How do German-Spanish bilingual children ask questions in their two languages?

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Aims of the study

- To determine whether the pitch accents and boundary tones of questions are acquired as soon as those of declaratives.

- To determine whether German-Spanish bilingual children acquire pitch accents and boundary tones of the two languages independently.

- To try to establish the phonological import of the F0 points and/or contours for the child: i.e. what are the phonological units of interrogative intonation in Spanish and in German?
• In previous studies we focused on pre-final and final pitch accents of declaratives:

- **Spanish**
  - prefinal: \(L^*\)\(H\)\(H^*\)\(L\)
  - German
  - prefinal: \(H^*\)\(L\)
  - prefinal: \(H^*\)\(L\)

- **Prefinal**
- **Final**

<table>
<thead>
<tr>
<th>Tonic</th>
<th>Posttonic</th>
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<tr>
<td>(L^*)</td>
<td>(H)</td>
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Previous results on declaratives

• We have shown (Lleó, Rakow & Kehoe 2004; Lleó & Rakow 2006) that:
• At age 3;0 monolingual Spanish children differentiate the two pitch accents of Spanish declaratives, the pre-final (or pre-nuclear) and final (or nuclear)
• At age 3;0 monolingual German children produce pitch accents of declaratives, pre-final as well as final, correctly
• At about age 2;0 the difference in Spanish between pre-nuclear and nuclear pitch accent is only produced by one out of three Spanish children
• At about age 2;0 monolingual German children produce the pre-final and final pitch accents of declaratives target-like
• Bilinguals at about age 3;0 tend to not differentiate between the two pitch accents of declaratives in Spanish, and to substitute a falling pitch accent for the rising one, i.e. pre-final and final tend to be the same, as in German
Peak Alignment: Mean values for Bilinguals (Jens and Simon 3;0)
Pitch accents and BTs in Spanish and German yes/no questions

Spanish: declaratives and yes/no questions

German: declaratives and yes/no questions
Pitch accents and BTs in Spanish and German *wh*-questions

Spanish: declaratives and *wh*-questions

German: declaratives and *wh*-questions
Comparison of *yes/no*-questions vs. declaratives

<table>
<thead>
<tr>
<th></th>
<th>Spanish</th>
<th>German</th>
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<tbody>
<tr>
<td><strong>Declaratives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Lower initial F0 peak at post-tonic</td>
<td>Initial F0 peak at stressed syllable</td>
</tr>
<tr>
<td>2.</td>
<td>Medial F0 rise</td>
<td>Medial F0 rise</td>
</tr>
<tr>
<td>3.</td>
<td>Final stressed syllable F0 rise</td>
<td>Final stressed syllable F0 rise</td>
</tr>
<tr>
<td>4.</td>
<td>F0 fall at the end</td>
<td>F0 fall at the end</td>
</tr>
<tr>
<td><strong>yes/no-questions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Higher initial F0 peak</td>
<td>Higher initial F0 peak</td>
</tr>
<tr>
<td>2.</td>
<td>No medial F0 rise</td>
<td>No medial F0 rise</td>
</tr>
<tr>
<td>3.</td>
<td>Final stressed syllable low F0</td>
<td>Stressed syllable low F0</td>
</tr>
<tr>
<td>4.</td>
<td>F0 rise at the end</td>
<td>F0 rise after last stress</td>
</tr>
</tbody>
</table>

Main differences between the two languages:
- Initial peak is higher and later in Spanish
- Final rising slope is much steeper in Spanish
### Comparison of *wh*-questions vs. declaratives

#### Spanish

<table>
<thead>
<tr>
<th>Declaratives</th>
<th>Wh-questions</th>
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<tr>
<td>1. Lower initial F0 peak at post-tonic</td>
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<tr>
<td>4. F0 fall at the end</td>
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#### German

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<th>Wh-questions</th>
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<td>1. Initial F0 peak at stressed syllable</td>
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</tr>
<tr>
<td>4. F0 fall at the end</td>
<td>4. F0 fall after last stress</td>
</tr>
</tbody>
</table>

### Main differences between the two languages:
- Initial peak is higher and later in Spanish
- Final falling slope is shorter in Spanish
Some assumptions

• Assumption 1: Spanish and German interrogative pitch accents and boundary tones are different

• Assumption 2: rising tones are more marked than falling tones

• Assumption 3: not necessarily all F0 values have phonological import, at least for the child, as some of them may just be interpreted as concomitant phonetic detail
Hypotheses

• H1) Monolinguals acquire F0 targets of interrogative intonation before 2;0
• H2) Bilinguals acquire F0 targets of interrogative intonation before 2;0
• H3) Alignment and scaling will be acquired later, especially by bilinguals
• H4) The steep final rising slope of Spanish yes/no-questions will be acquired later, especially by bilinguals
• H5) Intonation of yes/no-questions will be acquired later than intonation of declaratives and wh-questions
Data

- Subjects for yes/no-questions: at ages 2;0 and 3;0
  - 2 Spanish monolinguals (José, Miguel: 26 tokens)
  - 2 German monolinguals (Marion, Thomas: 34 tokens)
  - 2 Spanish-German bilinguals in Germany (Manuel, Simon: 36 tokens)
  - 2 Spanish-German bilinguals in Spain (Inés, Nardo: 20 tokens) only at age 3;0

- Subjects for wh-questions: at ages 2;0 and/or 3;0
  - 1 Spanish monolingual (Miguel 3;0: 17 tokens)
  - 1 German monolingual (Britta 2;0 and 3;0: 30 tokens)
  - 2 bilingual Spanish (Manuel 3;0, Simon 3;0: 20 tokens)
  - 1 bilingual German (Simon 3;0: 12 tokens)
Data collection

- Children were recorded fortnightly in unstructured play situations
- Bilinguals were visited by two separate teams
- All broad-focus yes/no-questions and wh-questions produced at ca. 2;0 and ca. 3;0 were selected for analysis
Method

- All interrogatives were measured at 4 points:
  - onset of utterance
  - 1st F0-peak
  - F0-minimum
  - final F0-peak

- What was measured:
  - F0 in semitones (ST) at each of the 4 points
  - distance in seconds (sec) between the points
  - distance in syllables between min F0 and final H/L
Results yes/no-Q: Monolingual

At age 2;0

- Miguel: 447 ms to 29,0 ST-Max; 23,2 ST-Min; 33,2 ST to end; 50,9 ST/sec from right; 1,6
- José: 358 ms to 29,1 ST-Max; 23,4 ST-Min; 30,4 ST to end; 26,2 ST/sec from right; 2,0
- Marion: 201 ms to 29,3 ST-Max; 22,4 ST-Min; 28,8 ST to end; 43,6 ST/sec from right; 1,9
- Tomás: 176 ms to 21,1 ST-Max; 15,9 ST-Min; 21,7 ST to end; 23,7 ST/sec from right; 1,7

First peak is later in Spanish, but same height
No difference in final rising slope, as in German

At age 3;0

- Miguel: 276 ms to 25,8 ST-Max; 22,5 ST-Min; 31,2 ST to end; 24,9 ST/sec from right; 2,0
- José: 243 ms to 25,9 ST-Max; 22,2 ST-Min; 26,3 ST to end; 22,7 ST/sec from right; 2,0
- Marion: 149 ms to 22,7 ST-Max; 19,7 ST-Min; 28,3 ST to end; 17,3 ST/sec from right; 3,0
- Tomás: 103 ms to 19,9 ST-Max; 15,0 ST-Min; 21,0 ST to end; 12,9 ST/sec from right; 3,0

First peak is later and higher in Spanish
Final rising slope is steeper in Spanish
Results yes/no-Q: Bilingual (DE)

At age 2;0

<table>
<thead>
<tr>
<th></th>
<th>ms to 1.Peak</th>
<th>ST-Max</th>
<th>ST-Min</th>
<th>ST to end</th>
<th>Slope-ST/sec</th>
<th>erguson from right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuel Sp</td>
<td>226</td>
<td>26,3</td>
<td>22,3</td>
<td>29,1</td>
<td>23</td>
<td>2,4</td>
</tr>
<tr>
<td>Simon Sp</td>
<td>188</td>
<td>22,5</td>
<td>17,5</td>
<td>25,0</td>
<td>27</td>
<td>1,8</td>
</tr>
<tr>
<td>Manuel Ge</td>
<td>272</td>
<td>24,6</td>
<td>20,6</td>
<td>29,8</td>
<td>28</td>
<td>2,2</td>
</tr>
<tr>
<td>Simon Ge</td>
<td>65</td>
<td>22,9</td>
<td>18,0</td>
<td>26,7</td>
<td>28</td>
<td>1,6</td>
</tr>
</tbody>
</table>

M: 1st peak late as in Spanish, slope as in German*
S: 1st peak target-like, slope smooth as in German

At age 3;0

<table>
<thead>
<tr>
<th></th>
<th>ms to 1.Peak</th>
<th>ST-Max</th>
<th>ST-Min</th>
<th>ST to end</th>
<th>Slope-ST/sec</th>
<th>erguson from right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuel Sp</td>
<td>136</td>
<td>23,3</td>
<td>20,2</td>
<td>24,0</td>
<td>24</td>
<td>1,5</td>
</tr>
<tr>
<td>Simon Sp</td>
<td>145</td>
<td>33,7</td>
<td>18,0</td>
<td>28,2</td>
<td>17</td>
<td>3,0</td>
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<tr>
<td>Manuel Ge</td>
<td>89</td>
<td>22,9</td>
<td>19,7</td>
<td>24,3</td>
<td>36</td>
<td>1,0</td>
</tr>
<tr>
<td>Simon Ge</td>
<td>47</td>
<td>19,9</td>
<td>17,4</td>
<td>25,0</td>
<td>18</td>
<td>4,5</td>
</tr>
</tbody>
</table>

M: 1st peak as in German, slope as in Spanish*
S: 1st peak target-like, slope as in German*
At age 3;0

<table>
<thead>
<tr>
<th>Subject</th>
<th>ms to 1.Peak</th>
<th>ST-Max</th>
<th>ST-Min</th>
<th>ST to end</th>
<th>Slope-ST/sec</th>
<th>α from right</th>
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</thead>
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<tr>
<td>Inés Sp</td>
<td>268</td>
<td>21,1</td>
<td>18,0</td>
<td>25,0</td>
<td>18</td>
<td>4,5</td>
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<tr>
<td>Bernh. Sp</td>
<td>149</td>
<td>21,9</td>
<td>17,3</td>
<td>21,4</td>
<td>18</td>
<td>3,5</td>
</tr>
<tr>
<td>Inés Ge</td>
<td>130</td>
<td>18,2</td>
<td>17,2</td>
<td>20,2</td>
<td>9</td>
<td>1,0</td>
</tr>
<tr>
<td>Bernh. Ge</td>
<td>168</td>
<td>21,6</td>
<td>17,9</td>
<td>23,7</td>
<td>14</td>
<td>1,5</td>
</tr>
</tbody>
</table>

I: First peak is higher and later in Spanish; final rising slope is smooth as in German

B: First peak is similar in height and timing; final rising slope is steeper in Spanish
### Results \(wh\)-Q: Monolingual

<table>
<thead>
<tr>
<th>(wh)-Q</th>
<th>ms to 1st peak</th>
<th>F0 in ST 1st peak</th>
<th>F0 in ST Min</th>
<th>Rising slope ST/ms</th>
<th>Tokens</th>
<th>Falling slope ST/ms</th>
<th>Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miguel</td>
<td>98</td>
<td>24</td>
<td>21</td>
<td>+16</td>
<td>7</td>
<td>-10</td>
<td>1 0</td>
</tr>
<tr>
<td>Britta 2;0</td>
<td>-50</td>
<td>26</td>
<td>18</td>
<td>+23</td>
<td>1 2</td>
<td>--</td>
<td>0</td>
</tr>
<tr>
<td>Britta 3;0</td>
<td>-77</td>
<td>23</td>
<td>17</td>
<td>+19</td>
<td>1 8</td>
<td>--</td>
<td>0</td>
</tr>
</tbody>
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Monolinguals produce 1st peak targetlike: delayed in Spanish, early in German at 2;0 and 3;0
Spanish monolingual: more falling than rising final slopes
German child produces all final slopes rising
Final rising slope is contrary to expected: steeper in German than in Spanish
Results wh-Q: Bilingual

<table>
<thead>
<tr>
<th>wh-Q</th>
<th>ms to 1st peak</th>
<th>F0 in ST 1st peak</th>
<th>F0 in ST Min</th>
<th>Rising slope ST/ms</th>
<th>Tokens</th>
<th>Falling slope ST/ms</th>
<th>Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuel Sp</td>
<td>5</td>
<td>24.5</td>
<td>20</td>
<td>+16</td>
<td>4</td>
<td>-5</td>
<td>4</td>
</tr>
<tr>
<td>Simon Sp</td>
<td>-58</td>
<td>22</td>
<td>15</td>
<td>+21</td>
<td>8</td>
<td>-12</td>
<td>4</td>
</tr>
<tr>
<td>Simon Ge</td>
<td>-55</td>
<td>23</td>
<td>16</td>
<td>+10</td>
<td>9</td>
<td>-31</td>
<td>2</td>
</tr>
</tbody>
</table>

Bilinguals produce first peak targetlike in German, but no delayed peak in Spanish
One bilingual (Simon) produces more rising than falling final slopes in both languages
The other bilingual (Manuel) produces same number of falling and rising slopes in Spanish
Simon produces steeper rising slope in Spanish than in German
Simon twice produces falling slope steeper in German than in Spanish
Summary of results

- **Monolinguals at 3;0**
  - First peak target-like: later and higher in Spanish than in German
  - Final rising slope target-like: steeper in Spanish than in German

- **Bilinguals at 3;0 (Germany)**
  - First peak either target-like or as in German
  - Final rising slope either as in German or as in Spanish in both languages
  - The two languages of the bilingual child are not differentiated in relation to the final slope

- **Bilinguals at 3;0 (Spain)**
  - First peak target-like: later (and higher) in Spanish than in German
  - Final rising slope target-like (steeper in Spanish) only in one child
Thus, both monolinguals and bilinguals seem to have acquired the intonational targets of interrogatives
  - but fine-tuning into the respective language is target-like mainly in the monolinguals and partly in one bilingual

What have children acquired? What are the phonological units of yes/no interrogative intonation?
  - According to the AM Model: tonal targets (H, L)

How about alignment and scaling?
  - Are they inseparable from targets? Or just epiphenomena?
Grammar vs. Phonetics?

- Defining the phonological units of yes/no interrogative intonation:
  
  - 1. Rise to first peak (H), higher than in declaratives
  - 1′. First peak is higher and later in Spanish than in German
  - 2. Steady fall to syllable with main stress (L)
  - 3. Yes/no: Rise up to a final high boundary tone (H%)
  - 4. Wh-: Fall down to a final boundary tone (L%)
  - 3′/4′. Final rising/falling movement is steeper in Spanish than in German

- Features 1, 2 and 3 are sufficient to distinguish interrogatives from declaratives: research on discrimination of sentence types has shown that 1 and 2 are used to recognize yes/no-interrogatives, and 3 in cases of ambiguity (Face 2005)

- Features 1′ and 3′/4′ differentiate the two languages, Spanish and German, in terms of alignment and scaling; they can be equated to phonetic properties, which do not contribute to semantic discrimination

- All children, monolinguals and bilinguals, produce 1, 2 and 3 correctly; but the monolingual German does not produce 4. Delay emerges in the bilinguals in relation to 1′ and 3′/4′. These features show interaction between the two languages of the bilingual child


Examples of non-targetlike alignment

• Manuel 2;0: smooth slope in Spanish
  – ¿Eso es una pelotita? ‘Is this a little ball?’
  – ¿Ese es de aquí? ‘This one belongs here’,
  – ¿Ese va a Mateo? ‘This one goes to Mateo?’

• Simon 3;0: smooth slope in Spanish
  – ¿Me buscas el pegamento? ‘Do you find the glue for me?’
  – ¿Puedo subir al tren? ‘Can/May I get into the train?’
  – ¿Eso es unas cereza? ‘Is this/Are these cherri(es)’

• Manuel 3;0: steep slope in German
  – Ist das Auto? ‘Is this a car?’,
  – Hier in dem Auto? ‘Here in the car?’
  – Schmeckt das die Banane gut? ‘Does the banana taste good?’
Conclusions

- It is important to differentiate the Grammar of Intonation from the phonetic realizations of the various pitch accents and boundary tones.

- At 2;0, monolinguals and bilinguals produce the four points of yes-no questions (i.e., first pitch accent, medial fall ending in L, and final boundary tone) adequately, both in Spanish and German.

- Differences are found in the phonetic realization:
  - Monolinguals at 2;0: first peak and final slope are not target-like.
  - Monolinguals at 3;0 produce first peak and slope target-like.
  - Bilinguals growing up in Germany produce final slope either as in German or as in Spanish, i.e. the same in both languages.
  - Only one of the two bilinguals growing up in Spain produces steeper slope in Spanish, differently from German.

- Bilinguals tend to realize similar values for the two languages, and need more time than monolinguals to acquire the correct alignment of certain tones.

- A steep rising boundary tone is more difficult to acquire, and needs more exposure to the language.

- Bilingual children acquire the crucial features, i.e. the phonological units, soon; however, they tend to compromise values, if these are not phonological, but phonetic epiphenomena.
References


