Early acquisition of word-level prosody

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It is widely believed that:

- Infants "have greater control of loudness, pitch, and duration than of articulatory movements" (Locke 1983: 13; Hallé, de Boysson-Bardiez, Vihman 1991)

- Prosody is crucial for acquisition of language, e.g.
  - the “prosodic bootstrapping hypothesis” (Gleitman & Wanner 1982, Pinker 1984, Morgan & Demuth 1996)
  - the “metrical segmentation hypothesis” (Cutler and collaborators, e.g. Cuttler & Norris 1988; Cutler 1996, 2001)

- Prosody is acquired quite early, before the child has acquired many of the distinctive features of the linguistic environment (e.g. Lieberman 1967)
However, prosodic aspects of child language have been much less studied than segmental aspects.

Few instrumental data on child prosody, in particular from a cross-linguistic perspective.

Goal: examining the acquisition of word level prosody by looking at:
- Acoustic correlates of stress
- Complex metrical patterns
- Intonational alignment and scaling
Acoustic correlates of stress
Method

- **Experimental design**: 2 conditions
  - [- stress] ⇒ V2 in bisyllabic words with penultimate stress
  - [+stress] ⇒ V in monosyllabic words

- **Material**: 5 pairs of familiar and imageable words

<table>
<thead>
<tr>
<th>English</th>
<th>Catalan</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potty</td>
<td>Taxi</td>
<td>Taxi</td>
</tr>
<tr>
<td>Money</td>
<td>Mami</td>
<td>Mami</td>
</tr>
<tr>
<td>Monkey</td>
<td>Papi/Pipi</td>
<td>Papi/Pipi</td>
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<tr>
<td>Baby</td>
<td>Bibe</td>
<td>Bibe</td>
</tr>
<tr>
<td>Mummy</td>
<td>Globus</td>
<td>Llave</td>
</tr>
</tbody>
</table>
Method

Mother-child pairs
Naming game
Played on computer

a) Mother-child
b) Mother-researcher

[mother] What is this?
[child] A monkey
[mother] Good! This is a monkey
[mother] Can you find it? There! Well done
What animal is Melanie looking for? (Monkey)

Yes, she’s looking for a monkey.

Can you find it?
Results: Pitch

ANOVA: Sig. effects of Condition and Age
2-yr-olds > Sig. effects of Condition for English
Results: Intensity

ANOVA: Sig. effects of Age (3 lang) and Condition

2-yr-olds > Sig. effects of Condition for English
Results: Duration

ANOVA: Sig. effects of Condition and Age
2-yr-olds > Sig. effects of Condition for Spanish

English  Catalan  Spanish
Stress

• In adults, stress differences are cued by robust and systematic acoustic cues: duration, intensity and higher pitch

• In early child speech, stress differences are cued mainly by intensity and pitch. Stressed syllables are louder and with a higher pitch

• Children achieve fine control of intensity and pitch by age 4

• Control of duration is achieved later, at least in stressed-timed and mixed languages such as English and Catalan

• Overall, stress is acquired at an early age, before full segmental control, but some phonetic cues come earlier than others

• There are cross-language differences in order of acquisition
Acquisition of complex metrical patterns
Children typically omit syllables from multisyllabic words ("truncation") or add them.

Early words tend to follow a strong-weak pattern (SW), e.g. Gerken 1994, Demuth 1996.

Explanations:
- "Trochaic bias", a possibly universal SW template, Allen & Hawkins 1980
- Distributional factors, i.e. frequency of syllable and prosodic word structures in the ambient language, preference for unmarked forms, Gerken 1994, Fikkert 1994, Demuth 2009
  - Spanish: simple syllabic structures, many words with 3 or more syllables
  - Spanish children do not have to learn complex syll structures and can produce multisyllabic words much earlier than German children, Lleó & Demuth 1999, Lleo 2006
<table>
<thead>
<tr>
<th>Material</th>
<th>Catalan</th>
<th>Spanish</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Sol</td>
<td>Sol</td>
<td>Sun</td>
</tr>
<tr>
<td></td>
<td>Tren</td>
<td>Tren</td>
<td>Train</td>
</tr>
<tr>
<td></td>
<td>Peu</td>
<td>Pie</td>
<td>Bee</td>
</tr>
<tr>
<td>SW</td>
<td>Nena</td>
<td>Nena</td>
<td>Angel</td>
</tr>
<tr>
<td></td>
<td>Lluna</td>
<td>Luna</td>
<td>Baby</td>
</tr>
<tr>
<td></td>
<td>Mono</td>
<td>Mono</td>
<td>Monkey</td>
</tr>
<tr>
<td>WS</td>
<td>Bebè</td>
<td>Bebé</td>
<td>Guitar</td>
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<tr>
<td></td>
<td>Camió</td>
<td>Camión</td>
<td>Balloon</td>
</tr>
<tr>
<td></td>
<td>Lleó</td>
<td>León</td>
<td>Giraffe</td>
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<tr>
<td>WSW</td>
<td>Sabata</td>
<td>Zapato</td>
<td>Potato</td>
</tr>
<tr>
<td></td>
<td>Pilota</td>
<td>Pelota</td>
<td>Banana</td>
</tr>
<tr>
<td></td>
<td>Pijama</td>
<td>Pijama</td>
<td>Pajamas</td>
</tr>
<tr>
<td>SWW</td>
<td>Àliga</td>
<td>Águila</td>
<td>Elephant</td>
</tr>
<tr>
<td></td>
<td>Música</td>
<td>Música</td>
<td>Crocodile</td>
</tr>
<tr>
<td></td>
<td>Mèlanie</td>
<td>Mélanie</td>
<td>Melanie</td>
</tr>
<tr>
<td>WWS</td>
<td>Cocodril</td>
<td>Caracol</td>
<td>Cockatoo</td>
</tr>
<tr>
<td></td>
<td>Elefant</td>
<td>Pantalón</td>
<td>Kangaroo</td>
</tr>
<tr>
<td></td>
<td>Pantaló</td>
<td>Violín</td>
<td>Violin</td>
</tr>
<tr>
<td>SWSW</td>
<td>Papallona</td>
<td>Mariposa</td>
<td>Caterpillar</td>
</tr>
<tr>
<td></td>
<td>Helicòpter</td>
<td>Elefante</td>
<td>Watermelon</td>
</tr>
<tr>
<td></td>
<td>Hipopòtam</td>
<td>Cocodril</td>
<td>Helicopter</td>
</tr>
<tr>
<td>SWSWW</td>
<td>(not available in CS)</td>
<td>Hipopótamo</td>
<td>Hippopotamus</td>
</tr>
</tbody>
</table>
Corpus

- Data:
  - 2835 words > 1197 in English, 724 in Spanish and 914 in Catalan
  - Five groups: children at 2, 4, and 6 years of age and adults talking to children (Child Directed Speech) and to the researcher (Adult Directed Speech).

- **For this study:**
  - Three age groups per language (2, 4, 6)
  - The first token produced by each child, preferably not repeated after the mother
  - 790 words of which 47 were truncated
Results

- Dataset of 790 words: one token per metrical pattern from each child
- 47 truncations, all in the speech of 2 and 4-year-olds
- Spanish and Catalan children produce fewer truncations than the English children
From age 2, Spanish and Catalan children produce correctly a much higher number of complex prosodic word forms.

By age 2, English children produce a 26% of truncated forms, while Spanish and Catalan children produce about half as many.

The acquisition of complex metrical patterns is accomplished earlier in Catalan and in Spanish that it is in English.
Acquisition of scaling and alignment
Intonation:

• Previous studies agree in that children:
  – Have a reduced pitch range
  – Acquire falling tones first (H* L%)
  – Acquire final rising tones much later (Snow 1998; Wells, Peppe & Goulandris 2005)
  – Show variability in intonational development

• Lack of consensus:
  – Age of acquisition of main intonation contrasts:
    • 1-2 years (Crystal 1976; Prieto & Vanrell 2007)
    • Depending on grammatical development (e.g. Snow & Balog 2002)
  – Few quantitative studies of phonetic realisation, especially alignment
    • Prieto & Vanrell (2007) show evidence of adult-like realization in children younger than 2
    • Frota & Vigario (2008)
Intonation:

- Are there developmental differences in the phonetic implementation of peak alignment and scaling (e.g. accentual range and pitch range)?
- If so, are differences found cross-linguistically?

  - This study:
    - Tonal alignment and scaling of peak in contour (L) H* L%
    - In English, Catalan, and Spanish
    - In 3 age groups
Intonation:

- We expect younger children to show:
  - A narrower accent range than adults
    - E.g. Crystal (1976), Snow (2002) claim that children have a reduced accent range compared to adults, and this increases as the child acquires a complex tonal inventory
    - H1 - Young children will have a narrower accent range than older children and than adults

- Developmental effects on alignment
  - H2 - Young children have less precise alignment than older children and than adults
Introduction:

• H3- Crosslinguistic differences in age of acquisition of alignment
  – A cross-linguistic comparison will allow us to study possible structural effects on acquisition of intonation
  – Languages differ in phonotactic complexity, rhythmic type, tonal inventories
  – Developmental crosslinguistic differences in age of acquisition of adult-like rhythm
    Spanish > Catalan >> English (Post this panel)
  – Prieto & Vanrell (2007) found that Catalan 2 year olds produce adult-like alignment
  – Later acquisition of mature alignment in English than in Catalan and Spanish
Corpus:

- + 21 words with different stress pattern, from S to SWSW
- Imageable and familiar to young children
- Easy to pronounce
- Comparable across languages
- V, CV and CVC, CCVC syllables balanced across languages

- Dataset has 584 tokens in total:
  - 395 tokens were produced with a falling tone
  - 229 with an extended level tone
Examples
1- Level contour (level, H1 H2)
2- Level contour (L H* H2)
3- Target contour (L H* L%)

LER, 2;0
KW, 4;0
JI, 4;0
Labelling and measurements

- Labelling
  - **Tones:** H, L, L%
  - Segmental landmarks: Syll Onset (o), Syll End (e)

- Relative to the syllable: (i) comparability across syllable types, (ii) comparability child-adult phonology

- **Truncation** was labelled: e.g. “banana” (WSW): “bana” (SW)
- **Indefinite article** was labelled: “un”, “una” is stressed in Catalan and Spanish. Often gets pitch accent and triggers downstep
Labelling and measurements

• Loudness
  – 1 quiet or shy, 2 normal, 3 loud or emphatic

• Calculations
  – H to Syll Onset (in seconds)
  – H to Syll End (in seconds)
  – L to Syll Onset
  – HminL (Acc Range, in semitones)
  – HminL% (Pitch Range, in semitones)

• Statistical analysis: Correlations, ANOVAs, ANCOVAs
Pitch scaling

ANOVA: sig effects of: Age, Lang, Age*Lang interaction
Pitch alignment
Summary: alignment in children

- Age has effects on alignment
- Adults
  - Strict anchoring of L to Syll Onset (at least for Catalan and Spanish)
  - Relative anchoring of peak, to Syll Onset and to Syll End
- Children
  - Alignment of L is quite good, yet it improves slightly with age
  - Peak alignment improves with age
  - Peak alignment (H to Syll End) is influenced by Syllable duration and Syllable duration is influenced by Age
  - However, after controlling for Syllable duration, still remains a correlation between Peak alignment and Age
Conclusions and further work

• Developmental differences in the acquisition of word level prosody
• Some elements are acquired earlier than others > duration

• Crosslinguistic differences:
  • Spanish > Catalan  >> English

• Work in progress:
  • Acquisition of determiners (a, the, un/a, el/la,…) and correlation with truncation of metrical patterns
  • Measuring other correlates of stress (formants, spectral balance,…)
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