Sebastian-Galles, Echeverria, & Bosch (2005)

“How early must an individual learn a second language to attain native performance?”
- Factors: age of acquisition, amount of exposure, aspect of language (vocab vs syntax), production and perception of sounds
- Explore bilinguals’ perception of phonology – “accent”
- Q: Are phonological difficulties with L2 due to L1 interference or normal maturation
  - What is role of early exposure to establish contrasts?
- Critical period hypothesis or progressive decline
  - <6mo universal phonetic sensitivity
Previous research: competence in L2

Current: examine phoneme perception in simultaneous bilinguals

Catalan: 8 vowels vs. Spanish: 5 vowels

Catalan only: /e/ vs. /ε/

E.g. finestra vs. finestra (Word vs. non-word)
Expmt 1
Establish method to analyze speech perception

- Participants
  - Early bilinguals
  - Monolingual < 4yr
  - Spanish-Catalan or Catalan-Spanish

- Task
  - Word discrimination task
  - Y/N “is it a word?”
  - Warned about replacement of sounds
  - Feedback during training
Lexical decision

- Meyer & Schvaneveldt (1971)
  - Priming task: word activates lexicon
  - RT task for word pairs: Word or non-word?
- Experiment 1: y/n both words?
  - Pairs: Associated words, unassociated, word-nonword, nonword-word, nonwords
  - Simultaneous presentation of stimuli
- Experiment 2: same/different judgment
Meyer & Schvaneveldt (1971)  
Exp 1: Y/N both words?

RT of correct responses Y-N task

- Associated vs. unassociated: 85ms difference
- Serial decision model: 2-stage decision process
  - 1\textsuperscript{st} non-word: quick N decision
  - Word-nonword pair: more errors b/c fast Y to word
CogLab data: Lexical decision (S’12 data)

Reaction times (ms) to second target

- Assoc words
- Unassoc words
- Word-non
- Non-Word
- Non-Non

Bread-Butter
Nurse-Mouse
Cold-Trief
Pafer-Bike
Morhi-Ardun
### Expmt 1
Establish method to analyze speech perception

<table>
<thead>
<tr>
<th>Participants</th>
<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Early bilinguals</td>
<td>- Catalan words (with /e/ and /ε/)</td>
</tr>
<tr>
<td>- Monolingual &lt; 4yr</td>
<td>- Non-words (switched /e/ and /ε/)</td>
</tr>
<tr>
<td>- Spanish-Catalan or Catalan-Spanish</td>
<td>- Real control words</td>
</tr>
<tr>
<td>-</td>
<td>- Non-word control words</td>
</tr>
<tr>
<td>-</td>
<td>- DV: error rates and reaction times (ms)</td>
</tr>
</tbody>
</table>

- Task
  - Word discrimination task
  - Y/N “is it a word?”
  - Warned about replacement of sounds
  - Feedback during training
Expmt 1: Results

Table 1
Mean A’ for each group of bilingual population and each stimuli type (standard deviation in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>ε-type</th>
<th>e-type</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Catalan</td>
<td>.874 (.058)</td>
<td>.953 (.046)</td>
<td>.974 (.013)</td>
</tr>
<tr>
<td>dominant bilinguals</td>
<td></td>
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Fig. 1. Average correct responses (percentages) in Experiment 1 for each stimulus type and bilingual group.
A’ = sensitivity

<table>
<thead>
<tr>
<th></th>
<th>Response Y</th>
<th>Response N</th>
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<tbody>
<tr>
<td>Stimulus Y</td>
<td>Hit</td>
<td>Miss</td>
</tr>
<tr>
<td>Stimulus N</td>
<td>False Alarm</td>
<td>Correct Rejection</td>
</tr>
</tbody>
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- Signal detection theory
- Want big difference between Hits and FA (better sensitivity)
- A’ (or d’) = Z(Hit) – Z(FA)
- If Hit = FA then d’ = 0; (A’ chance = 0.5; 1.0 = perfect)
Expmt 1: Results

$A' = \text{index of sensitivity}$

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Table 2
Mean reaction times for each control condition and bilingual population (standard deviation in parentheses): Experiment 1

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<tr>
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<th>Words</th>
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<td>Catalan dominant</td>
<td>965 (118)</td>
<td>1144 (155)</td>
</tr>
<tr>
<td>Spanish dominant</td>
<td>1043 (196)</td>
<td>1174 (171)</td>
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</tbody>
</table>

$N = 80$
Expmt 2

- Replicate control condition
- Method
  - Early bilinguals
  - Only spanish
  - Only catalan
  - Control stimuli
- Results
  - A’ non-sig results
  - RT (table 3)

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Table 3
Mean reaction times for each condition and bilingual population (standard deviation in parentheses): Experiment 2

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<td>Catalan dominant</td>
<td>934 (190)</td>
<td>1058 (170)</td>
</tr>
<tr>
<td>Spanish dominant</td>
<td>906 (114)</td>
<td>1103 (193)</td>
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N = 40
Expmt 3

- Add: simultaneous bilinguals
- Further split by Mom’s language

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</tr>
<tr>
<td>Simultaneous</td>
<td>.798 (.112)</td>
<td>.813 (.147)</td>
<td>.984 (.015)</td>
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<td>↑ns</td>
</tr>
<tr>
<td>Simultaneous</td>
<td>.750 (.114)</td>
<td>.758 (.140)</td>
<td>.981 (.017)</td>
</tr>
<tr>
<td>Spanish dominant</td>
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N = 40
Fig. 2. Individual scores for all participants as a function of bilingual group. Above, scores for ε-type stimuli. Below, scores for e-type stimuli.
Sebastian-Galles et al. (2005)

- Diff’s in initial exposure influences way language perceived
  - /ɛ/-type
    - Cat-Span & Simultaneous-Cat > Sim-Span > Span-Cat
  - /e/-type
    - Cat-Span > Sim-Cat > Sim-Span > Span-Cat
- “…exposure to a contrast is not enough for an individual to attain the same level of proficiency as bilinguals exposed to a single language during first year’s of life.”
- For simultaneous bilinguals, language used by mother predictor of ability on task
  - Suggests interference theory is incorrect
- Other discussion points:
  - Differences in exposure in later life
  - Exposure to “mispronunciations”
  - Do differences in phonological categories change way words are represented in lexicon?
Theories for how language is represented in bilingual brain

- Extended system hypothesis
  - One system

- Dual system hypothesis
  - Separate systems

- Tripartite system hypothesis
  - Everything common is represented once, and different features are in separate systems

- Subsystem hypothesis
  - Separate neuronal subsystems; part of larger linguistic system which can activate any part at any time
Lexical decision in bilinguals

- Is word recognition different in bilinguals?
- Ss: Dutch (L1) and English (L2)
  - Lexical decision task (single item)
- Results:
  - Dutch: 525ms; English 560ms (sig diff, p<.0010)
  - Same effects across both languages for
    • Imageability, familiarity, word length, simplicity
- Conclusions:
  - Decision times due to fluency differences?
  - Bilinguals process 2 languages in same and different ways
Brain areas and bilingualism
Kim, et al. (1997)

- How are multiple languages represented in the brain?
- Use fMRI to examine spatial relationship between L1 and L2
- Silent task: describe events of specific time during previous day in 1 language
- 6 “early” bilinguals (exposed since infancy)
- 6 “late” bilinguals (exposed during adulthood)
- Examine Broca’s area and Wernicke’s area…
Brain and language

- In 95% of cases language is left-hemisphere dominant (righties & most lefties)

- Broca’s area
  - Expressive-language deficit
  - Production

- Wernicke’s area
  - Unmeaningful production
  - Comprehension
“Late” bilingual participant: Broca’s area
“Early” bilingual participant: Broca’s area
“Late” bilingual: Wernicke’s area
Brain areas and bilingualism
Kim, et al. (1997)

- Late bilinguals:
  - 2 separate regions in Broca’s area
  - Little separation in Wernicke’s area

- Early bilinguals:
  - Little separation in Broca’s or Wernicke’s areas

- Age of acquisition determines organization of language in brain
- Does it depend on what 2 languages are learned?
Separation for different languages in “early” bilinguals
Bilingualism

- Pros and cons of bilingualism
  - **Advantages**
    - Peal & Lambert (1962): better in school and greater mental flexibility
      - 2 linguistic systems
      - Due to need to inhibit some responses?
    - More expertise in first language
    - Aware of subtle aspects of language
    - Aware of arbitrariness
    - Sensitivity to pragmatic aspects
  - **Disadvantages**
    - Language processing speed