Structure preservation in intonation

Investigating the prosody of infant-directed speech in English and Bengali

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Monday 25 February 2013

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Outline

- **Questions** *Motivation of study*
- **Background** *Intonational phonology of English, Bengali*
- **Data collection** *Experiment, recordings, annotation*
- **Results** *IDS vs. non-IDS: similarities, differences*
- **Discussion** *Proposed explanations for IDS differences*
- **Conclusions** *Summary, upcoming extensions*

Questions

Infant-directed speech (IDS)

- **Infant-directed speech (IDS)** or motherese is characterized as involving:
  - **Syntactically**: shorter sentences with simpler structure[1], focus movement[2]
  - **Lexically**: smaller vocabulary, paraphrasing[3]
  - **Phonetically**: expansion of vowel space[4], stop VOT manipulation[5], ***distinctive prosody***

[1] O' Grady 1997:250
[2] Cristia 2011
[3] Ferguson 1964, O' Grady 1997:250
[4] Andruski & Kuhl 1996, Burnham et al. 2002, Cristia 2011
[5] Sundberg & Lacerda 1999, Sundberg 2001

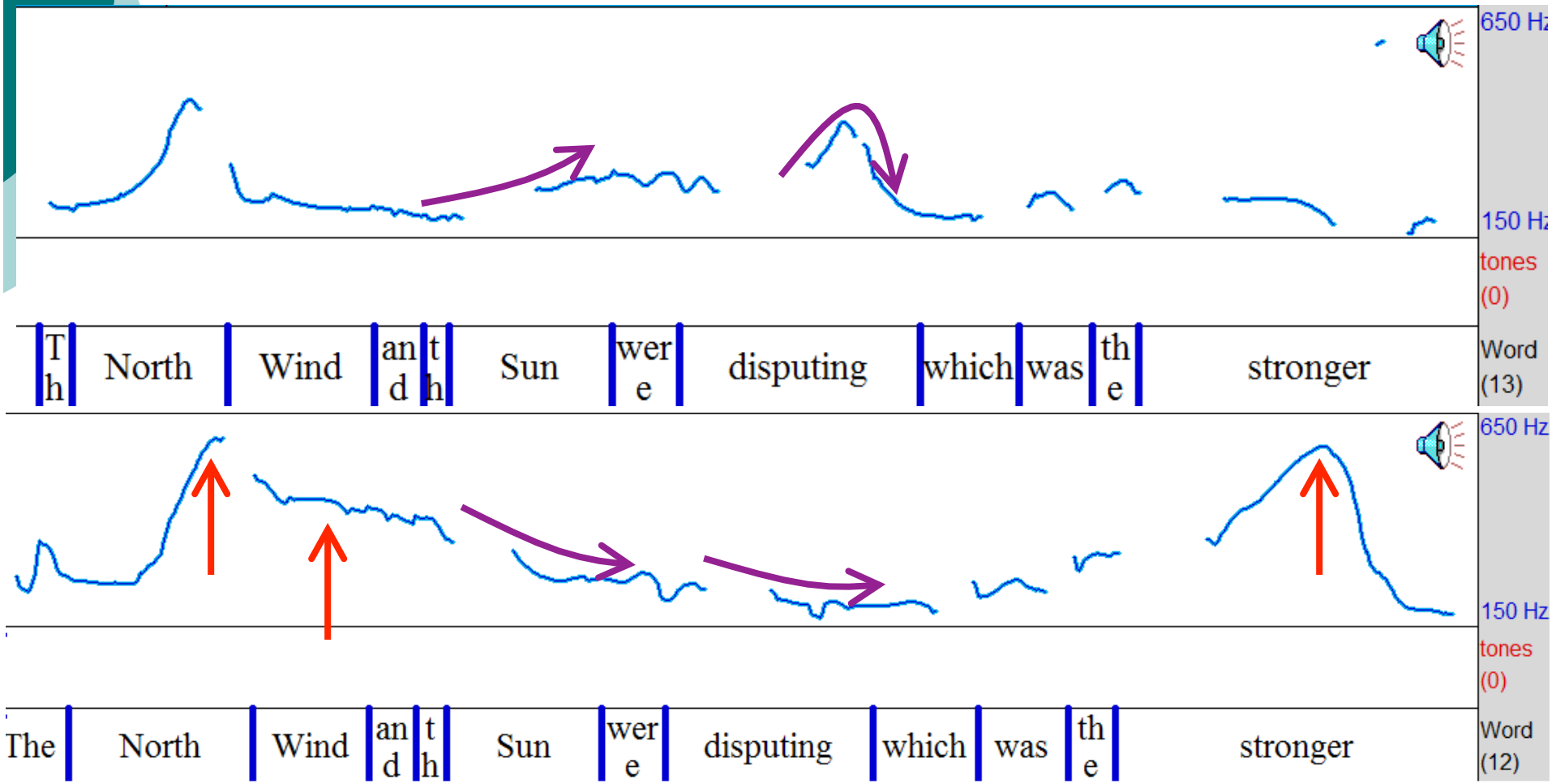
Infant-directed speech (IDS)

- IDS prosody is traditionally analyzed from an **acoustic-phonetic approach**[1]
  - Expansion of pitch range
  - Raising of pitch maximum
  - Exaggeration of contours
- Typically seen as a **non-phonological** or even **paralinguistic**[2] **phenomenon**

[1] Jacobson et al. 1983, Stern et al. 1983, Fernald & Simon 1984, Fernald et al. 1989, Fernald & Mazzie 1991, Greiser & Kuhl 1998, Masataka 1999

[2] Jacobson et al. 1983, O' Grady 1997:250

Infant-directed speech (IDS)



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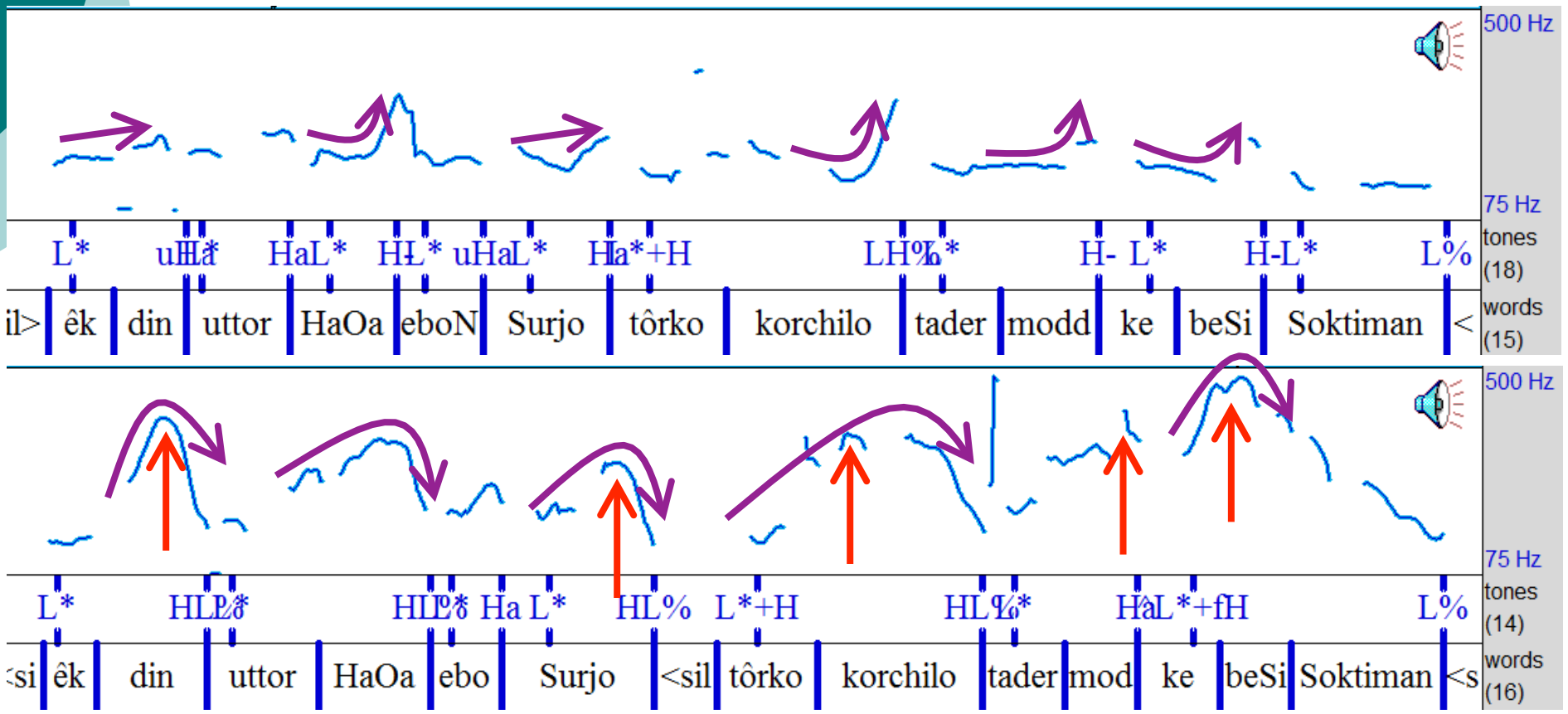

Basic questions

- It's well-established that cross-linguistically, IDS prosody involves a wider pitch range
- But are there **categorical changes** between non-IDS and IDS prosody?
- **What linguistic information might be conveyed** by the changes?
- What could be the **pressures motivating these changes**?

Background

Intonational phonology

- To help look beyond lg.-specific prosodic properties, I looked at two languages with typologically divergent intonation:
  - Mainstream American **English**
  - Bangladeshi Standard **Bengali**[1]

[1] The variety illustrated in Khan 2010

Intonational phonology

- **Shared features** of English and Bengali:
  - **Pitch accents**[1]: tones marking words
  - **Intonation phrases (IPs)**[2]: tonally-marked units
  - **Boundary tones**: tones marking ends of IPs
- **Language-specific features**:
  - **Inventory** of intonational tones
  - **What is conveyed** by specific tone sequences

[1] These are *postlexical* pitch accents, unlike the *lexical* pitch accents of Japanese, Swedish, etc., in that their presence and shape are not properties of the word.

[2] These "phrases" are *prosodic* units, only indirectly connected to *syntactic* units.

English: pitch accents

- **Pitch accents** occur on the stressed syllable of **prominent words**
  - Partial inventory:

Default	**Non-default (rising)**
H* (high)	L+H* (early rise)[1]
L* (low)	L*+H (late rise)

  - Choice is related to attitude[2], focus status[2], and tonal environment[3]

[1] Many researchers consider H* and L+H* to be variants of the same pitch accent.
[2] Beckman & Hirschberg 1990
[3] Dainora 2002, 2006

English: intonation phrases

- **Boundary tones** occur at the ends of **intonation phrases (IPs)**
  - Partial inventory:
    - L-L% (low)
    - H-H% (high)
  - Choice is related to sentence type, speaker confidence, finality[1]

[1] Beckman & Hirschberg 1990

Bengali: pitch accents

- **Pitch accents** occur on the initial syllable of nearly **all words**
  - Partial inventory:

Default	**Non-default (f-marked)**
L* (low)	fH* (extra high)
	L*+fH (rise to extra high)

  - Choice is related to speaker attitude[1], focus status/type[2], and tonal environment

[1] H* marks sarcasm or surprise, L* otherwise (Khan 2008, 2013 to appear)
[2] The choice of f-marked tone largely depends on focus type (Khan 2008, 2013 to appear)

Bengali: boundary tones

- **Boundary tones** mark the ends of IPs
  - Partial inventory:

L-initial	**H-initial**
L% (low fall)	H% (high rise)
LH% (low rise)	HL% (high fall)
	HLH% (high fall-rise)

  - Choice is related to sentence type, information structure, finality[1]

[1] Khan 2008, 2013 to appear

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Variable phrasing

- Prosodic phrasing in both languages is affected by:
  - **Syntactic structure**, e.g. disambiguation

[old [men and women]] <IP>

[[old men] <IP> and women] <IP>

  - **Information structure**, e.g. focus

I saw your mother reading the menu. <IP>

I saw YOUR MOTHER <IP> reading the menu. <IP>

  - **Other factors**, e.g. speech rate

Data collection

Design: subjects

- 19 subjects
  - 9 speakers of English (5M, 4F)
  - 10 speakers of Bengali (5M, 5F)
- All were parents of young children
- All reside in the Los Angeles area

Design: materials

- Recorded readings of the "North Wind and Sun" fable
  - Suitable for adult speech and IDS
  - Similar semantics/pragmatics across languages
  - Consistent semantics, morphosyntax, segmental phonology across conditions

এক দিন উত্তর হাওয়া এবং সূর্য তর্ক করছিল তাদের মধ্যে কে বেশি শক্তিমান। সেই মুহূর্তে ভারী চাদর পরা একজন পথিক তাদের দিকে হেঁটে আসে। হাওয়া আর সূর্য রাজি হয় তাদের মধ্যে যে সেই পথিকের গায়ের চাদর খোলাতে পারে, তাকেই বেশি শক্তিমান ধার্য করা হবে। এর

Design: conditions

- Two conditions
  - **Default reading** (non-IDS): "Read at a comfortable pace."
  - **Simulated infant-directed reading** (IDS): "Read as though you speaking to an infant."
    - Same text, illustrated with childlike drawings
    - Stuffed animals arranged around speaker

Experiment: annotation

- English annotation
  - Segmental: orthography
  - Prosodic: tone labels from MAE_ToBI[1]
- Bengali annotation
  - Segmental: phonemic romanization
  - Prosodic: tone labels from B-ToBI[2]

[1] Beckman et al. 2005
[2] Khan 2008, 2013 to appear

Analysis

- **Acoustic-phonetic measurements**
  - Pitch range
- **Categorical/phonological measurements**
  - Inventory of tones
  - Number of pitch accents
  - Number of IPs
  - Number of each type of pitch accents
  - Number of each type of boundary tones

Results

Preview of results

- What's the **same across conditions**:
  - For each lg., IDS and non-IDS can both be analyzed using the **same prosodic model**
- What **differs across conditions**:
  - IDS has **wider pitch range (higher max)**
  - IDS has **more IPs**
  - **Some tones are more frequent** in IDS
  - IDS has **more overall contour complexity**

Structure preservation

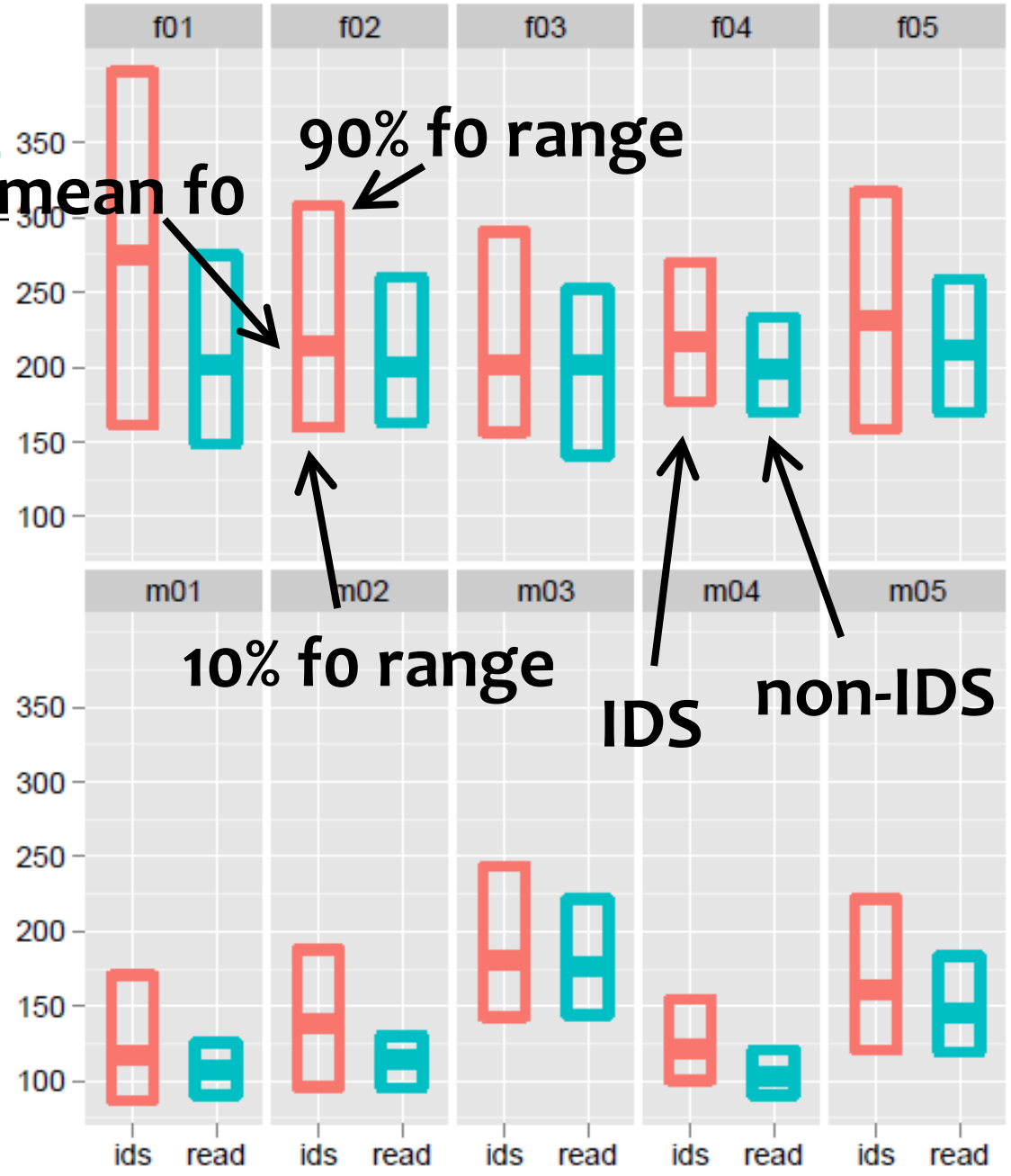
- IDS prosody uses the **same tonal inventory and grammar** as non-IDS prosody
  - No need to propose new (allo)tones for IDS
  - Same relations between tone sequence and intonational “meanings”

Structure preservation

- **Intonational structure preservation**
  - cf. phonemic structure preservation, in which a phonological process results in a sound already found in the phoneme inventory
  - German /d/ → [–voi] / __]$_{word}$
    - /t/ already found in inventory
  - Bengali /LH%/ → [HLH%] / [...__...]$_{IDS}$
    - /HLH%/ already found in inventory

Pitch range

- All Bengali speakers **raised the f0 max** in IDS
- f0 min not consistently lowered
- Same pattern seen in English
- Follows from previous studies
- "Authentic" IDS



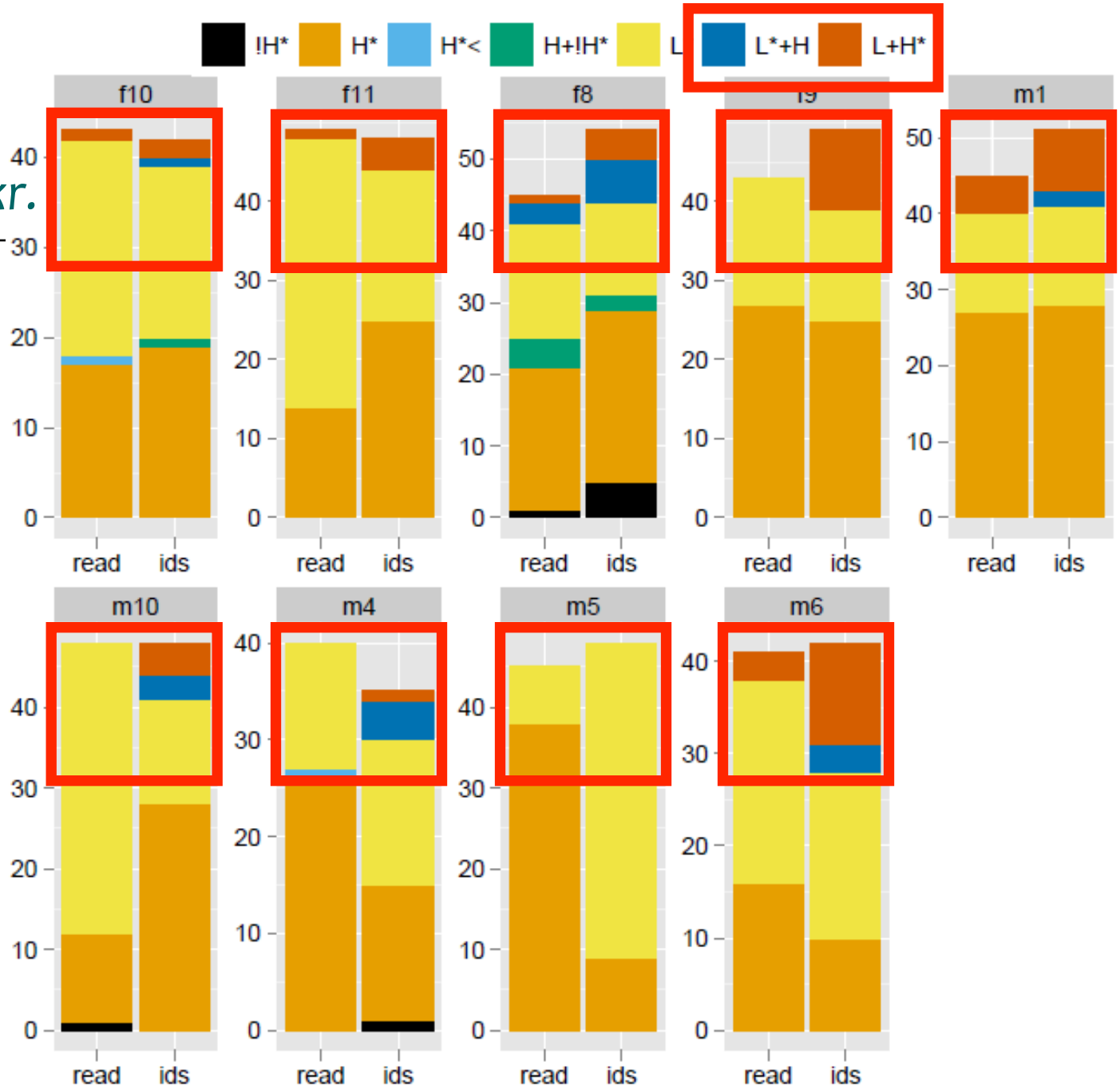
Preview of English-specific results

- English IDS involves:
  - Increase in **rising pitch accents**
  - Increase in **IPs**

English: pitch accents

- On average, speakers **increased the number and proportion of rising pitch accents in IDS**
  - 3.9% increase in **L*+H** proportion [$p = 0.02$]
  - 7.5% increase in **L+H*** proportion [$p = 0.01$]

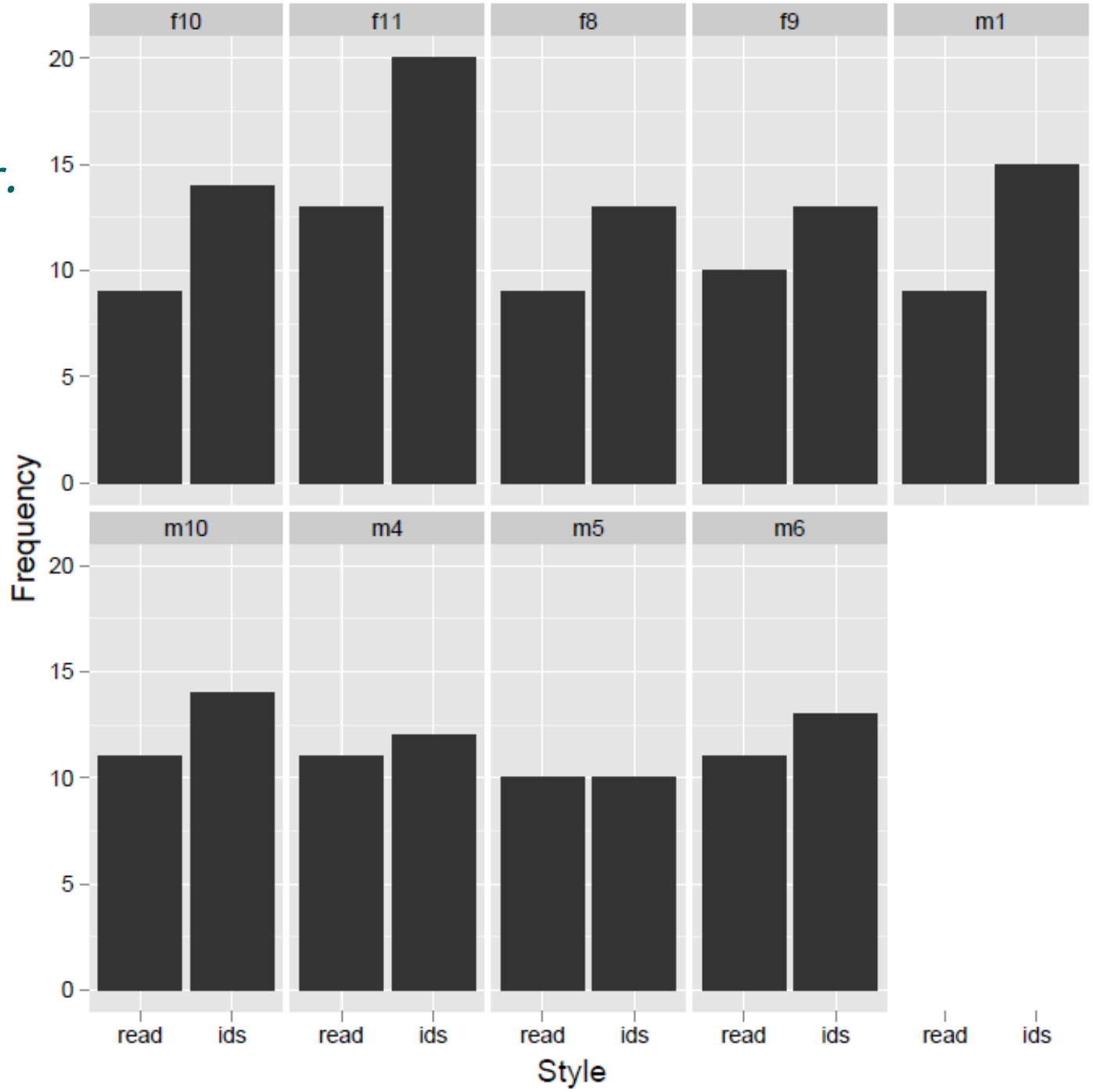
by spkr.



English: intonation phrases

- On average, English speakers produced **33.3% (=3.44) more IPs in IDS** [$p < 0.01$]

by spkr.


f10
f11
f8
f9
m1
m10
m4
m5
m6
Frequency
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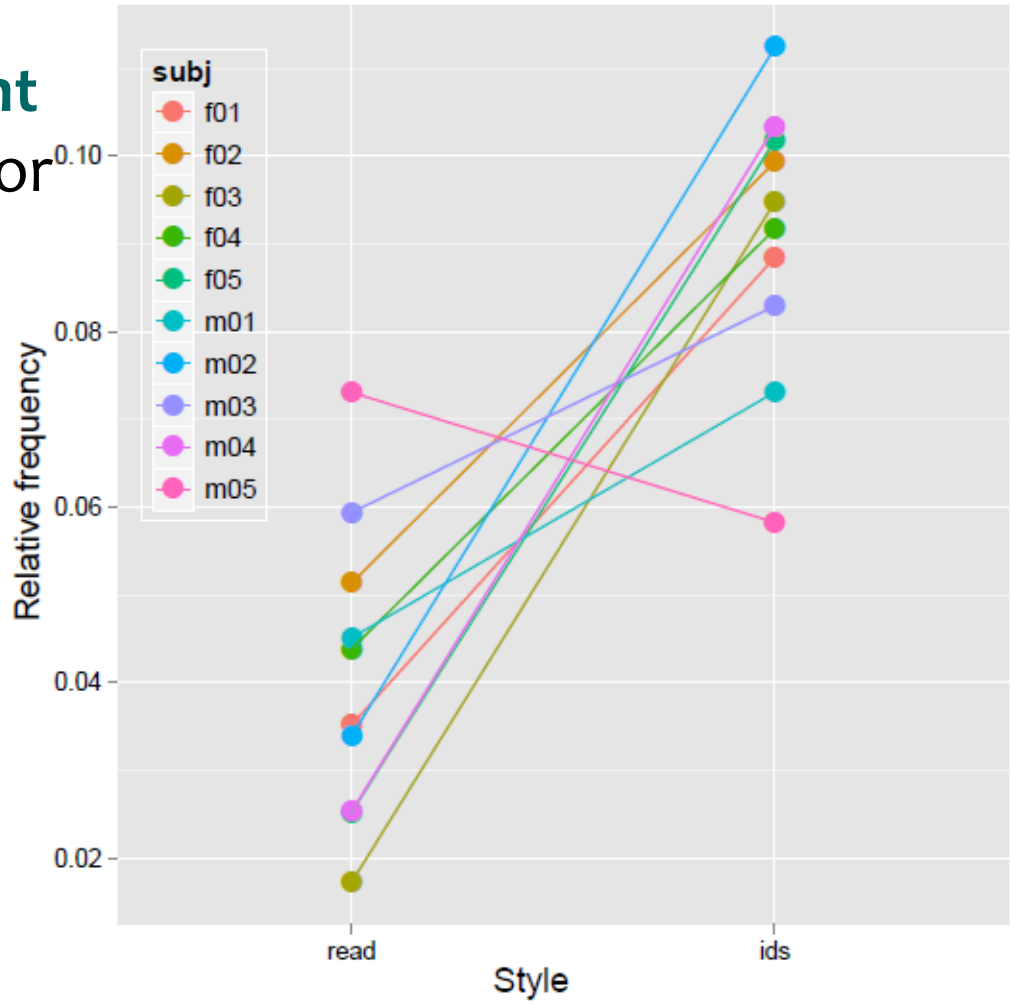
5
10
15
20
read
ids
Style

Preview of Bengali-specific results

- Bengali IDS involves:
  - Increase in **f-marked pitch accents**
  - Increase in **IPs**
  - Increase in **HL% and HLH% boundary tones**

Bengali: pitch accents

- **f-marked pitch accent use is higher in IDS** for all but one speaker
  - fH*
  - L*+fH



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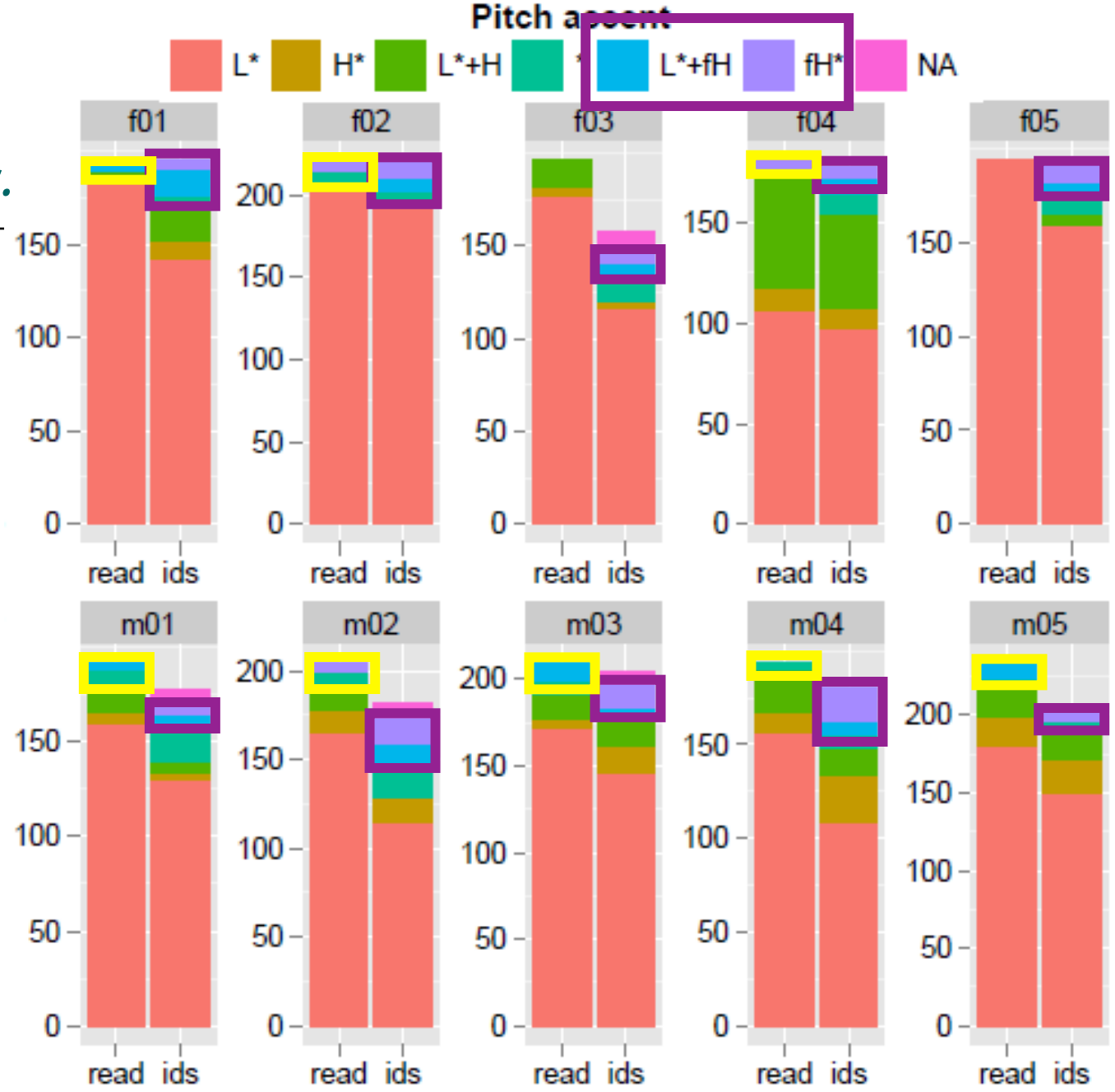


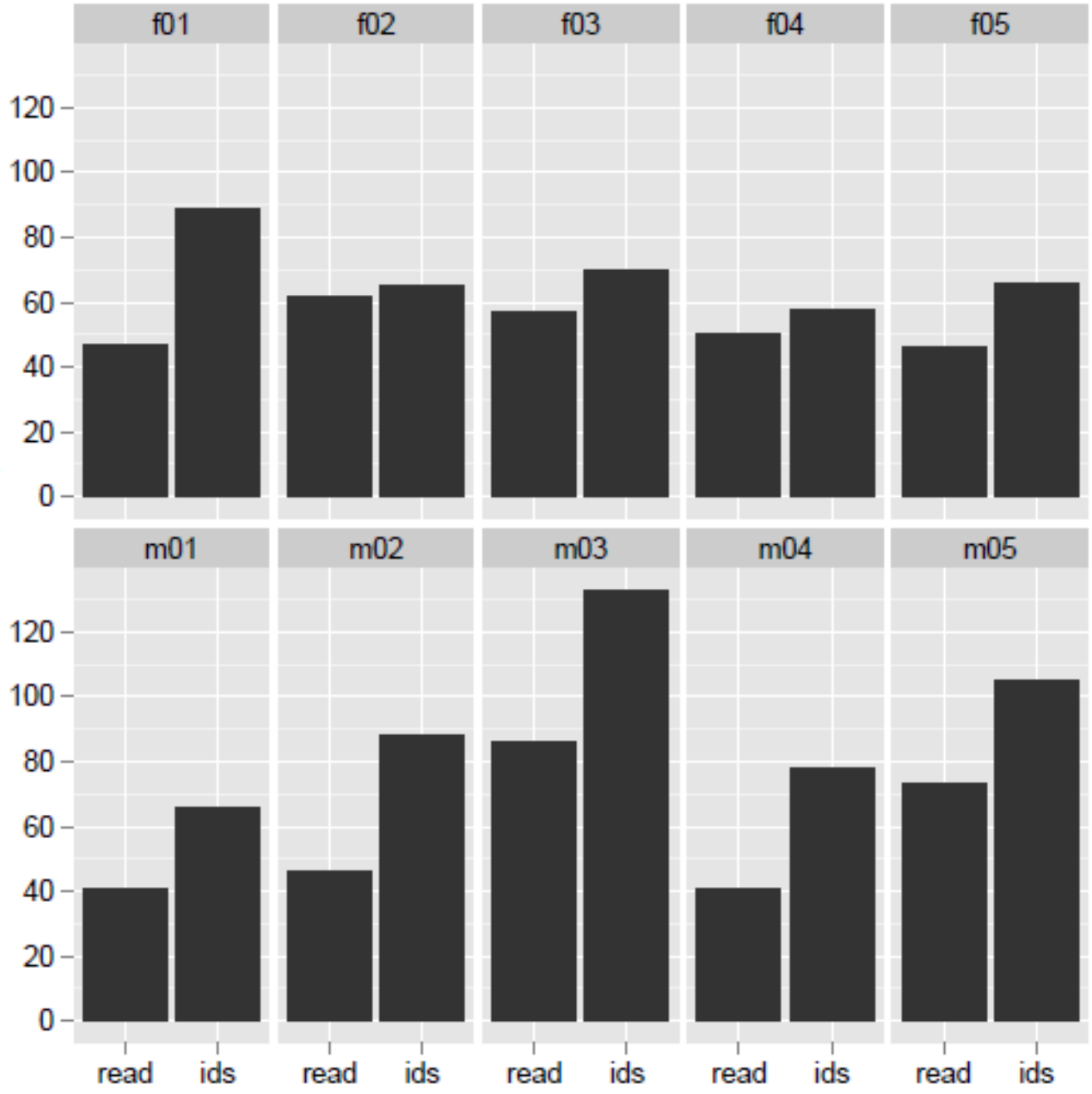
fH*, L*+fH in non-IDS

fH*, L*+fH in IDS

Bengali: intonation phrases

- On average, Bengali speakers produced **49.0% (= 8.97) more IPs in IDS** [$p < 0.01$]

by spkr.


f01
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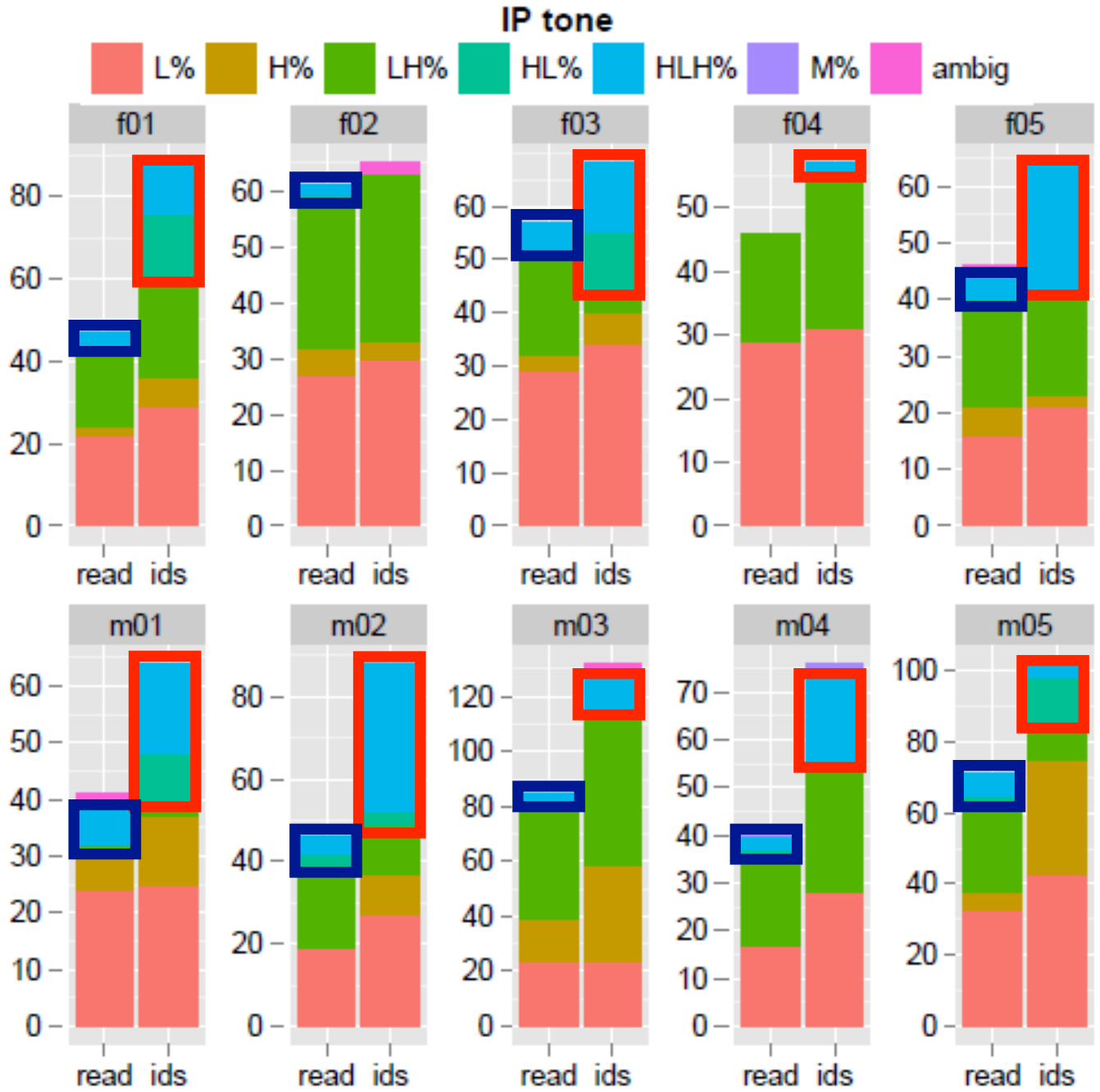
read
ids

Bengali: boundary tones

- The increase in IPs can be largely attributed to increases in those ending in:
  - **HL% (high falling)**
  - **HLH% (high falling-rising)**

by spkr.



HL%, HLH% in non-IDS

HL%, HLH% in IDS

Summary of results

- True for IDS in both languages:
  - More non-default pitch accents
    - Despite lack of increase in default pitch accents
  - More IPs
    - Certain boundary tones were more common
- So, why do we see ***these*** modifications?

Discussion

Why: pitch accent patterns

- Why does IDS involve an **increase in non-default accents**?
  - English rising L*+H and L+H*
  - Bengali f-marked fH* and L*+fH
- These tones can mark **focused elements**

➔ **Greater use of focus prosody in IDS**[1]

[1] IDS can also involve greater use of syntactic movement to convey focus (Cristia 2011).

Why: phrasing patterns

- Why does IDS involve **more IPs**?
  - IP breaks help **disambiguate syntax**
  - Boundary tones convey **information structure**
    - Bengali HL% can mark topicalization

➔ **More marking of syntactic/information structure in IDS**

Why: contour preference

- There could be other reasons why rising pitch accents and H-initial boundary tones are more common in IDS
  - **Preference for more pitch variation**, to "keep things interesting" for the infant[1]
  - **Preference for tones involving H** as infants prefer higher pitch[2]

[1] Fernald 1991, Werker & McLeod 1989
[2] Kearsley 1973, Fernald & Kuhl 1981

Why: contour preference

- But only tones with well-formed complex and high counterparts can undergo this substitution
- IDS **balances grabbing/keeping infant's attention with structure preservation**

Conclusions

Returning to the questions

- Are there **categorical changes** between non-IDS and IDS prosody? **Yes (but…)**
  - More substitution of default pitch accents with **non-default pitch accents**
  - Higher likelihood to **add IP breaks**
  - More substitution of lower/simpler tones with **higher/more complex tones**
  - But… the **basic prosodic system is the same**

Returning to the questions

- **What linguistic information might be conveyed** by the changes?
  - Greater use of IP breaks can disambiguate **syntactic structure**
  - Greater use of IP breaks and non-default pitch accents can highlight **topic, focus**

Returning to the questions

- What could be the **pressures motivating these changes**?
  - Pressures towards greater complexity: desire to **attract infant's attention**, desire to **clarify complex structures**
  - Pressure against greater complexity: **intonational structure preservation**

Work in progress

- More data on the way!
  - Second transcriber currently annotating English
  - Second transcriber has already annotated Bengali, data is currently being analyzed

Work in progress

- **More principled way** of looking at the connection between phonological changes and syntax/information structure
  - e.g. is probability of IP break higher at large syntactic phrase breaks?
- ***A great area for collaboration across linguistic subfields!***

Thank you!

Special thanks to my collaborator Kristine M. Yu, as well as to Jaime Panna Roemer, Megha Sundara, the Reed College Linguistics Department, the experimental subjects, and the audience here at UCL!