The perception of boundary tones in infancy

Megha Sundara, Monika Molnar & Sónia Frota
UCLA, BCBL, Universidade de Lisboa
## Introduction

- Across languages, pitch can signal differences in word meaning (tone in Mandarin, pitch accent in Japanese) or mark prominence/edges of prosodic units (intonation)
- Development of infants’ pitch discrimination abilities:

<table>
<thead>
<tr>
<th>Lexical</th>
<th>No variability</th>
<th>Segmental variability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tone</strong></td>
<td>✔ At 4-mo</td>
<td>✔(?) only &gt; 6 months, native (Mandarin)</td>
</tr>
<tr>
<td></td>
<td>✔ &gt; 6-mo for tone learners</td>
<td></td>
</tr>
<tr>
<td></td>
<td>✗ &gt; 6-mo for non-tone learners</td>
<td></td>
</tr>
<tr>
<td><strong>Pitch accent</strong></td>
<td>--</td>
<td>✔ Japanese 4-mo (＆10-mo)</td>
</tr>
<tr>
<td><strong>Intonation</strong></td>
<td></td>
<td>✔ European Portuguese 5-mo (＆8-mo)</td>
</tr>
<tr>
<td>Boundary tones</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

Mattock & Burnham, 2006; Mattock et al., 2008; Yeung et al., 2013; Liu & Kager, 2014; Shi 2010; Sato et al. 2009; Frota et al. 2014
Introduction

- There is cross-linguistic variation in how the difference between statements and yes/no questions is marked.

<table>
<thead>
<tr>
<th>Language</th>
<th>Statement</th>
<th>Yes/no question</th>
<th>Cues</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>The ball is red. L%</td>
<td>Is the ball red?</td>
<td>LH% or H%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Word order</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intonation</td>
</tr>
<tr>
<td>Portuguese</td>
<td>A bola é vermelha. L%</td>
<td>A bola é vermelha?</td>
<td>LH%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intonation</td>
</tr>
<tr>
<td>Basque</td>
<td>Baloia gorria da. L%</td>
<td>Baloia gorria (al) da?</td>
<td>HL%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intonation</td>
</tr>
<tr>
<td>Northern</td>
<td>La pelota es roja. L%</td>
<td>La pelota es roja?</td>
<td>HL% or H%</td>
</tr>
<tr>
<td>Spanish</td>
<td></td>
<td></td>
<td>Intonation</td>
</tr>
</tbody>
</table>

Ladd 2008; Frota 2014; Elordieta & Hualde 2014; Hualde & Prieto 2015

Soderstrom et al., 2011; Geffen 2014; Frota et al., 2014
Research questions

- Can English-learning and Basque-learning infants discriminate **Portuguese boundary tones** (when all else is controlled)?

- Is Portuguese-learning 5-month-olds’ ability to categorize boundary tones in the face of **segmental variability** a consequence of their language experience, i.e. is their perception **language-specific**?

- Series of 4 experiments examining English-learning and Basque-learning infants’ discrimination of **non-native** pitch contrasts, before 6 months of age
**Method**

- **Procedure:** Modified version of the visual habituation paradigm (using a design identical to Frota et al., 2014; Habit X)

- Looking times to visual display were recorded and compared.

  If sensitive to the prosodic contrast, infants should display longer looking times to the different trials.
Method

- **Procedure:** Modified version of the visual habituation paradigm (using a design identical to Frota et al., 2014; Habit X)

<table>
<thead>
<tr>
<th>Expt</th>
<th>Infants’ language</th>
<th>Habit %</th>
<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expt1</td>
<td>English</td>
<td>60</td>
<td>Segmental variability</td>
</tr>
<tr>
<td>Expt2</td>
<td>English</td>
<td>60</td>
<td>No variability (only “lamu”)</td>
</tr>
<tr>
<td>Expt3</td>
<td>English</td>
<td>50</td>
<td>No variability (only “lamu”)</td>
</tr>
<tr>
<td>Expt4</td>
<td>Basque</td>
<td>60</td>
<td>Segmental variability</td>
</tr>
</tbody>
</table>

= Portuguese

If sensitive to the prosodic contrast, infants should display longer looking times to the different trials.
Method

- **Stimuli:** 16 segmentally varied, single prosodic-word utterances produced by a female native Portuguese speaker in infant-directed speech
  - Bisyllabic all-sonorant pseudo-words with initial stress

Experiment 1: English infants, segmental variability

- **Stimuli:** Segmentally varied, different pseudo-words used for habituation and test phase (a challenging environment for prosodic discrimination)

- **Procedure:** Habituated till looking time declined to 60% of the looking time to the first 4 trials

- **Participants**
  - 22 monolingual 4-month-olds
  (mean age = 127 days; range = 114:148; 12 girls)

Same as Frota et al. 2014, for Portuguese infants
Results: Unlike Portuguese infants, English-learning infants failed to discriminate Portuguese segmentally varied statements from questions.

Frota et al. 2014
Experiment 2: English infants, no segmental variability

- **Stimuli:** One token ( /lamu/ ) sequences presented as declarative (final fall) or interrogative (final rise) > task simplified by reducing segmental variability

- **Procedure:** same as Expt.1

- **Participants**
  - Another 22 monolingual 4-month-olds
  (mean age = 127 days; range = 111:153; 11 girls)
Results: English-learning infants failed again to discriminate Portuguese statements from questions.

Experiment 2: English infants, no segmental variability.
Experiment 3: English infants, no variability & sensitive procedure

- **Stimuli:** One token (/lamu/) sequences > task simplified by reducing segmental variability, as in Expt.2

- **Procedure:** More stringent habituation criterion – decline in looking time to 50% of looking time to the first 4 trials (> longer habituation time)

- **Participants**
  - Another 22 monolingual 4-month-olds
  (mean age = 128 days; range = 110:147; 10 girls)
Experiment 3: English infants, no variability & sensitive procedure

**Results**: English-learning infants were now able to discriminate Portuguese statements from questions.
Experiment 4: Basque infants, segmental variability

- **Goal:** To address the possibility that English infants' difficulties are simply due to the non-native nature of Portuguese stimuli > if so, Basque infants are expected to fail.

- **Stimuli:** *Segmentally varied*, as in Expt. 1

- **Procedure:** Same as Expt. 1

- **Participants**
  - 21 monolingual Standard Basque-learning 4-month-olds (mean age = 130 days; range = 114:134; 12 girls)

Same as Frota et al. 2014, for Portuguese infants.
**Experiment 4: Basque infants, segmental variability**

- **Results:** Basque-learning infants successfully discriminated Portuguese statements from questions, like their Portuguese peers.
Discussion

- English-learning infants **FAIL** to discriminate the EP statement/yes-no question contrast (succeed **only** with no variability & tested with a sensitive procedure)

- Basque-learning infants **successfully** distinguish Portuguese boundary tones with *segmental variability*, like Portuguese infants
  - English-learning infants’ difficulty is not simply due to non-native stimuli

- Native language experience influences the perception of boundary tones earlier in development (4-5 mo) than vowels, consonants or even lexical tone
Future directions

- Investigate the aspects of infants’ specific language experience that give rise to cross-linguistic differences in developmental patterns: potential candidates
  - Cues available in the language for the statement/question distinction: English ≠ Portuguese, Basque (and Spanish)
  - Extent of variability in pitch in English IDS
  - Possible influence from Spanish in Basque intonation patterns (if falling-rising contours in Spanish questions ≅ Portuguese)
Thanks to Joseph Butler, Sun-Ah Jun, Marina Vigário; the audiences of TIE6 (Utrecht), WILD 2015 (Stockholm), WELL 2015 (Lisbon); all that helped with data collection; and especially all the infants and caregivers that have taken part in this study.

Obrigada
Thank you