NEUROPHYSIOLOGICAL INDICES OF THE EFFECT OF COGNATES ON VOWEL PERCEPTION IN LATE SPANISH-ENGLISH BILINGUALS

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Outline

• Cognates/lexical storage
• Vowels
• Purpose
• Method & procedures
• Stimuli
• Predictions
• Analysis
• Results
• Clinical implications
• Future directions
Cognates

- Cognates are words that have a shared meaning and origin and similar phonology across languages.

- **Upside**: Each time a word is accessed its translation equivalent is also accessed, placing cognates of both languages equally at a lower threshold for retrieval activation than non-cognates (e.g., Dijkstra, Grainger, & Van Heuven, 1999).

- **Downside**: A second language learner may access native language (L1) phonological representations of a cognate word form while speaking in their second language (L2).
Cognates – *lexical storage*

- ‘elephant’ & ‘elefante’ - shared lexical representation
- ‘chair’ & ‘silla’ – separate representations

**Cognates**: Similarities of ‘elephant’ and ‘elefante’ may cause confusion during the phonological selection stage of lexical retrieval

**Non-cognates**: ‘chair’ and ‘silla’ being phonologically dissimilar would not pose an issue with competing phonological activations
Lexical Access-Theories

• *Cognates are more easily accessed in both L1 and L2*

• **Dell**’s cascading view of lexical access (Dell, 1986)
  - Cognates - could lead to more competitors in both languages during the lexical selection process – phonological confusion?

• **Levelt**’s (1989; 1999) once the correct node has been selected, the phonological segments of only the chosen node are retrieved and irrelevant phonological information will be discarded
Vowels
Spanish-English Overlap

Vowel Inventory

<table>
<thead>
<tr>
<th>Spanish</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>/a/</td>
<td>/æ/</td>
</tr>
<tr>
<td>/e/</td>
<td>/i/</td>
</tr>
<tr>
<td>/i/</td>
<td>/u/</td>
</tr>
<tr>
<td>/o/</td>
<td>/v/</td>
</tr>
<tr>
<td>/u/</td>
<td>/I/</td>
</tr>
</tbody>
</table>
Spanish vowel inventory
Vowels - ERP

- Electrophysiological evidence has demonstrated poor discrimination of words vs. non-words that differed only in a vowel contrast which was not present in the subjects’ L1 (Sebastian-Galles, Rodriguez-Fornells, Diego-Bala, & Diaz, 2006.)

- Minimal Pairs as homophones?
  - (e.g., sit/seat or racket/rocket)
Purpose

• To examine whether the phonological relationship (cognate or non-cognate) between translation equivalents of L1 & L2 influence phonological perception in L2
• How will L2 words that differ only in one phonological element be processed by late-bilinguals?
Participants

• Participants included 15 native monolingual speakers of English and 15 late Spanish-English bilinguals between the ages of 19-41.

• All bilingual subjects began their exposure to English after the age of 14 years or later.

• Bilinguals were accepted from a variety of Spanish-speaking countries in Latin America and the Caribbean.
Procedure Before ERP

- **Monolinguals** –
  - PPVT
  - Case history form
  - 20 question definition test

- **Bilinguals** –
  - Language background questionnaire
  - PPVT (raw score)
  - 15 question English grammar test & 20 question definition test
  - Verbal Fluency Task (categories)
  - **After ERP**: bilinguals completed the TVIP
Methods

- The ERP experiment consisted of 10 blocks, each containing 80 word pairs (~42 min)
  - Interstimulus Interval (ISI) is 800 ms. They are allowed 1500 ms to answer.
  - Each word pair consisted of either a cognate or a non-cognate word which is produced in standard English or with a change to the stressed vowel
  - Discrimination task (same-different)
ERP system – 64 channel net
Stimuli

• Each word is a 2-syllable word, half of which have Spanish cognate equivalents
• The 3 target vowels (/ɪ, ɛ, æ/) were in stressed position
• Stressed vowel in each word was changed to a more Spanish-like vowel, or a tense vowel in English

Sister

• No prefix morphemes or word initial vowels were used
Types of word pairs

- Cognates Same trials /sɪstəm/-/sɪstəm/
- Cognates Different trials – /sɪstəm/-/sɪstəm/
- Non-cognates Same trials – /sɪstə/-/sɪstə/
- Non cognates Different trials - /sɪstə/-/sɪstə/
Ex. Candy
Behavioral Discrimination Results

Accuracy

- Behavioral results Bilinguals: 82% Monolinguals: 92%
- A mixed model regression with Group, Type, and Condition as factors revealed significant interactions of Group x Type ($z=-3.1, p<0.01$) and Group x Condition ($z=-4.8, p<0.01$).
- A' prime table of accuracy

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Monolinguals</th>
<th>Bilinguals</th>
<th>t-value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognate</td>
<td>0.832</td>
<td>0.731</td>
<td>3.18</td>
<td>0.007</td>
</tr>
<tr>
<td>Non-cognate</td>
<td>0.862</td>
<td>0.716</td>
<td>4.36</td>
<td>0.0008</td>
</tr>
</tbody>
</table>
Behavioral Discrimination Results

Accuracy

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- A mixed model regression with Group, Type, and Condition as factors revealed significant interactions of Group x Type (z=-3.1, $p<0.01$) and Group x Condition (z=-4.8, $p<0.01$).
- Bilinguals were significantly worse at different trials
Predictions

• Both Monolinguals and bilinguals will demonstrate awareness of same/different trials
• Monolinguals will not demonstrate a difference in their responses to cognates and non-cognates
• Bilinguals will demonstrate an attenuated response to cognate words
Planned Analysis

- Linear mixed models
- ERP data was examined using a 2x2x2 factorial design. A mixed model regression analysis was completed using Subjects as a random effect and Fixed effects of:
  - **Group** (monolingual or bilingual)
  - **Type** (cognate or non-cognate)
  - **Condition** (same or different)
Analysis Cont.

- Data was broken down into 80 ms time frames starting at 200 ms post-stimulus presentation.
- Electrodes with a correlation coefficient of at least .8 and above were selected for statistical analysis and placed into two regions of interest: frontal (sites 4, 5, 53, 55, 57, 61, 62) and parietal (sites 34, 41, 42, 38).
What did we look for?

• “P400” response is a positive response seen in fronto-central electrodes and demonstrates an effect of language experience (Wagner, et. al, 2012)

• Parietal sites were chosen to assess for the presence of an N400 component or late positive component (LPC) in the data.

• An N400 has been demonstrated to phonological violations and is modulated by familiarity or priming. Associated with retrieving the stored conceptual knowledge relating to a word (Kutas et. al, 2000).

• LPC is related to the response a participant makes to the stimulus (Linden, 2005).
Analysis – N400 response

• The N400 component is known to have a scalp distribution in the midline parietal and central areas of the scalp, typically centering at Pz, or site 34 (Duncan et. al, 2009).

• An N400 has been demonstrated to phonological violations and is modulated by familiarity or priming. Associated with retrieving the stored conceptual knowledge relating to a word (Kutas et. al, 2000).
Analysis – LPC response

• The LPC is typically present after the N400 component, with a similar parieto-central distribution.
• It is an index of retrieval of a lexical item from our long-term semantic storage. It is typically larger to the second word in a pair when the second word is different from the first (Rugg, 1987, Wagner, et. al, 2012).
• Related to the response a participant makes to the stimulus (Linden, 2005).
ERP Results
Results- Parietal model

- 360-439 ms similar responses from both language groups

- 440-519 ms time-frame there were significant interactions of Group x Type and Group x Type x Condition ($p<.001$)

- Significant differences in variance across language groups were present for the non-cognate Different condition ($F(1,27)=4.59, p<0.01$) but not for the cognate Different condition ($F(1,27)=1.4, p=0.25$)
Parietal Subtractions

MONOLINGUAL
BILINGUAL
Results- Parietal model

• Topography – MONO similar across types, BIL different across types

• The non-cognate trials alone revealed a significant interaction of Group x Condition ($p<0.001$), with the BILs demonstrating a robust negative response to non-cognates different trials

• Non-cognate mispronunciations were perceived as a mismatch, and appeared to result in a lexical search.

• Bilinguals demonstrated a larger LPC with non-cognates only Group x Type x Condition $p<.001$ in all time frames from 520ms to 800ms.
Parietal Subtractions

Bilingual

Monolingual

Non-Cognate - dots
Cognate - solid

Amplitude - µV

Time - ms

Non-Cognate - dots
Cognate - solid

Amplitude - µV

Time - ms
Parietal Subtractions
Non-Cognates

Mono-red
Cognates

![Graphs showing amplitude over time for Parietal Subtractions and Mono-red Cognates.](image-url)
Results – Frontal model

• Frontal Model electrodes demonstrate a clear language difference

• **Bilinguals demonstrate a more robust response to changes in cognate words**

• Bilinguals and monolinguals have similar responses to cognate words

• Bilinguals demonstrate minimal recognition of vowel changes in non-cognate words
Results – Lexical Access

- Standard and accented cognate forms seem to equally allow for lexical access with respect to the N400 measure – Dell’s model.
- Frontal positive component finding does not fit with Dell’s model because the cognate words showed larger discriminative responses.
- Dell’s model explains the early operation of the system, but Levelt’s model is supported by our findings in that once the lexical item is selected, incorrect phonological information can be inhibited.
Frontal – **Non-cognates**

- Mono different – red solid
- Biling different – black solid
- Same trials – dotted lines

Amplitude (µV)
Frontal – Cognates

Mono Diff – Red solid
Biling Diff - Black solid
Frontal Subtraction

Non-cognates. Monos - Red

Frontal Subtraction

Cognates. Monos - Red
**Bilinguals** Subtract – Cognates Solid line

**Monolinguals** Subtract – Cognates Solid line
Discussion

• Results suggest that both MONOs and late-L2 subjects were able to perceive the vowel change and demonstrate differential ERP responses to different compared to same pairs, at least for the cognate words.

• The BILs demonstrated an increased positivity at frontal sites (P400) for cognates words, but smaller or absent response for the non-cognates.

• For the similarities in N400 response, it may be that MONOs from the New York City area may accept these variant cognate pronunciations due to the listeners’ high level of passive exposure.
Discussion

• LPC findings

• (BIL greater response to non-cognates)

• It is possible that BILs were primed by both the standard and accented versions of the cognate words and therefore did not have to “work as hard” to retrieve the lexical entry when they heard the target word

• Another possibility is that LPC reflects difficulty/effort in detecting vowel change – Non-cognates require more effort?
Conclusions

• Late bilinguals may have more accurate phonological representations of the cognate than non-cognate words.

• Familiarity with a word leads to more accurate L2 perception.

• Cognates are assisting not only at a higher lexical level, but also at a lower speech perception level.
Clinical implications

- Adult L2 language classes rely on vocabulary and grammar lessons and neglect the importance of phonological perception and production and the role it plays in the efficiency of L2 communication exchanges.
- L2 learners may also be relying heavily on cognate words to communicate and understand, especially with languages such as English and Spanish where cognates are so prevalent.
Clinical implications

• These results further demonstrate the need for a greater emphasis being placed on phonological awareness in the L2 classroom environment.

• Language studies that emphasize phonological perception and production as well as place extra emphasis on words that do not share an L1 equivalent should prove worthwhile to this population.
Future directions

• Adding discrimination and identification tests of vowels in isolation
• Conduct a study using more frequently encountered words
• Comparing production and perception skills
• Using cognates and non-cognates in an oddball design
Thank you!!!