYLLABLE-TIMED THAN BrE



Variability of vocalic durations in read speech:
smaller in IndE

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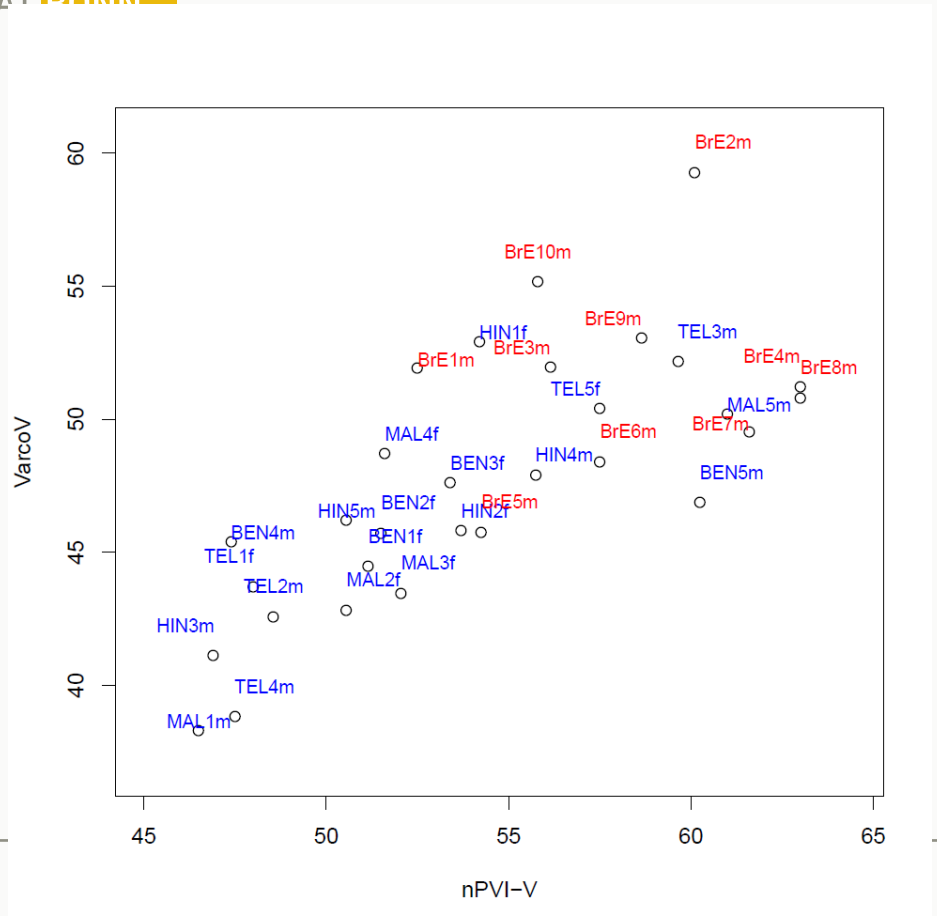
RESULTS: IndE MORE SYLLABLE-TIMED THAN BrE



Variability of vocalic durations in spontaneous speech:
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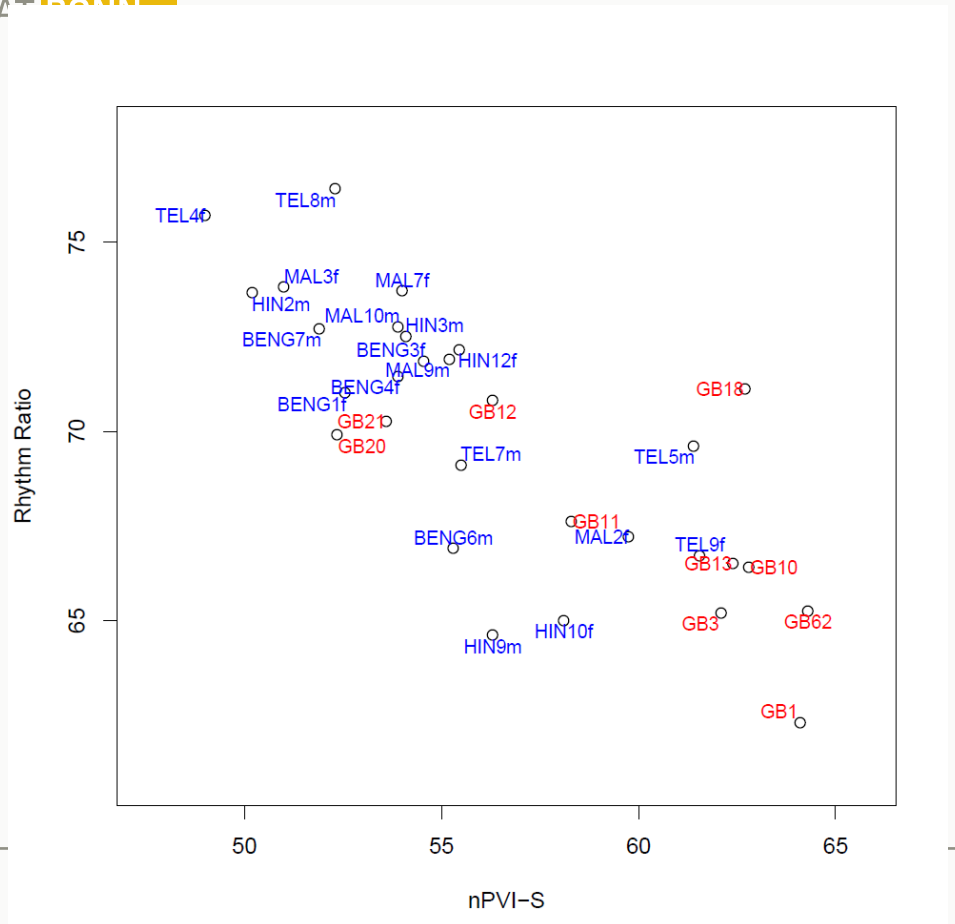
RESULTS: IndE MORE SYLLABLE-TIMED THAN BrE



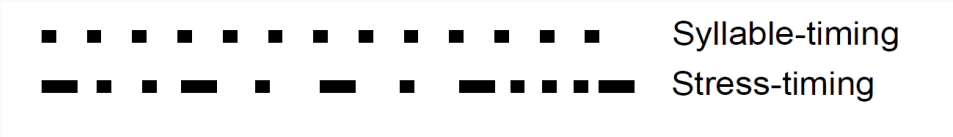
Measures of durational variability can also be applied to syllables: Variability of **syllable** durations in spontaneous speech is smaller in IndE

BEYOND VOWELS AND SYLLABLES

- Distinction between vowels and consonants not very salient (e.g. /w/ vs. /a/ and /w/ vs. /p/)
- Better: **Sonorant vs. obstruent durations**
- **Voiced vs. unvoiced durations** (Dellwo et al. 2007)
- For each of these, measures of durational variability and of percentage of utterance duration can be derived

PROMINENCE AND RHYTHM

- **Acoustic correlates of prominence**:
  Duration, intensity/loudness, f0/pitch, sonority



- Also: **Variability** in intensity, loudness, f0, variation in sonority
- Speech rate (Dellwo 2008)
- Consider all acoustic correlates of speech rhythm to construct a multidimensional model of speech rhythm

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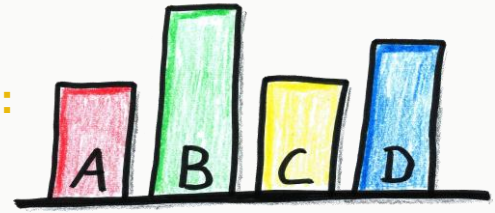
MULTIDIMENSIONAL ANALYSIS: RESULTS



Is IndE more syllable-timed than BrE?

- Acoustic correlates of speech rhythm that suggest IndE is more **syllable-timed** than BrE
- Acoustic correlates of speech rhythm that suggest IndE has a **similar rhythm** to BrE
- Acoustic correlates of speech rhythm that suggest IndE is more **stress-timed** than BrE

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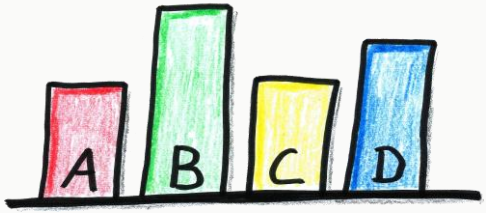

IndE MORE SYLLABLE-TIMED THAN BrE

- Variability of **vocalic** durations: smaller in IndE
- Variability of **syllable** durations: sometimes smaller in IndE
- Percentage of **voiced** durations over total utterance duration: higher in IndE
- Variation in **sonority**: less in IndE read speech
- Variability in **intensity** and **loudness**: smaller in IndE

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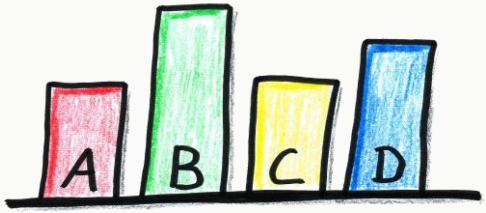

SIMILAR RHYTHM IN IndE AND BrE

- **Percentage** of vocalic and sonorant durations over total utterance duration
- Variability of **syllable** durations:
  sometimes equal in both varieties
- Variability of **voiced and sonorant durations**
- Variation in **sonority**:
  similar in both varieties in spont. speech

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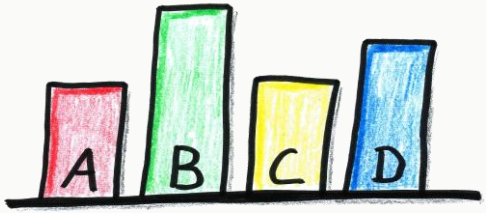

IndE MORE STRESS-TIMED THAN BrE

- **Speech rate**: lower in IndE

PERCEPTUAL EFFECTS

- Enhancing production measures of speech rhythm/rhythm metrics: Influence of differences in f0 on **perceived duration** (Fuchs 2014b)
- **Simultaneous variability** in duration and loudness reinforcing each other: less frequent in IndE (Fuchs 2014a)
- Prevocalic **glottal stop insertion** at word boundaries: more frequent in IndE (e.g. <town is> pronounced as [taʊnʔɪz])

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SUMMARY

- **Speech rhythm**:
  From durational variability to variability in **prominence**
- **Multi-dimensional analysis** of speech rhythm
- Vast majority of production measures of speech rhythm indicate there is **less variability** in prominence in IndE than in BrE (Fuchs 2016)
- **Perceptual effects** further reinforce syllable-timed character of IndE

PART 2: GOING FURTHER

- How do these results compare to **other varieties of English**?
- Widespread assumption that many **ESL varieties/Outer Circle varieties** are more syllable-timed than Standard British and American English
  (see the contributions in Kortmann & Schneider 2004)
- Extension to **four varieties**:
  Nigerian, Pakistani, Philippine and British English

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HYPOTHESIS

- No or limited **previous research** on the three ESL varieties
- **Hypothesis**: The three ESL varieties are more syllable-timed than British English

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DATA

- Source: Speech Accent Archive (https://accent.gmu.edu/)
- Read speech: 69-word passage, *Please call Stella*.
- Comparable, readily available data, but only read speech
- 10 speakers each from Nigeria, the UK, the Philippines, and 11 from Pakistan, i.e. 41 in total
- Age 19 – 48, median 27; 23 female, 18 male

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DATA: LIMITATIONS

- Variation in the sociodemographic profile of the speakers, esp. L1
- **UK**: all L1 English
- **Pakistan**: all L1 Urdu
- **Philippines**: Mostly L1 Tagalog/Filipino, plus one Cebuano speaker, two English
- **Nigeria**: L1s Yoruba and Hausa (three each), and one each of Ibibio, Igbo, Ebira and English

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DATA: LIMITATIONS

- **Variation** in occupational and academic profile (though a higher education background may be presumed for most)
- Some of the ESL speakers may have **spent time** in, or moved permanently to, the US, UK or Australia
- **Age of onset** of learning English ranged from 0 to 17 years but was during childhood for most speakers (median 4 years)

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DATA: LIMITATIONS

- **Preferable**: Homogeneous sample or larger sample with ordered heterogeneity, allowing for sophisticated statistical analysis
- **But**: A sample of speakers from these varieties, reading the same text was only available in this form

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METHODS

- Automatic **phonemic segmentation**, manually corrected (e.g. https://www.bas.uni-muenchen.de/Bas/BasMAUS.html)
- Transformation into V and C intervals
- Calculation of **rhythm metrics** with a Praat script (https://osf.io/79qyg/)

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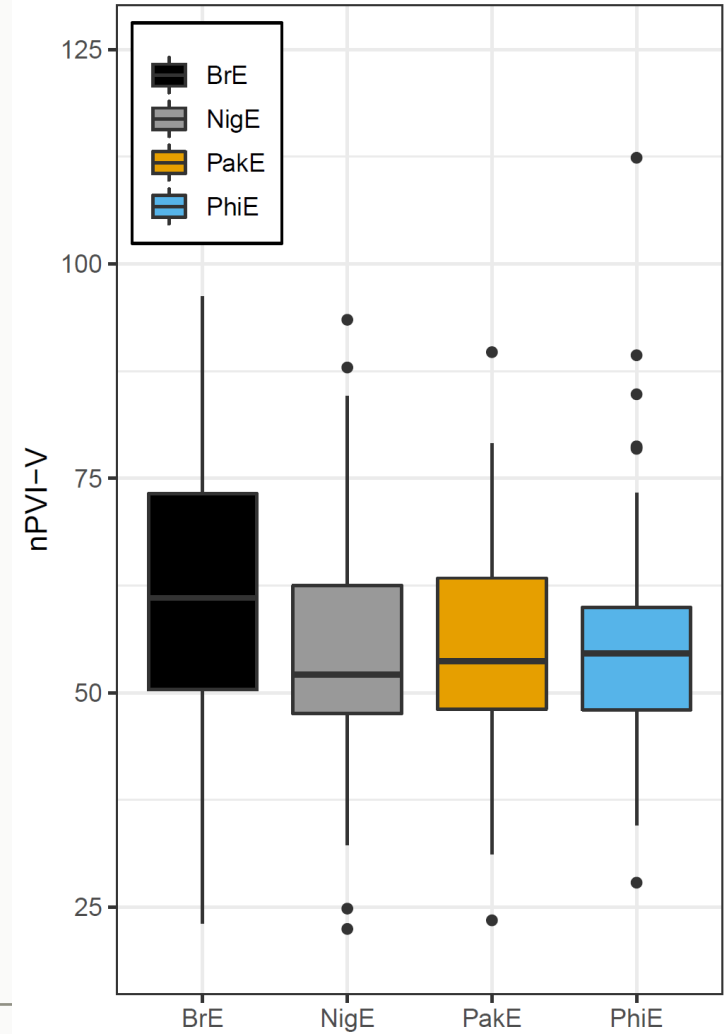
RESULTS: nPVI-V

- BrE has significantly higher values, i.e. a less even/more stress-timed rhythm than
  - NigE (p<0.01, z=-3.1)
  - PakE (p<0.01, z=-3.2)
  - PhiE (p=0.01, z=-3.0)
- Differences between NigE, PakE and PhiE are all not significant (p=0.99)



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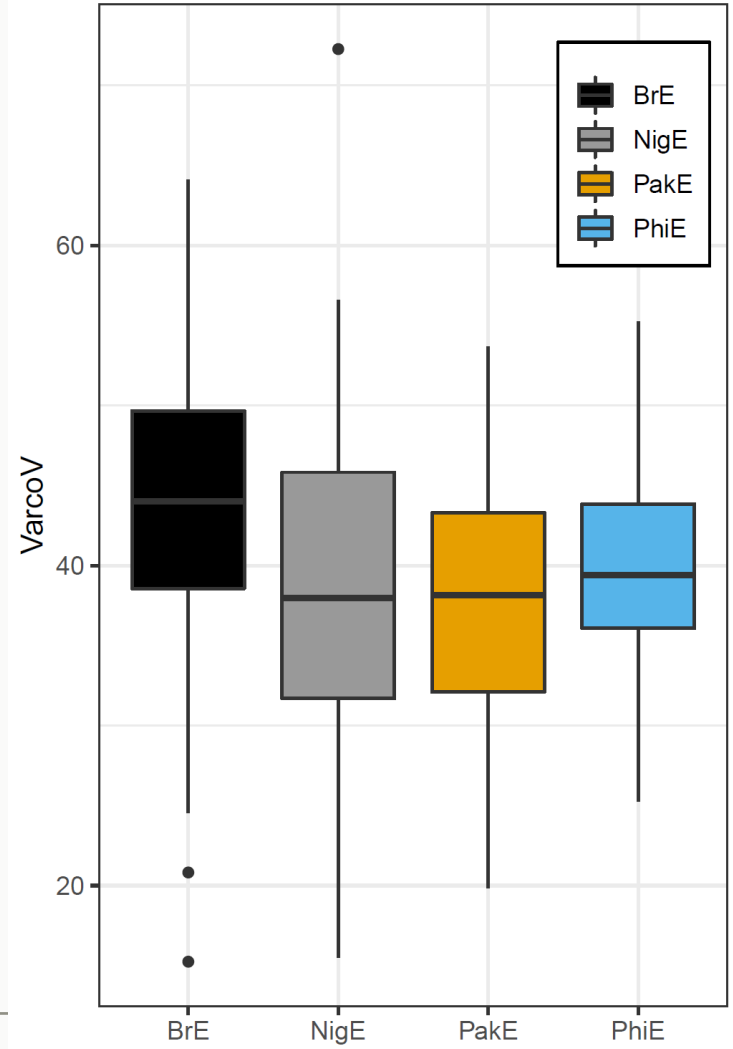
RESULTS: VarcoV

- BrE has significantly higher values, i.e. a less even/more stress-timed rhythm than
  - NigE (p<0.01, z=-3.0)
  - PakE (p<0.001, z=-3.8)
  - PhiE (p=0.05, z=-2.5)
- Differences between NigE, PakE and PhiE are all not significant (p > 0.6)



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DISCUSSION

- **Hypothesis confirmed**: The three ESL varieties are more syllable-timed than British English
- Mechanism: historical cross-linguistic influence/substrate transfer
- **Limitations**
  - No multi-dimensional analysis of speech rhythm
  - Heterogeneous sample
  - Only read speech

POTENTIAL FOR FUTURE RESEARCH

Opportunities for research on Nigerian English and Nigerian languages

1) Contrasting several L1 groups within Nigerian English – e.g. a reading passage for 10 - 20 Yoruba speakers, 10 - 20 Igbo speakers in English as well as in Yoruba and Igbo

- Speakers should have similar educational background

POTENTIAL FOR FUTURE RESEARCH

2) Contrasting sociolects within Nigerian English – e.g. a reading passage for 10 - 20 highly educated speakers, 10 - 20 speakers with lower level of education

3) Contrasting Nigerian English and Nigerian Pidgin – 10 – 20 speakers of each language/variety

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RECOMMENDED READING

Methodological guide:

Fuchs, Robert. 2023. Analysing the speech rhythm of New Englishes: A guide to researchers and a case study on Pakistani, Philippine, Nigerian and British English. In Wilson, Guyanne & Michael Westphal, eds. *New Englishes, New Methods*. Amsterdam: Benjamins, 132-155. (Preprint)

Also relevant:

Fuchs, Robert. 2016. *Speech Rhythm in Varieties of English. Evidence from Educated Indian English and British English*. Singapore: Springer.

Fuchs, Robert. 2023. A Synthesis of Research on Speech Rhythm in Native, Learner and Second Language Varieties of English – Introduction to the Volume. In Fuchs, Robert (ed.), *Speech Rhythm in Learner and Second Language Varieties of English*. Singapore: Springer, 1-14.

Fuchs, Robert. 2014. You got the beat: Rhythm and timing. In Raphael Monroy-Casas and Inmaculada de Jesus Arboleda Guirao, eds. *Readings in English Phonetics and Phonology*. Valencia: IULMA-UV, 165-188.

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FOLLOWING UP

- Interested in working with us?
- In addition to research on phonetics and phonology, also other areas aspects of varieties of English/World Englishes, Learner Corpus Research, discourse analysis of social media and traditional media, incl. data science and Big Data approaches
- Humboldt Foundation offers funding for scholars (PhD less than 12 years ago) to work with a German host for 12 to 18 months
- https://sites.google.com/view/rflinguistics/projects/research-fellowships
- https://www.iaak.uni-bonn.de/bael/en
- https://www.humboldt-foundation.de/en/apply/sponsorship-programmes/georg-forster-research-fellowship
- https://www.research-in-germany.org/en/research-funding/funding-programmes/avh-humboldt-research-fellowship-for-experienced-researchers.html

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FOLLOWING UP

- Erasmus+ Project on accent discrminination: https://www.circe-project.eu/
- Title: Counteracting Accent Discrimination Practices in Education

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