Neural Correlates of Lexical Development in Adult Second Language Learners

Angela Chouinard and Ping Li

Department of Psychology and Center for Brain, Behavior & Cognition, Pennsylvania State University

Abstract

This study uses functional magnetic resonance imaging (fMRI) to address three main issues in second language (L2) research:

- how lexical access develops in L2 learners
- how lexical access in the L2 interacts with L1 lexical access
- how these processes may be influenced by individual differences in non-linguistic domains.

Models of bilingual processing such as the inhibitory control (IC) model and the revised hierarchical model (RHM) suggest that

- (a) bilinguals must consistently use IC in comprehension and production,
- (b) highly proficient learners access concepts directly while less proficient learners access concepts through the L1, respectively.

The neural implications of these models is that less proficient bilinguals, compared with highly proficient bilinguals, will require more effort to inhibit their L1 in order to successfully retrieve words in the L2. To examine this, participants complete measures of Working Memory (WM) and Executive Control (EC) that are regressed on BOLD responses to a language-specific lexical decision task in the L2.

Hypotheses

1) Lower proficiency learners will engage
- inhibitory control areas
- LIFPC, ACC, caudate
- in addition to areas associated with semantic retrieval
  - LMTG
  - for both homographs and unambiguous L2 words.

Furthermore, we expect to observe lesser activation of the LMTG in low proficiency learners (1).

2) Higher proficiency learners will utilize more efficient networks
- centered on the LMTG
- consequently have less significant activation in the LIFPC or other inhibitory control areas
- Unambiguous L2 words
- Not interlingual homographs
- continue to elicit LIFPC activation.

Furthermore, the L2 networks should resemble the L1 networks in these participants.

3) These proficiency-based differences may also be moderated by individual differences in working memory (WM) and executive control (EC) abilities.

Materials and Methods

Participants

Adult undergraduate native English speakers from 200 to 400 level Spanish courses at the Pennsylvania State University. All participants will be right-handed.

Materials

- Stimuli will include Spanish and English words, as well as interlingual homographs.
- All stimuli will be equated for length and frequency.
- Spanish words will be co-referenced with the textbook from the 200-level classes to insure that the participants will be familiar with the stimuli.

Table 1: Stimulus words for each experimental condition in the lexical decision task.

![Image](http://example.com/image1.png)

Behavioral Results

Relationship between Working Memory and Proficiency

- Regression using TVIP as independent and accuracy on Letter-Number Sequencing task as dependent measures
- TVIP significant predicts working memory performance
  - F=8.54, p<.01
  - Adjusted R-square=.232
- No significant relationship between proficiency and performance on Flanker task

Figure 2.

Table 2. Predicted ROI Activations

<table>
<thead>
<tr>
<th>Learners</th>
<th>Time</th>
<th>Word Type</th>
<th>Predicted ROIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Memory</td>
<td>Time 1</td>
<td>Unambiguous</td>
<td>Homograph PFC, ACC, caudate, MTL</td>
</tr>
<tr>
<td>Low Memory</td>
<td>Time 1</td>
<td>Unambiguous</td>
<td>Homograph PFC, ACC, caudate, low MTL</td>
</tr>
<tr>
<td></td>
<td>Time 2</td>
<td>Unambiguous</td>
<td>Similar or lower PFC, ACC, and caudate to T1, higher MTL</td>
</tr>
</tbody>
</table>

Predicted Results and Analysis Cont.

Connectivity analyses:
- cSEM analysis (17)
- Allows for the estimation of
  - Contemporaneous relationships
  - Lagged relationships
  - Directionality
- Based on the model of Rodríguez-Fornells et al (8), we predict a relationship between
  - LIFPC
  - LMTG
  - ACC
  - Caudate
- General pattern
  - Greater coupling between control areas and MTG when participants have to respond to L2 words and homographs.

Individual Level Analyses:
- Group Iterative Multi Model Estimation (GIMME) program (9)
- These individual level maps will be evaluated against the behavioral WM and EC data.

Implications and Future Directions

Theoretical:
- The results of the proposed study will provide insight into the nature of the lexical learning mechanisms in the adult second language learner.
- Green’s convergence hypothesis (10)
- Hernandez and Li’s vocabulary-specific convergence hypothesis (11)

Applied:
- Results of this line of work could have implications for identifying biomarkers of successful language learning.

References


Contact Information

Please email amc497@psu.edu or call 814-867-07791 for further details.