Spanish heritage speakers resistant to degradation in L2 but not L1 speech recognition and production

Michael Blasingame, Ann R. Bradlow

Department of Linguistics, Northwestern University

INTRODUCTION

Heritage speakers as balanced bilinguals with dissociation of L1 and dominance

• For some bilinguals, L1 = native but L2 = dominant (referred to as heritage speakers)
• This dissociation allows us to directly examine the separate effects of dominance and age of acquisition on speech processing

Conflicting evidence for the role of language dominance and early acquisition

1. Heritage speakers show L2-dominant transfer of morphosyntax into heritage language
• Suggests that dominance matters more than early acquisition
2. In favorable conditions, heritage speakers demonstrate native-like performance in speech production in both languages
• Suggests early acquisition and dominance are both possible routes to robust speech processing in both languages
3. Early L2 learners (L1-dominant) still show vulnerabilities in speech perception in the L2
• Possibility of subtle speech learning deficiencies in either non-dominant L1 or dominant L2 of heritage speakers

What roles do early acquisition and dominance in usage have on speech processing?

• Age of Acquisition Hypothesis: If early acquisition is critical for native-like speech processing, then earlier bilinguals should be more resistant to signal degradations in the L1 but vulnerable in the L2
• Language Dominance Hypothesis: If language dominance is critical for native-like speech processing, earlier bilinguals should be more resistant to signal degradations in the dominant L2 compared to the L1 regardless of order of acquisition

METHODS

PARTICIPANTS

• Heritage speakers (SHS): 12 native (L1) Spanish speakers, acquired English after age 5-6, but attended middle school through college in English
• SHS are L2-dominant (English) based on written proficiency and course placement

PROCEDURE

• Experiments over two days blocked by language (English first) to avoid language mixing
- Experiment 1 – SHS speech perception accuracy
  - Listeners of Spanish and English (results not shown) also performed task: L2 L1-dominant English speakers and L2 L1-dominant Spanish speakers.
  - Participants listened to 50 sentences in each language and identified the final word
  - Final word predictability (from the preceding words) and speech style (clear vs. conversational) were randomized within SNR block

- Experiment 2 – SHS speech production accuracy (intelligibility)
  - Native English and Spanish listeners listened to SHS productions of the 110 simple sentences at two SNRs to provide intelligibility ratings
  - Each SHS was thus given an overall intelligibility score for each language by SNR

RESULTS

PARTICIPANTS

• Heritage speakers (SHS): 12 native (L1) Spanish speakers, acquired English after age 5-6, but attended middle school through college in English
• SHS are L2-dominant (English) based on written proficiency and course placement

PROCEDURE

• Experiments over two days blocked by language (English first) to avoid language mixing
- Experiment 1 – SHS speech perception accuracy
  - Listeners of Spanish and English (results not shown) also performed task: L2 L1-dominant English speakers and L2 L1-dominant Spanish speakers.
  - Participants listened to 50 sentences in each language and identified the final word
  - Final word predictability (from the preceding words) and speech style (clear vs. conversational) were randomized within SNR block

- Experiment 2 – SHS speech production accuracy (intelligibility)
  - Native English and Spanish listeners listened to SHS productions of the 110 simple sentences at two SNRs to provide intelligibility ratings
  - Each SHS was thus given an overall intelligibility score for each language by SNR

DISCUSSION

1. What factors affect speech perception and production?
   - While early acquisition is necessary for robust speech processing, it is insufficient on its own; language dominance also plays a critical role in modulating speech processing

2. Where do heritage speakers show resistance to signal degradations?
   - While favorable conditions allow SHS to achieve native-like performance in both languages, only the dominant language (the L2) is resistant to degradations

SELECTED REFERENCES


ACKNOWLEDGEMENTS

This work was made possible with the assistance of Emily Kahn (Research Assistant), Chun Liang-Chan (Technology Consultant), and Vanessa Dopler (Research Support Specialist).

This work was supported by Grant RO1-DC005794 from NIH-NIDCD.

EXPERIMENT 1 STIMULI: PERCEPTION

- Stimuli consisted of 60 keywords in English and Spanish each in sentence final position
- Stimuli were recorded by one balanced Spanish-English bilingual in both languages
- Three factors fully crossed for all keywords in both English and Spanish:
  - Factor
  - Predictability
  - SNR
  - Speech Style
  - Enhancement
  - High (supporting context)
  - SNR
  - 5 dB SNR
  - Clear speech
  - Degradation
  - Low (no contextual information)
  - 0 dB SNR
  - Plain speech

Example of high vs. low predictability sentence in English and Spanish (target word underlined)
- High: The meat from a pig is called pork
- Low: El padre dio la palabra

EXPERIMENT 2 STIMULI: PRODUCTION

- Stimuli consisted of 110 simple sentences in English and Spanish each adapted from [5]
- Sentences embedded in speech-shaped noise at 4 dB and -8 dB SNR for each language

Example of sample sentence in English: They are shopping for new school clothes.
Example of sample sentence in Spanish: El perro esta comiendo carne.

Speech intelligibility by heritage speakers in English and Spanish

<table>
<thead>
<tr>
<th>Language</th>
<th>SNR</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>4 dB</td>
<td>-8 dB</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Spanish</td>
<td>4 dB</td>
<td>-8 dB</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Speech intelligibility by heritage speakers in English and Spanish

<table>
<thead>
<tr>
<th>Language</th>
<th>SNR</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>4 dB</td>
<td>-8 dB</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Spanish</td>
<td>4 dB</td>
<td>-8 dB</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Word identification by heritage speakers in English and Spanish

<table>
<thead>
<tr>
<th>Language</th>
<th>SNR</th>
<th>0.85</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>+5 dB</td>
<td>0.85</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Spanish</td>
<td>+5 dB</td>
<td>0.85</td>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Word identification by heritage speakers in English and Spanish

<table>
<thead>
<tr>
<th>Language</th>
<th>SNR</th>
<th>0.85</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>0 dB</td>
<td>0.85</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Spanish</td>
<td>0 dB</td>
<td>0.85</td>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>