Rehabilitation of bilingual aphasia: Evidence for within and between language generalization

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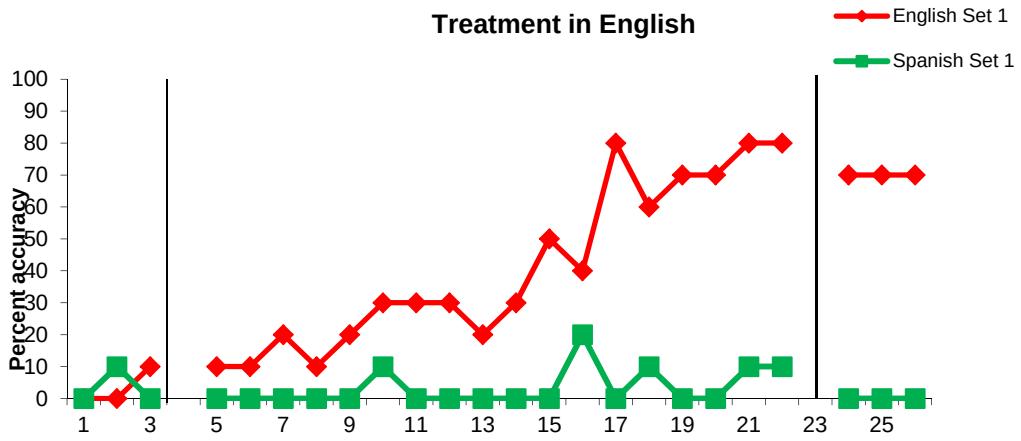
Significance of this problem

- It is estimated that 60% of the world is bi/multi-lingual.
- Within the US, Spanish-English bilingualism is the largest growing bilingual speaking population.
- 37 million in the United States (2010) are currently Spanish speakers.
- Obviously, this translates to an increase in clinical need to address bilingual aphasia rehabilitation,
- But no clear guidelines on how to do so…

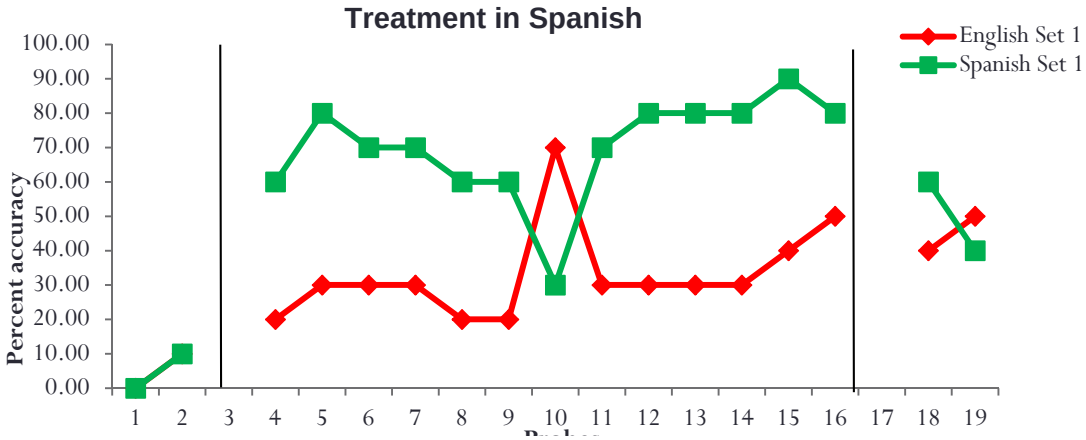
- A recent review of 13 studies on bilingual aphasia rehabilitation (Faroqi-Shah et al., 2010)
  - Except for one study with 30 participants (Junque et al., 1989), most studies were case studies.

  <u>The good news:</u>
  - 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.

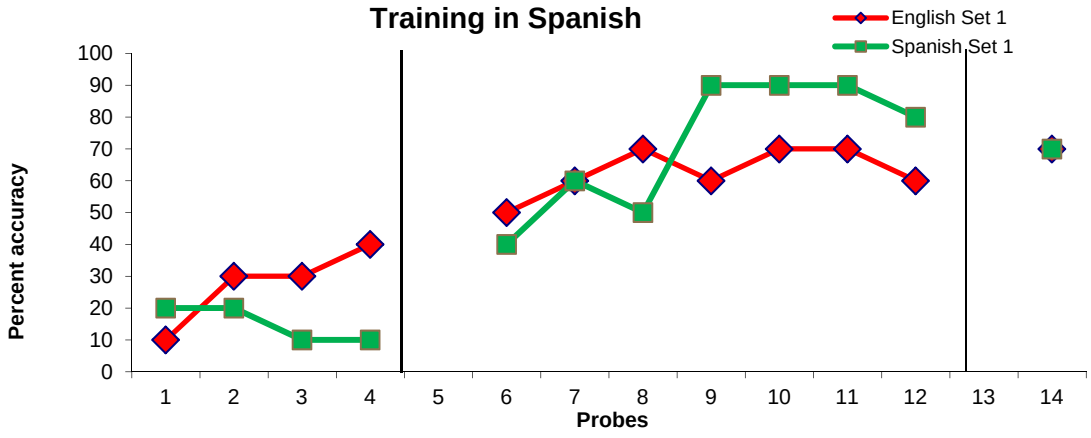
  <u>The bad news</u>
  - Variability in treatment type and consequent treatment outcomes
  - Other confounding variables including time post onset and nature of aphasia influence outcomes.



English dominant patient
Trained in English

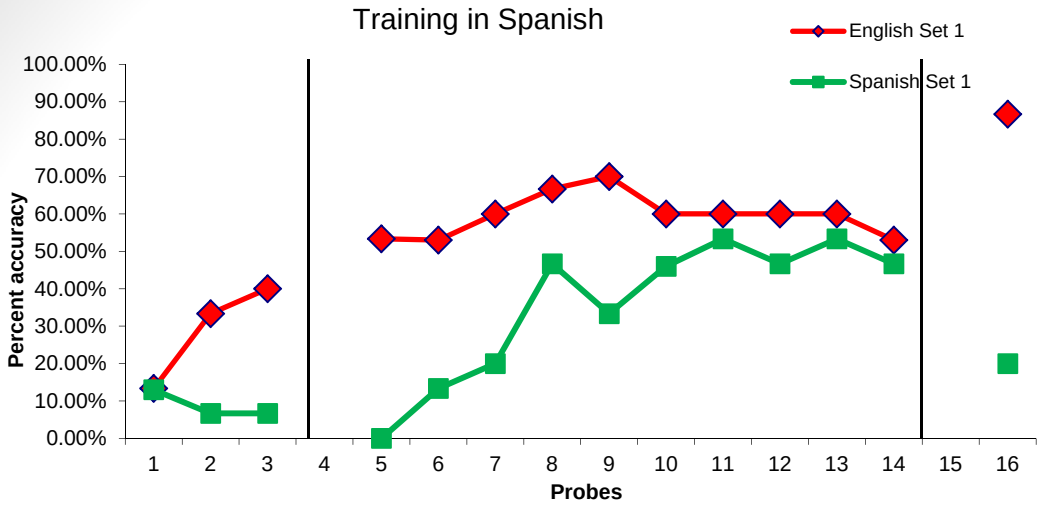


Equally proficient patient
Trained in Spanish

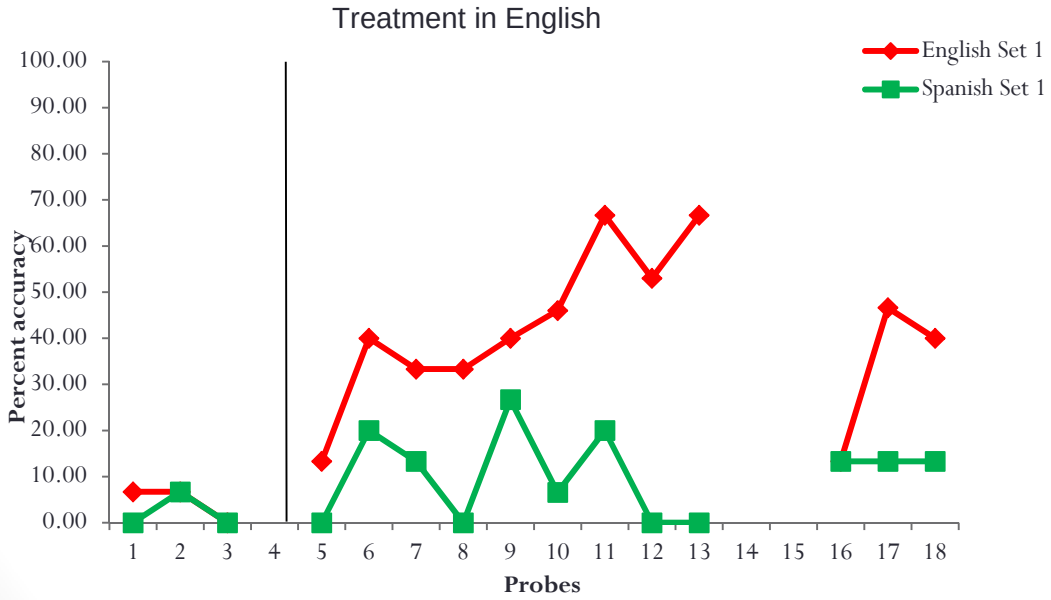


English dominant patient
Trained in Spanish

Edmonds & Kiran, 2006



English dominant patient
More impaired in Spanish
Trained in Spanish



Equally proficient
Trained in English

Kiran & Roberts, 2009

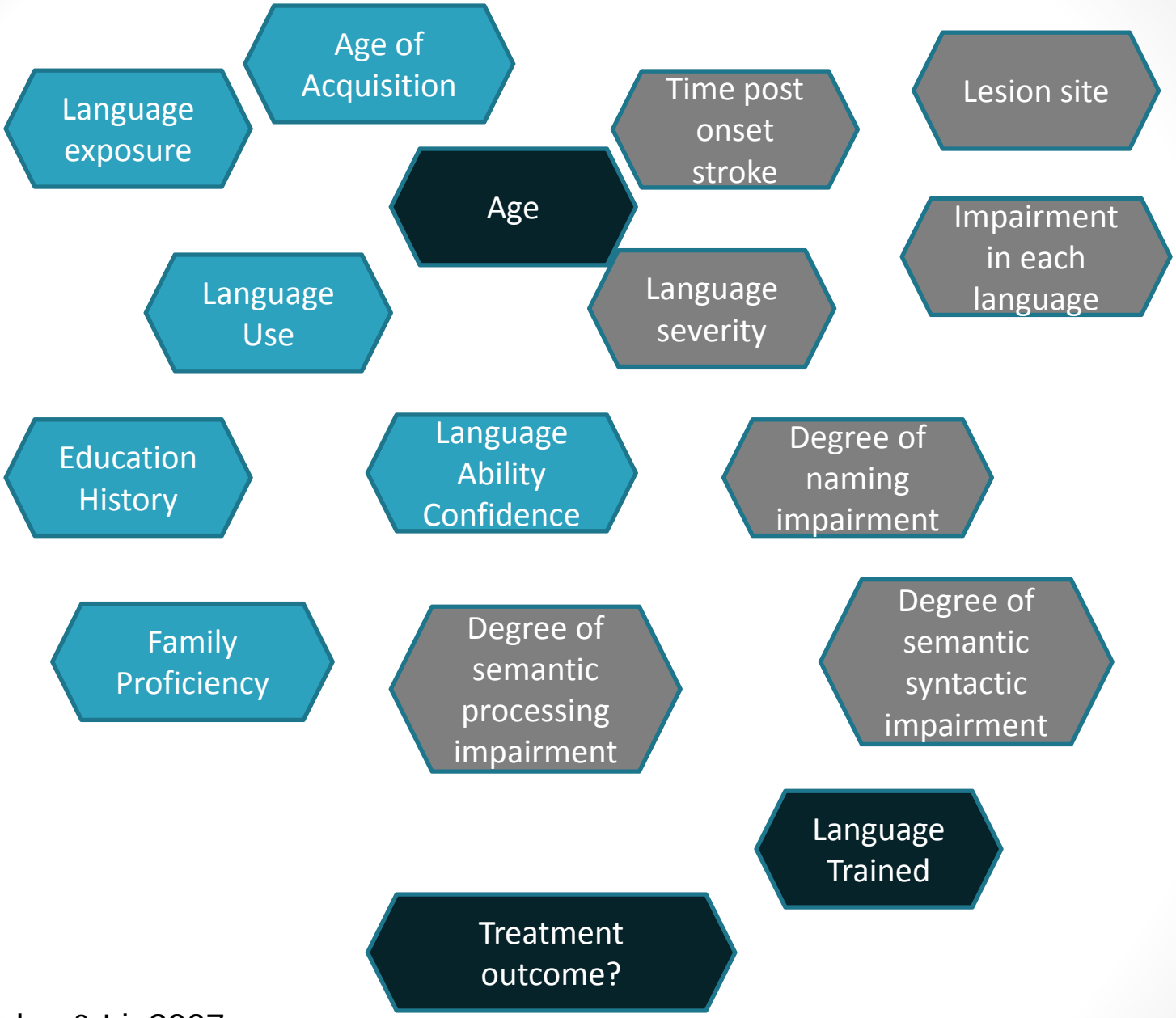
Other studies have similar issues

- Within language gains but no between- language transfer
  - But patients with differential proficiency and differential impairment in L1 (French) L2 (English) (Miller-Amberger, 2011)
  - Both languages (Spanish, English) trained (Galvez & Hinckley, 2003)

- Between language transfer
  - Trilingual patient - generalization from L3 (French) to L2 (English) but not L1 (German) (Miertsch, Miesel, & Isel, 2009)
  - Selective generalization from trained L2 (English) to L3 (French) but not L1 (Hebrew) (Goral et al., 2010)
  - Generalization for cognates but not for cognates (Kohnert, 2004)

Problem

- It is not clear whether treatment is effective in improving trained behavior/language
- It is not clear if generalization occurs, when it occurs and under what circumstances it does not occur



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

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

Rationale for this study

- Is there a principled way to understand the nature of rehabilitation in bilingual aphasia such that patterns of acquisition and generalization are predictable and logical?
- In this study, we examine a larger group of patients (N= 17) who have received therapy to improve naming in one language.
- The ultimate goal is to understand the factors that predict treatment outcomes.

Specific Questions

- Q1. What are the effects of treatment on acquisition of trained items on the trained language independent of what language is trained?
- Q2. What are the effects of treatment on generalization to translation items and untrained items independent of what language is trained?
- And… Q3. What are relevant factors influencing treatment outcomes?

Participants

- Seventeen patients with bilingual aphasia participated in the therapy experiment.
- Five of these patients have been reported previously (Edmonds & Kiran, 2006; Kiran & Roberts, 2010).
- All were at least five months post-onset from a left perisylvian area CVA (one had a gun-shot wound),
- Pre-morbidly right-handed and bilingual speakers of English and Spanish.
- Post-CVA they had language impairment in both languages.

Measures of level of bilingualism

- For each participant, a detailed language use questionnaire that obtained information in each language about:

- Age of Acquisition (AoA)
- Pre-stroke lifetime exposure
- Post-stroke current language use
- Self-rated language ability
- Education history
- Family proficiency

Measures of language impairment

- For each participant, assessment focused towards lexical semantic processing & naming

- PAPT- Three pictures
- English and Spanish versions of
  - Boston Naming Test
  - Bilingual Aphasia Test
  - Category Generation Task
  - Naming Baseline

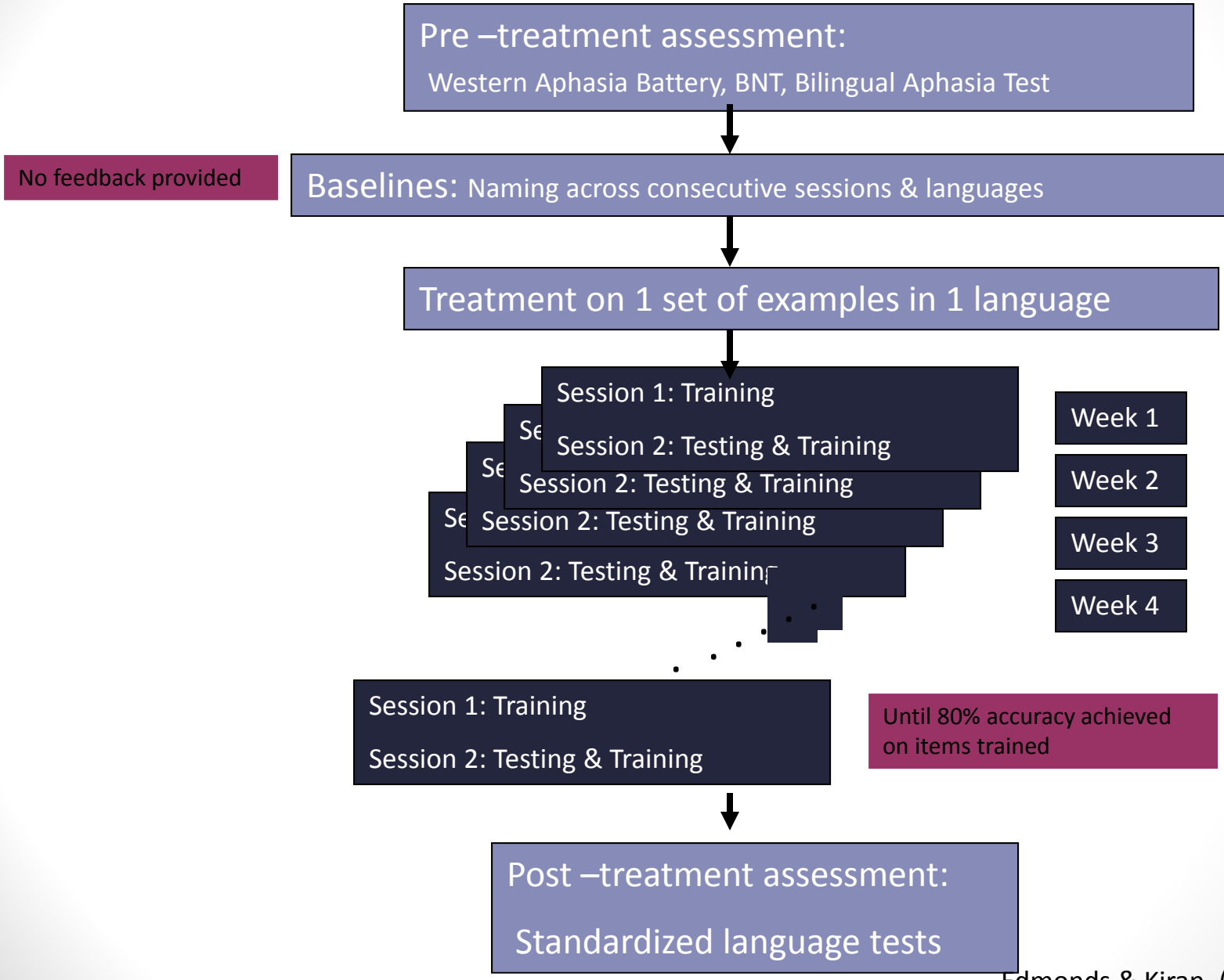
  - Western Aphasia Battery for some patients but not reported

Stimuli

- For each participant, a different list of stimuli were developed
  - Trained Language Set 1: *Celery*
  - Trained Language Set 2: *Cabbage*
  - Trained Language Unrelated Set: *Dustpan*
  - Untrained Language Set 1: *Apio*
  - Untrained Language Set 2: *Repollo*
  - Untrained Language Unrelated Set: *Recogedor*

- 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)

Schematic of treatment for each participant

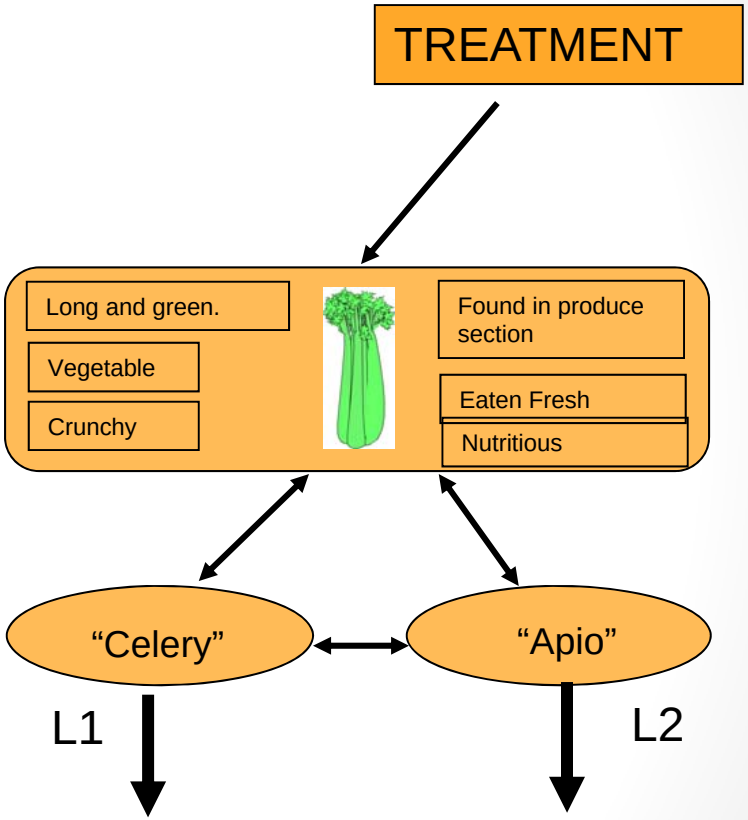


Edmonds & Kiran, (2006) *JSLHR*

Treatment protocol in Behavioral studies

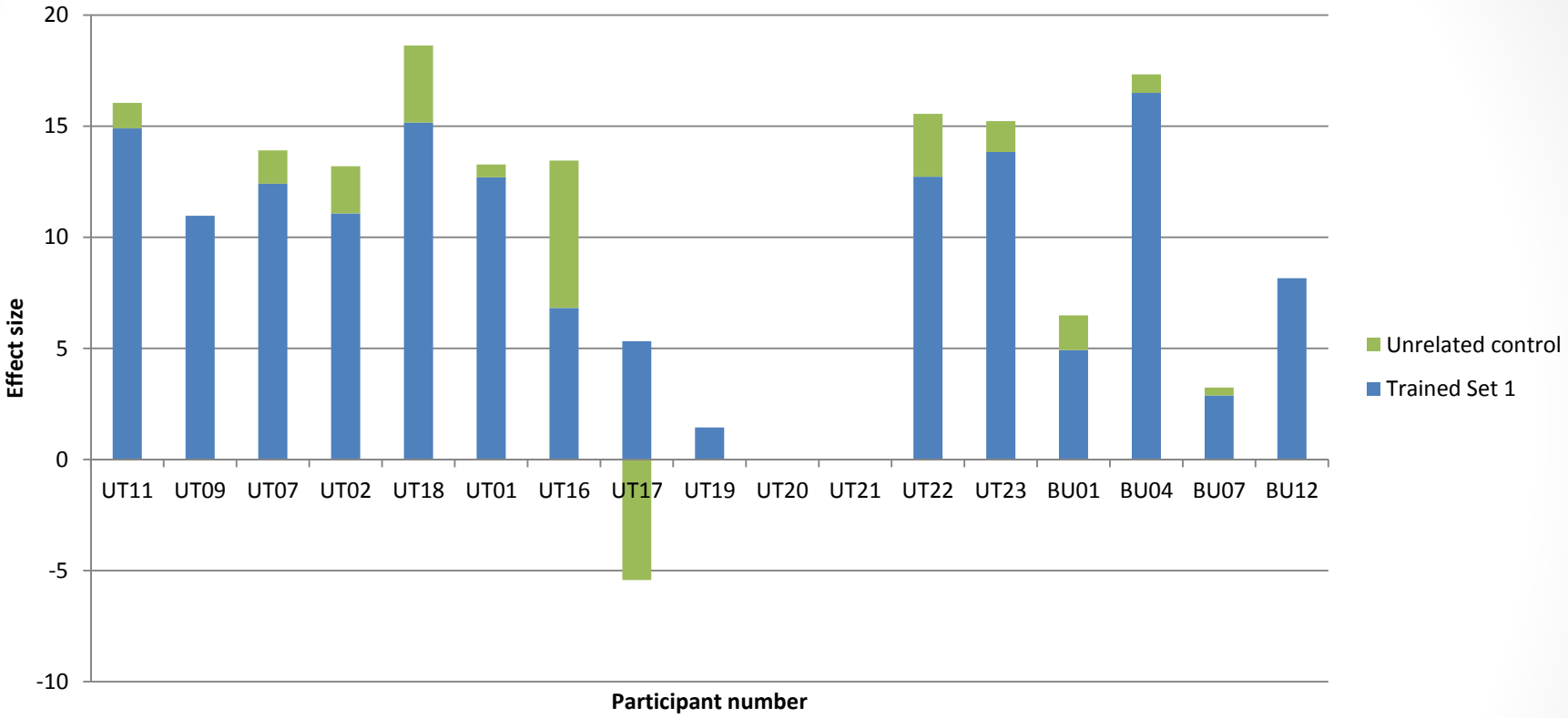
1. Name picture
2. If incorrect, told correct name
3. Choose 6 correct features from 12 cards
4. Answer 15 yes/no questions about the item
5. Named item again with feedback

- Treatment always provided only in one language (either English/Spanish) and amount of improvement examined



Edmonds & Kiran, 2006; Kiran & Roberts, 2009

Q1. What are the effects of treatment?

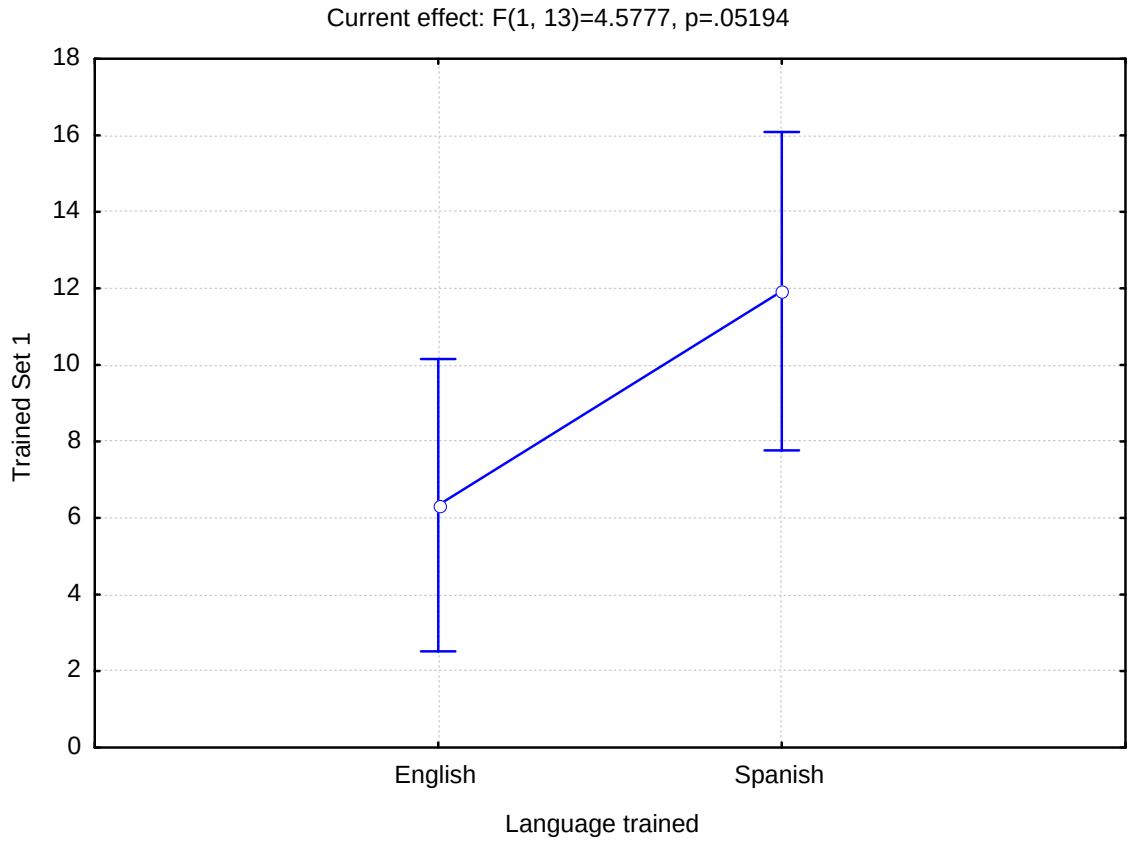


- 13/17 patients show Effect Sizes > 4.0*
- 10/17 patients show Effect Sizes > 10.0*
- Range of ES from 0 to 16.50

*Small ES
*Large ES (Beeson & Robey, 2006)

Q1. What are the effects of treatment?

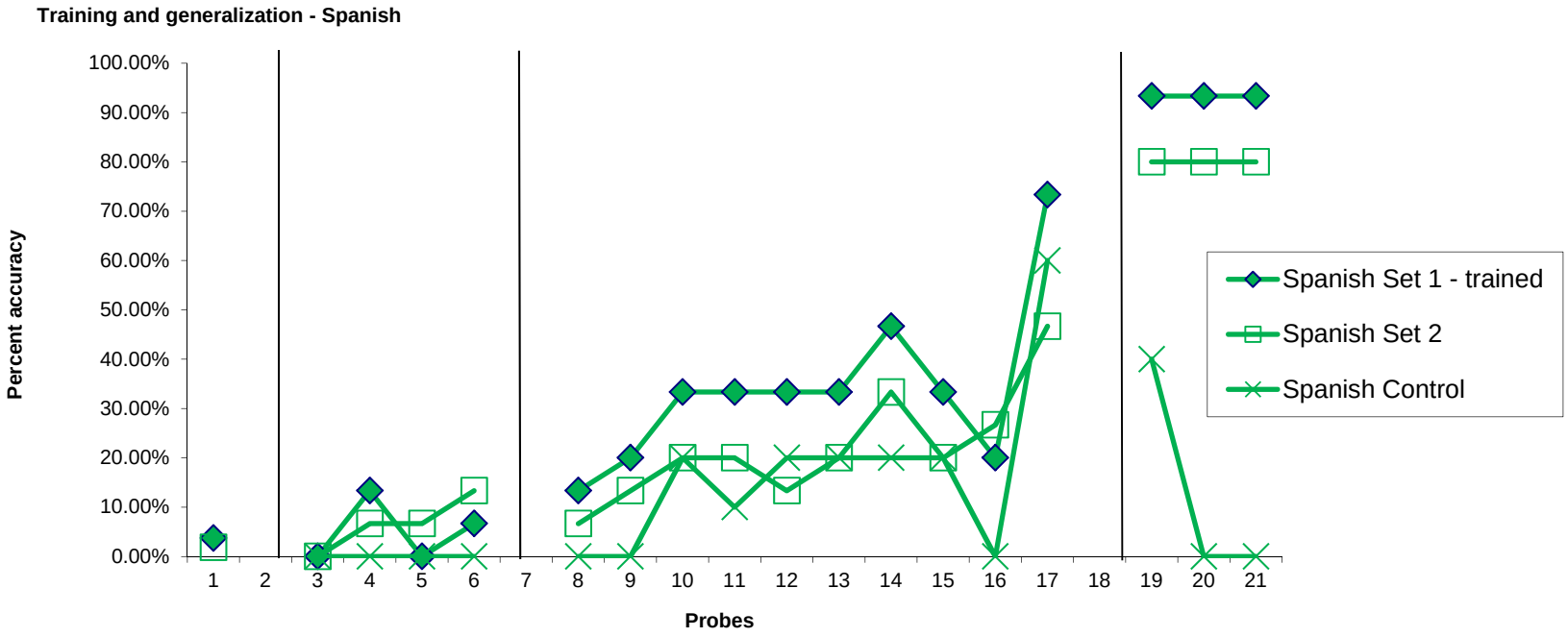
8/17 received tx in Spanish
9/17 received tx in English

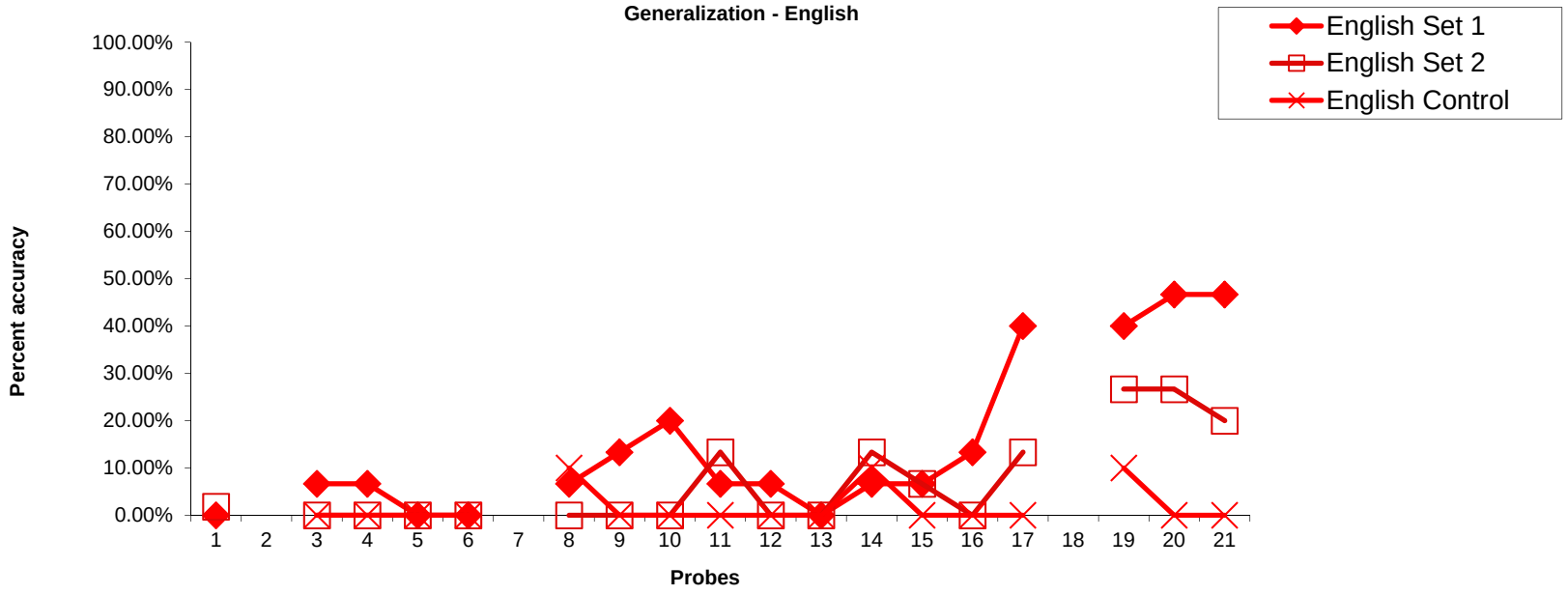


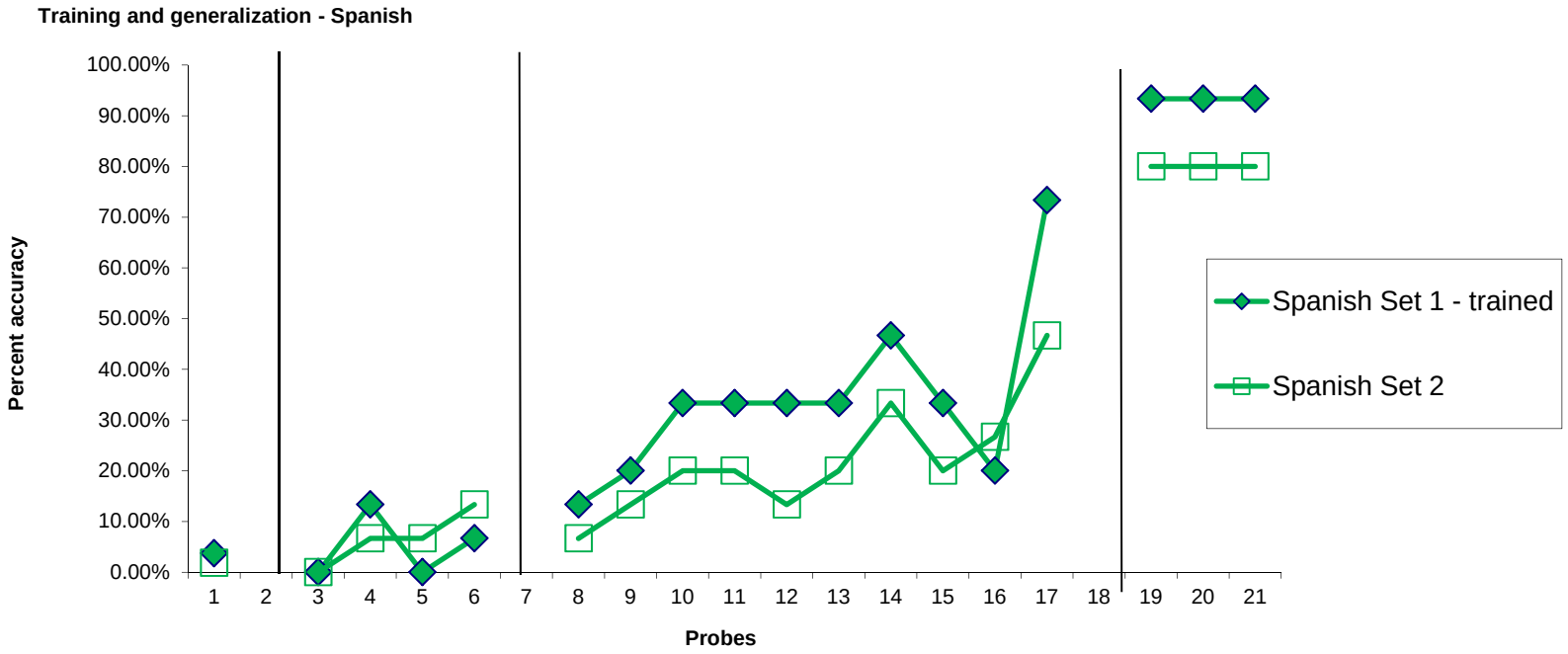
Training in Spanish results in greater effect sizes than training in English.

Q2. What are the effects of generalization?

- Examined cross-correlation function analyses using SPSS
  - improvements on the untrained items were associated with improvements in the trained language set 1.
- For each time series, a regression line is fit to the actual data and the residuals are calculated for that data. Then cross-correlations are calculated on the residuals and averaged over time (Box, Jenkins & Reinsel, 1994).
- In this study, for each patient, we correlated the time series between trained and untrained languages at 10 lag points (-5 to 5).
- Correlations that exceeded .50 and exceeded two standard errors were deemed statistically significant.


Training and generalization - Spanish
Percent accuracy
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Probes
Spanish Set 1 - trained
Spanish Set 2
Spanish Control

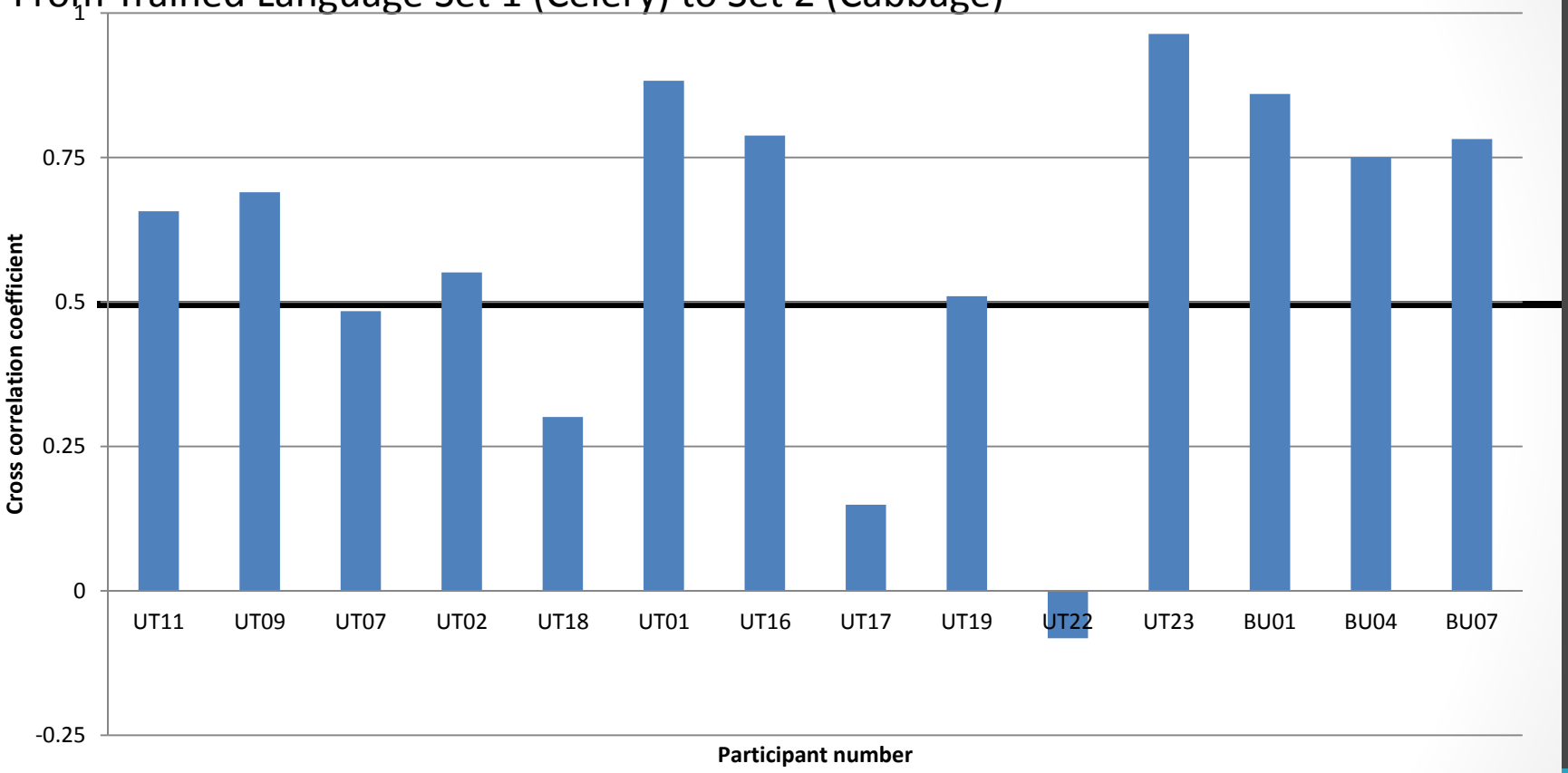

Generalization - English
Percent accuracy
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Probes
English Set 1
English Set 2
English Control



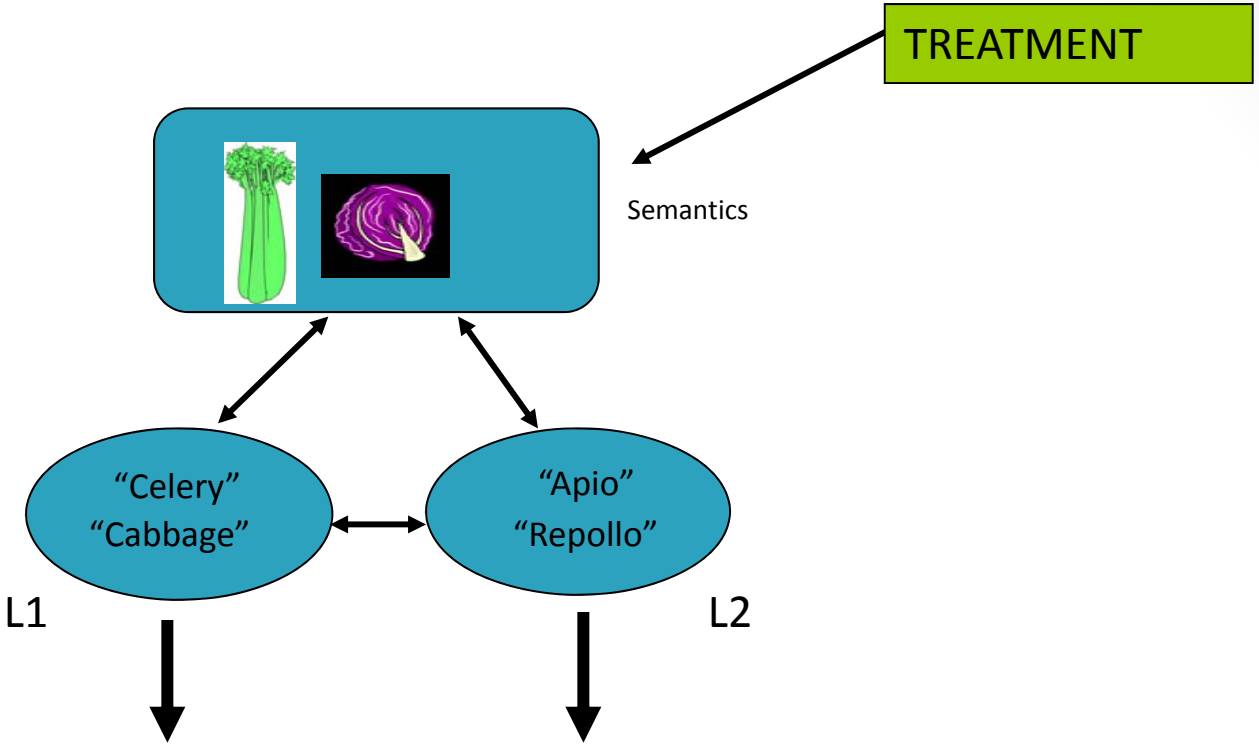
Within language generalization- Trained Set 1 and Trained set 2

Within Language Generalization

From Trained Language Set 1 (Celery) to Set 2 (Cabbage)

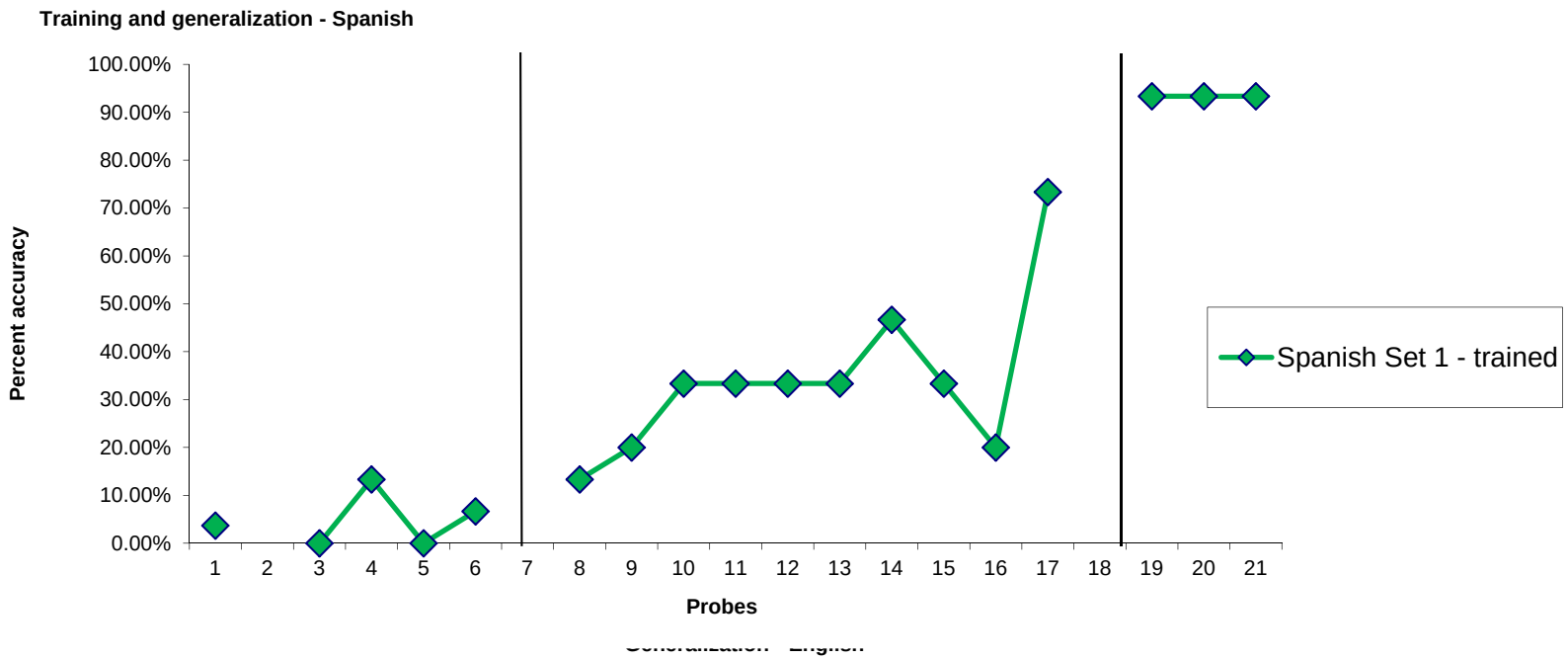


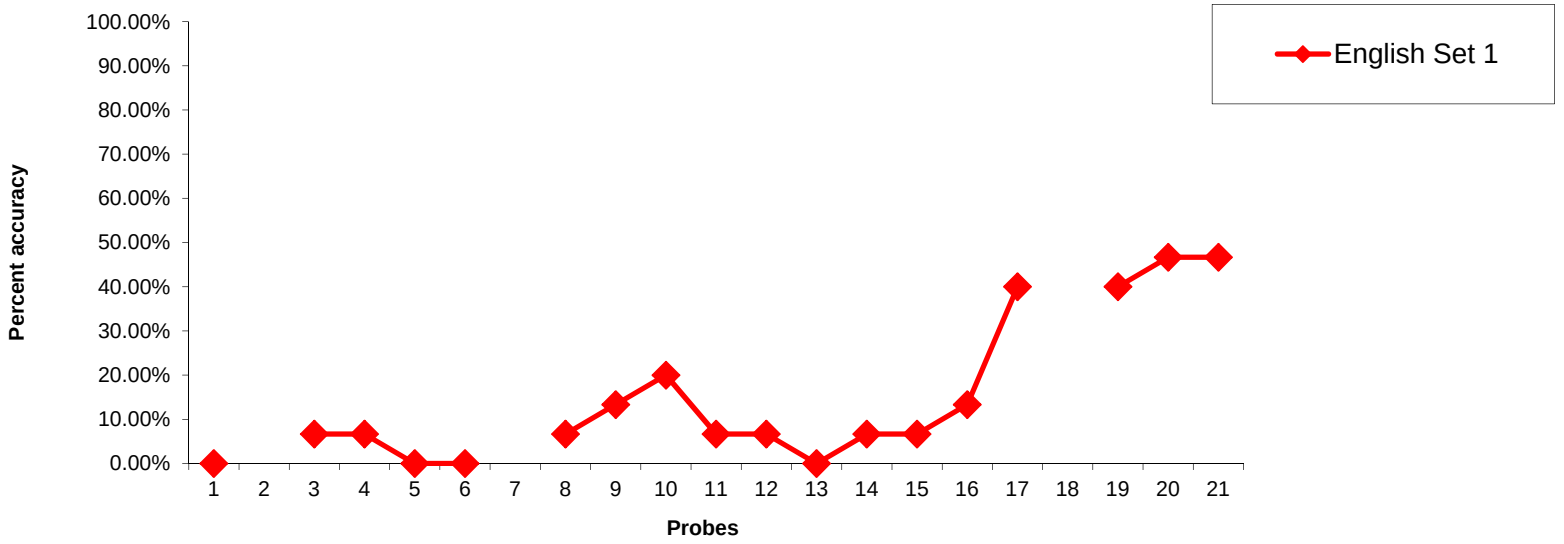
Correlations that exceeded .50 and exceeded two standard errors
Within language generalization in 10/14 cases



- Consistent with our previous work on generalization to semantically related items in monolingual aphasia (Kiran & Bassetto, 2008)

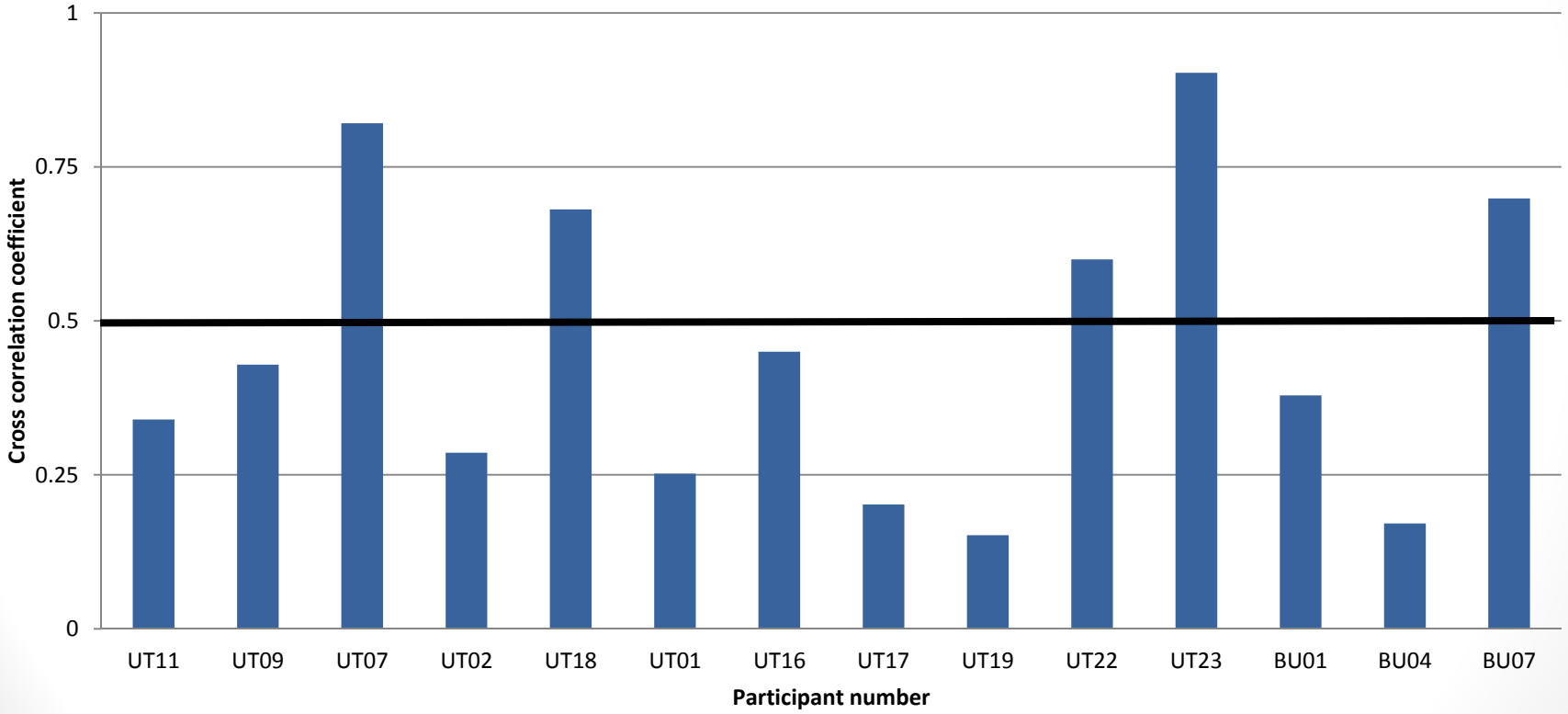
Between language generalization- Trained Language set 1 & Untrained Language set 1



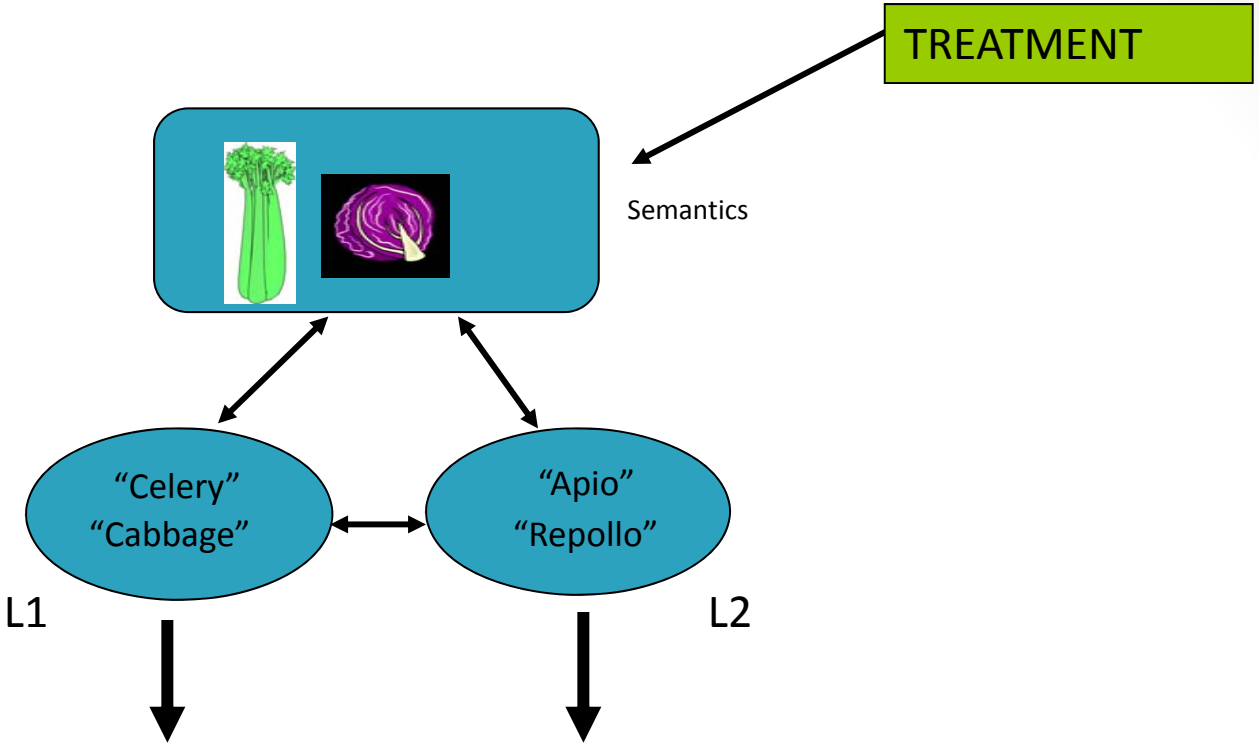


Between Language Generalization

From Trained Language Set 1 (Celery) to Untrained Language Set 1 (Apio)

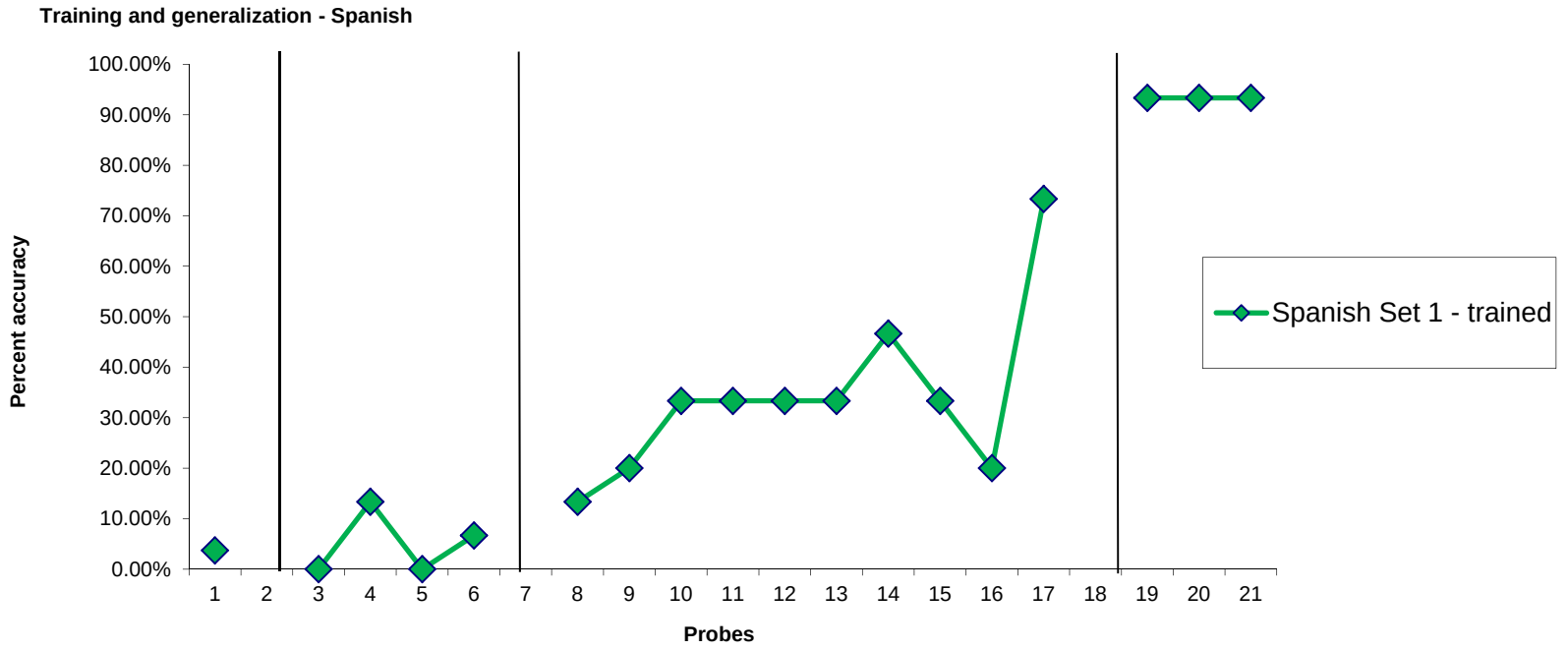


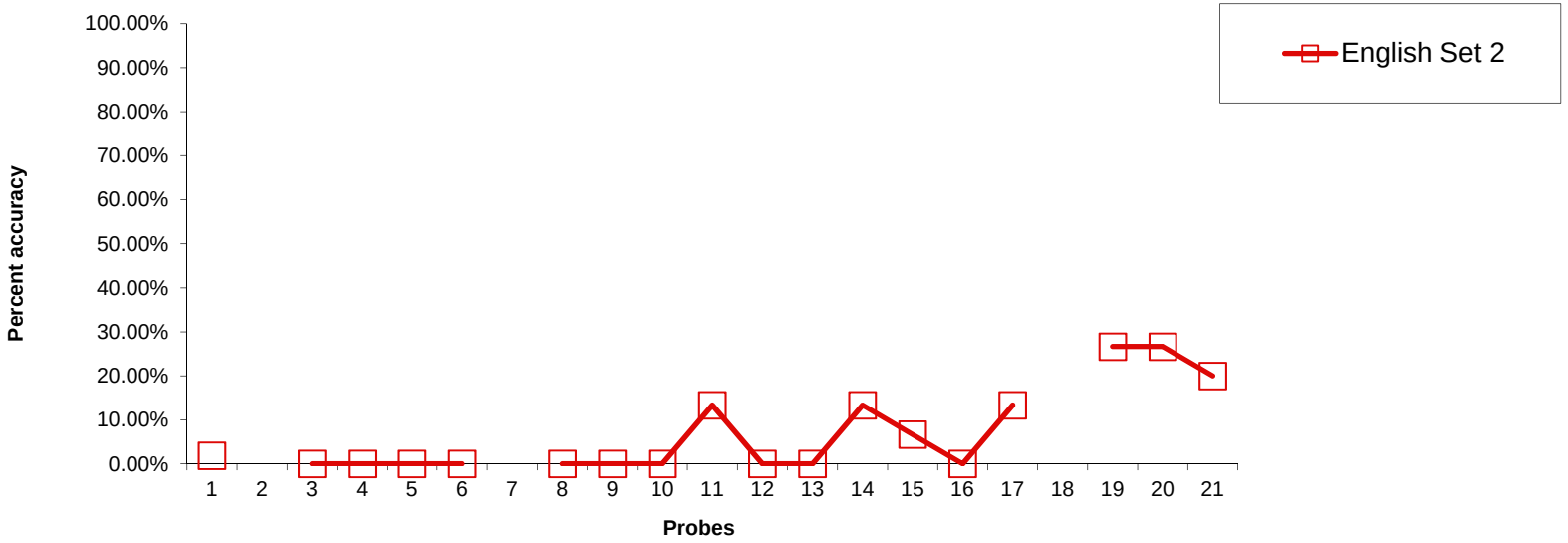
Between language generalization in 5/14 cases



- Selecting a word to speak in one language activates alternatives in the non-target language (e.g., Colomé, 2001; Costa, La Heij, & Navarette, 2006; Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, De Bot, & Schreuder, 1998).

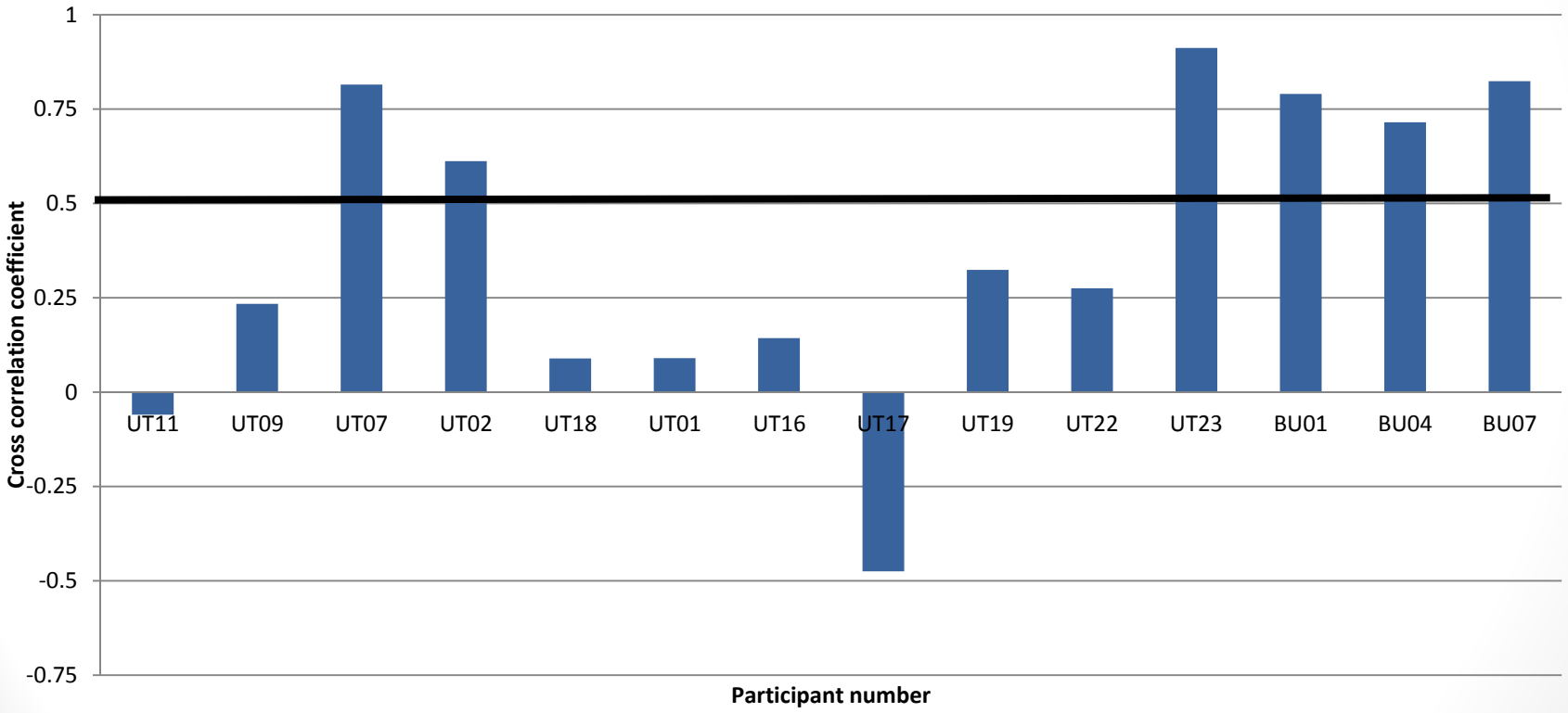
Between language generalization- Trained Language set 1 & Untrained Language set 2



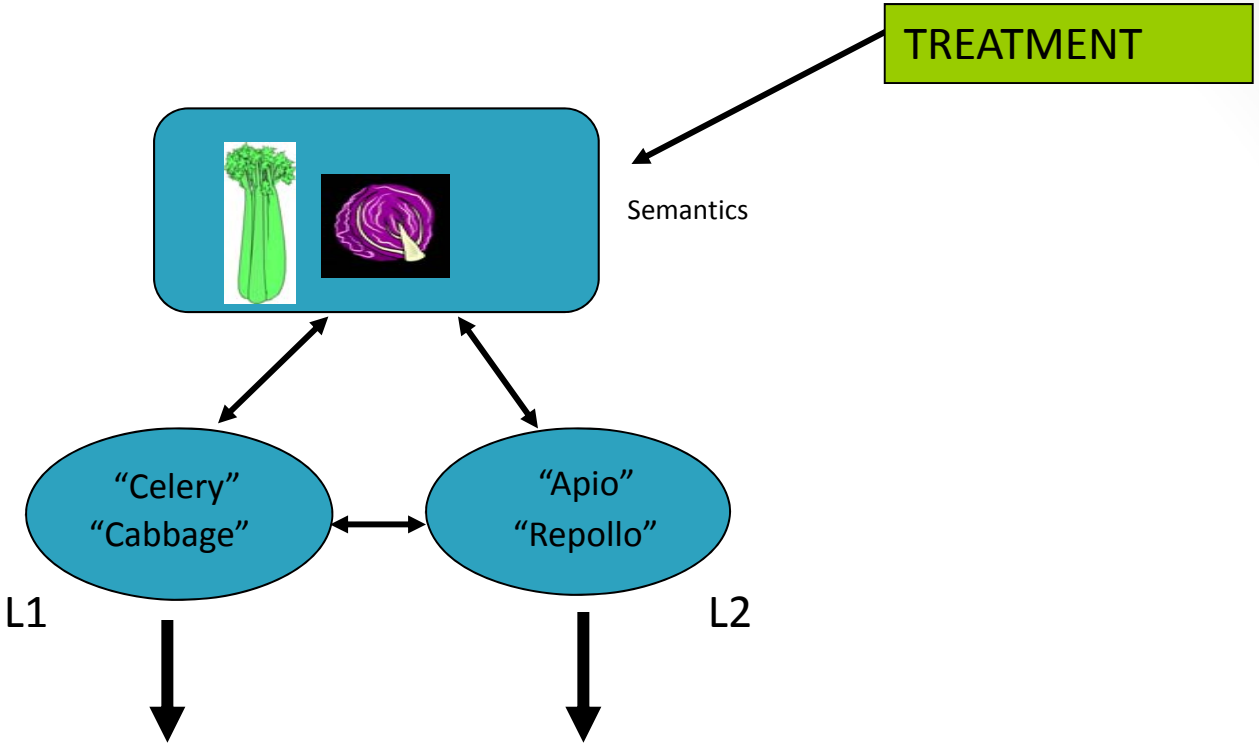


Between Language Generalization

From Trained Language Set 1 (Celery) to Set 2 (Repollo)



Between language generalization to untrained semantic related words 6/14 cases



- Training semantic representations and facilitating spreading activation between semantically related items in one language should also show generalization to translations in the untrained language -- whether or not the translations were directly trained.

Between Language generalization to untrained Set 1	Between Language generalization to untrained Set 2
Celery- Apio	**Celery-Repollo**
UT01	UT07
UT18	
UT22	
UT23	UT23
BU07	BU07
	UT02
	BU01
	BU04

- Some patients show between language generalization to both target types, others show generalization only one type.
- Asymetric costs for the more proficient language shows at least in differential proficiency, inhibiting a dominant languages may be more difficult than inhibiting a less dominant language (Costa, Santestevan, & Ivanova, 2006).

Obviously, the scenario is more complex:

- What about the patients who do not improve in treatment?
- What about the patients who show within language generalization and no between-language generalization?
- Cannot ignore language use and proficiency factors that may determine the level of bilingualism
- Cannot ignore stroke related factors -- mainly level of impairment in the domain being studying, time post onset

Q3: What factors predict treatment outcomes?

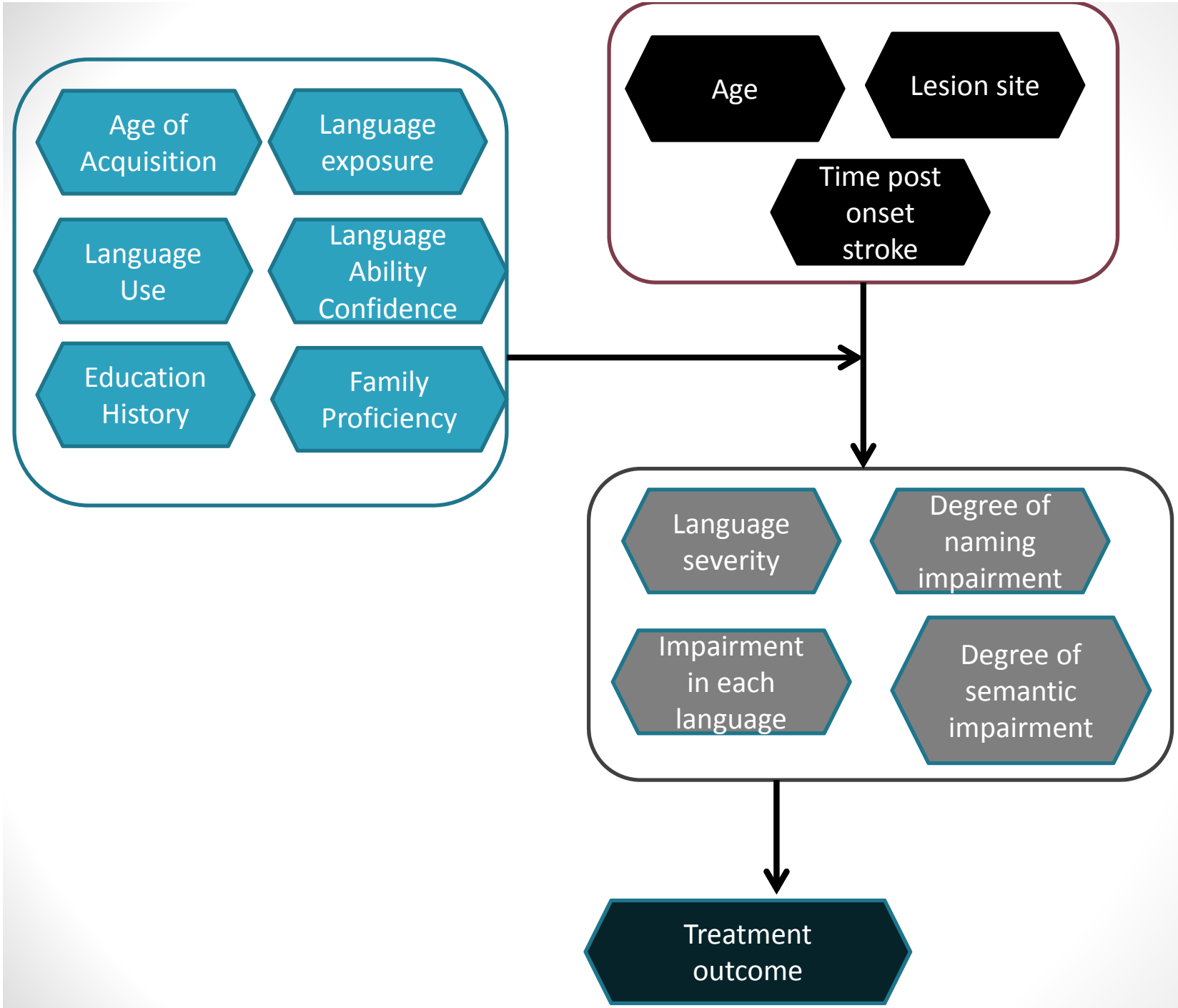
- Language Use Factors for each language:
  - Pre-stroke language exposure
  - Post-stroke current use
  - Self rated Language Ability
  - Education History
  - Family proficiency
  - Composite score for each language
- Impairment Factors:
  - Age
  - PAPT
  - BNT-English
  - BAT-Comprehension English
  - BAT-Semantic-English
  - BNT-Spanish
  - BAT-Comprehension-Spanish
  - BAT-Semantics-Spanish

Language Impairment Variables

- Forward stepwise multiple regression ($R = .7200$ $R^2 = .518$ Adjusted $R^2 = .449 F(2,14) = 7.5384$ $p < .006$)
  - PAPT ($B = .68$, $t = 3.5$, $p < .002$)
  - BNT-E, BNT – Sp not significant predictors

Level of bilingualism variables

- Forward stepwise multiple regression ($R = .775$ $R^2 = .602$ Adjusted $R^2 = .510$ $F(3,13) = 6.55$, $p < .006$)
  - Language Trained ($B = .64$, $t = 3.5$, $p < .003$)
  - Average English Composite ($B = .85$, $t = 3.4$, $p < .004$)
  - Average Spanish Composite ($B = .57$, $t = 2.3$, $p < .03$)


Age of Acquisition
Language exposure
Language Use
Language Ability Confidence
Education History
Family Proficiency
Age
Lesion site
Time post onset stroke
Language severity
Degree of naming impairment
Impairment in each language
Degree of semantic impairment
Treatment outcome

Summary

- Training naming **results in improvements on trained items** irrespective of language trained.
- Although, **ES in Spanish** are greater than ES in English.
- Training naming results in **within-language generalization** to semantically related items in **more than half (10/14) patients.**
- Training naming in one language results in **between language generalization in a little over 1/3** of the patients.
- Differences in patterns of between language generalization indicative of **the interplay between facilitation and inhibition.**
- Factors such as **semantic processing impairment and language use determine** the extent of treatment outcomes and may begin to explain when and why patients do not show improvements in therapy.

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