Early perception of the prosody of statements and questions

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Introduction: Questions and prosody across languages

- Languages differ in how the distinction between statements and yes-no questions is conveyed.

Morphosyntax

- e.g., English, Catalan (Ladd, 2008; Prieto & Rigau, 2007)

Intonation

- e.g., Vata, Shekgalagari (Hyman & Monaka, 2011; Rialland, 2007)

- e.g., Italian, Portuguese (Maiden & Robustelli, 2000; Mateus et al., 2003)
Introduction: Questions and prosody across languages

- Use of prosody (intonation) only, ∼second most frequent means to mark the distinction (Dryer, 2011)
- Although the functions of prosody are quite general across languages, prosodic cues are language-specific

- Final pitch (boundary tones)
  - Rising pitch (EP)
  - Falling pitch (Basque)
  - Low pitch (Chickasaw)

- Peak height
  - e.g., Balearic Catalan, Japanese (height of the rise)

- Peak alignment
  - e.g., Neapolitan Italian

- Focus, e.g. Portuguese

Lexical tone, e.g. Mandarin
Introduction: Questions and prosody across languages

- Romance languages: An illustration of intonational variation in signaling yes-no questions (Frota & Prieto, 2015)
Introduction: Questions and prosody across languages

- European Portuguese: Prosody only

Choveu? H+L* LH% / Choveu. H+L* L%
Introduction: Questions and prosody across languages

- European Portuguese (EP): Prosody only

Choveu? H+L* LH% / Choveu. H+L* L%

Did it rain? (Did it) rain?

(It has) rained

Intonation

MEANING
Introduction: Early perception of prosody

- The ability to identify forms of phonetic variation in speech that are relevant to meaning is essential to language development.
- Learning a language involves a stronger commitment to the native language as development proceeds, modulated by perceptual assimilation and phonetic salience (e.g., Kuhl 2004, Safran et al. 2006, Best & Roberts 2003, Narayan et al. 2010).
Introduction: Early perception of prosody

<table>
<thead>
<tr>
<th>Prosody</th>
<th>No variability</th>
<th>Segmental variability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td>✓</td>
<td>✗ only after 6 mos &amp; native</td>
</tr>
<tr>
<td>Tone</td>
<td>✓</td>
<td>✗? only after 6 months, native</td>
</tr>
<tr>
<td>Pitch accent</td>
<td></td>
<td>✓ as early as 4 mos, for Japanese learners</td>
</tr>
<tr>
<td>Tune</td>
<td>✓</td>
<td>✓ as early as 5 mos, Portuguese learners (native)</td>
</tr>
</tbody>
</table>

Some pitch contrasts perceived very early on, if native

Skoruppa et al. 2013; Mattock & Burnham, 2006; Mattock et al., 2008; Yeung et al., 2013; Liu & Kager, 2014; Brouwer & Fikkert, 2017; Shi 2010; Sato et al. 2009; Frota et al. 2014
Basic/frequent sentence types: Ability to distinguish between them is crucial (Frazier, Gelman, & Wellman, 2009; Koegel et al, 2010; Tyack & Ingram, 1977)
- Process the input the child is exposed to
- Communication and social interaction

Prosodic discrimination ability
- Prerequisite for the acquisition of statement/yes-no question categories

Little is known about infants’ perception of intonation
Introduction

- **Research questions**
  - Does early perception of intonation support precocious discrimination abilities for pitch contrasts (as in the case of pitch accent)?
  - To what extent is early sensitivity to pitch contrasts independent from/dependent on the native language?
  - Does the nature of the pitch cues matter?

- **Implications** for the acquisition of linguistic categories cued by prosody
Overview

1. Early discrimination studies
   - Study 1: native Statement vs. Yes-no question (EP)
   - Study 2: English-learning and Basque-learning infants’ perception of the EP sentence type distinction
   - Study 3: EP-infants’ perception of a lexical tone sequence contrast (Mandarin) and a lexical pitch accent contrast (Japanese)

2. Novel word learning and intonation – study 4

3. Other linguistic contrasts cued by prosody
   - Study 5: Broad vs. Narrow focus (EP: peak alignment)

4. General discussion
1. Early discrimination: Method

- **Procedure**
  - Modified version of the visual habituation paradigm (Stager & Werker, 1997)
  - Looking times to visual display were recorded and compared
  - If sensitive to the prosodic contrast, infants should display longer listening times to the novel (different) trials
1. Early discrimination: Study 1

- **The statement/yes-no question distinction**

  - Yes-no questions are string identical to statements (Mateus et al. 2003)
  - **Main cue final pitch**: statement: H+L*L%; question: H+L*LH%
  - Longer durations of nuclear and post-nuclear syllables in questions
  - Higher first peak in questions is optional (Frota 2002)
  - The prosodic contrast is perceived by adult native speakers (Falé & Faria 2005)

_Frota, Butler & Vigário (2014) Infancy, 19(2), 194-213_
1. Early discrimination: Study 1 statement/yes-no question

- **Materials:** Segmentally varied, single pseudo-word utterances produced by a female native speaker in infant-directed speech

<table>
<thead>
<tr>
<th>Acoustic analysis</th>
<th>Statements</th>
<th>Questions</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 Peak height 1st syll (Hz)</td>
<td>255</td>
<td>255</td>
<td>.16, p = .91</td>
</tr>
<tr>
<td>F0 range 1st syll (Hz)</td>
<td>67</td>
<td>66</td>
<td>0.12, p = .9</td>
</tr>
<tr>
<td>F0 range 2nd syll (Hz)</td>
<td>-25</td>
<td>192</td>
<td>23.46, p &lt; .001</td>
</tr>
<tr>
<td>Final F0 (Hz)</td>
<td>163</td>
<td>380</td>
<td>23.61, p &lt; .001</td>
</tr>
<tr>
<td>Duration (ms)</td>
<td>529</td>
<td>765</td>
<td>11.91, p &lt; .001</td>
</tr>
</tbody>
</table>
1. Study 1: Native discrimination of statement/yes-no question

- Participants
  - 40 infants (from monolingual homes in the Lisbon area) split into two age groups: 5-6 months, 8-9 months
    - 20 younger (8 female, M = 5 months 29 days, range 5 months 3 days – 6 months 23 days)
    - 20 older (10 females, M = 8 months 12 days, range 7 months 11 days-9 months 29 days)
1. Study 1: Native discrimination of statement/yes-no question

- Results: Both age groups display longer listening times to the novel test trials

ANOVA: within-subject factor trial type (familiar/novel) and two between-subject factors age group (younger/older) and habituation (statement/question).

- Significant difference between same and switch test trials ($F(1,36) = 54.18$, $p < .001$, $\eta^2 = .6$)

- No effect of age group ($F(1,36) = 2.13$, $p = .15$, $\eta^2 = .06$)

- No effect of habituation ($F(1,36) = 2.02$, $p = .16$, $\eta^2 = .05$)

- No significant interactions (trial type x age group $F(1,36) = 3.29$, $p = .08$, $\eta^2 = .08$; other, $F(1,36)<1$).

Paired T-tests: significant difference between same and switch trials for younger ($t(19) = 6.1$, $p < .001$, $d = 1.474$) and older ($t(19) = 4.42$, $p < .001$, $d = 0.816$) groups.

Infants are able to discriminate utterances that differ only in the prosodic features that cue statements and questions, as early as 5 months, in the presence of segmental variability.
1. Early discrimination: Study 2

**Non-native discrimination: English-learning and Basque-learning infants’ perception of the EP sentence type distinction**

<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.</td>
<td>Is the ball red?</td>
<td>Word order</td>
</tr>
<tr>
<td></td>
<td>L%</td>
<td>LH% or H%</td>
<td>Intonation</td>
</tr>
<tr>
<td>Portuguese</td>
<td>A bola é vermelha.</td>
<td>A bola é vermelha?</td>
<td>Intonation</td>
</tr>
<tr>
<td></td>
<td>L%</td>
<td>LH%</td>
<td></td>
</tr>
<tr>
<td>Basque</td>
<td>Baloia gorria da.</td>
<td>Baloia gorria (al) da?</td>
<td>Intonation</td>
</tr>
<tr>
<td></td>
<td>L%</td>
<td>HL%</td>
<td></td>
</tr>
<tr>
<td>Northern Spanish</td>
<td>La pelota es roja.</td>
<td>La pelota es roja?</td>
<td>Intonation</td>
</tr>
<tr>
<td></td>
<td>L%</td>
<td>HL% or H%</td>
<td></td>
</tr>
</tbody>
</table>

Sundara, Molnar & Frota (2015) 18th ICPhS, in progress

Ladd 2008; Frota 2014; Elordieta & Hualde 2014; Hualde & Prieto 2015
1. Early discrimination: Study 2

**Non-native discrimination: English-learning and Basque-learning infants’ perception of the EP sentence type distinction**

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<tr>
<td></td>
<td>L%</td>
<td></td>
<td>Intonation</td>
</tr>
<tr>
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<td>A bola é vermelha.</td>
<td>A bola é vermelha?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L%</td>
<td>LH%</td>
<td>Intonation</td>
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</tr>
<tr>
<td></td>
<td>L%</td>
<td>HL%</td>
<td>Intonation</td>
</tr>
<tr>
<td>Northern Spanish</td>
<td>La pelota es roja.</td>
<td>La pelota es roja?</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>HL%</td>
<td></td>
<td>Intonation</td>
</tr>
</tbody>
</table>

Sundara, Molnar & Frota (2015) 18th ICPhS, in progress

Soderstrom et al. 2011; Geffen, 2014; Geffen & Mintz, 2014
1. Non-native discrimination: Study 2
English infants, EP statement/yes-no question

- **Participants**

  - 22 infants (from English homes in the Los Angeles area): 4 months
    - 12 female, M = 127 days,
    - Range 114 days – 148 days

- From the literature on infant perception, no differences in discrimination abilities are expected between 4 and 5-month olds (Sato et al. 2009, for lexical pitch accent [HL / LH]; Yeung et al. 2013 for lexical tone [high-rising/mid level] also Weikum et al. 2007 for visual language discrimination)
1. Non-native discrimination: Study 2
English infants, EP statement/yes-no question

- Results: Unlike EP-infants, English-learning infants fail to discriminate the statement/question contrast

ANOVA: Habituation Condition (statement, question) and Trial-type (familiar, novel) as the independent variables and listening time as the dependent variable

- No effect of Habituation $F(1, 20)=0.003, p=0.9$
- No effect of Trial type $F(1, 20)=3.5, p=0.07$
- No interaction $F(1, 20)=1.1, p=0.3$

English infants do NOT show an early sensitivity to the prosodic features that cue statements and questions in EP, in the presence of segmental variability.
1. Non-native discrimination: Study 2
Basque infants, EP statement/yes-no question

- Adresses 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

- Participants
  - 21 monolingual Standard Basque-learning 4-month-olds
    - 12 female, M = 130 days,
    - Range 114 days – 134 days
1. Non-native discrimination: Study 2
Basque infants, EP statement/yes-no question

- Results: Unlike English-learning infants, Basque-learning infants are successful

ANOVA: Habituation Condition (statement, question) and Trial-type (familiar, novel) as the independent variables and listening time as the dependent variable

- Significant effect of Trial type $F(1, 19)=6.7$, $p=0.02$
- Also a main effect of Habituation $F(1, 19)=5.2$, $p=0.03$
- No interaction $F(1, 19)=.6$, $p=0.4$

Basque infants successfully categorized EP statements and questions, like their Portuguese peers
1. Early discrimination: Study 2

Summary

- Non-native discrimination: English-learning and Basque-learning infants’ perception of the EP statement/question distinction

<table>
<thead>
<tr>
<th>Language</th>
<th>Cues</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Word order, Intonation</td>
<td>✗</td>
</tr>
<tr>
<td>Portuguese (Northern Spanish)</td>
<td>Intonation</td>
<td>✓</td>
</tr>
<tr>
<td>Basque (Northern Spanish)</td>
<td>Intonation</td>
<td>✓</td>
</tr>
</tbody>
</table>

- English-learning infants’ difficulty is not simply due to non-native nature of the stimuli
- Native language experience influences the perception of pitch contrasts (boundary tones) early in development
1. Early discrimination: Study 3

Non-native discrimination: EP-learning infants’ perception of Mandarin tone and Japanese pitch accent contrasts: all **falling/low vs. rising/high** contrasts

<table>
<thead>
<tr>
<th>Language</th>
<th>Statement(-like)</th>
<th>Question(-like)</th>
<th>Prosody</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portuguese</td>
<td>H+L* L%</td>
<td>H+L* LH%</td>
<td>Intonation (phrasal)</td>
</tr>
<tr>
<td>Mandarin Chinese</td>
<td>Tone 1 + Tone 4</td>
<td>Tone 1 + Tone 2</td>
<td>Tone (mora/syllable)</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HL</td>
<td>LH</td>
<td></td>
</tr>
<tr>
<td>Japanese</td>
<td>HL pattern</td>
<td>LH pattern</td>
<td>Pitch accent (word)</td>
</tr>
</tbody>
</table>

Wang et al., 2001; Braun & Johnson, 2011; Broselow et al. 1987; Sato, Sogabe & Mazuka, 2009
1. Early discrimination: Study 3

Frota, Butler, Lu & Vigário (2016) Speech Prosody, in progress

- Non-native discrimination: EP-learning infants’ perception of Mandarin tone and Japanese pitch accent contrasts: all falling/low vs. rising/high contrasts

General early sensitivity to pitch contrasts predicts early discrimination

Similar overall contour shapes predict early discrimination

Effects of language experience predict NO discrimination

Pitch accent contrast expected to be closer to the tune than the lexical tone contrast
1. Early discrimination: Study 3
EP infants, Mandarin T1+T4 / T1+T2

- **Materials:** Segmentally varied bisyllabic (pseudo-)word produced by a female native speaker of Mandarin (C, V=EP)

### Acoustic analysis

<table>
<thead>
<tr>
<th></th>
<th>Tones14</th>
<th>Tones12</th>
<th>t-test</th>
<th>t-test (EP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 Peak height 1\textsuperscript{st} syll (Hz)</td>
<td>306</td>
<td>306</td>
<td>.172, $p = .87$</td>
<td>.16, $p = .91$</td>
</tr>
<tr>
<td>F0 range 1\textsuperscript{st} syll (Hz)</td>
<td>11</td>
<td>10</td>
<td>.74, $p = .47$</td>
<td>.012, $p = .9$</td>
</tr>
<tr>
<td>F0 range 2\textsuperscript{nd} syll (Hz)</td>
<td>-103</td>
<td>35</td>
<td>34.94, $p &lt; .001$</td>
<td>23.46, $p &lt; .001$</td>
</tr>
<tr>
<td>Final F0 (Hz)</td>
<td>205</td>
<td>284</td>
<td>28.16, $p &lt; .001$</td>
<td>23.61, $p &lt; .001$</td>
</tr>
<tr>
<td>Duration (ms)</td>
<td>763</td>
<td>801</td>
<td>4.87, $p &lt; .01$</td>
<td>11.91, $p &lt; .001$</td>
</tr>
</tbody>
</table>
1. Early discrimination: Study 3
EP infants, Mandarin T1+T4 / T1+T2

- **Materials:** Segmentally varied bisyllabic (pseudo-)word produced by a female native speaker of Mandarin

<table>
<thead>
<tr>
<th>Tones 14</th>
<th>Stat/Quest</th>
<th>t-test Man/EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 patterns 1(^{st}) syll</td>
<td>H / H</td>
<td>HL / HL</td>
</tr>
<tr>
<td>F0 patterns 2(^{nd}) syll</td>
<td>HL / HLH</td>
<td>L / LH</td>
</tr>
<tr>
<td>F0 range 2(^{nd}) syll (Hz)</td>
<td>103/35</td>
<td>25/192</td>
</tr>
<tr>
<td>Duration 1(^{st}) syll (ms)</td>
<td>270/279</td>
<td>310/397</td>
</tr>
<tr>
<td>Duration 2(^{nd}) syll (ms)</td>
<td>493/522</td>
<td>310/437</td>
</tr>
</tbody>
</table>

**Pitch height / direction**

Differences between the EP and Mandarin prosodic contrasts
1. Non-native discrimination: Study 3
EP infants, Mandarin T1+T4 / T1+T2

- Participants

  - 40 infants (from monolingual homes in the Lisbon area) split into two age groups: 5-6 months, 8-9 months (as in Study 1)
    - 20 younger (8 female, M = 5 months 25 days, range 5 months 2 days – 6 months 19 days)
    - 20 older (10 females, M = 8 months 21 days, range 7 months 13 days-10 months 8 days)

Effects of language experience predict NO discrimination
Similar overall contour shapes predict early discrimination
General early sensitivity to pitch-based contrasts predicts early discrimination
1. Non-native discrimination: Study 3
EP infants, Mandarin Tones 14 / 12

- **Results:** Unlike in the intonation contrast, EP infants fail to discriminate the lexical tone contrast.

ANOVA: Habituation Condition (statement, question) and Trial-type (familiar, novel) as the independent variables and listening time as the dependent variable.

**Younger**
- No effect of Trial type ($F(1,18) = .07, P = .79, \eta^2 = .00$);
- No effect of hab ($F(1,18) = .21, p = .65, \eta^2 = .01$);
- No interaction ($F(1,18) = .93, p = .35, \eta^2 = .05$)

**Older**
- No effect of Trial type ($F(1,18) = 1.45, p = .25, \eta^2 = .07$);
- No effect of hab ($F(1,18) = .13, p = .72, \eta^2 = .01$);
- No interaction ($F(1,18) = .52, p = .48, \eta^2 = .03$)

EP-learning infants do NOT show an early sensitivity to the prosodic features that cue the Mandarin Tone contrast, in the presence of segmental variability.
1. Early discrimination: Study 3
EP infants, Japanese HL and LH word patterns

**Materials:** Segmentally varied bisyllabic (pseudo-)word produced by a female native speaker of Japanese (C, V=EP)

<table>
<thead>
<tr>
<th></th>
<th>HL/LH</th>
<th>Stat/Quest</th>
<th>t-test Jap/EP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F0 patterns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st syll</td>
<td>H / L</td>
<td>HL / HL</td>
<td>-</td>
</tr>
<tr>
<td>2nd syll</td>
<td>L / LH</td>
<td>L / LH</td>
<td>-</td>
</tr>
<tr>
<td><strong>F0 range</strong></td>
<td>122/75</td>
<td>25/192</td>
<td><em>p &lt; .001 / p &lt; .001</em></td>
</tr>
<tr>
<td>2nd syll (Hz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>141/165</td>
<td>310/397</td>
<td><em>p &lt; .01 / p &lt; .001</em></td>
</tr>
<tr>
<td>1st syll (ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd syll (ms)</td>
<td>190/232</td>
<td>310/437</td>
<td><em>p &lt; .001 / p &lt; .01</em></td>
</tr>
</tbody>
</table>

(materials from Sato, Sogabe & Mazuka 2009)
1. Non-native discrimination: Study 3
EP infants, Japanese HL and LH word patterns

- Participants

  48 infants (from monolingual homes in the Lisbon area) split into two age groups: 5-6 months, 8-9 months (as in Study 1)
  - 24 younger (11 female, M = 6 months 3 days, range 4 months 28 days – 7 months 11 days)
  - 24 older (13 females, M = 9 months 3 days, range 7 months 19 days-10 months 20 days)

Effects of language experience predict NO discrimination

Similar overall contour shapes predict early discrimination

Pitch accent contrast expected to be closer to the tune than the lexical tone contrast

General early sensitivity to pitch-based contrasts predicts early discrimination
1. Non-native discrimination: Study 3
EP infants, Japanese HL and LH word patterns

- Results: The older age group of EP infants, but not the younger, discriminates the pitch accent contrast

ANOVA: Habituation Condition (statement, question) and Trial-type (familiar, novel) as the independent variables and listening time as the dependent variable

**Younger**
No effect of Trial type ($F(1,22) = .00, p = .99, \eta^2 = .00$), no effect of hab ($F(1,22) = .37, p = .55$), no interaction ($F(1,22) = .1, p = .75, \eta^2 = .75$)

**Older**
Significant effect of Trial type ($F(1,22) = 5.72, p < .05, \eta^2 = .21$), no effect of hab ($F(1,22) = .25, p = .62, \eta^2 = .01$), no interaction ($F(1,22) = .09, p = .77, \eta^2 = .00$)

Sensitivity to the prosodic features that cue the Japanese pitch accent contrast was found for the *older* infants
1. Early discrimination: Study 3

Summary

- Non-native discrimination: EP-learning infants’ perception of the Mandarin and Japanese lexical pitch contrasts

A GLMM was used (along the lines of Skoruppa et al. 2013)
- Effect of language (F(2,122) = 8.26, p < .001)
  . Borderline interaction Language x Age (F(2,122) = 2.91, p = .058)
- EP vs. Mandarin: only an effect of language (F(1,76) = 15.28, p < .001)
- EP vs. Japanese: effect of language (F(1,84) = 11.7, p < .01) and interaction Language x Age (F(1,84) = 5.68, p < .05)
# 1. Early discrimination of statement(-like) and question(-like) prosody: Summary & Discussion

<table>
<thead>
<tr>
<th>Language (Tune)</th>
<th>Cues</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Word order</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Intonation</td>
<td></td>
</tr>
<tr>
<td>Portuguese</td>
<td>Intonation</td>
<td>✔</td>
</tr>
<tr>
<td>Basque (Northern Spanish)</td>
<td>Intonation</td>
<td>✔</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Statement(-like)</th>
<th>Question(-like)</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Portuguese (Tone)</td>
<td>H+L* L%</td>
<td>H+L* LH%</td>
<td>Younger ✔</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Older ✔</td>
</tr>
<tr>
<td>Mandarin Chinese (Tone)</td>
<td>Tone 1 + Tone 4</td>
<td>Tone 1 + Tone 2</td>
<td>Younger X</td>
</tr>
<tr>
<td></td>
<td>H HL</td>
<td>H LH</td>
<td>Older X</td>
</tr>
<tr>
<td>Japanese (Pitch accent)</td>
<td>HL pattern</td>
<td>LH pattern</td>
<td>Younger X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Older ✔</td>
</tr>
</tbody>
</table>
1. Early discrimination of statement (-like) and question(-like) prosody: Summary & Discussion

- Findings do NOT support
  General early sensitivity to pitch-based contrasts, independent from the native language (early discrimination expected)

- By contrast, they point to the influence of native language experience on infants’ perception

Effects of language experience (different discrimination patterns)

Differences in discrimination abilities

Cues available in the language
Tune ≠ Tone & Pitch accent; Pitch accent contrast closer to tune

Phonetic salience

Similar overall contour shapes (similar discrimination patterns)
2. Novel word learning and intonation

- Discrimination studies strongly suggest early ambient language effects (e.g., Yeung et al. 2013), rather than general discrimination abilities for statement(-like) and question(-like) prosody, involving a pitch height & direction difference, in the presence of segmental variability.

- Whether and when do infants assign a function to the native prosodic contrast they perceive as early as 5 months?

- Young learners’ interpretation of phonetic variation: meaningless variation; variation that conveys meaning≈phonological contrast (at what level)
2. Novel word learning and intonation

- Previous word learning studies, including EP

<table>
<thead>
<tr>
<th>Type of contrast</th>
<th>Language</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td>English EP</td>
<td>1;2 ✔</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1;0 ✔; 2;0 ✔; 3;0 ✔; 4;0 (✔)</td>
</tr>
<tr>
<td>Tone</td>
<td>Mandarin-English *English(-X)</td>
<td>1;6 ✔; 2;0 ✔; 3;0 ✔; 4;0 (✔)</td>
</tr>
<tr>
<td></td>
<td>*English</td>
<td>1;6 ✔; 2;0 X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1;2 ✔; 1:5 (X) ;1;7 X</td>
</tr>
<tr>
<td>Tune</td>
<td>English (Rise-fall, Level)</td>
<td>2;6 X</td>
</tr>
<tr>
<td></td>
<td>EP (statement, question)</td>
<td>1;0 ✔; 2;0 ✔; 3;0 X; 4;0 X</td>
</tr>
<tr>
<td>Vowel</td>
<td>English</td>
<td>&lt; 2;0 ✔; 2;6 ✔</td>
</tr>
<tr>
<td></td>
<td>Mandarin-English</td>
<td>3;0 (✔); 4;0 ✔</td>
</tr>
</tbody>
</table>

Curtin, 2009; Curtin et al., 2009; Quam & Swingley, 2010; Frota et al., 2012; Singh et al., 2014, 2015; Hay et al., 2015
2. Novel word learning and intonation:

Study 4

Frota, Butler, Correia, Severino & Vigário (2012) 36th BUCLD, 190-201
Frota et al., submitted

- Findings that EP learners are sensitive to statement/question prosody in a novel word learning task (lexically irrelevant pitch is NOT ignored)

<table>
<thead>
<tr>
<th>Animation</th>
<th>Training Phase (51 sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19 sec: Doll introduces toys, labels one of them</td>
</tr>
<tr>
<td></td>
<td>Hello</td>
</tr>
<tr>
<td></td>
<td>Toy labeled 2 times</td>
</tr>
<tr>
<td></td>
<td>Toy not labeled 2 times</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ostensive Labelling</th>
<th>32 sec: Toy repeatedly labeled 10 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Phase (67 sec)</td>
<td></td>
</tr>
<tr>
<td>Test Trials</td>
<td></td>
</tr>
<tr>
<td>NP trial:</td>
<td>o [ˈmilu] [0.360 ms]</td>
</tr>
<tr>
<td>Utterance trial:</td>
<td>está aqui o [ˈmilu]? [0.670 ms]</td>
</tr>
</tbody>
</table>

An eyegaze-based procedure (similar to Quam & Swingley 2010) where visual fixation to the labeled picture in the training phase is the response variable.
2. Novel word learning and intonation: Study 4

- Auditory stimuli:
  Stress contrast: penult / final \([\text{milu}] / [\text{milu}]\)
    - Stress can be lexically contrastive (as in English, Spanish)
  Pitch contrast: declarative / interrogative (H+L* L\text% / H+L* LH\text%)
    - Intonation contrast not lexically relevant
  Vowel contrast: \([i]\) and \([a]\) \([\text{milu}] / [\text{malu}]\)

Trained label
Deviant labels:
- Stress Change
- Intonation Change
- Vowel Change
Coding for analysis: For each subject in each test trial, proportion looking time at the labeled object picture ‘A’ (looking at ‘A’ divided by the total looking time for both pictures)

- We used two time windows after the onset of the target word: 367+2000 ms for 1&2 year-olds, 367+1500 ms for 3&4 (Fernald et al. 1998, Swingley & Aslin 2002, Gredebäck et al. 2010, Gonzalez-Gomez, et al., 2013)
2. Novel word learning and intonation:

Study 4 - Proportion looking time to the labeled object picture

**Exp1 (n=48)**

**Younger:**

- Trained
- SC
- IC
- Both

Significant results against change

**Exp2 (n=24)**

**Younger:**

- Trained
- VC
- IC

Significant difference from trained

**Older:**

- Trained
- SC
- IC
- Both

Younger: 1-year olds and 2-year olds

Older: 3-year olds and 4-year olds
2. Novel word learning and intonation: Summary & Discussion

- Whether and when do infants assign a function to the native prosodic contrast they perceive as early as 5 months?
- EP learners regard statement/question prosody as relevant in a novel word learning task by 1;0; only at 3;0 they interpret the prosodic contrast as lexically irrelevant.
- Although at odds with native language phonology, EP learners respond differently to one-word utterances depending on their statement or question prosody, showing that the prosodic contrast affects meaning.
3. Other linguistic contrasts cued by prosody

- Early ambient language effects, rather than general discrimination abilities where shown for statement(-like) and question(-like) prosody, involving a pitch height & direction difference, in the presence of segmental variability.
- EP learners treat the statement/question prosodic contrast as relevant to meaning.
- Prosodic cues to linguistic categories vary across and within languages: Does the nature of the pitch cues matter?
The broad/narrow focus distinction

- Broad focus: the whole sentence expresses new information; Narrow focus: a particular element is the relevant part of the utterance (identification, contrast/correction, Krifka 2007, Gussenhoven 2008, Ladd 2008)
- **Main cue pitch alignment**: broad focus $\text{H}+\text{L}^*\text{L}\%$; narrow focus $\text{H}^*+\text{L} \text{ L}\%$
- Longer durations in narrow focus; Peak height is optional (Frota 2000, 2002)
- The prosodic contrast is perceived by adult native speakers (Frota 2012)
3. Other linguistic contrasts cued by prosody: Study 5 – Broad vs. Narrow focus

- **Materials:** Segmentally varied one pseudo-word utterances produced by a female native speaker in infant-directed speech

### Acoustic analysis

<table>
<thead>
<tr>
<th></th>
<th>Focus</th>
<th>Neutral</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 peak (Hz)</td>
<td>249.79</td>
<td>230.8</td>
<td>7.4, p &lt; .001</td>
</tr>
<tr>
<td>F0 low (Hz)</td>
<td>160.26</td>
<td>161.53</td>
<td>1.05, p = .31</td>
</tr>
<tr>
<td>Timing of the fall (ms)</td>
<td>140</td>
<td>- 29</td>
<td>22.12, p &lt; .001</td>
</tr>
<tr>
<td>Duration pre-tonic (ms)</td>
<td>101</td>
<td>159</td>
<td>6.95, p &lt; .001</td>
</tr>
<tr>
<td>Duration stressed (ms)</td>
<td>262</td>
<td>254</td>
<td>1.22, p = .24</td>
</tr>
<tr>
<td>Duration post-tonic (ms)</td>
<td>236</td>
<td>229</td>
<td>1.49, p = .16</td>
</tr>
</tbody>
</table>

**Pitch timing:** early/late alignment of the pitch fall

- Study 5 – Broad vs. Narrow focus
3. Other linguistic contrasts cued by prosody: Study 5 – Broad vs. Narrow focus

- Participants
  - 40 infants (from monolingual homes in the Lisbon area) split into two age groups: 7 months, 12 months
    - 20 younger (10 female, M = 6 months 28 days, range 6 months– 8 months 3 days)
    - 20 older (9 females, M = 12 months 7 days, range 10 months 16 days-14 months 6 days)

- Procedure
  - Same as all previous discrimination studies
  - If sensitive to the intonational contrast, infants should display longer listening times to the novel (different) trials
3. Other linguistic contrasts cued by prosody: Study 5 – Broad vs. Narrow focus

- **Results:** Only the older infants display longer listening times to the novel test trials.

![Graph showing listening time (s) for familiar and novel stimuli for younger and older infants.]

- Difference in discrimination abilities for the **statement/question** prosodic contrast (as early as 5 months), and for the **broad/narrow focus** contrast only by 12 months.

**The nature of the pitch cues seems to matter!**
4. General Discussion

- Statements and Questions: the ability to distinguish between them is crucial
- **Prosody** is frequently the key: prosodic discrimination abilities as a prerequisite for the acquisition of Questions
- Our findings do NOT support general discrimination abilities for pitch contrasts across languages: **Similar** contour shapes > **different** discrimination patterns
- Effects of **language experience** emerge early in the 1\textsuperscript{st} year and may constrain young learners’ interpretation of phonetic variation as meaningful (phonological contrast)
4. General Discussion

- Perceptual trajectory of prosodic contrasts may depend on the primary cues involved (pitch height & direction vs. pitch alignment)
  - relating to previous reports on diffs. between infants’ perception of lexical pitch, stress and duration contrasts

- Discrimination abilities as a prerequisite for the acquisition of linguistic categories cued by prosody > our findings suggest an advantage of certain prosodic cues over others with implications for the acquisition of distinctions cued by prosody, within and across languages
Questions and prosody

Native listener

Morphosyntax

Intonation

Final pitch (boundary tones)

Peak height

Peak alignment

My language!
Thanks to all the families and nurseries that have taken part in these studies.

Obrigada
Thank you

DEPE: PTDC/CLE-LIN/108722/2008
EBELa: EXCL/MHC-LIN/0688/2012
H21: PTDC/MHC-LIN/3901/2014
Early perception of the prosody of statements and questions

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Universidade de Lisboa