



Intonational phonology in Bengali and English infant-directed speech

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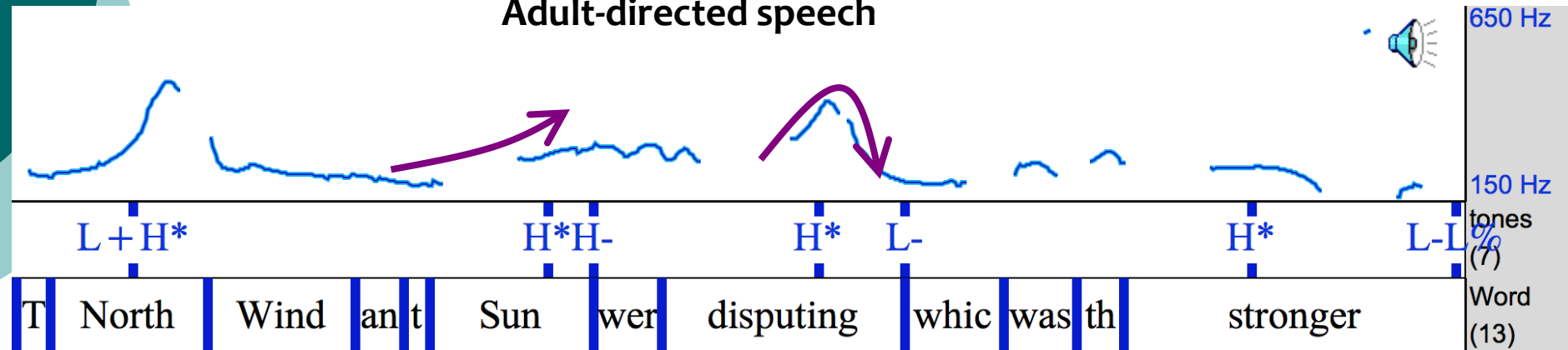
Speech Prosody 7, Trinity College Dublin
Friday 23 May 2014

Hypothesis: affect and grammar

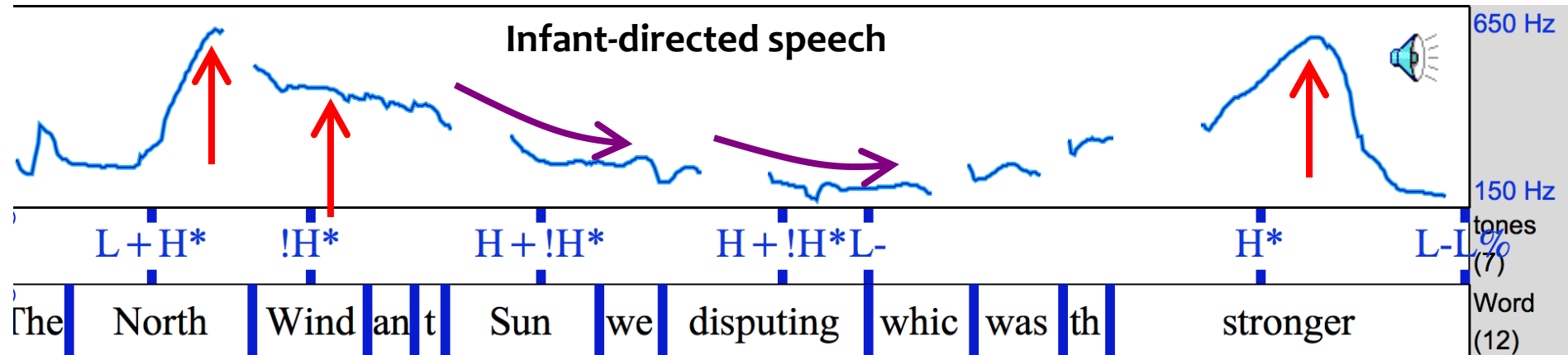
- How do we build the intonational contour of an utterance?
 - Grammatical structure?
 - Social context / affect?
- Prosodic choices are **conditioned on both**
- How do we know?
- Case study: **Infant-directed speech in Bengali and English**

Infant-directed speech (IDS): English

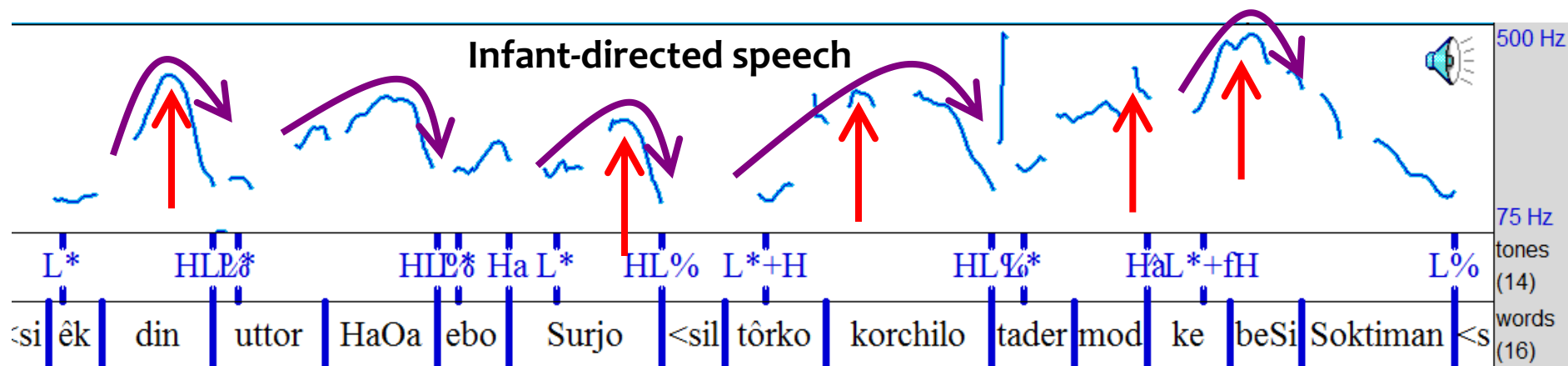
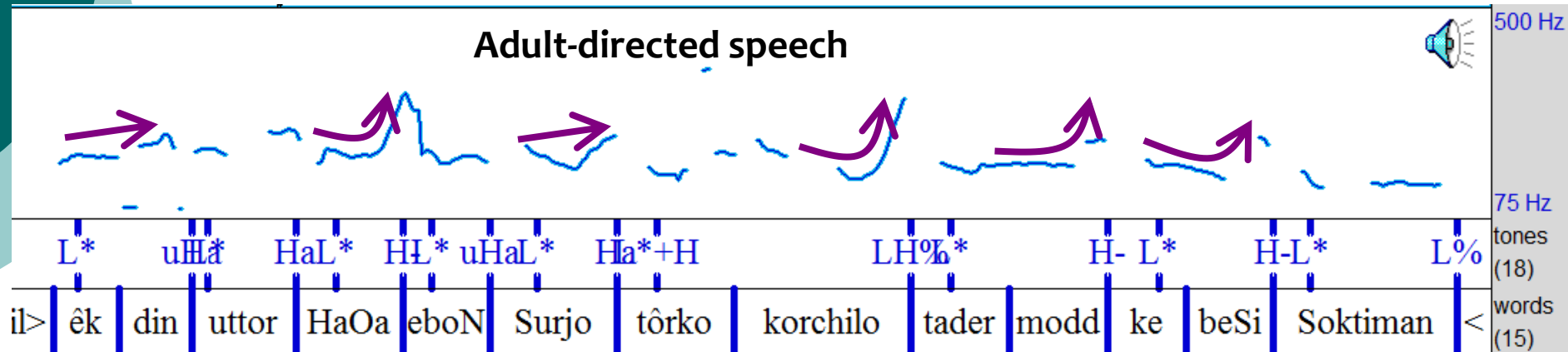
Adult-directed speech



Infant-directed speech



Infant-directed speech (IDS): Bengali





Background

Infant-directed speech (IDS)

- IDS prosody is traditionally analyzed from an **acoustic-phonetic approach**¹
 - Expansion of fo range via raising of fo max
 - Increase in fo variability, e.g. sinusoidal, bell-shaped contours
 - Exaggeration of contours
- These manipulations maintain infant **attention**, elicit positive **emotional rapport**²

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

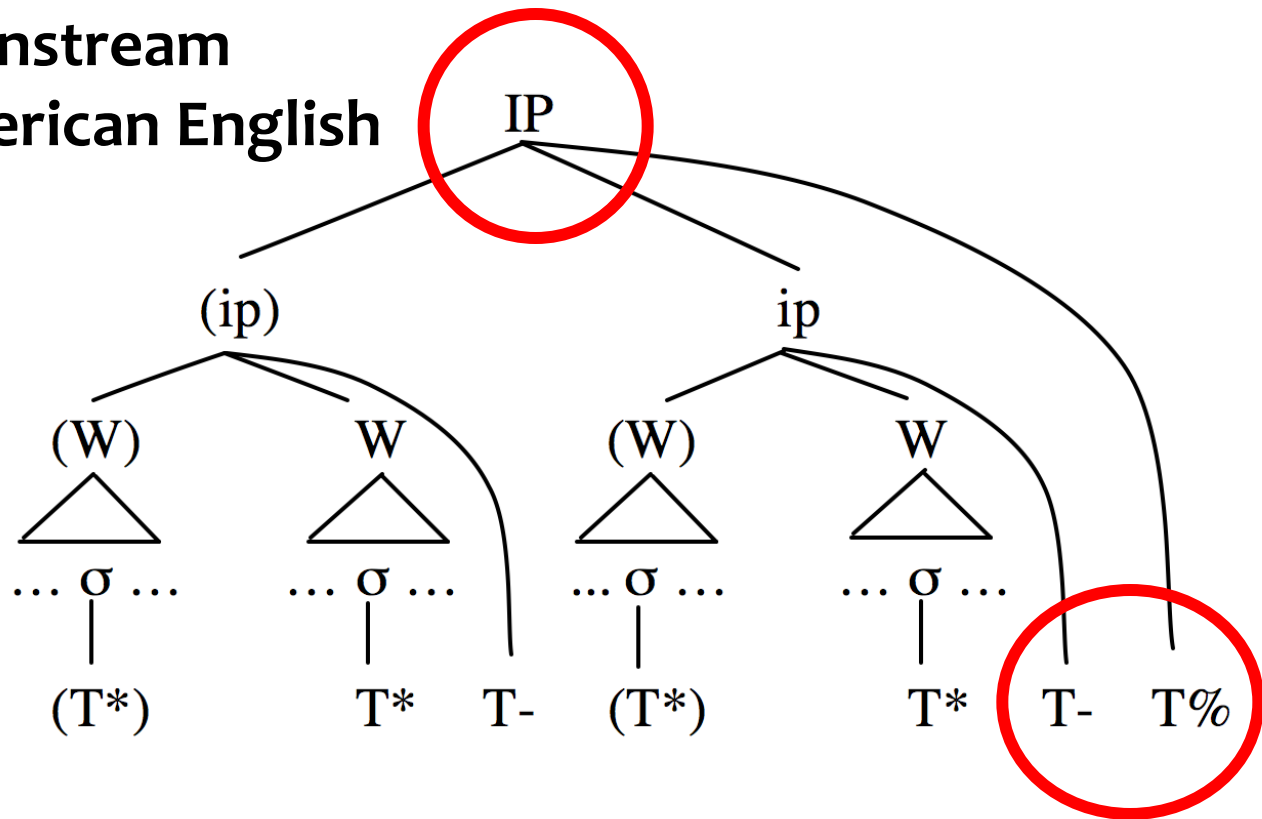
² Stern et al. 1982

Grammatical structure in intonation

- Intonation is also **grammatically structured**
 - **Finite inventory** of discrete tonal elements
 - **Hierarchical** prosodic structure
 - **Predictable variation** in tones (allotones)
 - **Phonotactic grammar** of licit tonal sequences
 - **Semantic/pragmatic** motivation for choice of tonal elements

Hierarchical prosodic structure

Mainstream
American English



Hypothesis

- Attentional/emotional context and grammar **jointly constrain** fo modulation
 - Prosodic choices within intonational grammar **motivated by attentional/emotional context**
 - Prosodic choices within attentional/emotional context **constrained by intonational grammar**

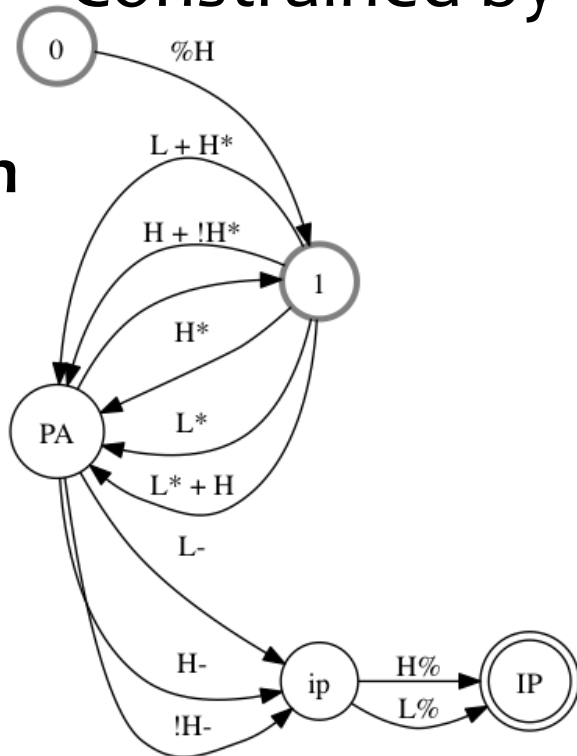


Attentional/emotional motivation

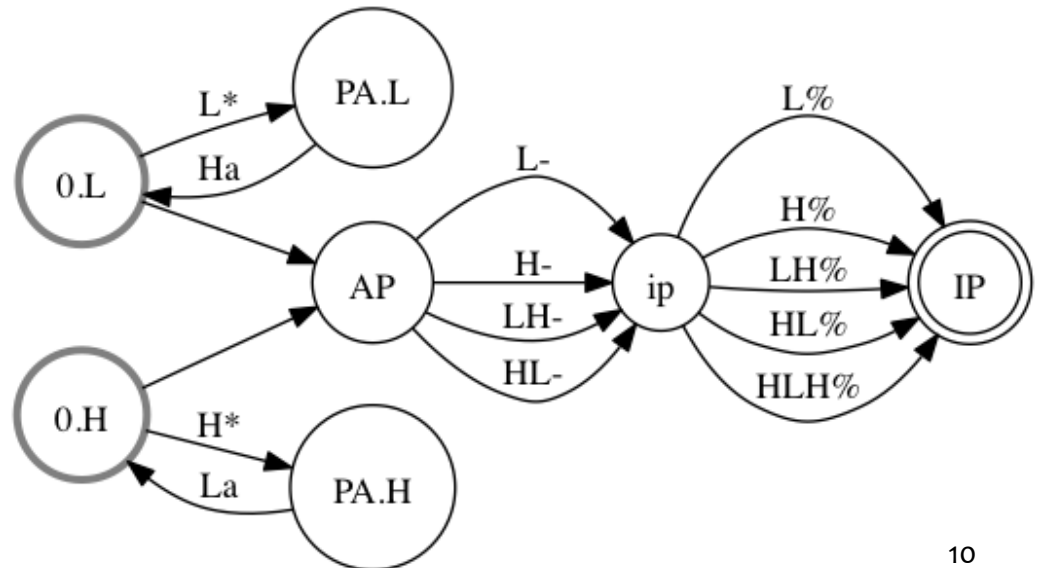
Increase in tonal categories with **higher targets** and **multiple turning points**

Constrained by lg-specific grammar

English



Bengali



Semantic/pragmatic motivation

- Increase in tonal categories **highlighting information structure**
- Constrained by lg-specific grammar
 - Bengali: 5 **pitch accents**
 - L* (low)
 - H* (high)
 - L*+H (rising)
 - fH* (super-H + compression)
 - L*+fH (super-H rising + cmp)
 - Bengali: 5 **boundary tones**
 - L% (low fall)
 - LH% (low rise)
 - H% (high rise)
 - HL% (high fall)
 - HLH% (high fall-rise)

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LH% (low rise)

H% (high rise)

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HLH% (high fall-rise)

These mark focus



Semantic/pragmatic motivation

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- Bengali: 5 **pitch accents**

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HLH% (high fall-rise)

These mark topics



Semantic/pragmatic motivation

○ Increase in tonal categories **highlighting information structure**

○ Constrained by lg-specific grammar

● Bengali: 5 **pitch accents**

L* (low)

H* (high)

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● Bengali: 5 **boundary tones**

L% (low fall)

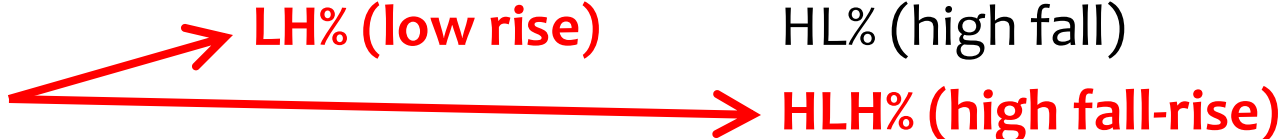
H% (high rise)

HL% (high fall)

LH% (low rise)

HLH% (high fall-rise)

These are continuation rises





Experimental design

Design: subjects

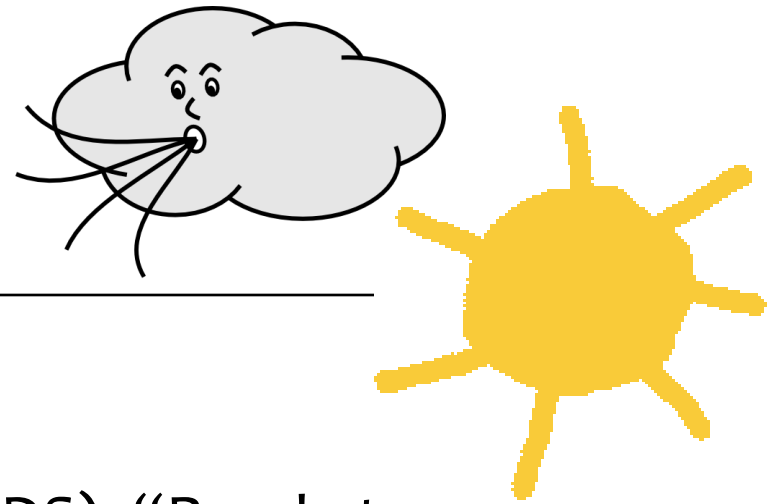
- 20 subjects
 - 10 speakers of English (5M, 5F)
 - 10 speakers of Bengali (5M, 5F)
- All were parents
 - English: parents of 4.5-mo-olds
 - Bengali: parents of young children

Design: materials

- Recorded “North Wind and Sun” fable
 - Suitable for adult speech and IDS
 - Similar semantics/pragmatics across languages
 - Consistent semantics, morphosyntax, segmental phonology across styles
 - Used in studies of speech rhythm & prosody

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: styles



○ Two styles

- **Default reading** (non-IDS): “Read at a comfortable pace.”
- **Simulated infant-directed reading** (IDS):
 - Same text, illustrated with childlike drawings
 - Stuffed animals arranged around speaker



Experiment: annotation

- English MAE_ToBI¹ annotation
 - 2 transcribers without knowledge of study
- Bengali B-ToBI² annotation
 - 1 transcriber so far (2nd author)

¹ Beckman et al. 2005

² Khan 2008, 2014

Analysis

- **Acoustic-phonetic measurements**
 - fo min, max, range, standard deviation
- **Phonological data collection**
 - Inventory of tones
 - Number of pitch accents and boundary tones
 - Frequency of different tonal categories
- **Statistics**
 - Mixed effects logistic and poisson regression



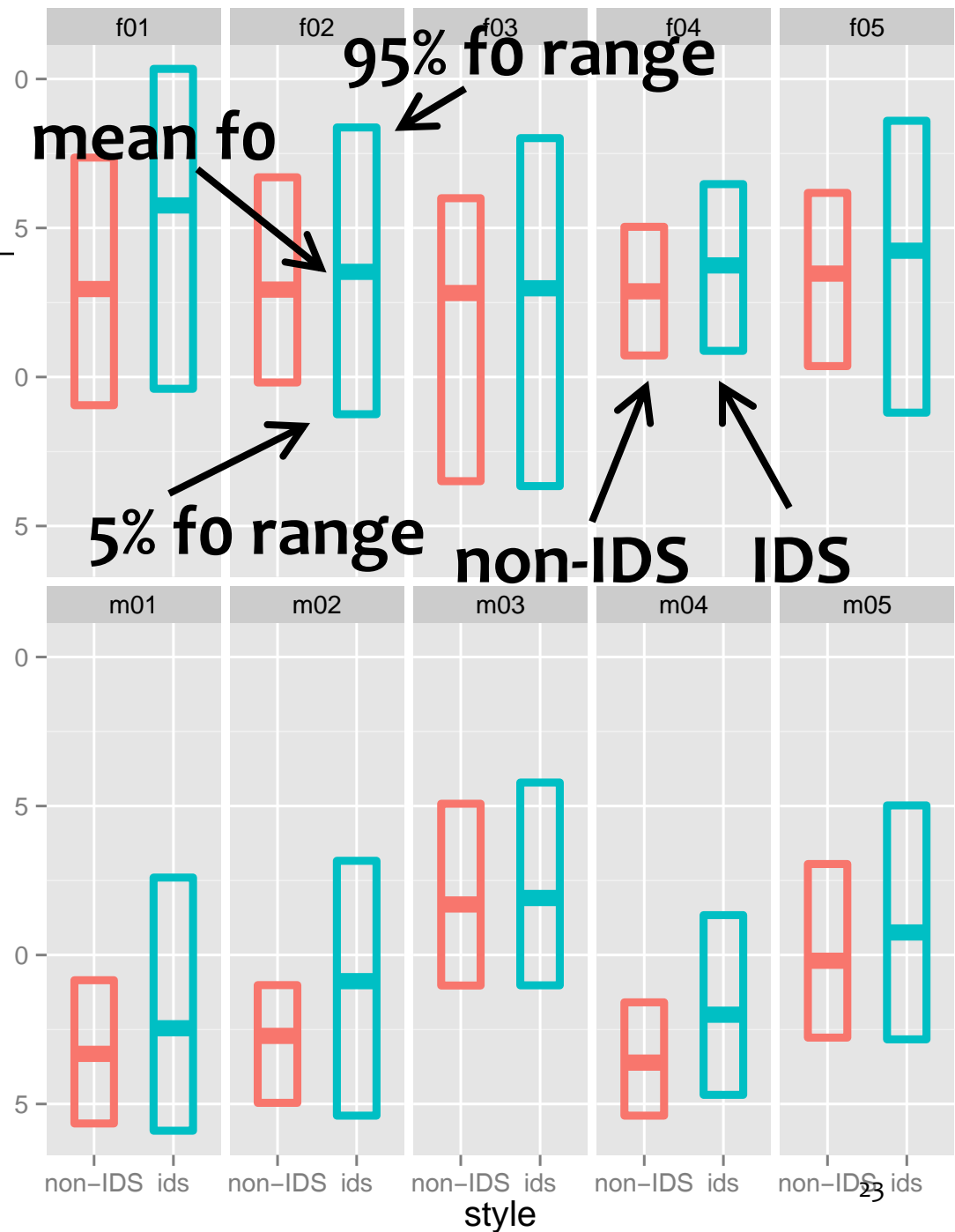
Results

Preview of results

- What's the **same across styles**:
 - 1) For each lg., IDS and non-IDS can both be analyzed using the **same prosodic model**
- What **differs across styles**:
 - 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 complex tones** ← we'll come back to this in the discussion

2) Pitch range

- All Bengali speakers **raised the fo max** in IDS
- **Higher fo variability** in IDS
- Same pattern seen in English
- Replicates previous studies
- **Validation of simulated IDS**



Preview of English-specific results

- English IDS involves:
 - Increase in **L+H*** pitch accent
 - Increase in **IPs**

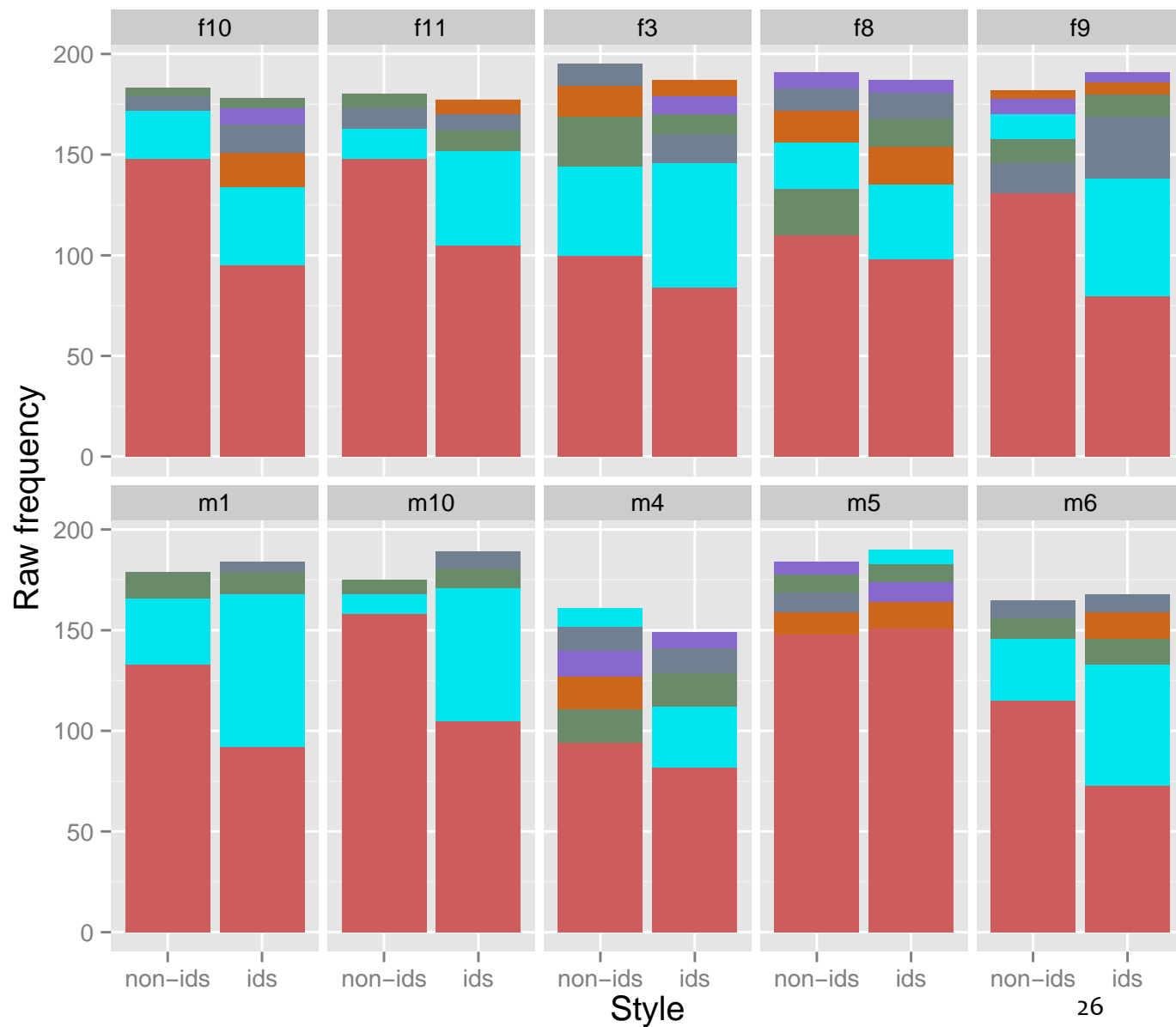
3) English: pitch accents

- **No change in number of PAs** between styles
- **Speakers increased the number and proportion of L+H* in IDS**
 - non-IDS 20.8% vs. IDS 30.1%

Frequency of tones conditioned on speaker and style, T1

Pitch accents: * (green), H* (red), H+!H* (grey), L* (orange), L*+H (purple), L+H* (cyan)

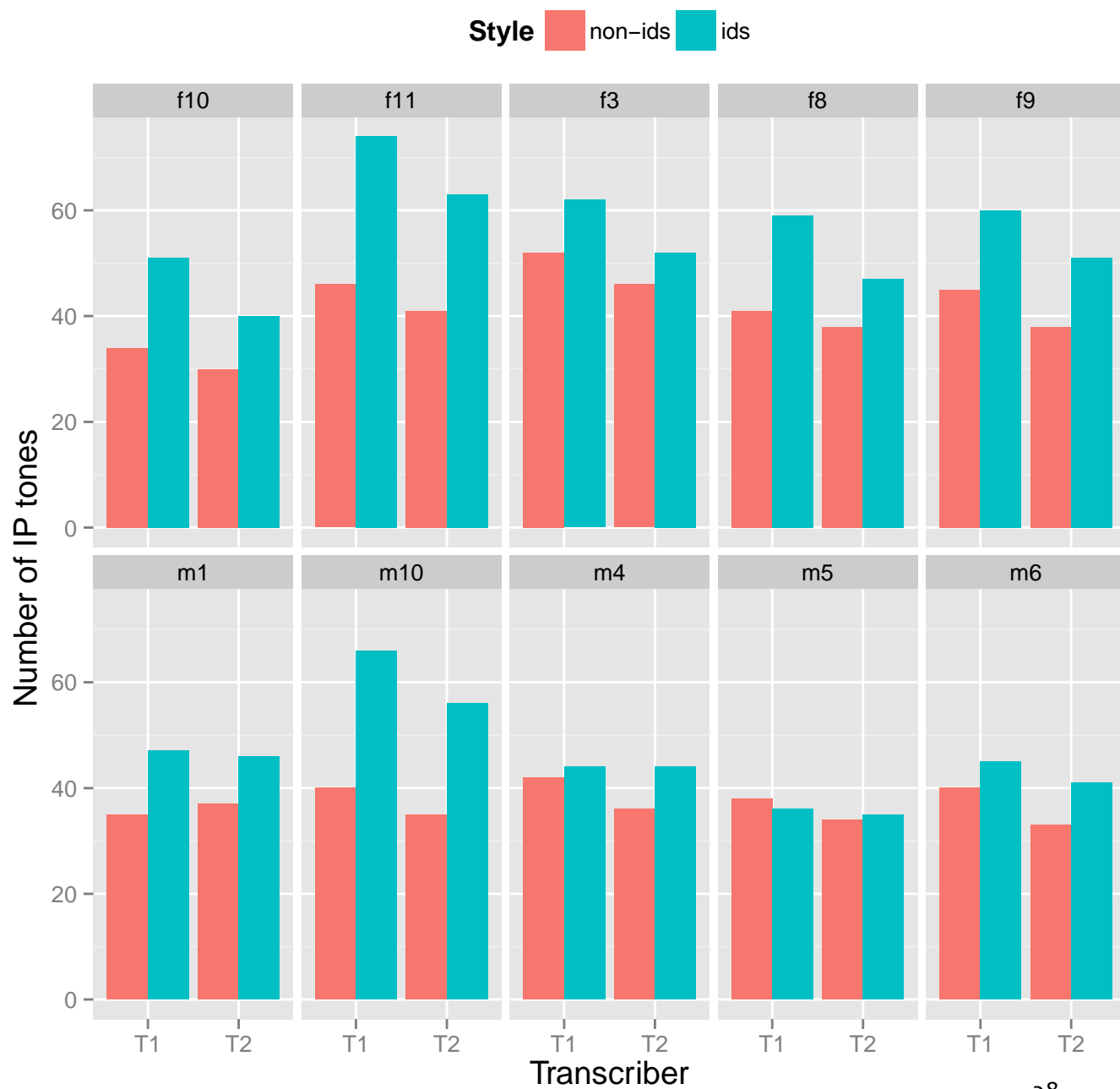
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4) English: IPs

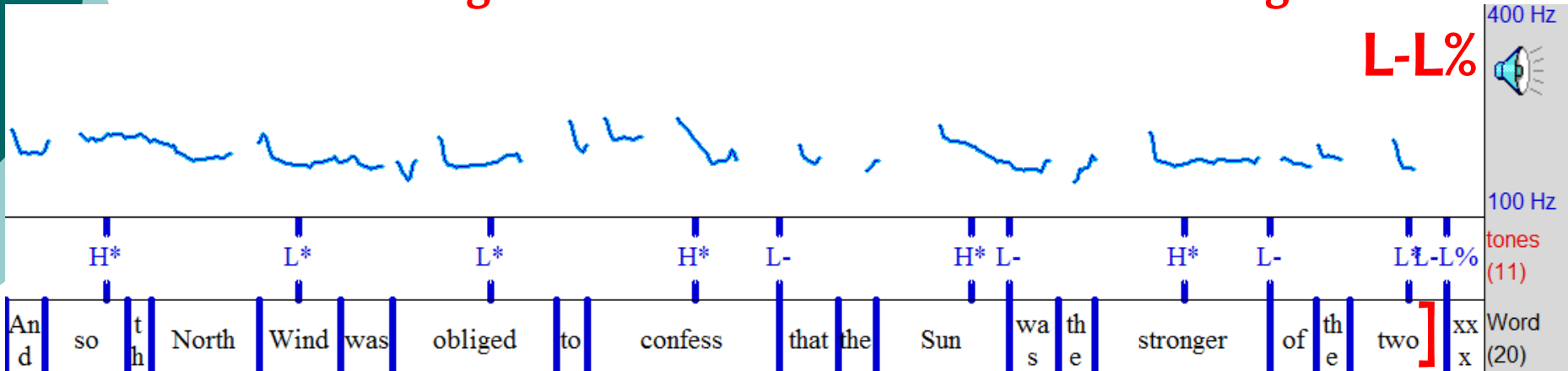
- On average, English speakers produced **30.5% (=12) more IPs in IDS**

by spkr.

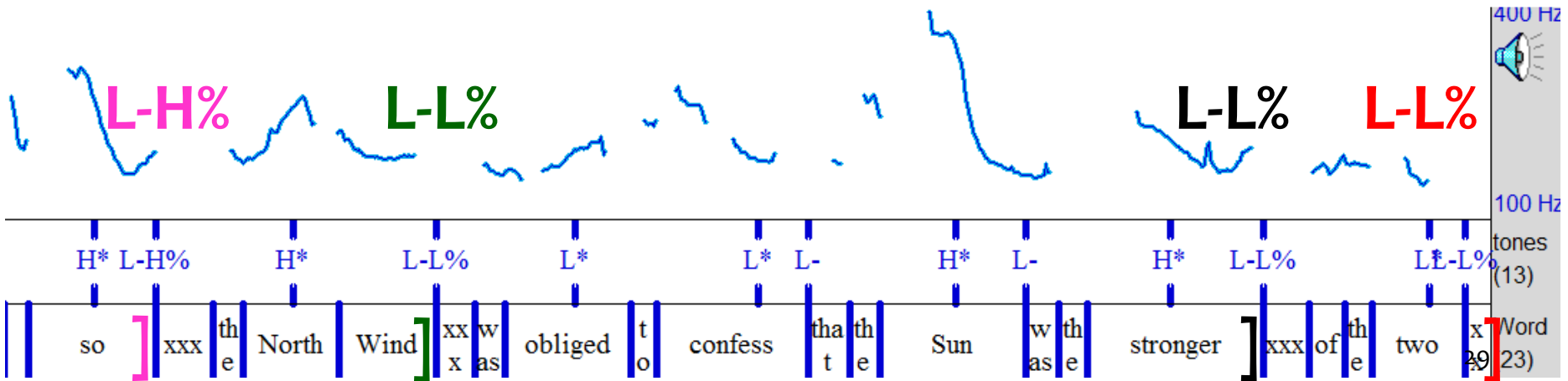


4) English: IPs

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



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



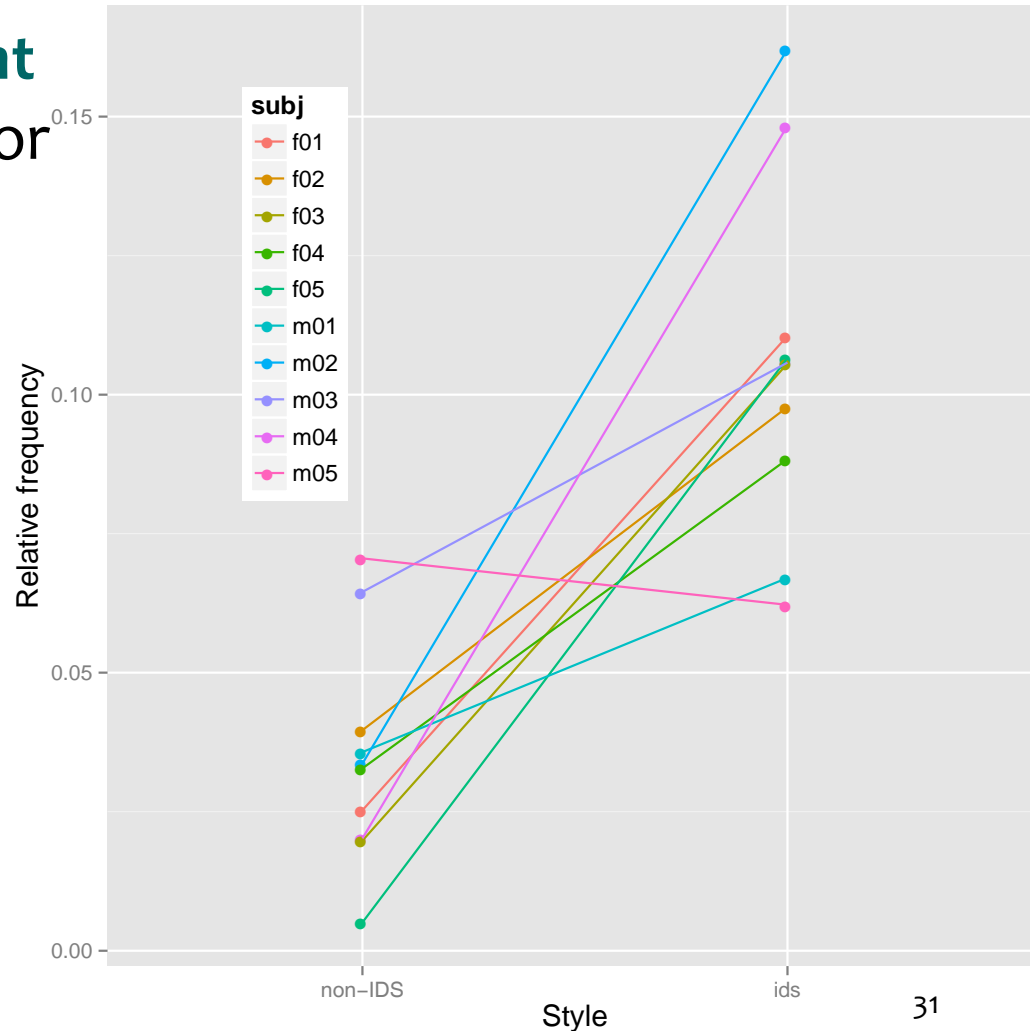
Preview of Bengali-specific results

- Bengali IDS involves:
 - **Decrease in pitch accents** overall
 - Increase in 2 PA types: **fH***, **L+fH***
 - Increase in **IPs**
 - Increase in **HL%** and **HLH% boundary tones**

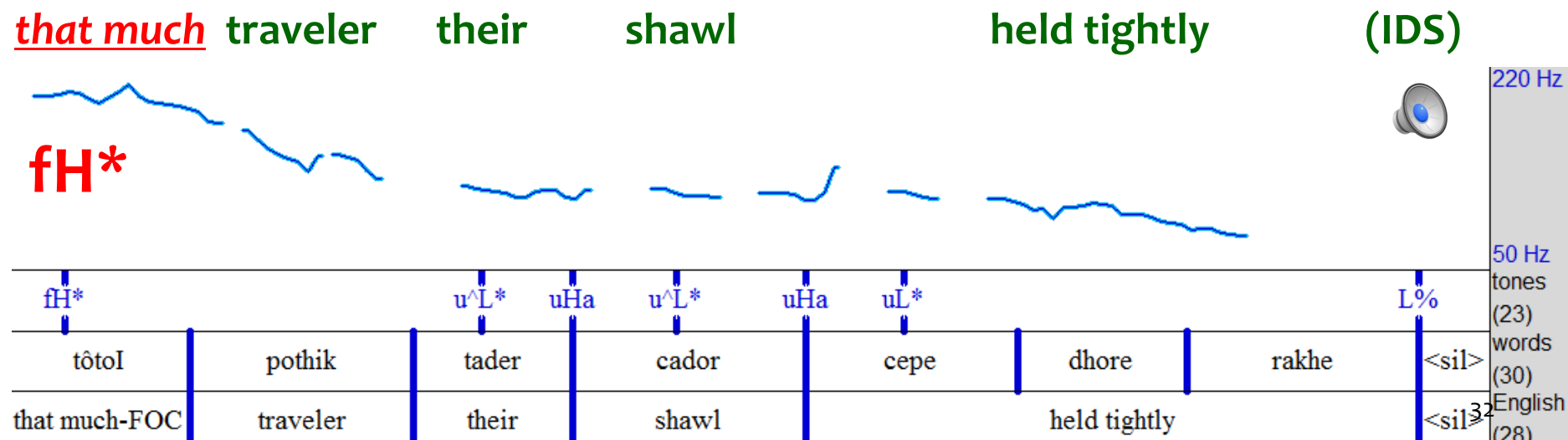
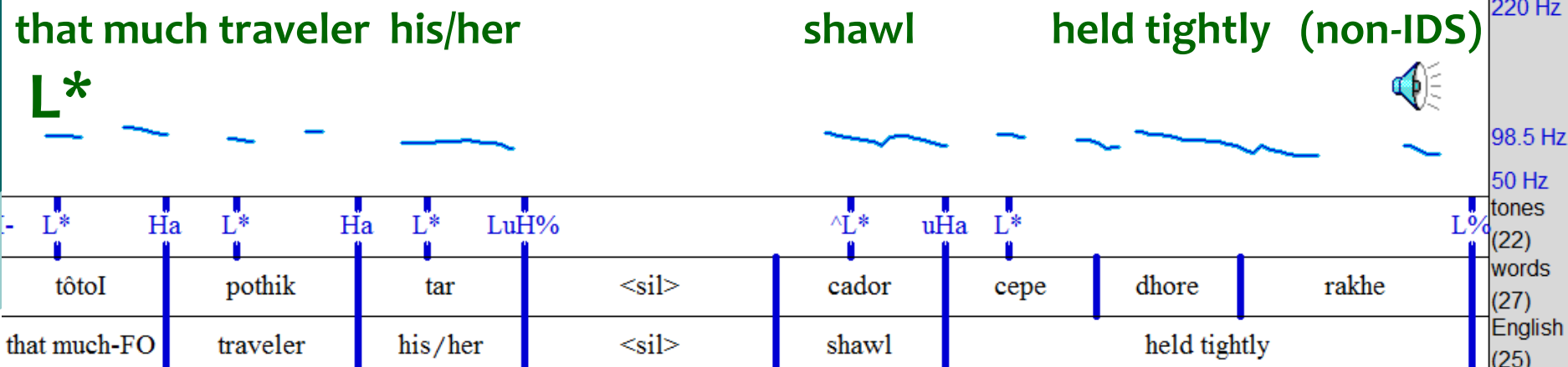
3) Bengali: pitch accents

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

- fH^*
- L^*+fH



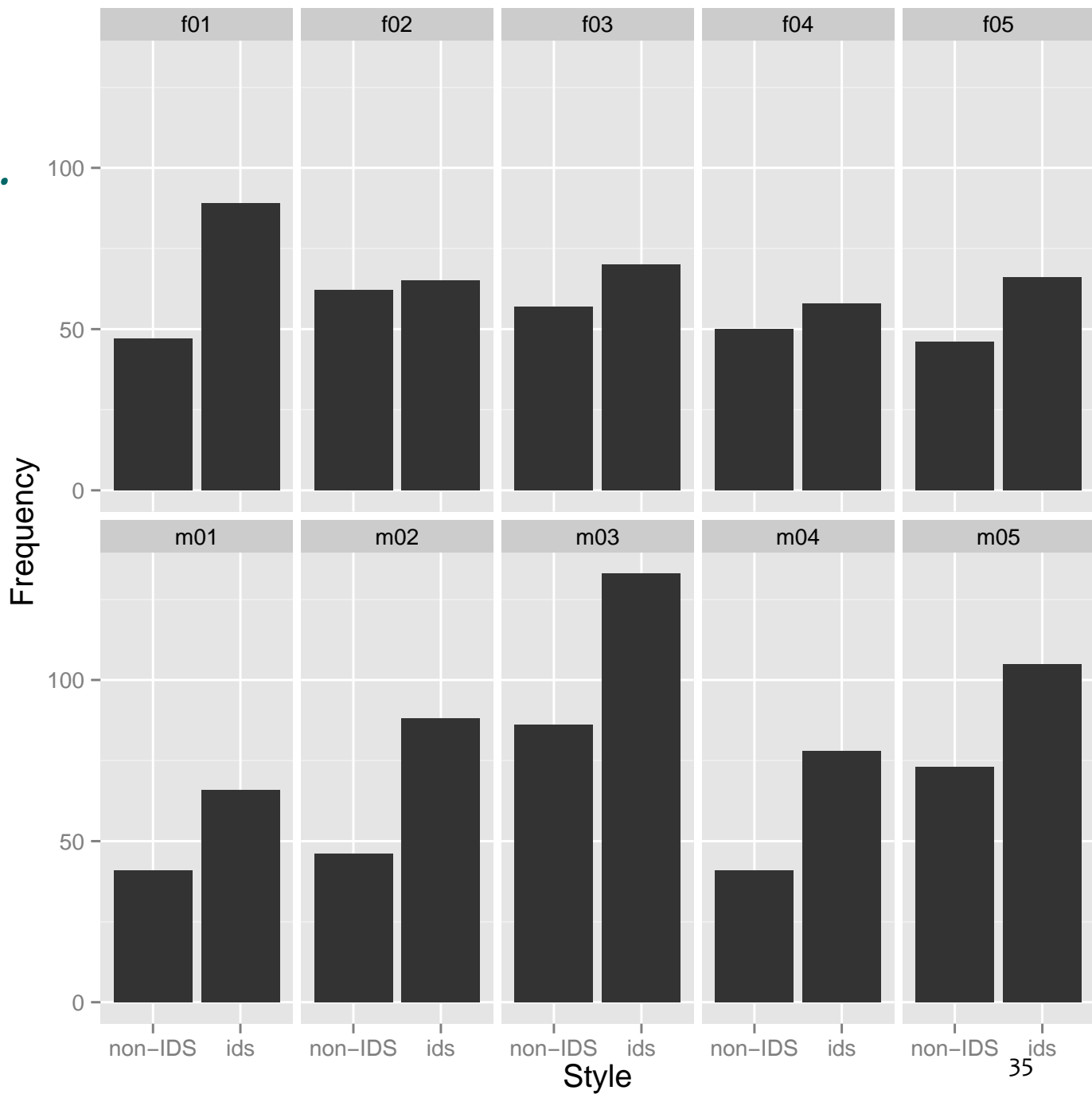
3) Bengali: pitch accents



4) Bengali: IPs

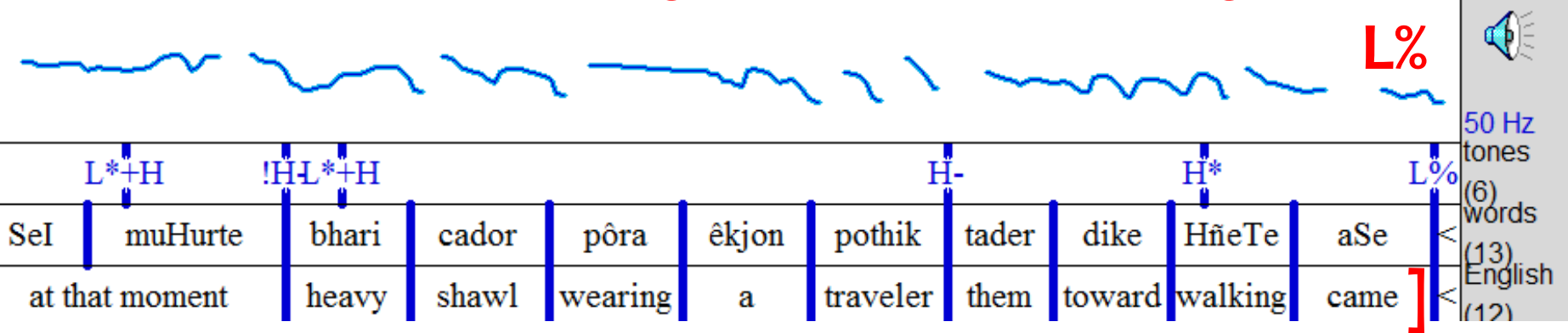
- On average, Bengali speakers produced **49.0% (= 8.97) more IPs in IDS**

by spkr.

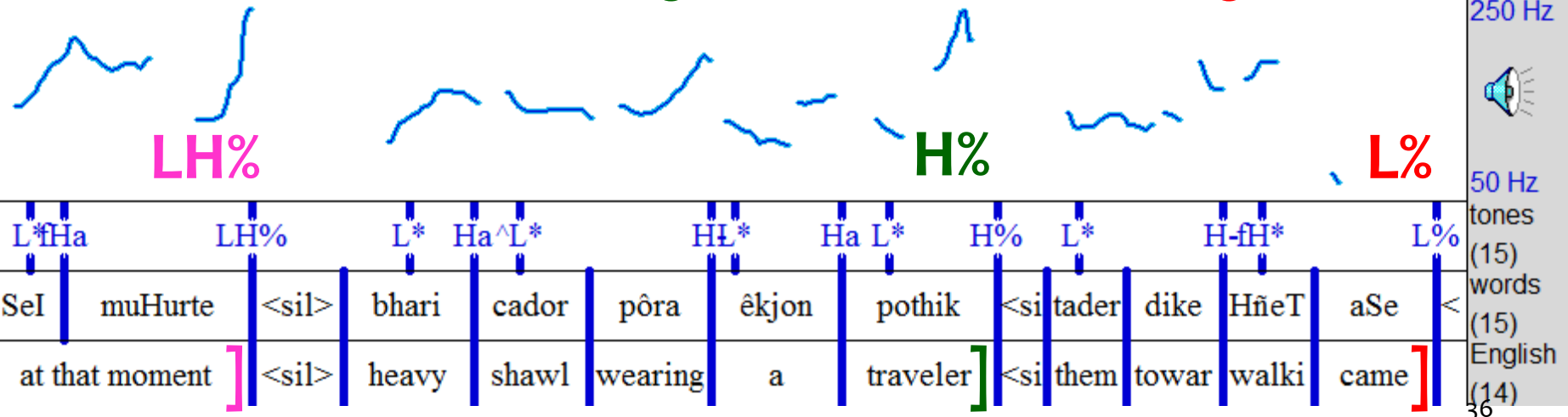


4) Bengali: IPs

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

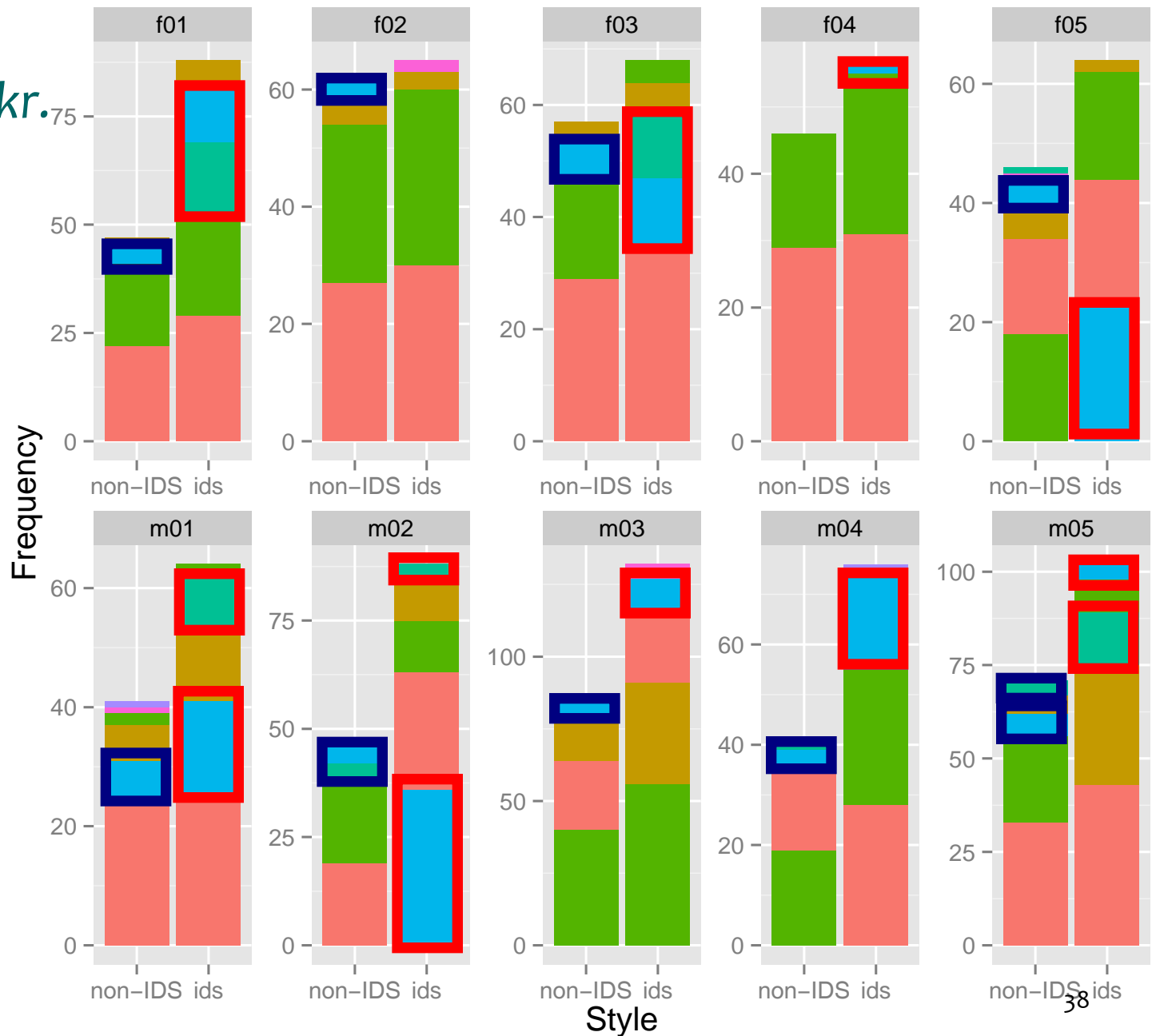


3) Bengali: boundary tones

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

IP tone L% H% LH% HL% HLH% M% ambig

by spkr.

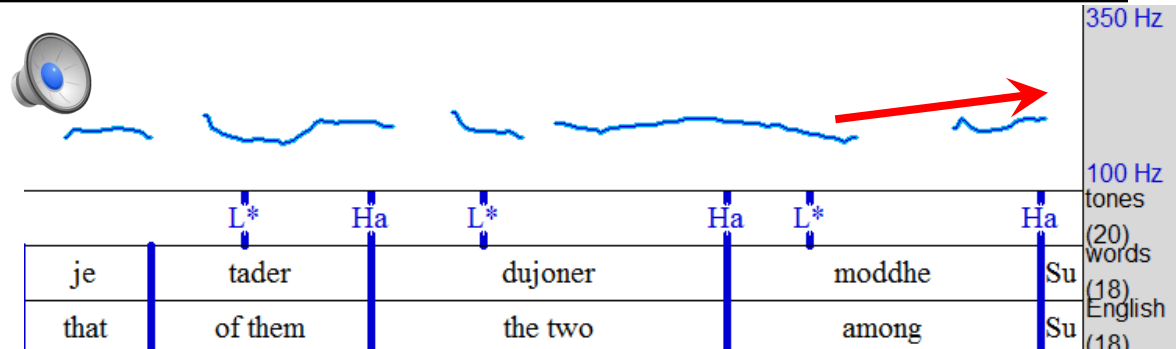


**HL%, HLH%
in non-IDS**

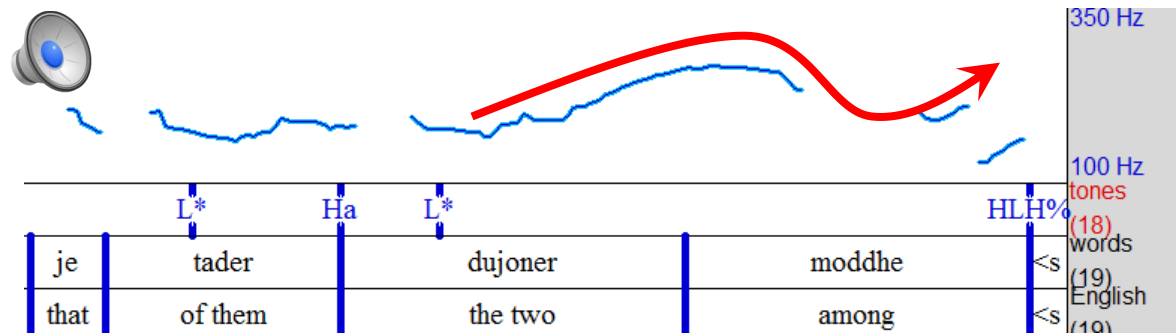
**HL%, HLH%
in IDS**

3) Bengali: boundary tones

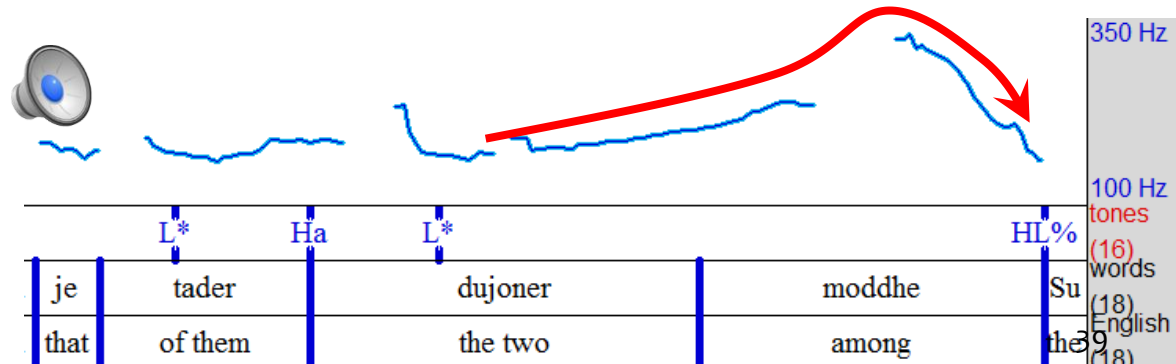
Ha in non-IDS
Default



HLH% in IDS
Continuation



HL% in IDS
Topicalization



Summary of results

- True for IDS in both languages:
 - No increase in number of PAs overall
 - Increase in number within **subset of PAs**
 - L+fH* and fH* in Bengali
 - L+H* in English
 - Increase in number of IPs
 - Certain boundary tones were more common
- So, why do we see **these** modifications?



Discussion

Why: PAs engage infant

- Why does IDS involve an **increase in non-default accents?**
 - English bitonal PAs, esp. L+H*
 - Bengali H*, fH*, and L*+fH
- **More pitch variation**, to engage the infant's interest¹
- **More tones involving expanded pitch range** as infants prefer higher pitch²

¹ Fernald 1991, Werker & McLeod 1989

² Kearsley 1973, Fernald & Kuhl 1981

Why: PAs mark info structure

- So why don't all pitch accents in IDS become high/rising?
- Change in distribution is **restricted**
- These particular high/rising tones mark **focused elements**¹

¹ Pierrehumbert & Hirschberg (1990) for English, Khan (2008, 2014) for Bengali

Why: PAs mark info structure

- Use of fH*, L*+fH in Bengali increases for:
 - **Wh-words**, words with **focus enclitics**
 - **Modifiers**, e.g. *warm, immediately*
- Use of L+H* in English increases for:
 - **Turning points** on subject arguments:
 - “... the North Wind gave up the attempt. Then the Sun shined out warmly.”
 - **Alternatives on a scale**, e.g. *more, stronger, first*

➔ **Greater use of focus prosody in IDS¹**

¹IDS also involves greater use of focus movement in the syntax (Fernald & Mazzie 1994).

Why: phrasing engages infant

- Why does IDS involve an **increase in IPs?**
- More IP boundary tones means **more tones involving expanded pitch range...**
- ...and **more pitch variation**

Why: phrasing marks info structure

- Why else does IDS involve **more IPs**?
- IP breaks help **demarkate syntactic structure**
- IP boundary tones convey **information structure**

Why: phrasing marks info structure

- Not all IP boundary tones are increased in use in IDS (at least in Bengali)
 - L% is less common in IDS
 - Those whose use is increased include:
 - LH%, HLH%: **continuation rises**
 - H%, HL%: **backgrounding/topicalization**
- More explicit marking of information structure in IDS**



Conclusions

Conclusions

- We compared **IDS vs. non-IDS**:
 - IDS has more tones with **greater pitch range and modulation**, which can elicit / maintain attention and build rapport
 - IDS has more explicit marking of **info structure**

Conclusions

- We compared **Bengali vs. English**:
 - Bengali uses more boundary tones with **more inflection points**
 - Bengali uses more **topic-marking** tones
 - English has more IPs in IDS, but **distribution of different boundary tones remains constant**

Conclusions

- Growing literature on **role of grammar in constraining IDS** in lexical tone/LPA lgs (Mandarin¹, Thai², Japanese³)
- First such study on languages without lexical tonal contrasts

Intonation is conditioned by both attentional/emotional motivations and grammatical structure

Acknowledgments

Many thanks to our transcribers, our speakers, and everyone in the audience!

অসংখ্য ধন্যবাদ!

[ʔsoŋk^ho d̪^{h̃}on:obaɖ̪]