MASSACHUSETTS GENERAL HOSPITAL

BOSTON UNIVERSITY

WHAT IS THE NATURE OF BILINGUAL APHASIA AND BILINGUAL APHASIA REHABILITATION?

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Pdfs of this presentation are uploaded at http://www.bu.edu/aphasiaresearch/ under recent news in the lab

FUNDING ACKNOWLEDGMENT

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Intellectual contribution for part I of talk: Mira Goral at CUNY.

Soon to appear article in ASHA LEADER

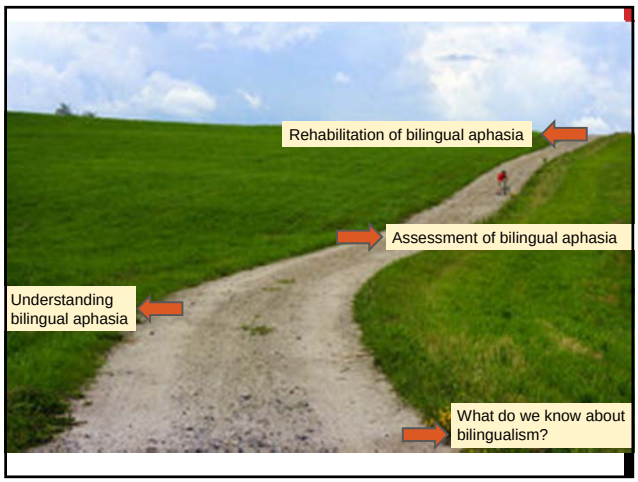
DISCLOSURES

Consultant for Constant Therapy (LLC).

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 her immediate family?**

ANOTHER EXAMPLE:



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. **There are cognitive consequences of being bilingual**
4. **There are structural and functional changes in the bilingual brain**

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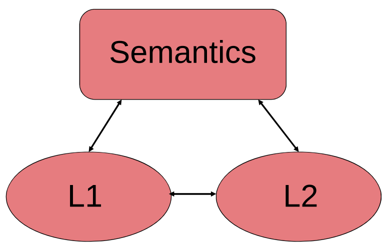
1. Language processing in a bilingual individual is a dynamic process

- 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 attentuation/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)

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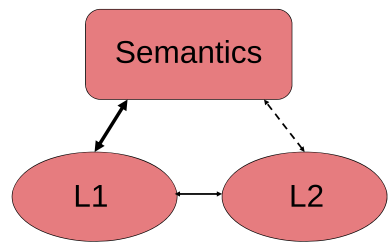

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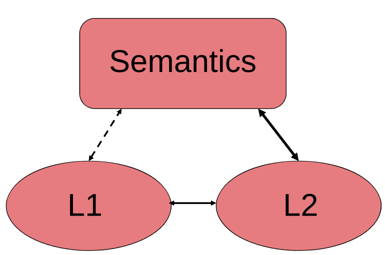

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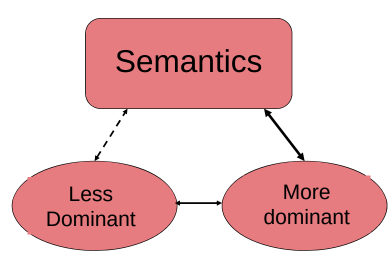

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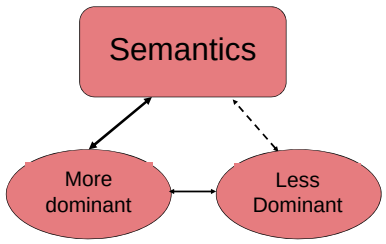

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Asymmetrical Model (Kroll & Stewart, 1994)

IMPLICATIONS FOR APHASIA:

The dynamic nature of language dominance, including factors such as attrition and immersion, needs to be taken into account when evaluating impairment in the multiple languages of multilinguals and deciding which language to treat.

With many of the clients we see, it is reasonable to expect that there may have been some attrition in L1 and that L2 may have become the dominant language.

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2. **Both language systems are active during language processing tasks**
3. There are cognitive consequences of being bilingual
4. There are structural and functional changes in the bilingual brain

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
  - 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)
- Sentence processing
  - ERP studies show cross language interactions occurs even highly proficient participants are reading sentences in one language (Thierry & Wu, 2007).

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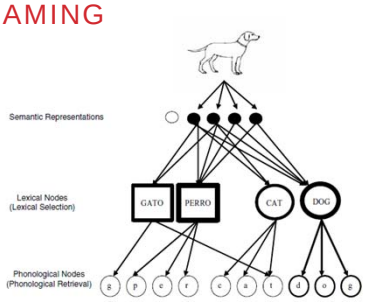
SCHEMATIC OF BILINGUAL PICTURE NAMING



Schematic of bilingual picture naming of Dog in English. The squares represent the lexical nodes of the language not-in-use (Spanish), and the circles represent the lexical nodes of the language in use (English). The arrows represent the flow of activation and the thickness of the circles indicates the level of activation of the representations.

Costa, La Heij, & Navarette, 2006

Everyone now agrees that non-target language is active during production-

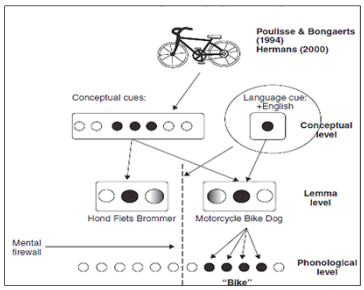
How do bilinguals resolve the activation in the non-target language?

- Selective attention to the target language
- Inhibition of the non-target language

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.
- MENTAL FIREWALL MODEL (Kroll et al., 2008)-
- Through selective attention, the target language is heightened, and a mental firewall is established in the non-target language

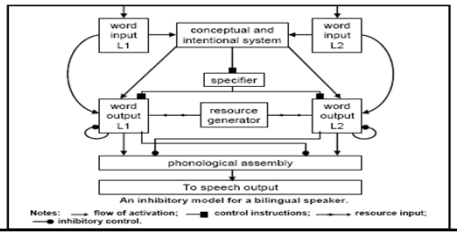
How do bilinguals resolve non-target activation?

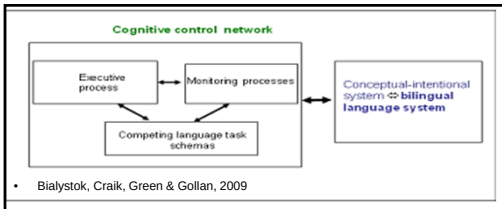


Kroll , Bobb, Misra & Guo, 2008; Kroll, Guo & Misra, in press

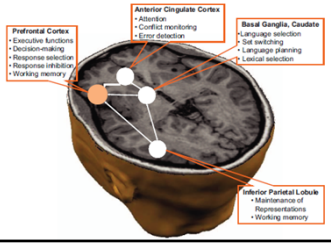
Inhibitory control model

- 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.





- Bialystok, Craik, Green & Gollan, 2009



Abutalebi & Green, 2007

IMPLICATIONS FOR APHASIA:

Understanding that all languages are active during language processing tasks is very important

If target words and structures are active in all the languages of the individual, then training in one language should result in changes in all languages.

However, it may also be possible that if all languages are always active, there may be a greater likelihood of interference among the languages when the client is experiencing word-retrieval difficulties in one language.

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Cognitive consequences of being bilingual

- Relative to monolinguals, bilinguals have the advantage switching between tasks, ignoring irrelevant information, and resolving online conflict (e.g., Bialystok, Craik, Green, & Gollan, 2009).
- Bilingual children outperform monolingual children on nonlinguistic tasks of selective attention and inhibition (e.g., Bialystok, 2001; Bialystok, Craik, Klein, & Viswanathan, 2004)
- Bilingual older adults are more efficient switchers than monolinguals and may even delay the onset of dementia by four years (Craik, Bialystok, & Freedman, 2010)
- Bilingual language switching costs and some disadvantage during language processing (e.g., Anton-Mendez & Gollan, 2010)

Read Bialystok, Craik, Green & Gollan, 2009, PSPI for a complete review

IMPLICATIONS FOR APHASIA:

It may be possible that working with multilingual individuals on cognitive exercises (targeting inhibition and suppression) may have beneficial effects on their ability to maintain cognitive control.

Training cognitive control (or efficient inhibition/suppression of irrelevant information) can be done in tandem with language therapy.

However, it is also possible that multilingual individuals may be more susceptible to aphasia and may have greater language deficits relative to monolingual individuals (Wong & Kiran, submitted).

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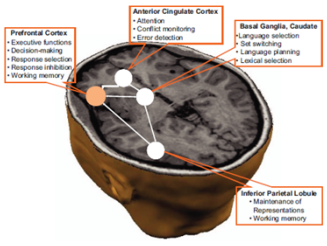
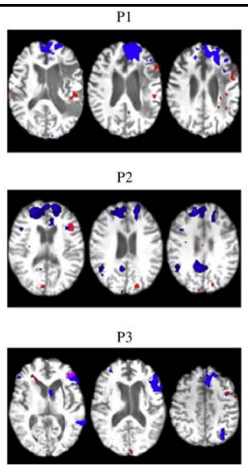
Structural and functional changes in the bilingual brain

- Depending on proficiency, bilinguals show a more widespread network of activation for L2 processing than L1 processing (Sebastian, Kiran, & Sandberg, 2012)
- More prefrontal and ACC activity indicates more cognitively controlled processing for the weaker L2 relative to L1 (Abutalebi & Green, 2007)
- Bilinguals show greater gray matter density in the left inferior parietal cortex than monolinguals (Mechelli et al., 2004)
- Even non-language areas such as ACC are structurally different in bilingual adults compared to monolingual adults (Abutalebi et al., in press)

Read Brain & Language 109 (2009) for a special issue on the bilingual brain



Abutalebi & Green, 2007



Specifically, increased activation was observed in the left frontal cortex and anterior cingulate gyrus during the weaker native language processing.

In participants with aphasia, increased bilateral activation was observed during the weaker native language processing, indicating that decreased language usage/proficiency results in a distributed network of activation.

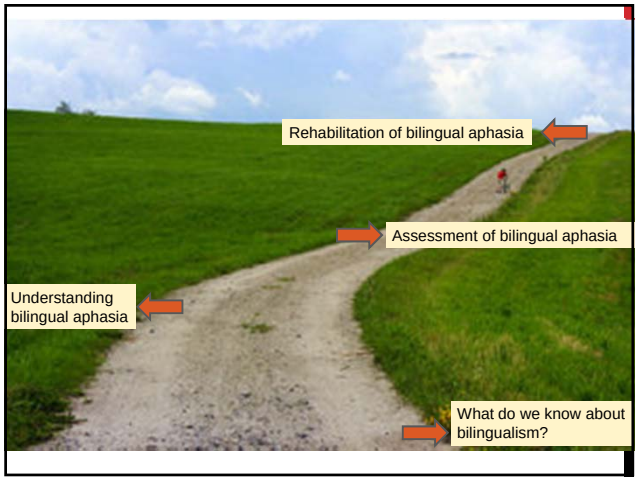
(Sebastian, Kiran, & Sandberg, 2012)

IMPLICATIONS FOR APHASIA:

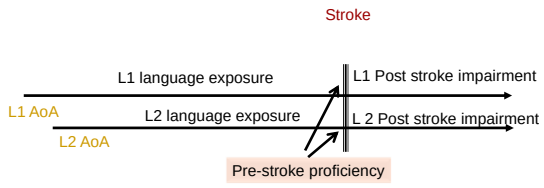
It is likely that after brain damage, the same mechanisms that come into play when predicting the neural substrates of language recovery in monolingual aphasia are also true in multilingual aphasia.

The redundancy of the neural regions may support language recovery in ways that are facilitative.

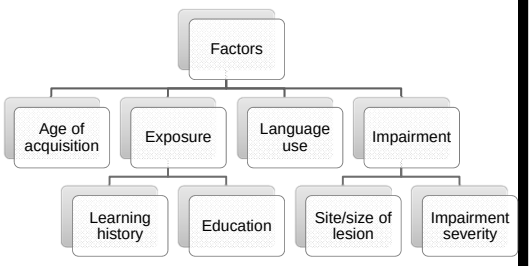
WHAT DOES THIS RESEARCH MEAN FOR YOUR PATIENT WITH BILINGUAL APHASIA?



SCHEMA FOR BILINGUAL APHASIA



FACTORS INFLUENCING LANGUAGE RECOVERY AND REHABILITATION



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

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

UNDERSTANDING THE NATURE OF BILINGUAL APHASIA

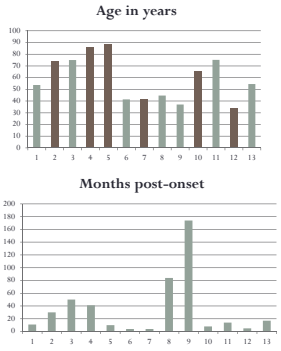
N = 19 bilingual aphasia patients

Standard Bilingual Aphasia Assessments

- Bilingual Aphasia Test in English & Spanish
- Boston Naming Test in English and Spanish

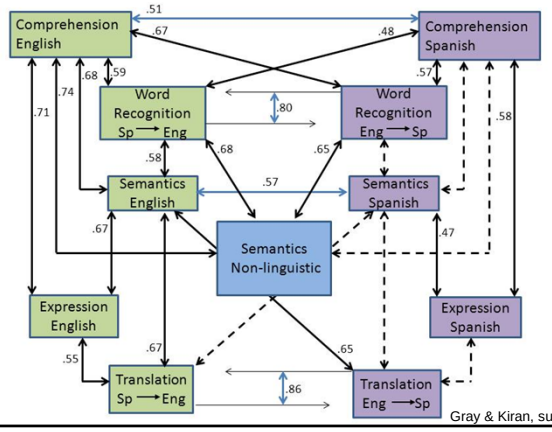
Pyramids and Palm Trees Test

- 3 pictures



Gray & Kiran, submitted

Validation of theoretical framework



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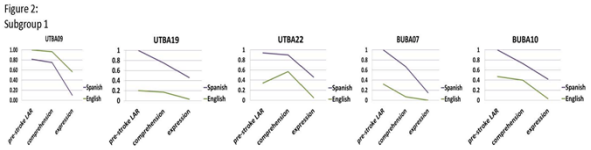
Validation of theoretical framework

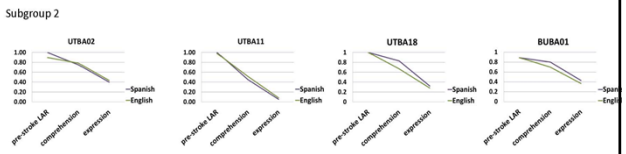
Subgroup 1: Differential pre-stroke language rating followed by similar trending post-morbid language impairment for both comprehension and expression measures.



Gray & Kiran, submitted

Validation of theoretical framework

Subgroup 2: Equivalent pre-stroke language rating followed by similar levels of post-morbid language impairment for both comprehension and expression measures.



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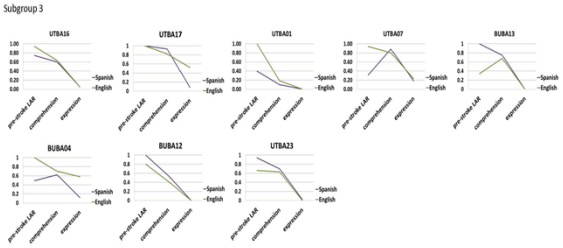
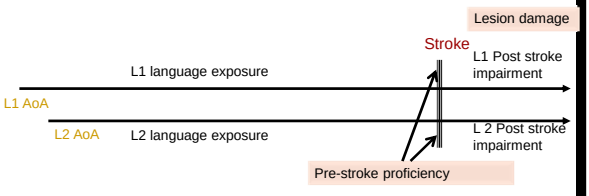
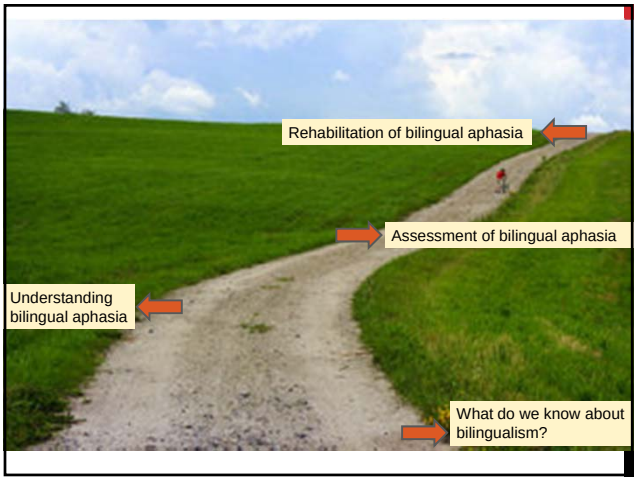


Gray & Kiran, submitted

Pre-stroke proficiency drives post stroke impairment in aphasia





CURRENT STANDARDIZED ASSESSMENTS

Aachen Aphasia Test **(Graetz, de Bleser, and Willmes, 1992; Luzzati, Willmes, and de Bleser, 1992; Miller, de Bleser, and Willmes, 1997)**

Boston Diagnostic Aphasia Examination **(Goodglass and Kaplan, 1983; Goodglass, Kaplan, and Barresi, 2000; Laine, Goodglass, Niemi, Koivuselka-Sallinen, Tuomainen, and Martilla, 1993),**

Bilingual Aphasia Test **(BAT) (Paradis and Libben 1987; Juncos Rabadan, Elosua de Juan, Pereiro Rozas, and Torres Maroño, 1998)**

Multilingual Aphasia Examination **(MAE)**

BUT SEVERAL PROBLEMS WITH SUCH ASSESSMENTS

Not normed across different languages

Translated tests may introduce biases of items and levels of difficulty.

Difficulty levels may be unequal between languages (e.g., BNT)

OTHER ASSESSMENT MEASURES

Category generation across the two languages

- Difference in the number of words produced in each language
- Roberts and Le Dorze (1998) found similar performance across the two languages of French-English bilingual adults with aphasia

Discourse production on a narrative task across the two languages

- Muñoz and Marquardt (2004) examined semantic accuracy of the utterance, the number of verbal disruptions (such as repetitions, omissions, fillers), and word retrieval errors (such as semantic errors, phonemic errors, descriptions).

LEXICAL SEMANTIC ACCESS IN BILINGUAL APHASIA

Normal Bilingual Adults: N = 12

Spanish-English Bilingual Aphasia Adults N = 13

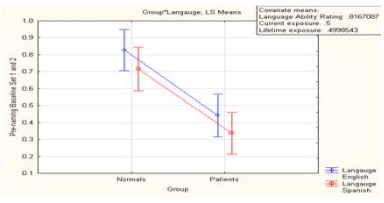
Task:

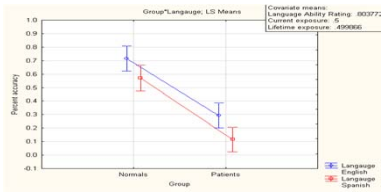
- Boston Naming Test
- Category Naming Test Picture set of 60 semantically related picture pairs
- Category generation task (animals, food, clothing)
- English and Spanish

Dependent measures

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

Kiran, Balachandran, & Lucas, submitted





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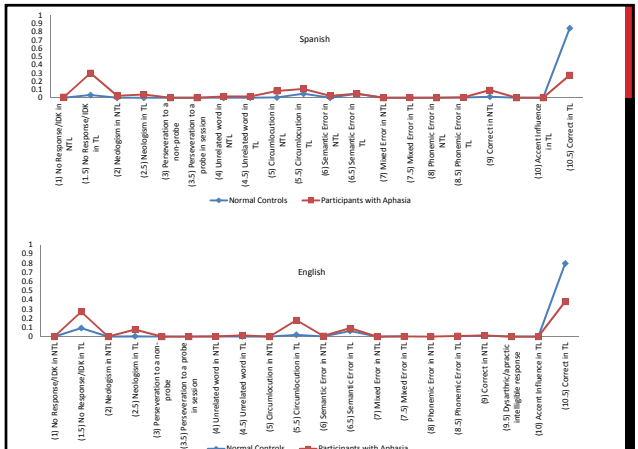

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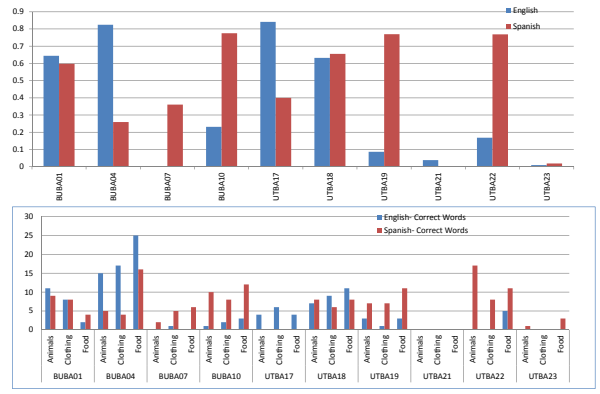

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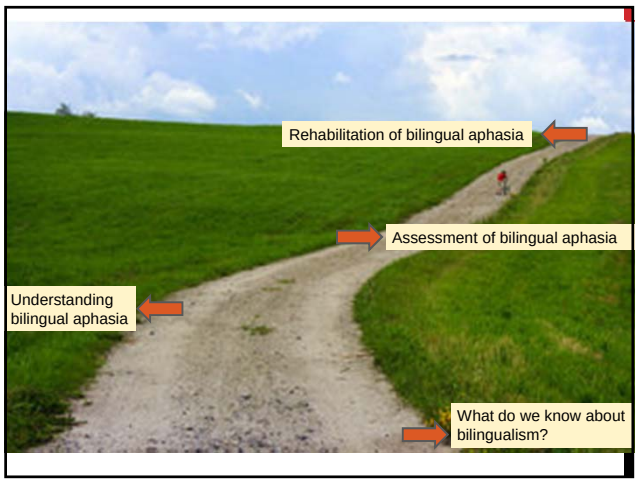


BILINGUAL APHASIA REHABILITATION

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.
- 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 do not specifically influence treatment outcomes.
- Other confounding variables including time post onset and nature of aphasia influence outcomes

LANGUAGE INTERVENTION IN FRENCH–ENGLISH BILINGUAL APHASIA

Pt: 1 mod-severe Broca's aphasic, 59yo

MPO: 5 years; L1-French; L2-English

AoA: French from birth, English "some" exposure from general community, tv, etc. 15yo English school. After graduation, used both languages regularly (speaking, reading, writing)

Proficiency-fluent in English, but French dominant

Dx: greater L2 impairment compared to L1

English (L2); 45 min. 4x/week = 48 hours therapy

- formal/informal, devoted to conversation
- develop fx'l phrases and vocab, based on PACE

Gains in L2 but not in L1 (measured by BAT)

Results: language-specific improvement (Miller-Amberger, 2011)

Transfer patterns of naming treatment in a case of bilingual aphasia

Pt: 1 transcortical motor aphasic, 71 yo

MPO: 6; L1 Spanish; L2 English

AoA: Spanish birth; 18yo immigrated to US and completed 2 yrs education

Proficiency: balanced

"skill-based" therapy for naming deficits (fruit, colors, clothing)

L1 first (then naming subtest of BAT administered in L1/L2),

L2 second with BAT post-testing

Cueing hierarchy: semantic cues, then phonemic cues, then repetition

No crosslinguistic generalization following treatment

(Galvez & Hinckley, 2003)

CROSS LANGUAGE TRANSFER IN A TRILINGUAL APHASIA PATIENT

1 trilingual aphasic (German, English, and French)

Had previously been treated significantly on L1 (German) without noted improvements to L2 (English) and L3 (French)

Intensively treated on L3 using treatment focused on lexical-semantic deficit (not specified therapy)

L2 and L3 improved significantly following treatment
L1 did not improve but was at the highest level pre-treatment

While procedure is unclear, this study provides further evidence that training semantic information in one language can generalize to other languages

Also suggests that training less proficient language will generalize more

Miertsch, Miesel, & Isel, 2009

COGNITIVE AND COGNATE-BASED TREATMENTS FOR BILINGUAL APHASIA

Pt: 1 severe transcortical motor aphasia, 62 yo

MPO: 1 year, L1 Spanish, L2 English

AoA: Spanish from birth, English "was his second language"

Moved to the US at 35 yo

Proficiency: balanced, advanced medical degrees in both languages

Treatment

Week 1—two 1 hour sessions, Spanish (one week interval)

Week 2—two 1 hour sessions, English

Kohnert, 2004

Tasks: identify training item pictures, match written words to referents, generate semantic associations to target words, complete cloze tasks, writing to dictation, confrontation naming with hierarchy of cues.

Stimuli

Training: 20 Spanish-English word pairs (half cognates)

Testing: 20 Spanish-English word pairs (half cognates)

Results

Crosslinguistic generalization was reported for cognates, but not for non-cognates.

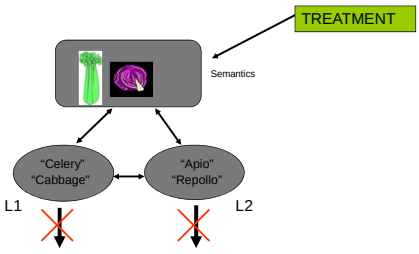
Issue

No true control condition, extent of improvements are unclear

Were the untrained stimuli tested?

Kohnert, 2004

CROSS LINGUISTIC GENERALIZATION



Edmonds & Kiran, (2006) *JSLHR*

Pt	Sex	Age	MPO	Family / Social	Work	Education	Self-ratings (L1/L2) (1–7)
1	F	53	9	Spanish only until 21 years -Prior to CVA, 100% English at home with -Spanish and English with grown children	Factory: 50% English 50% Spanish	-Educated in Spanish -Learned and used English	Speech: 6/7 Comp: 7/7
2	M	54	8	Both languages from birth -Prior to CVA, Spanish primarily with mother (bilingual) -100% English at home with spouse	Surveyor: 70% English 30% Spanish	Educated in English -No Spanish training -Read in English for leisure	Speech: 7/5 Comp: 7/6
3	F	53	9	-Both languages from birth -Prior to CVA, 80% English and 20% Spanish (with husband) at home	Retail: 70% English 30% Spanish	-Educated in English -No Spanish training -English only at work -Read in English for leisure	Speech: 7/3 Comp: 7/5

Edmonds & Kiran, (2006) *JSLHR*

STIMULI

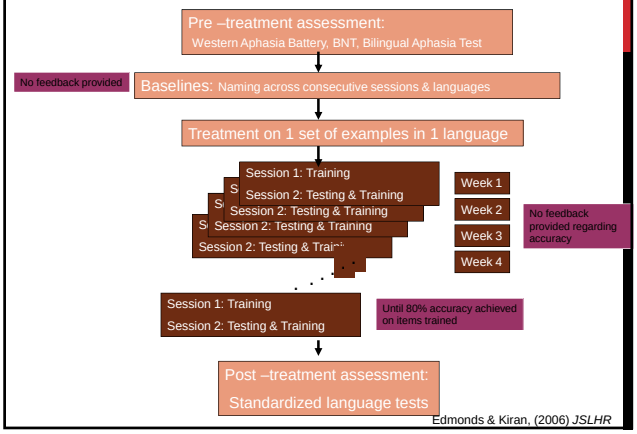
For each participant, a different list of stimuli were developed

Frequency of items matched within language and across languages for each participant

- Matched semantically unrelated control set for English and Spanish (e.g., boat, *vaca*) (N=5 for each set)
- No cognates (e.g., elephant/*elefante*) or pairs with 50% or more phonetic similarity (cat/*gato*)
- Only one pair per semantic category used (e.g., tools, furniture)
- No more than 4 syllables for any word

Edmonds & Kiran, (2006) *JSLHR*

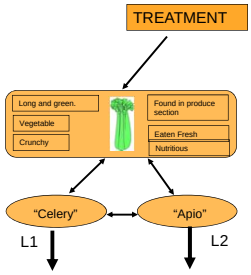
SCHEMATIC OF TREATMENT FOR EACH PARTICIPANT



Edmonds & Kiran, (2006) *JSLHR*

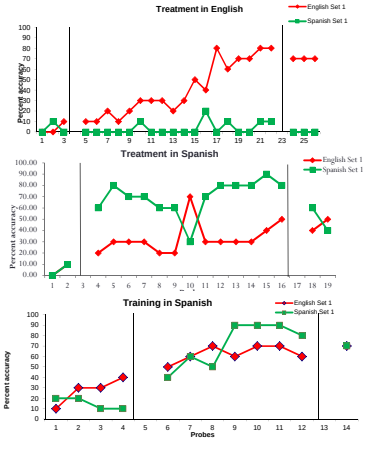
TREATMENT PROTOCOL IN BEHAVIORAL STUDIES

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**

Edmonds & Kiran, 2006; Kiran & Roberts, 2009



English dominant patient
Trained in English

Equally proficient patien
Trained in Spanish

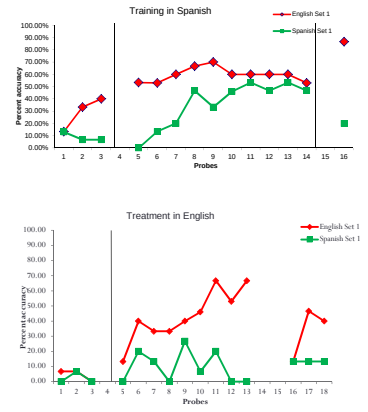
English dominant patient
Trained in Spanish

Edmonds & Kiran, 2006

IN A FOLLOW UP STUDY

Demographic information						Language History and Proficiency			
Pt	Sex	Age	Education	Etiology	MPO	Family / Social	Work	Reading/Writing	Self-ratings (L1/L2) (1–7)
1	F	55	14 yrs	Left MCA	11	Born in US. Began English at age 5. Spanish from birth. Married to bilingual Spanish speaker.	English: 50% Spanish 50% Clerk in community education for English as a second language	Educated in English Self taught Spanish Read and wrote English and Spanish materials	Speech 6/7 Comp 6/7 Reading 4/7 Writing 4/7
2	F	87	12 years	Left MCA	6	Spanish only with relatives, friends. English with grandchildren and other professionals.	50% English 50% Spanish Writer of Mexican fiction books	Educated in Spanish Read and Wrote English and Spanish materials	Speak: 7/7 Comp: 7/7 Read: 7/7 Write: 7/7

Kiran & Roberts, 2009



English dominant patient
More impaired in Spanish
Trained in Spanish

Equally proficient
Trained in English

Kiran & Roberts, 2009

IS THERE ANOTHER WAY TO UNDERSTAND THE NATURE OF BILINGUAL APHASIA REHABILITATION?

Develop a computational simulation of bilingual aphasic naming deficits and rehabilitation of bilingual aphasia.

Similar to predicting rehabilitation of naming deficits (Plaut, 1996) which has led to the complexity account of treatment deficits for naming deficits (Kiran, 2007)

COMPUTATIONAL MODELING: SOM

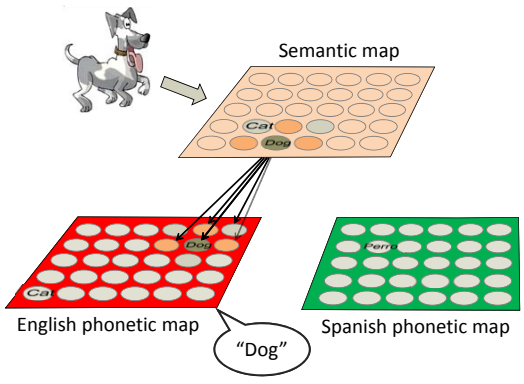
Self Organizing Maps (Kohonen, 1995) is an type of artificial neural network that is based on unsupervised learning.

SOMs operate in two modes

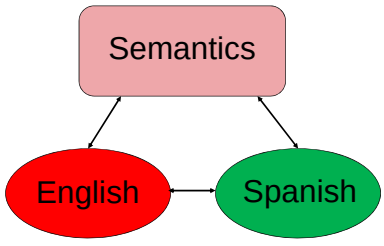
- Training -builds the map using input examples
- Mapping- classifies a new input vector

SOMs have been used to understand bilingual language learning (Li, Zhao & McWhinney, 2007) and biological/psychiatric conditions (Hamalainen,1994; Hoffman, Grasemann, & Miikkulainen, 2011)

NAMING TASK IN BILINGUAL DISLEX MODEL



MODEL OF BILINGUAL LEXICAL ACCESS

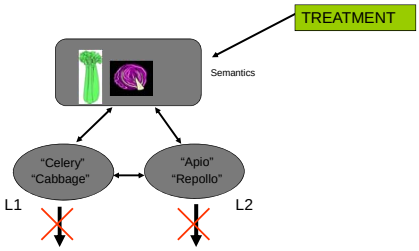


Asymmetrical Model
(Kroll & Stewart, 1994
Kroll et al., 2010)

PATIENT STUDY 3: (N = 17)

	AOA		Lifetime Exposure		Treatment Effect Size	
	English	Spanish	English	Spanish	English	Spanish
UTBA01	Native	native	high	low	12.70	0.58
UTBA02	late	native	low	high	4.95	11.08
UTBA07	native	native	moderate	moderate	3.11	12.41
UTBA09	early	native	moderate	moderate	2.07	10.97
UTBA11	late	native	moderate	high	14.90	1.15
UTBA16	native	native	high	low	6.82	0.83
UTBA17	early	native	high	low	5.32	1.19
UTBA18	late	native	moderate	moderate	1.73	15.17
BUBA01	late	native	low	high	4.92	1.42
BUBA04	early	native	high	low	2.61	16.50
BUBA07	late	native	low	high	2.89	4.08
UTBA19	late	native	low	high	1.44	4.90
UTBA20	late	native	low	high	0	0
UTBA21	early	native			0	0
UTBA22	late	native	low	high	0.13	12.73
UTBA23	early	native	low	high	10.68	13.84
BUBA12	late	native	low	high	8.16	0

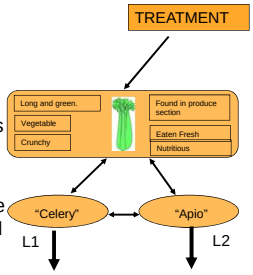
IN OUR PATIENT REHABILITATION STUDIES...



Edmonds & Kiran, 2006; Kiran & Roberts, 2009

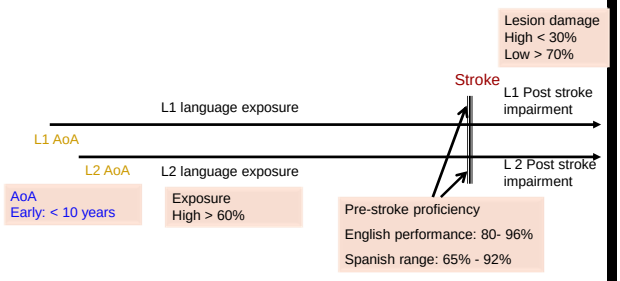
REHABILITATION IN THE DISLEX MODEL

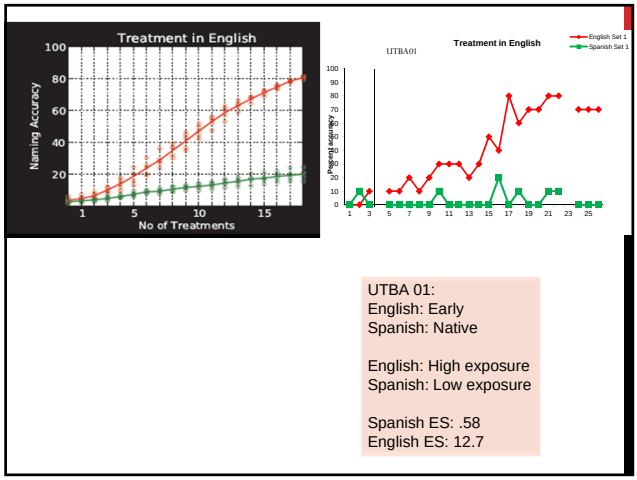
- The starting point was set to either a severe impairment in naming (30% or less accuracy) or mild impairment (70% or high naming accuracy).
- Model retrained trained with different number and schedule of presentations of words in one language
- Treatment always provided only in one language (either English/Spanish) and amount of improvement examined
- Generalization (cross language transfer) examined to untrained language



Edmonds & Kiran, 2006; Kiran & Roberts, 2009

Approach

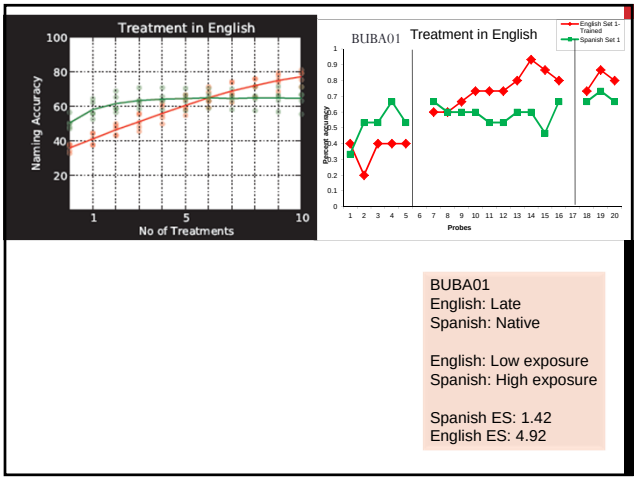




UTBA 01:
English: Early
Spanish: Native

English: High exposure
Spanish: Low exposure

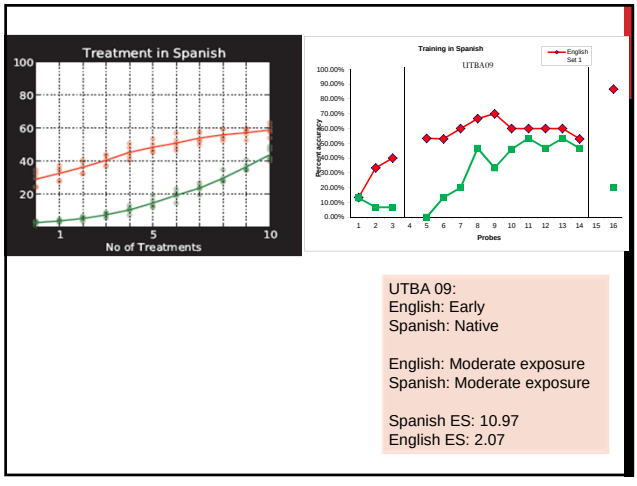
Spanish ES: .58
English ES: 12.7



BUBA01
English: Late
Spanish: Native

English: Low exposure
Spanish: High exposure

Spanish ES: 1.42
English ES: 4.92

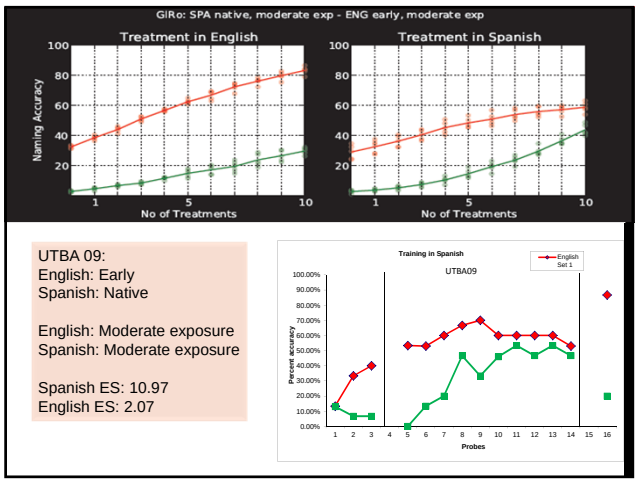


UTBA 09:
English: Early
Spanish: Native

English: Moderate exposure
Spanish: Moderate exposure

Spanish ES: 10.97
English ES: 2.07

THE MODEL CAN ALSO PREDICTS WHAT TREATMENT OUTCOME MAY HAVE BEEN IF THE OTHER LANGUAGE WAS TRAINED



UTBA 09:
English: Early
Spanish: Native

English: Moderate exposure
Spanish: Moderate exposure

Spanish ES: 10.97
English ES: 2.07

SUMMARY

Model can predict rehabilitation outcomes

- Of the 17 patients, good fit for 12 patients,
- For patients that do not have a good fit, model overestimates outcomes
  - Education/literacy issues in patients
  - Severe phonological output deficits
  - Severity of language/cognitive issues

Provides a starting point for understanding why patient did not improve

Model can also predict what treatment outcome may have been if treatment plan was different that what was followed…

WHAT DOES THIS RESEARCH MEAN FOR YOUR PATIENT WITH BILINGUAL APHASIA?

THINGS TO REMEMBER WHEN WORKING WITH A PATIENT

- Training one language does not mean you are jeopardizing the other language.
- The brain regions that you are likely engaging when providing therapy in one language are probably the same as when you are engaging the client in the second or third language
- Considering the clients' language backgrounds and relative strength of their languages.
- Making informed decisions about code-switching and translation. Code-switching and translation may be a useful tool for some clients but may promote cross-language competition and interference in others.
- Considering clients' personal preference, as well as cultural and sociolinguistic contexts.

Questions to ask your clients about their language use/history	
Age of Acquisition	At what age did you learn Language 1, Language 2, Language 3…?
Language Exposure	During your lifetime (before the stroke), what languages did you hear, speak and read? About what percentage of the time and what contexts were you exposed to L1/L2/L3…?
Confidence/Self Rating	Prior to your stroke/brain injury, how comfortable were you conversing/reading/listening to L1? Prior to your stroke/brain injury, how comfortable were you conversing/reading/listening to L2… L3…?
Post Stroke Exposure	After your stroke, what language(s) do you spend most of your time speaking/listening? About what percentage of the time and in what contexts are you exposed to L1/L2/L3…?
Education	What is the highest level of education/literacy you have achieved in L1? What is the highest level of education/literacy you have achieved in L2…? L3…?