The use of cognitive control in the comprehension of Spanish-English code-switching

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Introduction

- Code-switching is generally defined as the alternation between languages in bilingual speech (Poplack, 1980)
  - El niño encontró el libro en el suelo [intra-sentential]
  - Fuiamos a la piscina, y luego para una siesta [inter-sentential]
- A bilingual’s propensity to code-switch and pattern of code-switching is constrained by proficiency and context
- Code-switching remains understudied; however, experimental evidence on cue language switching reveals switch costs in production and comprehension (Weust & Alport, 1999; Abutalebi et al., 2007)

- It remains an open question whether these switch costs are due to the characteristics of the subjects, the use of external cues to signal switching, or are reflective of code-switching

Questions

- If switching is difficult, is cognitive control recruited to guide the comprehension of code-switches?
- Cognitive control is used to manage conflicting representations or override prepotent responses in linguistic and domain-general tasks (Novick et al., 2005)
- Brain regions associated with cognitive control (e.g., LIFG, ACC) have been implicated in bilingual language control and cue language switching (Abutalebi & Green, 2008)
- Does a bilingual’s experience with code-switching modulate the difficulty of integrating code-switches?
- If code-switching use is an experience-based linguistic skill, then bilinguals with more exposure to code-switching should exhibit reduced use of cognitive control

Approach

- Use fMRI with auditory stimuli to investigate involvement of LIFG and ACC in code-switching comprehension
- Auditory presentation reflects observation that code-switching is primarily a spoken language phenomenon

Expectancy (Expected, Unexpected) x Switch (No Switch, Expected) Design

- Main Effect for Switch (F(1,23) = 15.956, p < 0.001)
- Negative correlation with self-reported CS exposure ratings and Switch conditions (r values are p < .03)

Participants

- 24 Spanish (L1) - English (L2) bilinguals

<table>
<thead>
<tr>
<th>Measure</th>
<th>Spanish</th>
<th>English</th>
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<tbody>
<tr>
<td>BNT</td>
<td>20.92 (4.16)</td>
<td>21.54 (4.05)</td>
</tr>
<tr>
<td>Grammar ***</td>
<td>38.42 (4.99)</td>
<td>44.42 (4.81)</td>
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<tr>
<td>AoA ***</td>
<td>0.96 (0.75)</td>
<td>5.77 (3.11)</td>
</tr>
<tr>
<td>Speaking</td>
<td>9.42 (0.72)</td>
<td>9.04 (1.23)</td>
</tr>
<tr>
<td>Listening</td>
<td>9.79 (0.51)</td>
<td>9.5 (0.83)</td>
</tr>
<tr>
<td>Writing</td>
<td>8.67 (1.34)</td>
<td>8.87 (1.2)</td>
</tr>
<tr>
<td>Reading</td>
<td>9.04 (1.23)</td>
<td>9.42 (0.72)</td>
</tr>
</tbody>
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- Bilinguals acquired Spanish as the first language
- Bilinguals are fairly balanced across the two languages, although significant difference on grammar scores

Results within Stroop Conflict Area of LIFG

- No effects in ACC

Results within Stroop Conflict Area of ACC

- Clusters thresholded by z > 2.3 with corrected cluster significance threshold of p < 0.05

Exploratory Analysis on Gender of Article

- To the extent that successful integration of code-switching relies upon forming expectations of likeswitch point, pronominal gender may be an informative cue
- In contrast with monolingual Spanish use, Spanish-English bilinguals show preferences for using masculine-marked Spanish article with code-switched NPs (Otheguy & Ladus, 2003)
- If grammatical gender is potentially a cue, then masculine-marked code-switched NPs should require less cognitive control (i.e. less conflict)

Conclusions

- Bilinguals revealed a robust main effect for code-switches in LIFG but not in ACC
  - The ability to integrate code-switches relies upon attending away from a same language representation to the other language
  - Lack of effect in ACC is in contrast to cued language switching paradigms
  - Semantic manipulation showed no reliable effects in co-localized regions or at whole brain
  - Previous neuromaging studies show effect in LIFG for semantic violations but not expectancy (e.g. Baumgaertner, et al., 2002)
  - Lack of effect differs from behavioral and ERP measures of semantic expectancy
  - Individual differences emerge in LIFG based on a bilingual’s self-reported exposure to code-switching
  - Indicating experience with code-switching may result in more efficient use of cognitive control when alternating between languages or 2) better ability to form predictions of when a code-switch may occur

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