Intonational phonology in Bengali and English infant-directed speech

Kristine M. Yu, University of Massachusetts Amherst
Sameer ud Dowla Khan, Reed College
Megha Sundara, University of California Los Angeles

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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 f0 range via raising of f0 max
  - Increase in f0 variability, e.g. sinusoidal, bell-shaped contours
  - Exaggeration of contours
- These manipulations maintain infant **attention**, elicit positive **emotional rapport**\(^2\)

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\(^2\) 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

[Diagram showing a hierarchical structure with labels for IP, (ip), (W), W, (W), and symbols for Σ, T*, T, and T%]
Hypothesis

- Attentional/emotional context and grammar *jointly constrain* f0 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 Ig-specific grammar
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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*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
Design: styles

- Two styles
  - Default reading (non-IDS): “Read at a comfortable pace.”
  - Simulated infant-directed reading (IDS): “Read as if speaking to your 4-mo-old child.”
    - Same text, illustrated with childlike drawings
    - Stuffed animals arranged around speaker
Experiment: annotation

- English MAE_ToBI\(^1\) annotation
  - 2 transcribers without knowledge of study
- Bengali B-ToBI\(^2\) annotation
  - 1 transcriber so far (2\(^{nd}\) 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)**
  3) IDS has a **higher proportion** of certain tones
  4) IDS has **more IPs**
  5) IDS has **more complex tones**

*expected*

*we’ll come back to this in the discussion*
2) Pitch range

- All Bengali speakers raised the f0 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%
by spkr.
4) English: IPs

- On average, English speakers produced 33.3% (=3.44) more IPs in IDS
by spkr.

Number of IP tones

Transcriber

Style non–ids ids

f10 f11 f3 f8 f9

m1 m10 m4 m5 m6

T1 T2 T1 T2 T1 T2 T1 T2 T1 T2
And so the NW was obliged to confess that the Sun was the stronger of the two.

And so the North Wind was obliged to confess that the Sun was the stronger of the two.

And so the North Wind 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

that much traveler  his/her  shawl  held tightly  (non-IDS)

that much traveler  their  shawl  held tightly  (IDS)

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by spkr.

fH*, L*+fH in non-IDS

fH*, L*+fH in IDS

Pitch accent

Style

Frequency

by spkr.
4) Bengali: IPs

- On average, Bengali speakers produced 49.0% (= 8.97) more IPs in IDS
by spkr.
At that moment a traveler wearing a heavy shawl came walking towards them.

Bengali: IPs

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

LH%
H%
L%
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)
by spkr.

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

**Frequency**

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

**Style**

- f01
- f02
- f03
- f04
- f05
- m01
- m02
- m03
- m04
- m05

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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:
  - 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 interest

- More tones involving expanded pitch range as infants prefer higher pitch

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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 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 IDS**

¹ IDS also involves greater use of focus movement in the syntax (Fernald & Mazzie 1991).
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 demarcate 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 (Mandarin\(^1\), Thai\(^2\), Japanese\(^3\))
○ First such study on languages without lexical tonal contrasts

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

\(^1\) Liu et al (2007), \(^2\) Kitamura et al. (2002), \(^3\) Igarashi et al (2013)
Acknowledgments

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অসংখ্য ধন্যবাদ!

[ʃonkʰo ḍʱonːobad]