Bilingual brain, literacy and cognition: a cross-linguistic perspective

Ioulia Kovelman
University of Michigan
kovelman@umich.edu

Ca' Foscari University of Venice
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Bilingual Literacy in Children

- Mechanisms of bilingual reading
- Brain organization for bilingual reading
- Dyslexia in bilingual readers
- Implications for Instructional Approach
Bilingual Literacy

- Adults and 2nd language learners: L1 influences L2
- Simultaneous child learners?

Cummins et al., 2012
Bilingual Acquisition Models

Independence in Bilingual Acquisition

*Simultaneous* bilinguals show language-specific patterns of reading acquisition (Das et al., 2010)

- Uncover two reading systems within one child!

Transfer in Bilingual Acquisition

*Sequential* bilinguals show structural impact of L1 on L2 literacy (Tan et al., 2003)

- Structural impact in simultaneous bilinguals?
Question 1: Does bilingual Spanish exposure impact children’s phonological processing in English?

Participants

- English monolinguals (n = 35, average age 10)
- Spanish-English bilinguals (n = 35, average age 10)
  - Early bilingual exposure (before age 5, 3 years before testing)
  - English-dominant literacy instruction, starting with K
  - Experimental tasks: Reading, Vocabulary, Phonological Awareness, Syntax, RAN, and Executive Function (HTKS)
  - Mechanism of reading: Step-wise hierarchical regression

Transfer Hypothesis & Prediction

- Bilinguals: greater reliance on phonology for reading in English.

(Kremin et al., IJBEB, 2017)
English & Spanish in Bilinguals

- English dominant biliterates

<table>
<thead>
<tr>
<th>Construct</th>
<th>English mean (SD)</th>
<th>Spanish mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading (Standard)</td>
<td>108 (24)</td>
<td>91 (15)</td>
</tr>
<tr>
<td>Vocabulary (Standard)</td>
<td>108 (17)</td>
<td>105 (19)</td>
</tr>
<tr>
<td>Phonology (Percentile)</td>
<td>77 (20)</td>
<td>78 (21)</td>
</tr>
<tr>
<td>Syntax (Percentile)</td>
<td>89 (12)</td>
<td>75 (20)</td>
</tr>
</tbody>
</table>
No differences in reading and language
Effect of English-dominant instruction

(Kremin et al., IJBEB, 2016)
Bilingual Literacy Mechanisms

Stronger reliance on Phonological Awareness in Bilinguals?

<table>
<thead>
<tr>
<th>English in Monolinguals</th>
<th>Spanish in Bilinguals</th>
<th>English in Bilinguals</th>
</tr>
</thead>
<tbody>
<tr>
<td>English RAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English Vocabulary</td>
<td></td>
<td>English Vocabulary</td>
</tr>
<tr>
<td>Spanish Phonology</td>
<td></td>
<td>English Phonology</td>
</tr>
<tr>
<td>Spanish Syntax</td>
<td></td>
<td>English Syntax</td>
</tr>
<tr>
<td>$R^2=.76$</td>
<td>$R^2=.77$</td>
<td>$R^2=.81$</td>
</tr>
</tbody>
</table>
Bilingual Acquisition Models

Independence in Bilingual Acquisition

Simultaneous bilinguals show language-specific patterns of reading acquisition (Das et al., 2010)
- Language-specific reading mechanisms

Transfer in Bilingual Acquisition

Sequential bilinguals show structural impact of L1 on L2 literacy (Tan et al., 2003)
- Greater reliance on phonology for reading in English
Spanish-English Bilingualism

Structural Impact

- Literacy - YES
- Brain - ?
Brain Bases of Bilingual Literacy

Question 2: Does bilingualism influence the brain bases of English literacy?

Participants
- English monolinguals (n=11, mean age = 8.5)
- Spanish-English & French-English bilinguals (n = 13, mean age = 8.12)

fNIRS overt reading task
- Regular words: carpet
- Irregular words: island
- Pseudowords: blicket

(Jasinska, Kovelman et al., NeuroPsychologia, 2017)
Cross-Linguistic Variation

- Paulesu et al., 2000: Italian & English Monolinguals
- Regular, Irregular, Pseudoword Reading Task
- Pseudoword task

**English > Italians**
- Left IFG/Broca’s

**Italians > English**
- Left STG/Wernike’s

**Question**: Cross-linguistic impact on bilinguals?
Spanish/French-English Bilinguals

% Correct

Regular | Irregular | Pseudowords

English Monolinguals | Spanish Bilinguals | French Bilinguals

(Jasinska, Kovelman et al., NeuroPsychologia, 2017)
Does Bilingualism Impact the Reading Brain?

Monolingual Brain
(Paulesu, 2000)

Bilingual Brain?

English pseudoword task

English

Italian

Mono > Spanish Biling

Spanish Biling> Mono

French Biling > Mono
Spanish-English Bilingualism

Spanish Impact
- Literacy – YES
- Brain – YES
- Chinese?

Spanish

SOUND

MEANING

Monolingual > Bilingual
Bilingual > Monolingual

Chinese

PRINT

Mono > Bilingual
Bilingual > mono
Chinese-English Bilinguals

Participants

- **Chinese-English bilinguals** (ages 6-12)
  - 57 completed behavioral assessment
  - 15 completed fMRI imaging, 11 used for analyses
  - Born in the US to 1st generation immigrants
  - Exposed to English prior to Kindergarten
  - 85th percentile English vocab, 65% correct Chinese vocabulary
  - English-only schooling, weekly heritage school classes
  - Same neighborhoods & school district as English monolinguals

- **English Monolinguals** (ages 6-12)
  - 77 completed behavioral assessment (Hsu et al., IJEB, 2016)
  - 24 completed fMRI imaging (Arredondo et al., HBM, 2015)
  - 11 fMRI participants were matched by age and gender to bilinguals (Ip et al., minor revisions with Dev Science)
**Literacy in Chinese-English Bilinguals**

**Bilinguals vs Chinese Monolinguals**
- Same on PA & MA
- Lower on vocabulary & word reading
English Literacy Path Analyses

English in Monolinguals (n=77, ages 6-12)

Meaning

- Morphological Awareness
  - R² = 0.70
  - 0.34**

- Vocabulary
  - R² = 0.22
  - 0.02

- Phonological Awareness
  - R² = 0.34**

Print

- Morphological Awareness
  - R² = 0.79

Sound

- Morphological Awareness
  - R² = 0.33

English in Bilinguals (n=57)

- Vocabulary
  - R² = 0.44**

- Phonological Awareness
  - R² = 0.42**

- Word Reading
  - R² = 0.63

(Hsu et al., IJEBEB, 2016)
Spanish-English Bilingualism

SOUND

➢ Spanish bilinguals
➢ English monolinguals

MEANING

➢ Chinese bilinguals
➢ English bilinguals

Structural Impact

➢ Literacy – YES
➢ Brain - YES
➢ Contrasting effects for Spanish & Chinese
Bilingualism
• Monolinguals are constrained by single linguistic experience
• Bilingualism alters spoken word processing, affecting literacy

Reading brain revealed through bilingualism?
• Multiple paths to successful literacy across languages
• Multiple paths to successful literacy within a language
• Core mechanisms of phonological and semantic word processing?
Dyslexia & Biliteracy

Independence in Bilingual Acquisition
Language-specific learning in bilingual dyslexia?

Transfer in Bilingual Acquisition
Cross-linguistic effects in bilingual dyslexia?
Language-Specific Learning in Bilingual Dyslexia?

Klein & Doctor, *Dyslexia in Different Languages*, 2003

- English-Afrikaans bilinguals in South Africa
- 3 children with dyslexia, ages 10-12
- Phonological deficits in both languages
- Experiment: Homophone reading task
  - Homophones: fair/fare, ate/eight, hear/here
  - In English, used lexical whole-word recognition
  - In Afrikaans, used phonological sound-out method
- ✔ Language-specific learning in dyslexia
Language-specific skills and sequence of Acquisition

Sequence matters: early & simultaneous is better
Simultaneous learners = better English-specific skills
Sequential Span 1, Eng 2 learners = better sound mapping

Berens, Kovelman et al., 2013
Transfer in Bilingual Dyslexia?


- Italian-English bilinguals in Canada, ages 9-13
  - 2nd generation, English dominant

- High versus low skilled readers
  - bilinguals (n=62/19), English monolinguals (n=101/119)
Table 5. *Mean scores and t test comparisons according to level of English reading skill on English tests: Bilingual and monolingual children ages 11–13 years*

<table>
<thead>
<tr>
<th>English tests</th>
<th>Skilled</th>
<th>Less skilled</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bilingual children</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>78.35</td>
<td>21.20</td>
<td>7.59***</td>
</tr>
<tr>
<td></td>
<td>(16.43)</td>
<td>(9.76)</td>
<td></td>
</tr>
<tr>
<td>Pseudoword</td>
<td>64.09</td>
<td>33.60</td>
<td>3.05**</td>
</tr>
<tr>
<td></td>
<td>(19.96)</td>
<td>(31.73)</td>
<td></td>
</tr>
<tr>
<td>Spelling</td>
<td>64.87</td>
<td>39.00</td>
<td>2.37*</td>
</tr>
<tr>
<td></td>
<td>(22.71)</td>
<td>(27.59)</td>
<td></td>
</tr>
<tr>
<td>Working memory</td>
<td>6.96</td>
<td>7.40</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>(1.41)</td>
<td>(1.52)</td>
<td></td>
</tr>
<tr>
<td>Oral cloze</td>
<td>17.31</td>
<td>15.20</td>
<td>2.80**</td>
</tr>
<tr>
<td></td>
<td>(1.58)</td>
<td>(1.79)</td>
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</tr>
<tr>
<td>n</td>
<td>45</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Monolingual children</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>60.39</td>
<td>9.58</td>
<td>18.78***</td>
</tr>
<tr>
<td></td>
<td>(19.52)</td>
<td>(7.86)</td>
<td></td>
</tr>
<tr>
<td>Pseudoword</td>
<td>52.66</td>
<td>15.60</td>
<td>11.36***</td>
</tr>
<tr>
<td></td>
<td>(20.84)</td>
<td>(14.75)</td>
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<tr>
<td>Spelling</td>
<td>36.00</td>
<td>7.72</td>
<td>8.26***</td>
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<tr>
<td></td>
<td>(25.28)</td>
<td>(8.31)</td>
<td></td>
</tr>
<tr>
<td>Working memory</td>
<td>6.19</td>
<td>5.07</td>
<td>2.69**</td>
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<td>(3.34)</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>64</td>
<td>60</td>
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</tbody>
</table>

Note: Standard deviations are in parentheses; df = 48 for the bilingual groups and df = 122 for the monolingual groups. Scores on reading tests and spelling tests are in percentiles; the remaining scores are raw.

* p < .05; ** p < .01; *** p < .001.

Each age group (9–10 and 11–13 years) was compared to the performance of the bilingual groups with the performance of their monolingual counterparts on the reading, spelling, memory, and syntactic tasks. This analysis revealed that, in the 9–10 years age group, skilled readers performed better than less skilled readers on all tasks except working memory: word reading, $F(3, 123) = 155.71$, $MSE = 231.54, p < .001$; spelling, $F(3, 123) = 37.04$, $MSE = 45.32$; oral cloze, $F(3, 123) = 7.64$, $MSE = 8.13$ (for all tasks, $p < .001$). Tukey HSD tests confirmed that skilled readers were more proficient than less skilled readers when comparing not only within but also between bilingual and monolingual children in all phonologically related tasks.
Bilingual Reading Acquisition

Independence in Bilingual Acquisition

Simultaneous bilinguals show language-specific patterns of language acquisition (Pena, Bedore, Barron, 2016)

- TD: Language-specific bilingual reading strategies
- ✔ Dyslexia: Language-specific learning

Transfer in Bilingual Acquisition

Sequential bilinguals show structural impact of L1 on L2 language and literacy (Bassetti, Vaid et al., 2012)

- TD: Neurocognitive transfer of phonological abilities
- ✔ Dyslexia: transfer
Implications for Literacy Instruction

Language-Specific Learning

- Single language instruction and dyslexia remediation work, even with low proficiency in that language (Geva et al., 2000).

Bilingual Transfer

- Learning to read in two languages can be harder than learning just one. Yet, bilingual learners with dyslexia also enjoy the benefits of bilingual transfer and long-term literacy benefits (Siegel et al., 2016)
Literacy & Dyslexia Revealed through Bilingual Brain Development

By Ioulia Kovelman, Silvia Bisconti, and Fumiko Hoefft

Reading is one of the most important skills learned in early childhood. Yet many young learners fail to meet the national standards in reading achievement, and young bilingual learners often are represented in this low-achieving group (Pugh et al., 2011). The goal of this paper is to explore how bilingualism affects the development of literacy in bilingual children, bilingual children with dyslexia, and monolingual children with dyslexia who are learning to read in a new language.

Impact of Bilingualism on Learning to Read?

Even when using only one of their languages, bilinguals often access linguistic and orthographic representations of their other language (Kroll & Bialystok, 2013). Such tight interaction between bilinguals' two languages facilitates the bidirectional sharing or “transfer” of literacy knowledge gained in one language towards learning to read in another language (Cummins, 2012).

For example, studies comparing bilinguals learning English and a language with
Thank you!

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Lisa Bedore, PhD
Elizabeth Pena, PhD
UM Psychology
UM CHGD
UM fNIRS Lab
UM fMRI Lab

Students
Maria Arredondo, PhD
Melanie Armstrong
Lucy Hsu, PhD
Frank Hu, PhD
Ka I Ip
Rebecca Marks
Neelima Wagley

Parents & Children