Stress pattern preference in Spanish-learning infants: The importance of syllable weight

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Workshop on Prosodic Development
Universitat Pompeu Fabra | April 16th, 2010
OVERVIEW

- Infants show sensitivity to prosodic information (rhythm and intonation) very early in life
  - i.e. newborns can use prosodic information to distinguish languages from different rhythmic classes (Mehler et al., 1988)
Later in development, these early sensitivities are not only refined, but also attuned to the specific prosodic characteristics of the input language. 4-month-olds can distinguish languages from the same rhythmic class (Bosch & Sebastián-Gallés, 1997).
OVERVIEW

- Attunement to relevant prosodic information in the native language can go together with a loss or decline in sensitivities present earlier in development.
  - i.e. The ability to discriminate between trochees and iambs is constrained only in French-, but not in Spanish-learning 9-month-old infants (Skoruppa et al., 2009)
Attunement of early sensitivities to the specific prosodic characteristics of the input language can also be identified by emergent attention biases observed in infants’ prosodic preference.
Previous results:

*Biases observed in infants’ prosodic preference*

- Lexical stress preference studies have been performed with pre-lexical infants from different language environments (English, German and French) obtaining different outcomes.
Previous results on stress pattern preference:

*Biases observed in infants’ prosodic preference*

- English-learning infants

- 9-month-olds (but not 6-month-olds) preferred to listen to disyllabic trochees than iambs (Jusczyk et al., 1993).
  - Between 6 and 9 months of age → growing knowledge about the distribution of stress within words in the language.
Previous results on stress pattern preference: *Biases observed in infants’ prosodic preference*

- **German-learning infants**

- 6-month-old (but not 4-month-olds) listened significantly longer to trochaic than to iambic disyllabic pseudo-words
  - German-learning infants also show a trochaic bias, even at a younger age (Höhle, 2002; Höhle et al., 2009).
Previous results on stress pattern preference: *Biases observed in infants’ prosodic preference*

- **French-learning infants**
  
- 6-month-old French infants did not show any lexical stress preference (not trochaic neither iambic preference). Crucially, they were able to differentiate both stress patterns (Höhle et al., 2009).
Previous results on stress pattern preference: *Biases observed in infants’ prosodic preference*

- These results reveal an earlier emergence of a trochaic bias for German- and English-learning infants (6 and 9 months respectively), but not for French-learning infants.

- They demonstrate that the trochaic bias is acquired after 6 months of age, and that it is not language-general but language specific.
Previous results:

**Biases observed in infants’ prosodic preference**

- English and German are stress-timed languages, with words being predominantly trochaic.
  - The rhythmic unit is the *trochaic stress unit*.

- French is a syllable-timed language with *fixed stress* on the last syllable of a word (or phrase).
  - The rhythmic unit is the *syllable*.

Could the trochaic bias be closely related to the rhythmic properties of the input language?
However, languages differ in many other aspects...

- General rhythmic properties (stress-timed vs. syllable-timed language classes),
- but also in more specific rhythmic features related to lexical stress regularities (fixed vs. variable stress),
Current study

- In this context, we aimed at exploring the lexical stress pattern preference in Spanish-learning infants.

- Spanish, a language that ‘shares’ different aspects with each of the languages previously explored.
Current study: Language comparisons

- We present a simple description of Spanish prosodic characteristics and a comparison with English and French.

- This description is based on the following aspects: 1) rhythmic category, and 2) type and predominance of lexical stress patterns
Current study: Language comparisons

1) From a general rhythmic perspective:

- Spanish and French are grouped together as syllable-timed languages
- English and German belong to the stress-timed category
Current study: Language comparisons

- From a general rhythmic perspective:
  - In Spanish the syllable, but not the trochaic stress unit, is the basic rhythmic unit that characterizes it.

Spanish ≈ French
Current study: Language comparisons

2) From a lexical stress perspective:

- Stress in Spanish is variable and it does not always correspond with one of the word boundaries.

- Stress in English, although variable, falls primarily on the initial syllable of a word.

- Stress in French is fixed and falls invariably on the last syllable of each word or phrase.
Current study: Language comparisons

- From a lexical stress perspective (Spanish):
  - The most frequent word shape is disyllabic
  - Around 65% of Spanish disyllabic word types are trochaic (Alcina & Blecua, 1975; Quilis, 1981).
  - A similar distribution (around 70%) in corpus studies from speech addressed to children (Prieto, 2006; Roark & Demuth, 2000; Saceda-Ulloa, 2005)
Current study: Language comparisons

- From a lexical stress perspective (English):
  - The most common type of word is a disyllable (Carlson et al., 1985; Cutler & Carter, 1987).
  - A great number of disyllabic words have initial stress - 74% of word types and 78% of word tokens - (Cutler & Carter, 1987).

Spanish ≈ English
EXPERIMENTAL PART

- We aimed to explore the *lexical stress preferences / trochaic bias* in Spanish-learning infants at 9 months of age.

- **Spanish**, a syllable-timed language with no vowel reduction and *variable stress* (but predominantly trochaic).

  \[ \text{French} \approx \text{Spanish} \approx \text{English} \]
Experiment 1:

- Predictions

  - General / global rhythmic properties are the only decisive or crucial factor
    - Spanish-learning infants will behave like French-learning infants (showing no bias at all).

  - It is driven by the dominance of a stress pattern in the input
    - Spanish-learning infants will show a trochaic bias (like English- and German-learning infants).
Experiment 1:

- **Method**
  - **Participants**: Twenty Spanish-learning infants of 9 months of age.
  
  - **Stimuli**: A total of 84 CVCV nonsense words uttered by a female speaker using infant-directed-speech (IDS) intonation.
Experiment 1:

Method

- **Stimuli**: Percentage of trochaic and iambic dissyllabic CV.CV words in Spanish.

<table>
<thead>
<tr>
<th></th>
<th>Trochees</th>
<th>Iambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>59.9%</td>
<td>40.1%</td>
</tr>
<tr>
<td><strong>CV.CV</strong></td>
<td><strong>85.5%</strong></td>
<td><strong>14.5%</strong></td>
</tr>
<tr>
<td>(35% of</td>
<td>(49.7%</td>
<td>(12.6% of the</td>
</tr>
<tr>
<td>dissyllabic</td>
<td>of the</td>
<td>dissyllabic iambs)</td>
</tr>
<tr>
<td>words)</td>
<td>dissyllabic trochees)</td>
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</table>
Experiment 1:

- **Method**

- **Stimuli: Acoustic measurements**

<table>
<thead>
<tr>
<th></th>
<th>Trochees (SW)</th>
<th>Lambs (WS)</th>
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<tbody>
<tr>
<td></td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Pitch (Hz)</strong></td>
<td>329.75 (30.49)*</td>
<td>222.22 (16.09)</td>
</tr>
<tr>
<td><strong>Intensity (dB)</strong></td>
<td>83.53 (2.34)*</td>
<td>73.45 (2.75)</td>
</tr>
<tr>
<td><strong>Duration (ms)</strong></td>
<td>219.71 (30.53)*</td>
<td>205.51 (42.88)</td>
</tr>
</tbody>
</table>
Experiment 1:

- **Procedure**
  - A slightly modified version of the Head-turn Preference Procedure (HPP) was used.
    - 4 familiarization trials
    - 12 test trials (6 trochaic & 6 iambic)
      - Lists of six different tokens, repeated three times (trial length: 27”).
  - Measure: Looking time to trochaic vs. iambic nonsense word lists.
Experiment 1:

- Setting
Experiment 1:

Results

![Bar chart showing mean looking times (s) for TROCHAIC CVCV and IAMBIC CVCV, with p > 0.1]
Experiment 1:

- **Discussion**

- Our results *failed* to reveal a preference for a trochaic pattern using lists composed of CVCV nonsense words.

- These results differ from those previously reported in English-learning infants at 9 months (Jusczyk et al., 1993) and in German-learning infants at 6 months, but are in accordance with data from 6-month-old French-learning infants (Höhle et al., 2009).
Experiment 1:

Discussion

The failure to observe a preference for the trochaic stress pattern cannot be due to the fact that infants were not able to discriminate both stress patterns.

- Previous studies have demonstrated that 9-month-old Spanish-learning infants are able to distinguish iambic from trochaic using equivalent material (Pons & Bosch, 2007; Skoruppa et al., 2009).
Experiment 1:

- Discussion

- Our results seem to parallel French-learning infants’ results (Höhle et al., 2009).

- A similar explanation could be applied here: For syllable-timed languages, lexical stress preferences may follow a different time-course or might develop differently compared to stress-timed languages.
Experiment 1:

- Discussion

- However, we must be cautious in establishing a simple parallelism between our data and these previous results
  - 1) because the French-learning participants were younger than ours (6 vs. 9 months of age)
  - 2) because of the important differences in the lexical stress properties between French and Spanish.
Experiment 1:

- Discussion

- Other input factors (not related to the rhythmic class) could be responsible for this null outcome.
  - It is possible that 9-month-old Spanish-learning infants may have started to develop a trochaic bias, but some input factors might hinder the emergence of this trochaic bias at this specific age.
Experiment 1:

- **Discussion**

- As previously said, languages differ in many aspects...
  1) In general rhythmic properties (stress-timed *versus* syllable-timed language classes),
  2) In specific rhythmic features related to lexical stress regularities (fixed *versus* variable stress),
3) Stress placement can be constrained by the structure of syllables within a word:

- In Spanish, heavy syllables are the ones ending with a consonant coda. They systematically capture stress.
- In English, syllable weight has been considered an important factor of stress placement (but vocalic reduction is also closely linked to stress assignment).
- French is considered a weight-insensitive language.
Language comparisons

3) Stress placement can be constrained by the structure of syllables within a word:

- In Spanish, stress is assigned to the final syllable of a word when it is heavy (it ends with a consonant - except for inflectional plurals, that is, -s nominal and -n verbal endings) or on the penultimate syllable if the final syllable ends with a vowel (Guion et al., 2004; Harris, 1983).
Because stress and syllable weight are closely dependent in Spanish it may be the case that this specific link is crucial to observe a clear preference.

Exploring the role of syllable weight in Spanish-learning infants will help to reveal if any specific pattern of preference could eventually be found at this specific age.
The role of syllable weight: Previous studies

- Turk et al. (1995) examined the role of syllable weight on the previously observed trochaic bias. It was observed that the English-learning infants’ preference was not restricted to words in which the stressed syllables were either heavy or contained tense vowels.

- Syllable weight was not found to be a determinant factor for lexical stress preference in English-learning infants.
Experiment 2 and 3: The role of syllable weight

The aim of the next two experiments was to examine whether a preference for a specific stress pattern could emerge with words containing a heavy syllable (CVC.CV or CV.CVC word structure)
Experiment 2 and 3: The role of syllable weight

Predictions

- If syllable weight is a relevant factor, infants will show a lexical stress preference that reflects the predominant accentual pattern of words when syllabic structure is taken into account.
  
  1) Preference for **CVC.cv** lists (trochaic pattern) vs. **cvc.CV** lists (iambic pattern)

  2) Preference for **cv·CVC** lists (iambic pattern) vs. **CV·cvc** lists (trochaic pattern).
Experiment 2 and 3: The role of syllable weight

- Participants:
  - Twenty 9-month-old Spanish-learning infants (Experiment 2).
  - Twenty 9-month-old Spanish-learning infants (Experiment 3).

- Procedure:
  - The same as in Experiment 1.
Experiment 2 and 3: The role of syllable weight

- **Stimuli - Experiment 2-:**
  - The nonsense words had a CVC.CV structure. A total of 168 disyllables were created using as codas the consonants that typically occupy this syllable final position in Spanish.

  - Sixteen lists with 12 items in each were created, all being phonotactically legal (i.e., minto, kento, munka, banto).
Experiment 2 and 3: The role of syllable weight

- **Stimuli - Experiment 3-:**
  - The nonsense words had a CV.CVC structure and were created using the endings -on, -or, -al, -el, -in, and -un (*i.e.* dibon, botun, sutal).
  - A total of 168 disyllabic nonsense words were used (14 lists of 12 items per list - trial length: 18”).
Experiment 2 and 3: The role of syllable weight.

**Method**

- **Stimuli:** Percentage of trochaic and iambic dissyllabic CVC.CV and CV.CVC words in Spanish.

<table>
<thead>
<tr>
<th>Dissyllabic words</th>
<th>Trochees</th>
<th>Iambs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>59.9%</td>
<td>40.1%</td>
</tr>
<tr>
<td><strong>CVC.CV</strong></td>
<td>95.3% (46.0% of the</td>
<td>4.7% (3.4% of the</td>
</tr>
<tr>
<td>(29% of dissyllabic</td>
<td>dissyllabic trochees)</td>
<td>dissyllabic iambs)</td>
</tr>
<tr>
<td>words)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CV.CVC</strong></td>
<td>7.1% (4.3% of the</td>
<td>92.9% (84.0% of the</td>
</tr>
<tr>
<td>(36% of dissyllabic</td>
<td>dissyllabic trochees)</td>
<td>dissyllabic iambs)</td>
</tr>
<tr>
<td>words)</td>
<td></td>
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</tbody>
</table>
Experiment 2:

**Method**

- **Stimuli:** Acoustic measurements (CVC.CV)

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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Pitch (Hz)</strong></td>
<td>205.21 (25.9)*</td>
<td>144.59 (6.95)</td>
</tr>
<tr>
<td><strong>Intensity (dB)</strong></td>
<td>78.09 (1.18)*</td>
<td>72.30 (2.64)</td>
</tr>
<tr>
<td><strong>Duration (ms)</strong></td>
<td>315.12 (40.5)*</td>
<td>132.85 (32.56)</td>
</tr>
</tbody>
</table>
Experiment 3:

Method

- **Stimuli**: Acoustic measurements (CV.CVC)

<table>
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<tr>
<td></td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Pitch (Hz)</strong></td>
<td>284.20 (17.9)*</td>
<td>177.15 (16.35)</td>
</tr>
<tr>
<td><strong>Intensity (dB)</strong></td>
<td>75.68 (2.8)*</td>
<td>74.49 (2.96)</td>
</tr>
<tr>
<td><strong>Duration (ms)</strong></td>
<td>302.37 (88.8)*</td>
<td>151.99 (39.76)</td>
</tr>
</tbody>
</table>
Experiment 2 and 3: The role of syllable weight

Results

* p < 0.03
Discussion

- Results of experiment 2
  - When the predominant pattern of the language (trochaic) converges with syllable weight information, the “expected” trochaic preference emerges.

- Results of experiment 3
  - Syllable weight can drive the preference for a specific stress pattern: Infants preferred to listen to iambic items, even though in their language trochees are more predominant than iambics.
Discussion

- These results indicate that 9-month-old Spanish-learning infants seem to have acquired knowledge about the most frequent stress pattern in CVC.CV and in CV.CVC words.
  - Infants listened longer to trochaic nonsense CVC.CV word lists and to iambic CV.CVC word lists.
General discussion

- From the results of the first experiment (using a CV.CV structure):
  - The failure to observe a trochaic preference in Experiment 1 may be due to the fact that trochaic stress units are not characteristic of a syllable-timed language such as Spanish.

The trochaic bias would reflect the acquisition of the general rhythmic properties of the native language.
General discussion

- However, as already said, we must be cautious in establishing a simple parallelism between our data and previous results
  - 1) because the French-learning participants were younger than ours (6 vs. 9 months of age)
  - 2) because of the important differences in the lexical stress properties between French and Spanish.

Thus, focusing solely on the language rhythmic properties without considering other factors would make this interpretation hasty.
General discussion

The failure to observe a clear preference for CV.CV trochaic over iambic patterns in our 9-month-olds may also be interpreted as an indication that both stress patterns are acceptable in Spanish.

This possibility cannot be ruled out. The proportion of trochaic words is higher than the proportion of iambic words, but not absolutely predominant (≈60%).
General discussion

- The results of the experiments 2 and 3...
  - Would suggest that Spanish-learning infants’ preference patterns are
    - not based on general rhythmic properties of the language
    - not based on rhythmic properties of the most frequent words in their language (trochaic disyllables)
    - but on more specific knowledge that involves linking stress information to syllable structure.
General discussion

- In sum,
  - In Spanish, syllable weight seems to be a significant component linked to lexical knowledge and possibly relevant for stress acquisition/segmentation.
Final comments

- Segmentation studies with 9 month-old Spanish-learning infants manipulating these factors (lexical stress and syllable weight) would reveal whether this information is used in word segmentation tasks.