



Intonation for infants

The prosody of “motherese”

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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

Audience

- We make subtle but systematic changes in our speech depending on our **audience**
- Some audiences trigger **hyperarticulation**
 - Non-native speakers¹



¹ Knoll et al. 2006, Uther et al. 2007

Audience

- We make subtle but systematic changes in our speech depending on our **audience**
- Some audiences trigger **hyperarticulation**
 - Non-native speakers¹
 - **Children/infants**²

¹ Knoll et al. 2006, Uther et al. 2007

² Video of Pat Kuhl's TED talk





Infant-directed speech (IDS)

- **Infant-directed speech (IDS)** or motherese is characterized as involving:
 - **Syntactically**
 - Shorter sentences with simpler structure¹
 - Focus movement²
 - **Lexically**
 - Smaller vocabulary³
 - Paraphrasing³

¹ O' Grady 1997:250

² Cristia 2011

³ Ferguson 1964, O' Grady 1997:250



Infant-directed speech (IDS)

- **Infant-directed speech (IDS)** or motherese is characterized as involving:
 - **Phonetically**
 - Expansion of vowel space (/i/ vs. /u/ vs. /ɑ/)¹
 - Stop VOT manipulation (/p t k/ vs. /b d g/)²
 - **Distinctive prosody** (intonation, rhythm)

¹ Andruski & Kuhl 1996, Burnham et al. 2002, Cristia 2011

² Sundberg & Lacerda 1999, Sundberg 2001, but cf. Synnøstvedt 2010



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 contours²
- Seen as a **non-phonological** or even **paralinguistic**³ **phenomenon**

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

² True for both tonal and non-tonal lgs. (Liu et al. 2007)

³ Jacobson et al. 1983, O'Grady 1997:250

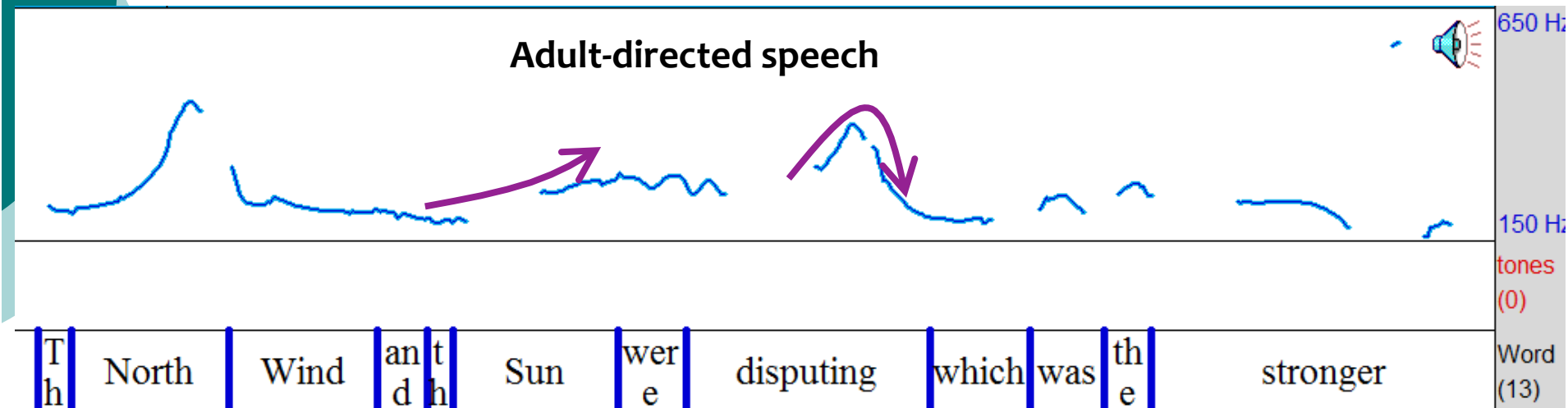


Infant-directed speech (IDS)

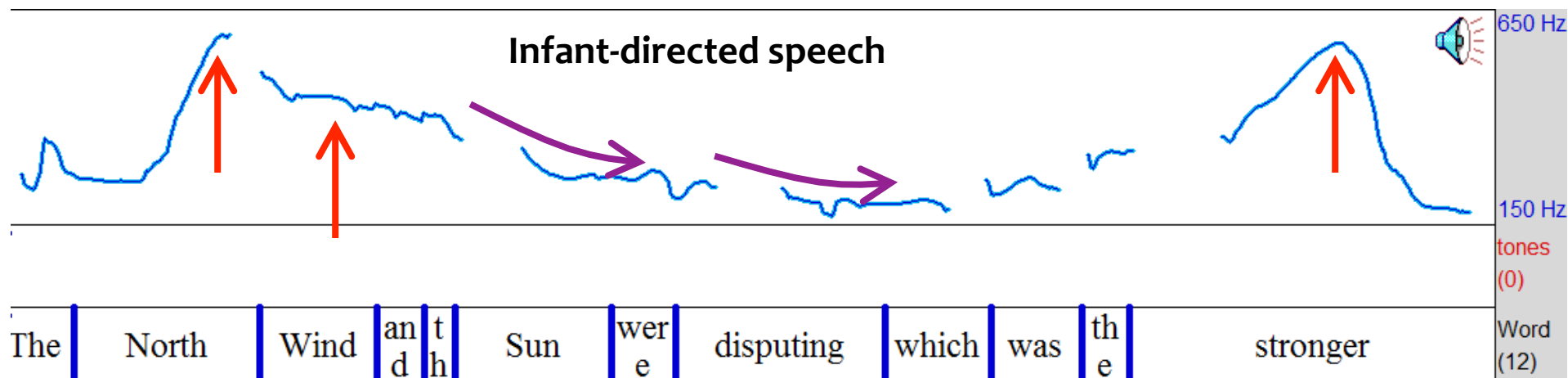
- But intonation is currently seen as fully **linguistic** and even **phonological**
 - **Finite inventory** of tones
 - **Hierarchical** prosodic structure
 - **Predictable variation** in tones (allotones)
 - **Grammar of tonal sequences** (“tonotactics”)
- ***Is IDS intonation somehow different?***

Infant-directed speech (IDS)

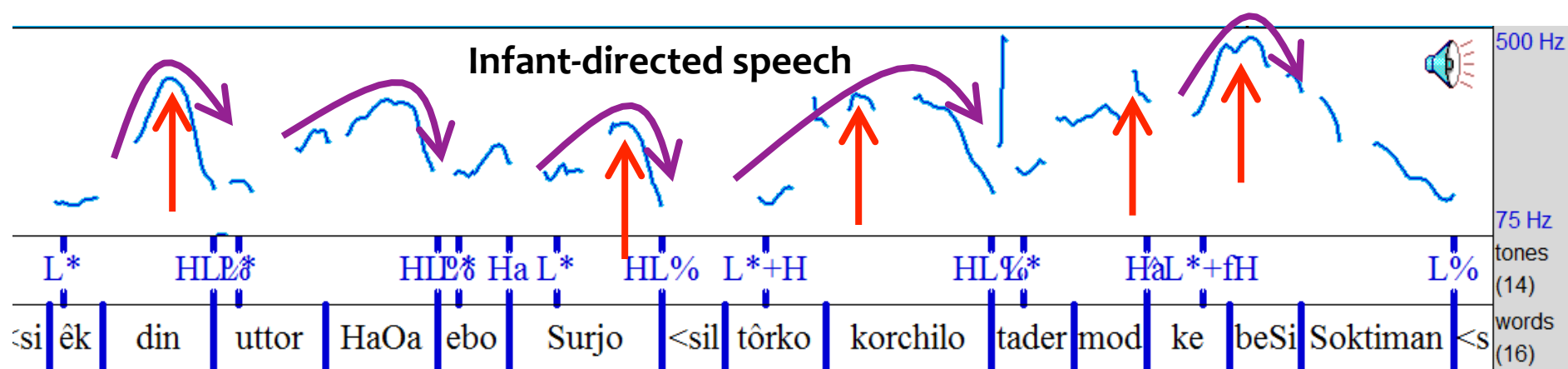
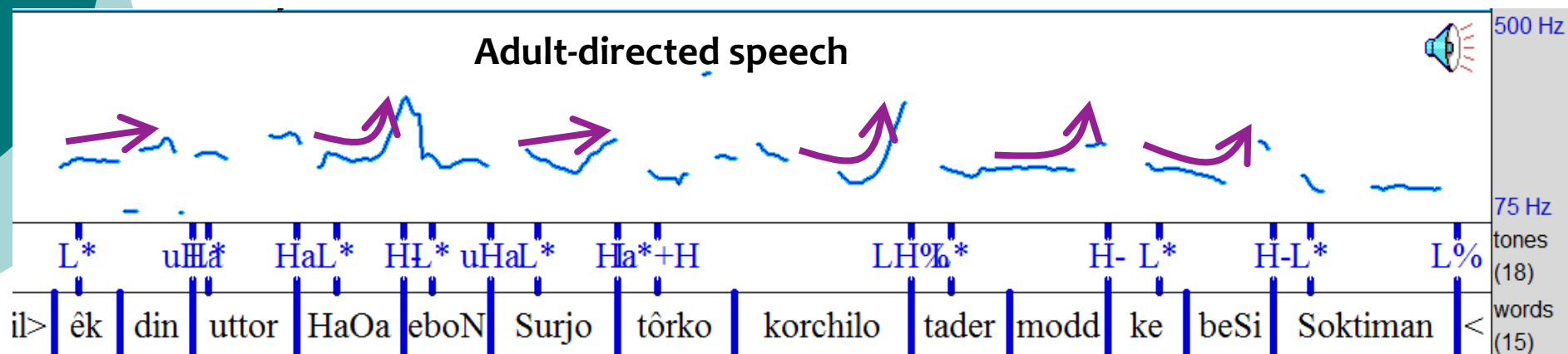
Adult-directed speech



Infant-directed speech



Infant-directed speech (IDS)





Basic questions

- 1) In addition to the wider pitch range, are there **categorical changes** in IDS prosody?
- 2) What **linguistic information** might be conveyed by such changes?
- 3) What could be the **pressures motivating these changes**?



Background



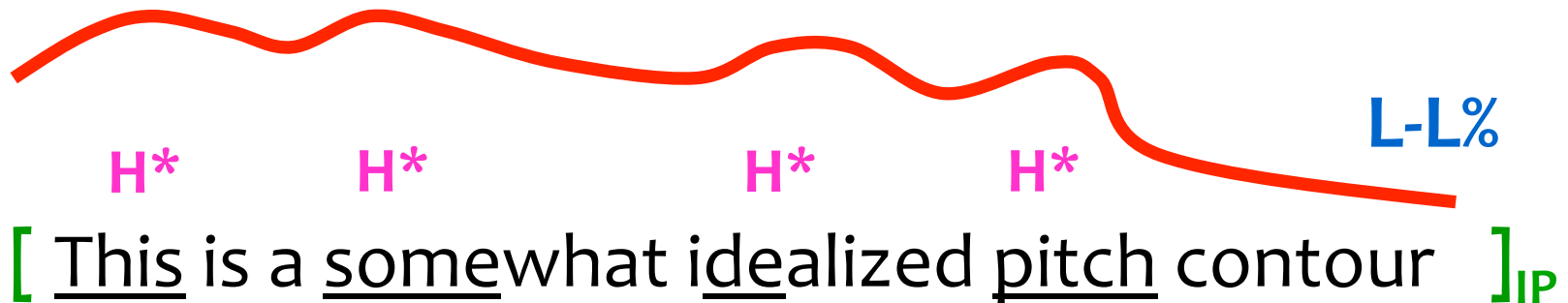
Intonational phonology

- 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 on stressed syllables
 - **Intonation phrases (IPs)**²: large prosodic units
 - **Boundary tones**: tones marking ends of IPs





Intonational phonology

- **Language-specific features:**

- **Inventory** of intonational tones

- English has no HL% (high falling boundary)
 - Bengali has no H-L% (high plateau boundary)

- **Meanings conveyed** by specific tone sequences

- H* is default in English, sarcastic in Bengali
 - L* is default in Bengali, doubting in English



English: pitch accents

- English: inventory of 5 basic **pitch accents**

- Partial inventory:

- | <u>Default</u> | <u>Non-default (rising)</u> |
|----------------|--------------------------------|
| H* (high) | L+H* (early rise) ¹ |
| | L*+H (late rise) |

- Choice is related to attitude², focus status², and tonal environment³

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

- English: **5 boundary tones** can occur at the ends of **intonation phrases (IPs)**
 - Partial inventory:
 - L-L% (low fall)
 - H-H% (high rise)
 - Choice is related to sentence type, speaker confidence, finality¹

¹ Beckman & Hirschberg 1990



Bengali: pitch accents

- Bengali: inventory of 6 pitch accents

- Partial inventory:

- | <u>Default</u> | <u>Non-default (f-marked)</u> |
|----------------|-------------------------------|
| L* (low) | fH* (extra high) |
| | L*+fH (rise to extra high) |

- Choice is related to speaker attitude¹, focus status/type², 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

- Bengali: inventory of 5 **boundary tones**

L-initial

L% (low fall)

LH% (low rise)

H-initial

H% (high rise)

HL% (high fall)

HLH% (high fall-rise)

- Choice is related to sentence type, information structure, finality¹

¹Khan 2008, 2013 to appear



Bengali: boundary tones

- Bengali: inventory of 5 **boundary tones**

L-initial

L% (low fall)

LH% (low rise)

H-initial

H% (high rise)

HL% (high fall)

HLH% (high fall-rise)

*Both can serve as
topicalizers*

- Choice is related to sentence type, information structure, finality¹

¹ Khan 2008, 2013 to appear



Bengali: boundary tones

- Bengali: inventory of 5 **boundary tones**

L-initial

L% (low fall)

H-initial

H% (high rise)

HL% (high fall)

LH% (low rise)

HLH% (high fall-rise)

*Both can serve as
continuation
rises*

- Choice is related to sentence type, information structure, finality¹

¹ Khan 2008, 2013 to appear



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

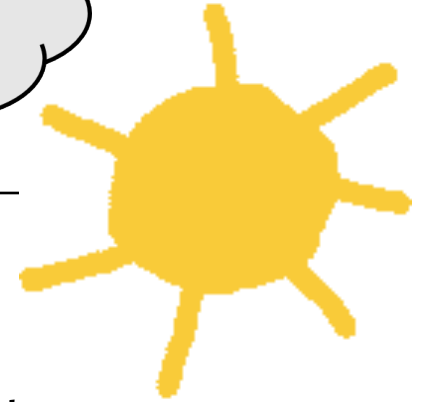
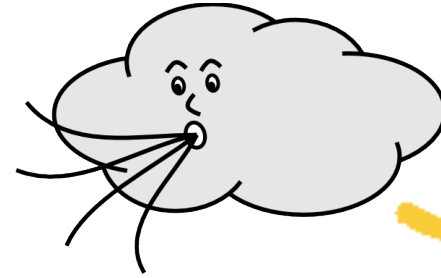


Design: materials

- 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_ToBI¹
- Bengali annotation
 - Segmental: phonemic romanization
 - Prosodic: tone labels from B-ToBI²

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 accent
 - Number of each type of boundary tone



Results



Preview of results

- What's the **same across conditions**:
 - 1) For each lg., IDS and non-IDS can both be analyzed using the **same prosodic model**
- What **differs across conditions**:
 - 2) IDS has **wider pitch range (higher max)** ↖ expected
 - 3) IDS has a **higher proportion** of certain tones
 - 4) IDS has **more IPs**
 - 5) IDS has **more overall contour complexity** ↖ we'll come back to this in the discussion



1) Structure preservation

- IDS prosody uses the **same tonal inventory and grammar** as non-IDS prosody
 - No IDS-specific tones or allotones
 - No IDS-specific “tonotactic” rules
 - No IDS-specific relations between tone sequences and intonational meanings



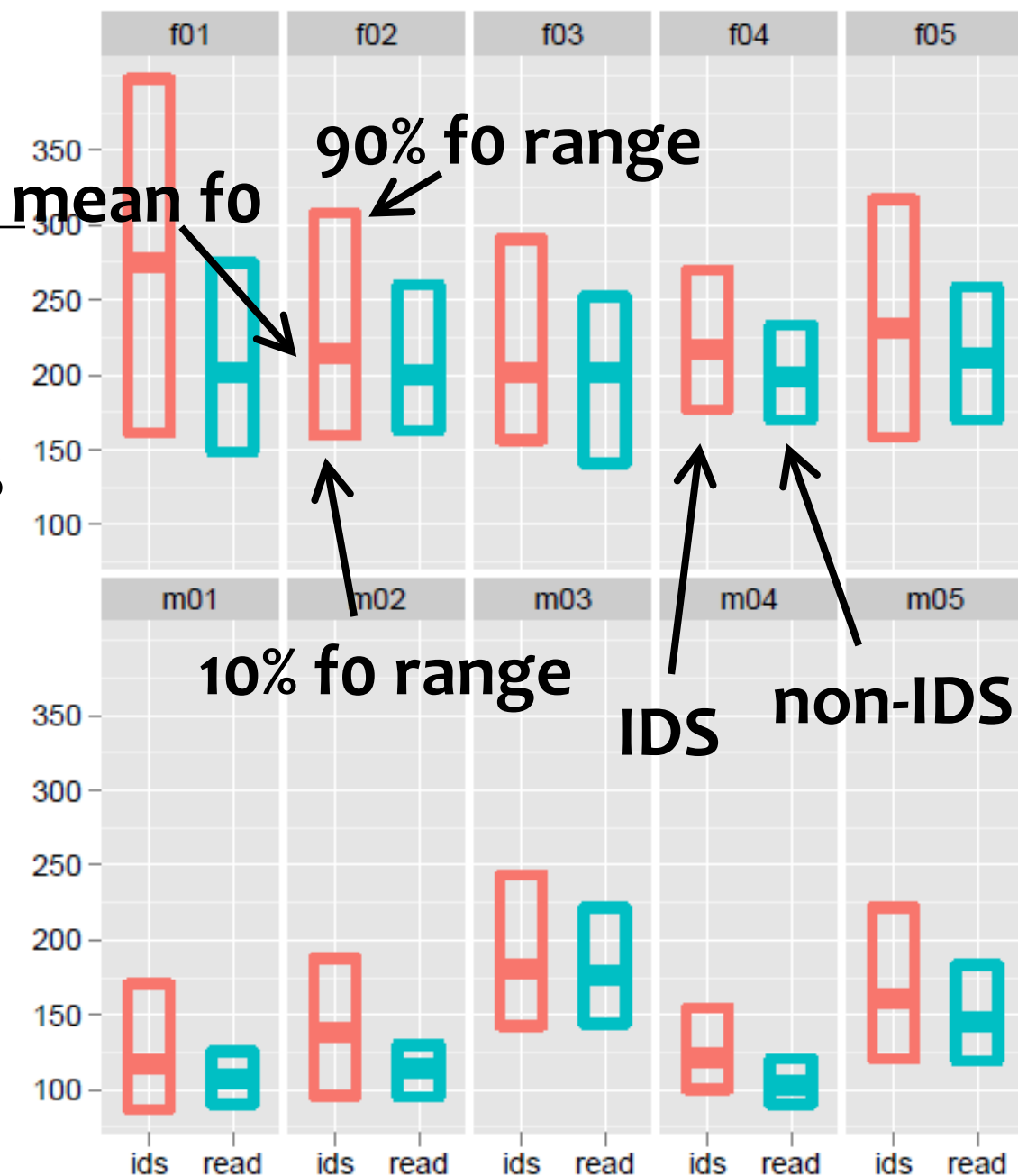
1) Structure preservation

○ 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 (opt.)
 - /HLH%/ already found in inventory

2) Pitch range

- All Bengali speakers **raised the fo max** in IDS
- fo 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**

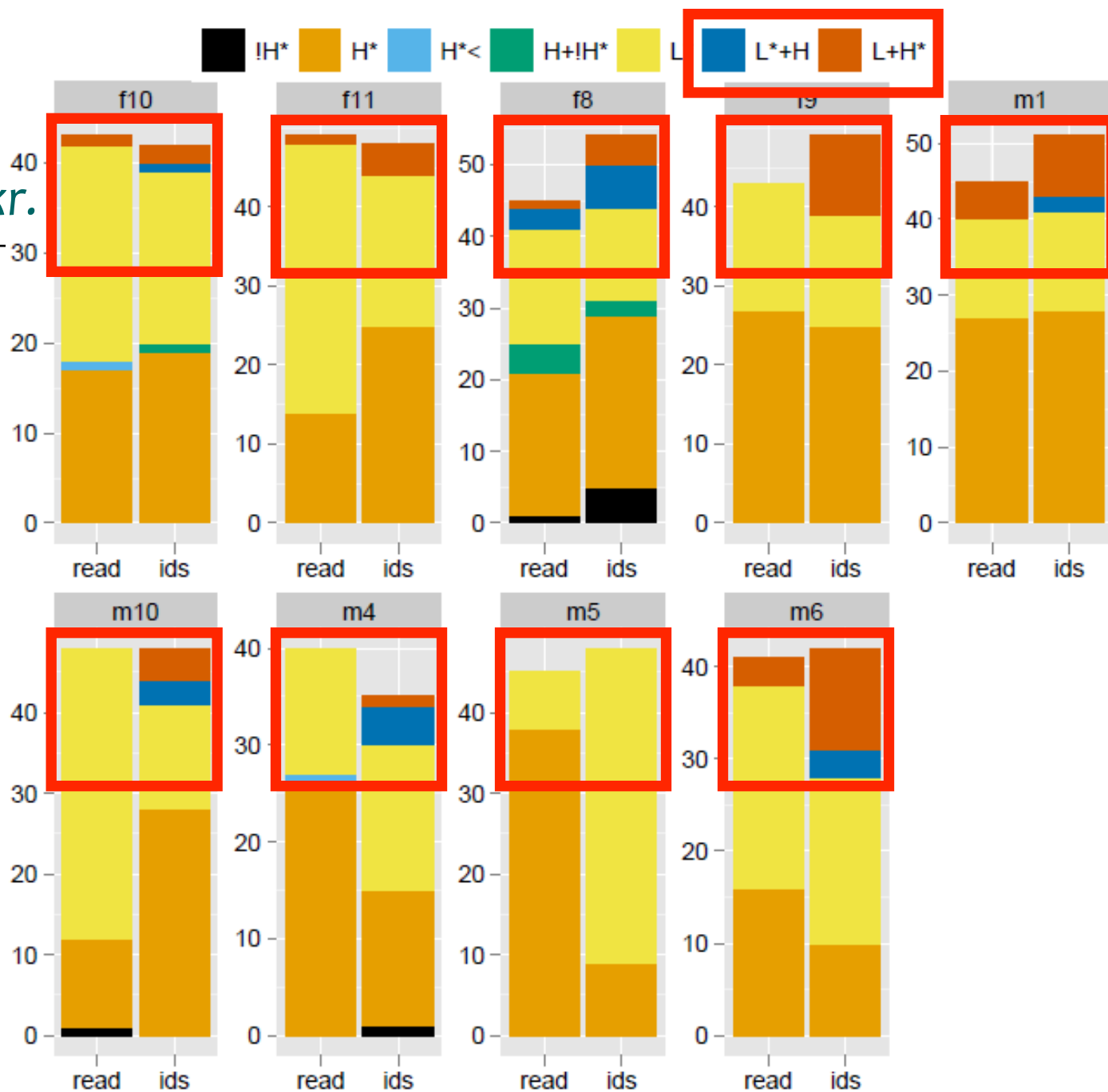


3) English: pitch accents

- 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.



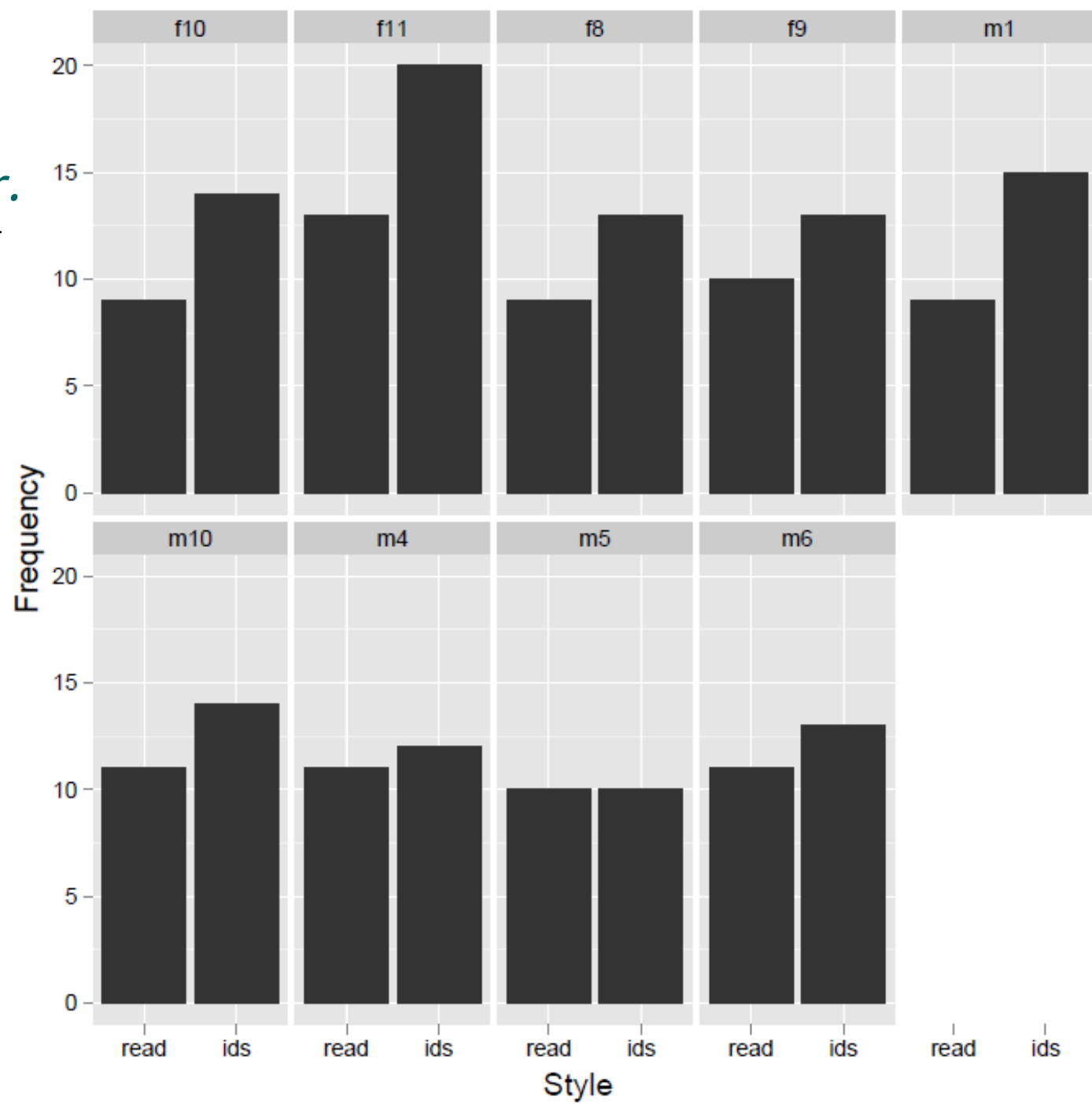


4) English: intonation phrases

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



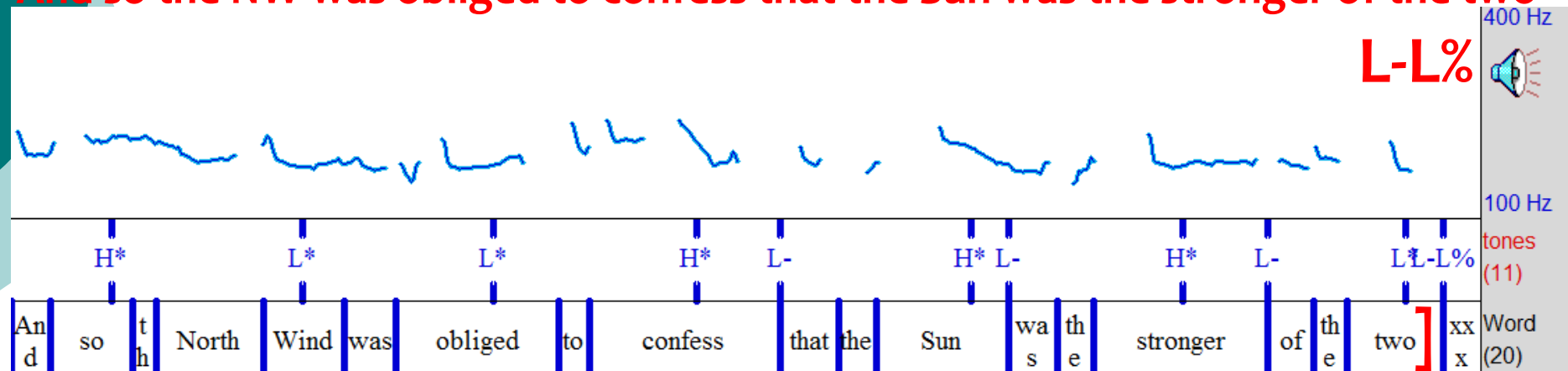
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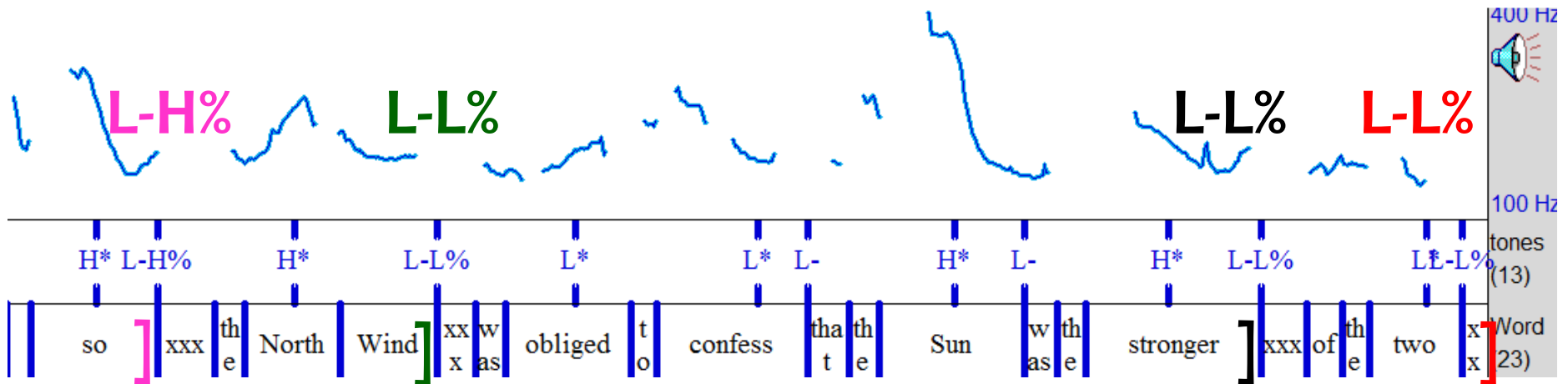
4) English: intonation phrases

And so the NW was obliged to confess that the Sun was the stronger of the two

L-L%



And so the NW was obliged to confess that the Sun was the stronger of the two





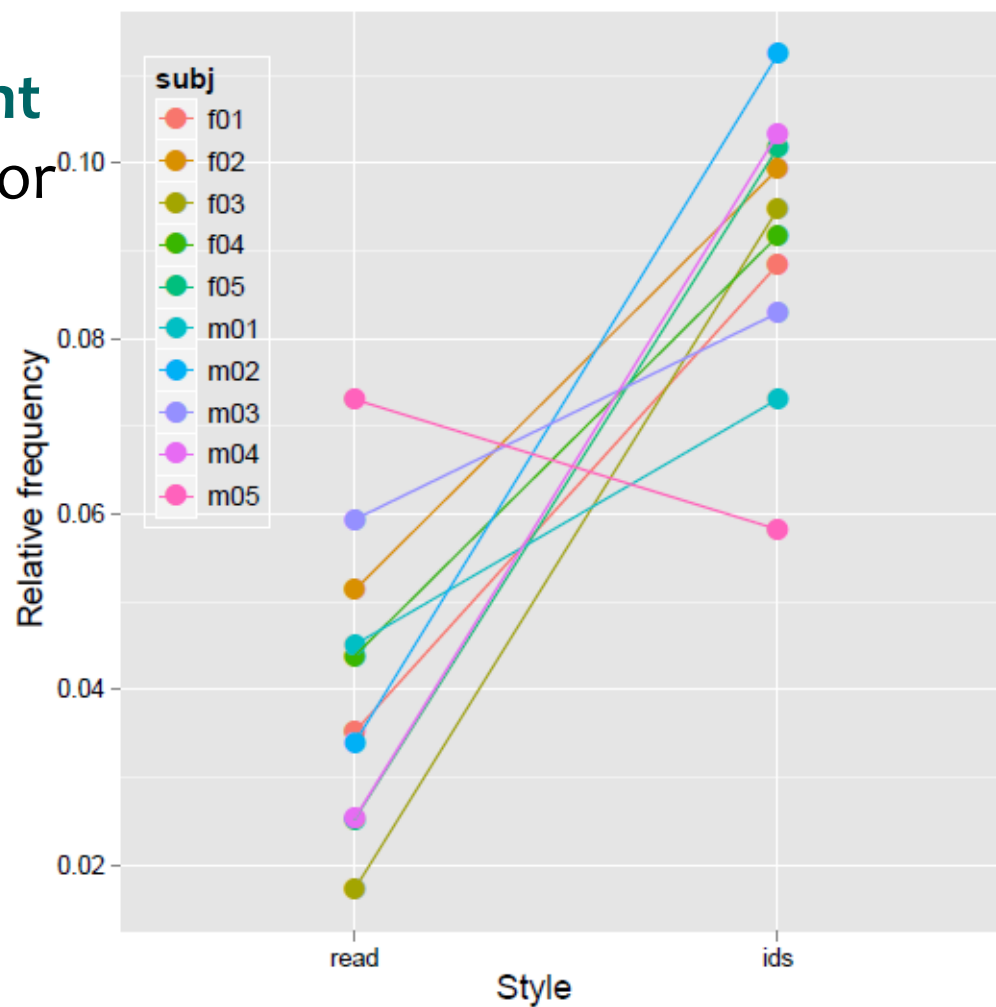
Preview of Bengali-specific results

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

3) Bengali: pitch accents

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

- fH*
- L*+fH



3) Bengali: pitch accents

that much traveler his/her

shawl

held tightly (non-IDS)

L*



L* Ha L* Ha L* LuH%

tôtoI

pothik

tar

<sil>

^L*

uHa

L*

L%

cador

cepe

dhore

rakhe

that much-FO

traveler

his/her

<sil>

shawl

held tightly

220 Hz
98.5 Hz
50 Hz
tones
(22)
words
(27)
English
(25)

that much traveler their shawl

held tightly (IDS)

fH*



fH*

u^L*

uHa

u^L*

uHa

uL*

L%

tôtoI

pothik

tader

cador

cepe

dhore

rakhe

<sil>

that much-FOC

traveler

their

shawl

held tightly

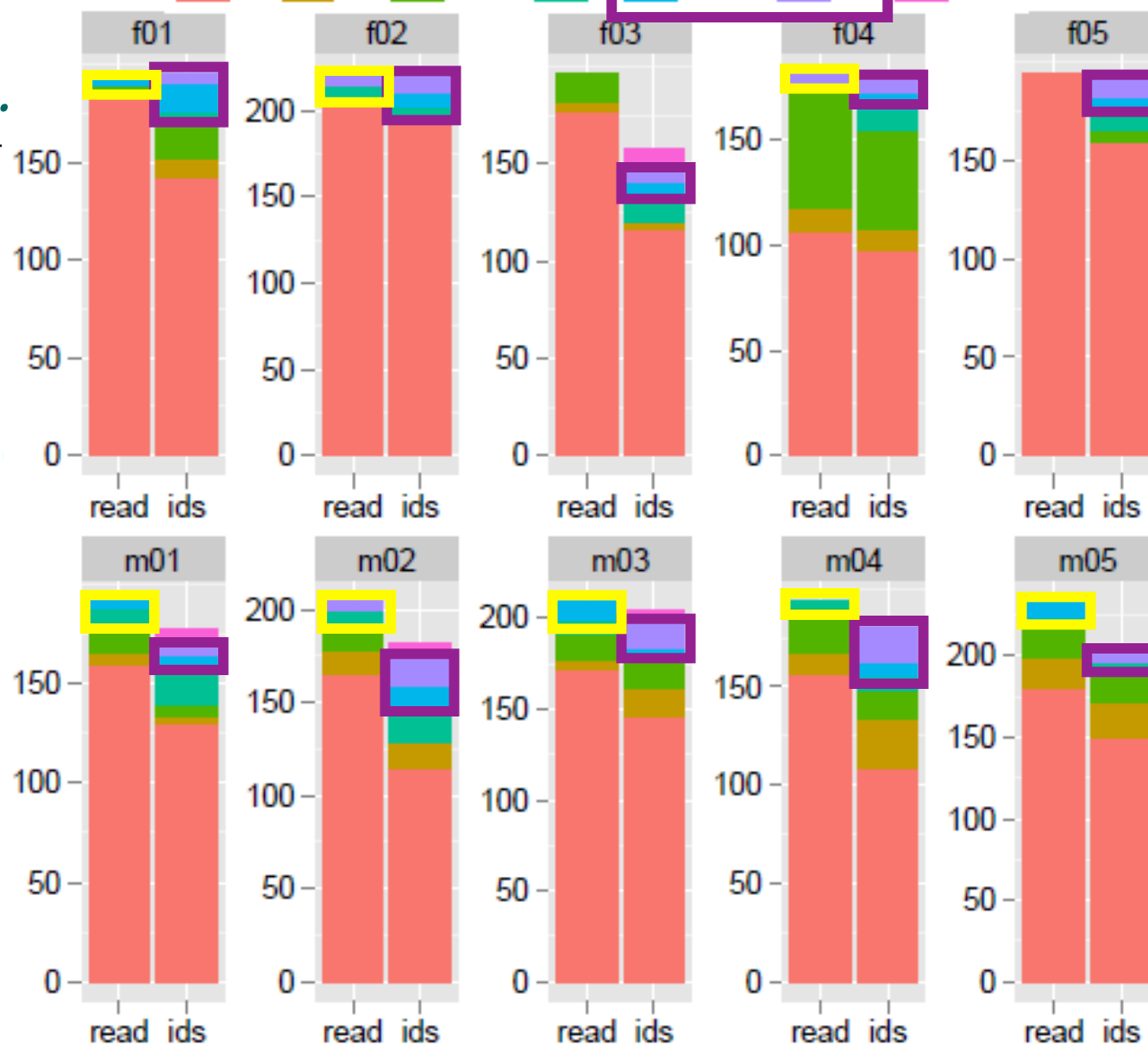
<sil>

220 Hz
50 Hz
tones
(23)
words
(30)
English
(28)



by spkr.

Pitch accent



fH*, L*+fH
in non-IDS

fH*, L*+fH
in IDS

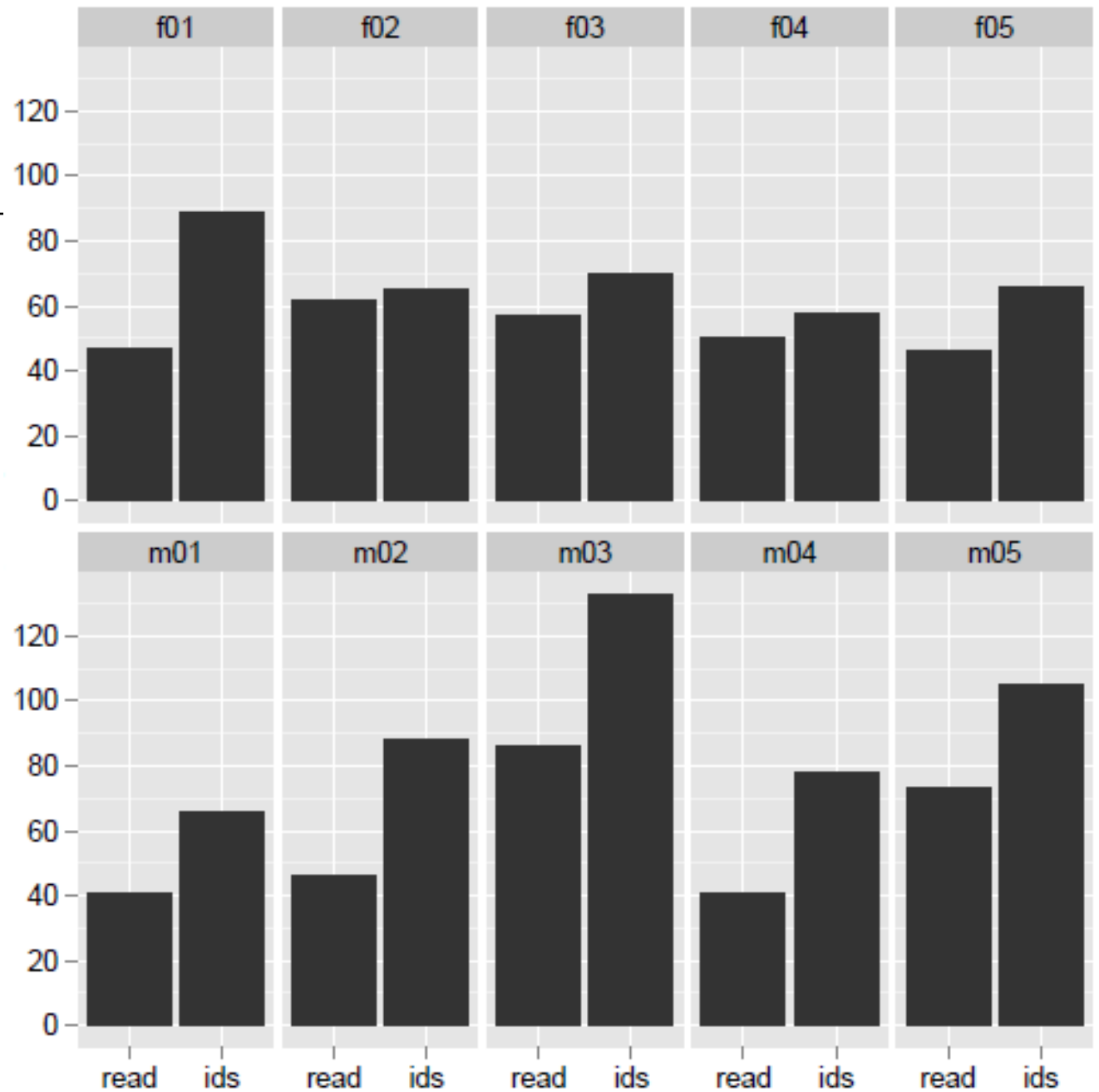


4) Bengali: intonation phrases

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

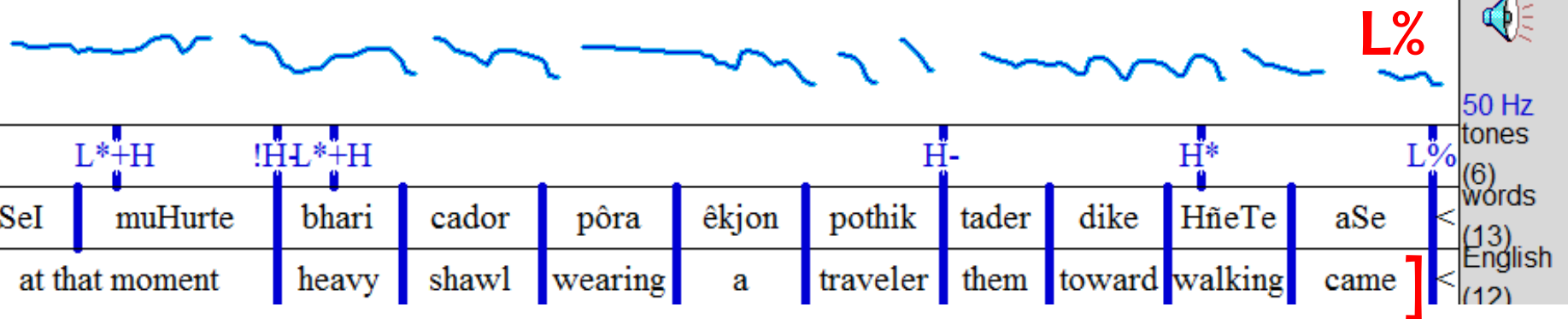


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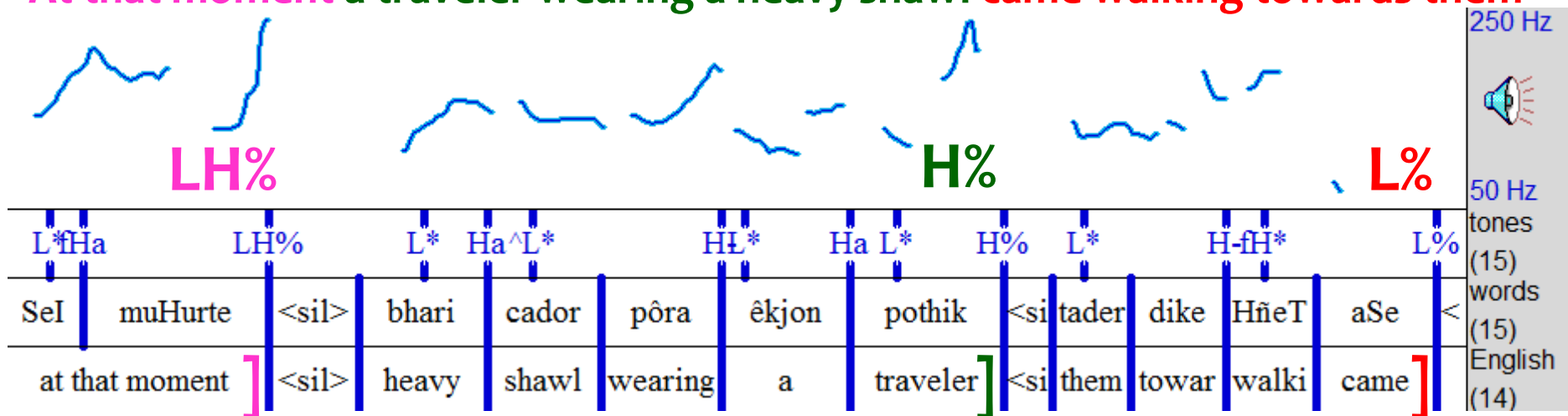


4) Bengali: intonation phrases

At that moment a traveler wearing a heavy shawl came walking towards them



At that moment a traveler wearing a heavy shawl came walking towards them



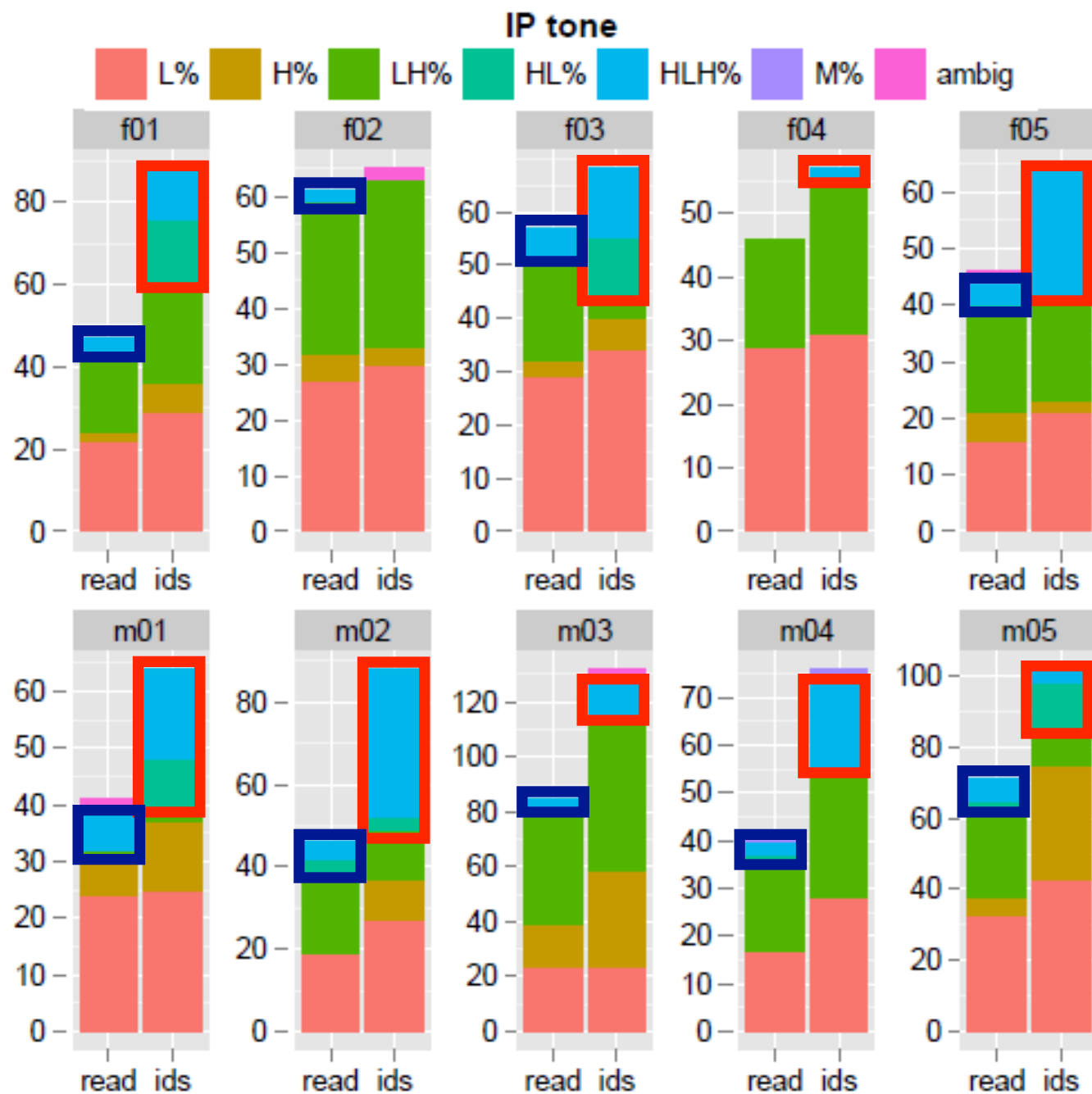
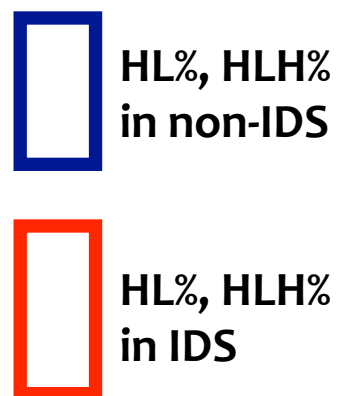


3) Bengali: boundary tones

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

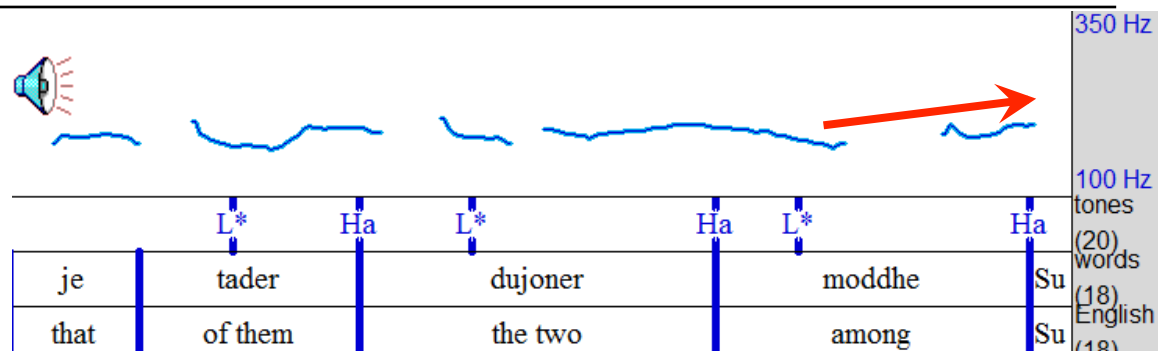


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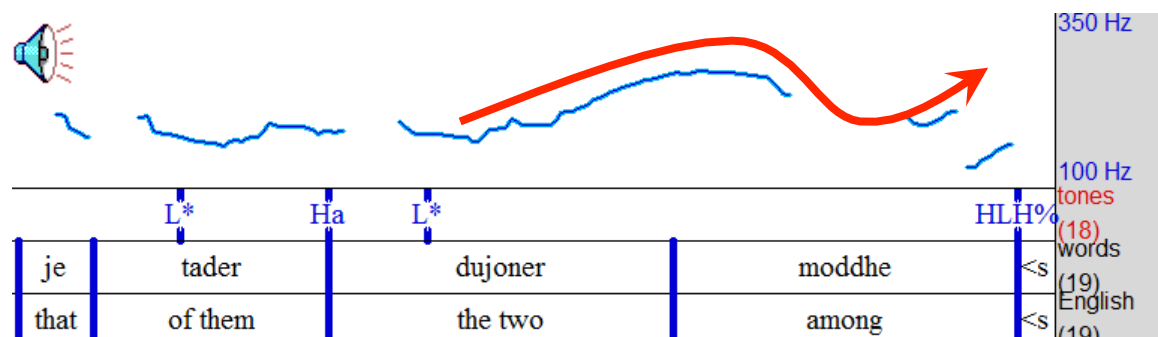


3) Bengali: boundary tones

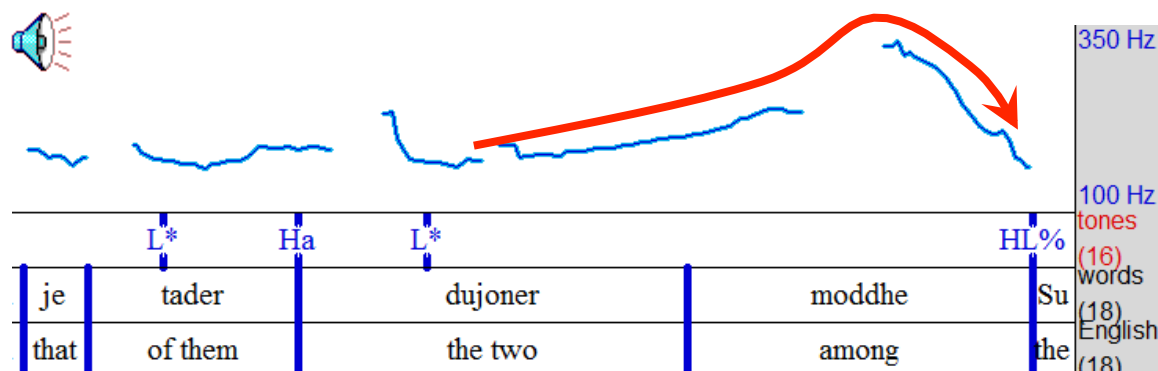
Ha in non-IDS
Default



HLH% in IDS
Continuation



HL% in IDS
Topicalization





Summary of results

- True for IDS in both languages:
 - More non-default pitch accents
 - Rising pitch accents in English, f-marked in Bengali
 - ***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**¹
➔ **Greater use of focus prosody in IDS**²

¹ Pierrehumbert & Hirschberg (1990) for English, Khan (2008, 2013) for Bengali

² IDS also involves greater use of focus movement in the syntax (Fernald & Mazzie 1991).



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 infant¹
 - **Preference for tones involving H** as infants prefer higher pitch²

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 certain boundary tones and non-default pitch accents can highlight **topic, focus**



Returning to the questions

○ What could be the **pressures motivating these changes?**

- Desire to **attract infant's attention**
- Desire to **clarify complex structures**
- **Intonational structure preservation**

Pressures
promoting
tonal
complexity

Pressure
fighting
tonal
complexity



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 experimental subjects, and the audience here!