Application of Current Theoretical Models to Bilingual Aphasia Rehabilitation

Teresa Gray M.A. CCC-SLP
Doctoral Candidate, Boston University,
Sargent College of Health and Rehabilitation Sciences
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DISCLAIMER

- The authors have no relevant financial or nonfinancial relationships in the products or services described, reviewed, evaluated or compared in this presentation.
Your patient

- He is 63 years old, post-stroke, and multilingual.
- He was born in Colombia, South America, and spoke mostly Spanish as a child and young adult.
- He majored in French in college and spent a summer in France. He moved to North America when he was 22 and married an American who spoke only English. He had a stroke a year ago.
- You will have to decide in which language to provide therapy.
- Would you provide therapy in Spanish, the first acquired language, or in English, the language learned later but the one the client has been speaking with his immediate family?
Road Map

- The nature of bilingual language processing
- The nature of language impairment in bilingual aphasia
- Language therapy for bilingual aphasia
Road Map

- The nature of bilingual language processing
- The nature of language impairment in bilingual aphasia
- Different types of language therapy for bilingual aphasia
Research in bilingualism

1. Language processing in a bilingual individual is a dynamic process

2. Both language systems are active during language processing tasks

3. Language control: how the target language is activated
Research in bilingualism

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1. Language processing in a bilingual individual is a dynamic process

- Learning L2 not only changes representations and access for L2 but also for L1

- Mixing between the two languages poses a greater cost to L1 (more dominant) than to L2 (less dominant) (Christoffels, Kirk, & Schiller, 2007; Kroll, Dijkstra, Janssen, & Schriefers, 2000).

- Immersion experiences in L2 result in attenuation/attrition of L1 (Linck et al., 2009)

- Long term immersion can change the dominance, with L2 now becoming the L1
Model of Bilingual Lexical Access

(de Groot, 1992, 1994)

Asymmetrical Model
(Kroll & Stewart, 1994)
Model of Bilingual Lexical Access

(de Groot, 1992, 1994)  Asymmetrical Model
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Semantics

More dominant

Less Dominant

Research in bilingualism

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2. Both language systems are active during language processing tasks

- **Word recognition and production**
  - Robust research evidence that parallel activation of a bilingual’s two languages is observed during word recognition and production.
  - Selecting a word to speak in one language activates alternatives in the non-target language (e.g., Colomé, 2001; Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, De Bot, & Schreuder, 1998).
  - Parallel activation is also observed when languages differ in script (e.g., Chinese/English; Japanese/English)
Research in bilingualism

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3. Language control: how the target language is activated
Models of language control

- Selective attention to the target language
- Inhibition of the non-target language
Bilingual lexical retrieval

Adapted from Costa, La Heij, & Navarette, 2006
Selective attention to the target language

- According to Costa et al., 1999; Finkbeiner et al., 2006; there is activation in the non-target language but this activation is controlled by an attentional mechanism that effectively ignores competitors that are not from the target language.
• Inhibitory control model
  • In contrast, the Control Activation and Resource Model (Green, 1986; 1998) assumes that all activated alternatives potentially compete for selection
  
  • A specified inhibitory mechanism eventually resolves the competition by inhibition of candidates in the non-target language.

Road Map

- Understand the nature of bilingual language processing

- Understand the nature of language impairment in bilingual aphasia

- Understand the different types of language therapy for bilingual aphasia
What does this mean for bilingual aphasia?

Studies that explore **language** impairment:

- Lexical access (Edmonds & Kiran, 2006; Kiran & Lebel, 2007; Kiran & Tuchtenhagen, 2005; Lalor & Kirsner, 2001),

- Syntactic processing (Hernandez et al., 2008; Kambanaros et al., 2012; Tschirren et al., 2011),

- Orthographic processing (Raman & Weekes, 2005; Weekes, 2005, 2012; Yin et al., 2005; Zhang et al., 2009).

Studies that explore **control** impairment:

- Pathological switching (Fabbro et al. 2000; Ansaldo et al. 1997),

- Green et al. (2010),

- Verreyt et al. (2013),

- Gray & Kiran (under review).
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Lexical semantic access in bilingual aphasia

Normal Bilingual Adults: N = 12; Bilingual Aphasia Adults N = 13 (all participants Spanish-English speakers)

- Task:
  - Boston Naming Test
  - Category Naming Test Picture set of 60 semantically related picture pairs
  - Category generation task (animals, food, clothing) (Spanish/English)

- Dependent measures
  - Percent naming accuracy - BNT
  - Average percent naming accuracy across two semantically related sets

- Results: bilingual patients with aphasia exhibit lexical retrieval deficits, but the underlying mechanism supporting lexical retrieval on naming tasks for bilingual patients with aphasia still mirrors bilingual language processing utilized by healthy bilinguals.

Kiran, Balachandran, & Lucas (2013)
Language impairment vs Proficiency

19 Spanish-English bilingual adults with aphasia (mean age 63.1, SD 17.82); 11 females

- Bilingual Aphasia Test (BAT): English and Spanish + Part C
- Boston Naming Test (BNT): English and Spanish
- Pyramids and Palm Trees (PPT): Picture Version
- Language Use Questionnaire (Kiran, Peña, Bedore, & Sheng, 2010)
Framework of bilingual language processing

Comprehension English

Word Recognition
Sp → Eng

Semantics English

Semantics Non-linguistic

Expression English

Translation Sp → Eng

Comprehension Spanish

Word Recognition
Eng → Sp

Semantics Spanish

Expression Spanish

Translation Eng → Sp
Language impairment vs. Proficiency

Group 1a: Differential pre-stroke language rating followed by similar levels of post-morbid language impairment for both comprehension and expression measures.

Group 1b: Equivalent pre-stroke language rating followed by similar levels of post-morbid language impairment for both comprehension and expression measures.

Group 2: Differential pre-stroke language rating followed by similar levels of post-morbid language.

Gray & Kiran, 2013, JSHLR
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Language control: pathological switching and mixing

- Language switching: e.g., I want water. Tengo sed. [I am thirsty]
- Language mixing: e.g., I want the hombre [man] to move. (Adrover-Roig et al., 2011)

- In bilingual aphasia, it has been documented that patients can have problems controlling their two languages (Abutalebi, Miozzo, & Cappa, 2000; Aglioti & Fabbro, 1993; Aglioti, Beltramello, Girardi, & Fabbro, 1996; Ansaldo & Marcotte, 2007; Ansaldo, Saidi, & Ruiz, 2000; Fabbro, Peru, & Skrap, 1997; Fabbro, Skrap, & Aglioti, 2000; Goral et al., 2006; Keane & Kiran, in press; for a review see Ansaldo, Marcotte, Scherer, & Raboyeau, 2008).
Green et al. (2010)

- 2 bilingual adults with aphasia (L1 Spanish/L1 French, L2 English)
- Parallel recovery/impairment
- 12 healthy non-native English bilingual controls
- 14 healthy native English monolingual controls

Tasks

<table>
<thead>
<tr>
<th>Linguistic Task</th>
<th>Non-Linguistic Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng</td>
<td>L1</td>
</tr>
<tr>
<td>lexical decision</td>
<td>Stroop</td>
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</tbody>
</table>

Results

<table>
<thead>
<tr>
<th>Linguistic Task</th>
<th>Non-Linguistic Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng</td>
<td>L1</td>
</tr>
<tr>
<td>Patient 1:</td>
<td></td>
</tr>
<tr>
<td>lexical decision</td>
<td>X</td>
</tr>
<tr>
<td>Patient 2:</td>
<td></td>
</tr>
<tr>
<td>lexical decision</td>
<td>X</td>
</tr>
</tbody>
</table>
Verreyt et al. (2013)

- 1 French (L1) - Dutch (L2) bilingual adult with aphasia
- Differential language impairment (L1 is stronger than L2)

Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>General lexical decision</td>
<td>cognate facilitation</td>
</tr>
<tr>
<td>Selective French lexical decision</td>
<td>no effect of cognate facilitation</td>
</tr>
<tr>
<td>Selective Dutch lexical decision</td>
<td>cognates identified with less accuracy than Dutch non-cognates</td>
</tr>
<tr>
<td>Flanker</td>
<td>impaired control</td>
</tr>
</tbody>
</table>

Stimuli in each lexical decision task:
- 30 Dutch-French cognates
- 30 Dutch noncognates
- 30 French noncognates
- 90 non-words
Gray & Kiran (under revision)

- 10 Spanish-English bilingual adults with aphasia
- 30 Spanish-English, age matched neurologically healthy bilingual adults

Experimental Paradigms:

<table>
<thead>
<tr>
<th>Linguistic Task</th>
<th>Non-Linguistic Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic judgment</td>
<td>Flanker</td>
</tr>
</tbody>
</table>

Translation (Tr)
Semantic (S)
Unrelated (un)
Semantic Translation (STr)
Unrelated Translation (UnTr)

Fastest

Tr  S  Un  STr  UnTr  Slowest
Road Map

✓ • Understand the nature of bilingual language processing

✓ • Understand the nature of language impairment in bilingual aphasia

• Understand the different types of language therapy for bilingual aphasia
What does this have to do with Bilingual aphasia rehabilitation?

- What are the implications of this research?
  - Cross-language parallel activation = Cross-language generalization?
  - Cross-language interference - Can competition be capitalized in therapy?
  - Cognitive control of the language system - Train language or cognition?
A recent review of 13 studies on bilingual aphasia rehabilitation (Faroqi-Shah et al., 2010)

- Except for one study with 30 participants (Junque et al., 1989), most studies were case studies.

The good news:
- Therapy provided in the L2 results in improved treatment outcomes in the treated language.
- Cross language transfer occurs in over half the participants.
- Age of acquisition and language differences across studies do not specifically influence treatment outcomes.

The bad news
- Variability in treatment type and consequent treatment outcomes
- Other confounding variables including time post onset and nature of aphasia influence outcomes.
Between and within language generalization

Semantic Representation

Lexical selection

Phonological retrieval

Kiran et al., AJSLP, 2013

- Trained celery, cabbage improved (within-language)
- Trained celery and apio [direct translation] improved (between-language)
- Trained celery and repollo [cabbage] improved (between-language)

Cross correlation coefficient

Participant number
Between and within language generalization

Semantic Representation

Lexical selection

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Phonological retrieval

trained celery, cabbage improved (within-language)
trained celery and apio [direct translation] improved (between-language)
trained celery and repollo [cabbage] improved (between-language)
• What is the ultimate goal?

• Predict treatment outcomes, between-language generalization after rehabilitation in individuals with naming deficits

• Simulation of language deficits (Keidel et al., 2010), modeling rehabilitation of alexia (Welbourne & Lambon-Ralph, 2005, 2007), naming deficits (Plaut, 1996)
Language exposure

Language Use

Education History

Family Proficiency

Age of Acquisition

Age

Language severity

Time post onset stroke

Lesion site

Impairment in each language

Language trained

Degree of naming impairment

Degree of semantic syntactic impairment

Degree of semantic processing impairment

Language Ability

Confidence

Treatment outcome?

Hernandez & Li, 2007;
Li, Zhao, & McWhinney, 2007; Abutalebi, 2008

Fabbro, 2001a; Lorenzen & Murray, 2009;
Mechelli, Crinion, et al., 2004
Patient study

- 17 Spanish-English adults with aphasia
- Battery of standardized tests that examined receptive/expressive language in Spanish and English
- Language use questionnaire

- 10 weeks of naming therapy was administered.
  - 2x/week, 2 hours
Treatment protocol in behavioral study

1. Name picture
2. If incorrect, told correct name
3. Choose 6 correct features from 12 cards
4. Answer 15 yes/no questions about the item
5. Named item again with feedback

- Treatment always provided only in one language (either English/Spanish) and amount of improvement examined:
  - Within language: trained items & semantically related words,
  - Between Language: direct translations and semantic relations

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Edmonds & Kiran, 2006; Kiran & Roberts, 2009
Therapy video here
Three distinct groups of participants emerged:

- **Group 1 (A):** model matched patient performance for both the trained and untrained language
- **Group 2 (B):** model matched patient performance for the trained language only
- **Group 3 (C):** model matched patient performance for untrained language better than the trained language.
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Conclusions

- Bilingual language processing is dynamic
- Both languages are active in parallel
- Language impairment in bilingual aphasia is influenced by pre-stroke language proficiency and language control may be affected.

In terms of therapy:
1. Better understand the interaction between facilitation and interference across a range of patients
2. We need to better understand the interaction between language and cognitive control
3. Extend the computational model that accounts for facilitation and interference to predict treatment outcomes
Thank you!

Contact information:
Teresa Gray: tgray@bu.edu