NEW APPROACHES TO REHABILITATION IN APHASIA

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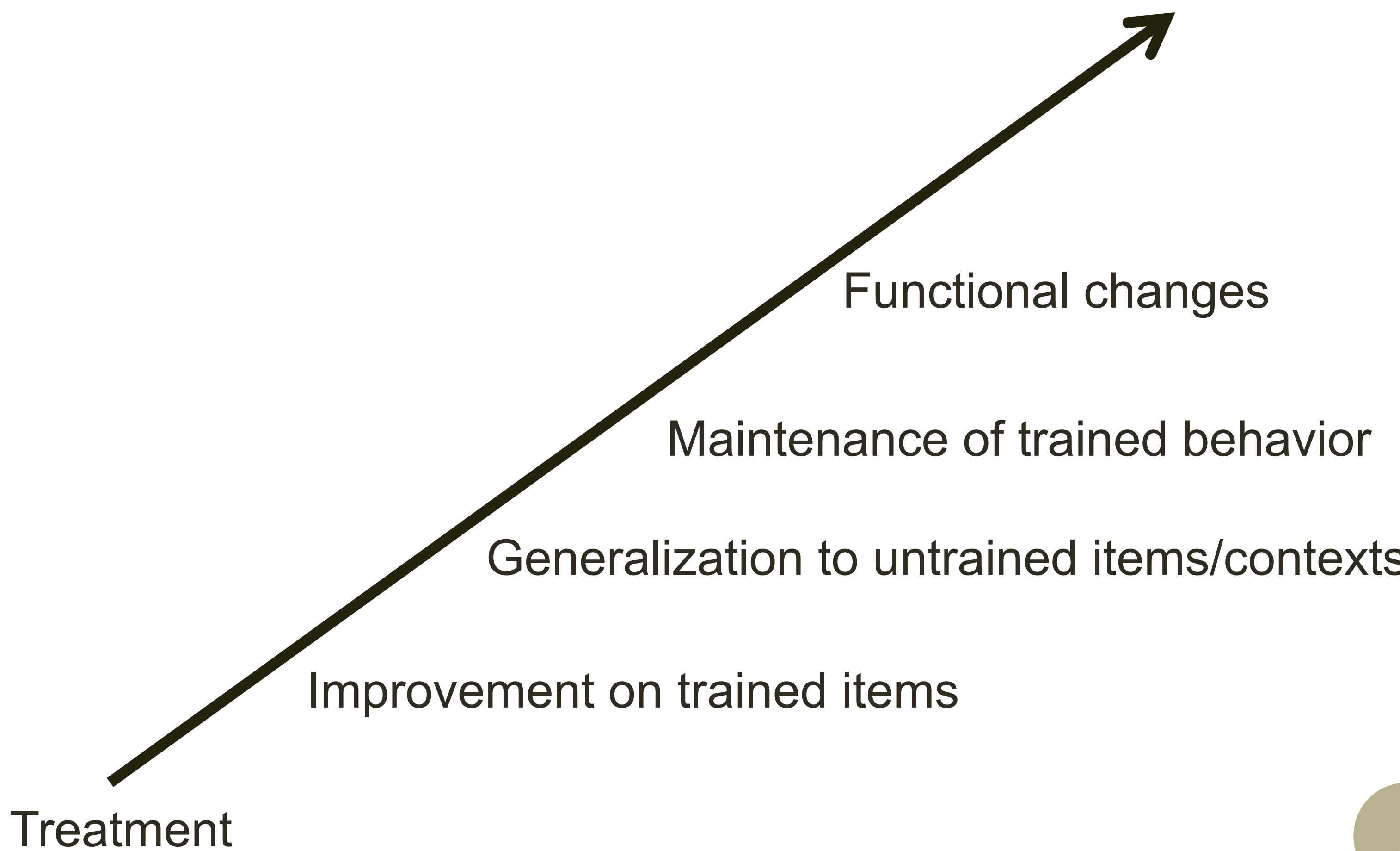
WHAT IS THE AIM OF TREATMENT?



OUTLINE OF TALK

- Melodic intonation therapy (and studies with fMRI)
- CIAT (and studies with fMRI)
- Complexity in therapy (and studies with fMRI)
- Semantic and phonological component therapy
- Bilingual aphasia therapy
- tDCS
- Computational modeling

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Melodic Intonation Therapy

- Observation: nonfluent aphasic patients can often sing the words to familiar songs, but cannot produce propositional language
- Melodic Intonation Therapy (MIT) (Sparks, Helm & Albert, 1973) seeks to improve conversational speech by recruiting language areas in the right hemisphere of the brain
- Instead of speaking, the patient "sings," illustrating the melody pattern, rhythm, and points of stress of each utterance
- MIT has been shown to be effective when done intensively and over a long period of time
- MIT is hierarchically designed

What Makes MIT Unique?

Intonation

- Intended to engage the right hemisphere, given its dominant role in processing spectral information, global features of music, and prosody.
- Right hemisphere may be better suited for processing slowly modulated signals, while the left hemisphere may be more sensitive to rapidly modulated signals.
- Slower rate of articulation and continuous voicing that increases connectedness between syllables and words in singing may reduce dependence on the left hemisphere.

Left-hand Tapping

- May engage a right hemisphere sensorimotor network that controls both hand and mouth movements.
- May also facilitate sound-motor mapping, which is a critical component of meaningful vocal communication.
- May pace the speaker and provide continuous cueing for syllable production.

(Schlaug et al, 2008)

Inclusion Criteria

Patients most likely to show a good response to Melodic Intonation Therapy have most or all of the following characteristics:

- Aphasia is caused by a unilateral, left-hemisphere stroke with no evidence of right hemisphere involvement.
- Speech output consists of poorly articulated, nonfluent, or severely restricted verbal output that may be confined to nonsense, stereotypical phrases (e.g. "bika, bika").
- The person is able to produce some real, accurate words when singing familiar songs.
- Repetition is poor, even for single words.
- Auditory comprehension is at least moderately preserved, as indicated by standardized testing.

Hierarchy of MIT

Level I (nonverbal):

- Introduction of the hand holding/tapping and basic melodies
- After brief instructions the clinician hums a melody twice while hand tapping with the client
- The client is then signaled to join in with the clinician
- The clinician fades out vocal participation but continues hand tapping

Level II (linguistic material added):

- Made up of four steps
- Client who succeeds has acquired skill of repeating intoned sentences immediately after hearing the model and in response to a question

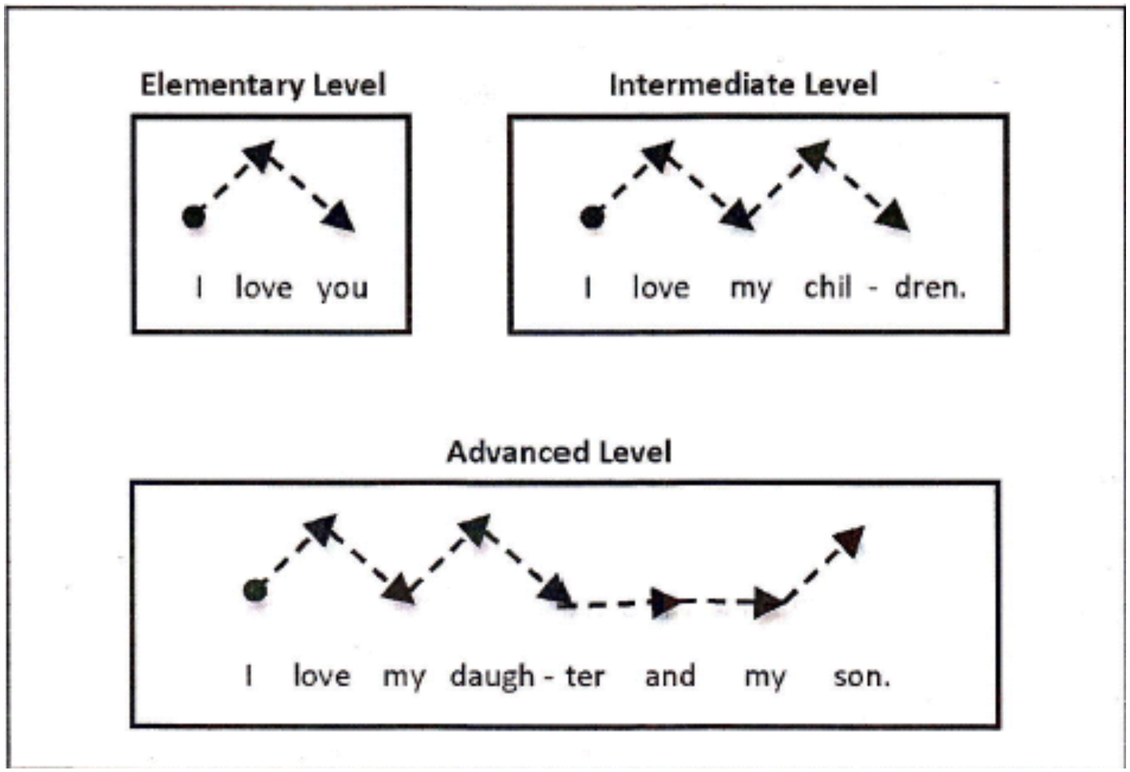
Level III:

- In between step from ability to repeat in Level II and return to speech prosody and responsive speech in Level IV
- Phonemic cueing is replaced by backup system
- Completion of these three steps means modification of client response from repetition to more difficult responses involving retrieval

Level IV (*sprechgesang*):

- Return to normal speech prosody
- Use of the *sprechgesang* technique (fading of melodic intonation, lies halfway between speech and singing)
- Longer delays before response
- Incorporation of multiple, and more complex questions
- Client has completed the MIT program and carried over skills acquired early in the program to normal speech

http://www.bethabe.org/MUSIC_INSTITUTE55.html



Evidence for effectiveness

- Schlaug et al., 2008
  - Patient improved significantly on measures of **speech output** and **confrontational naming** after 40 sessions of MIT compared to a patient receiving Speech Repetition Therapy.
  - Results: Post-forty-session fMRI revealed **posterior perisylvian activation** on the left, **superior temporal and inferior precentral gyrus activation** on the right, and more prominent right-hemisphere activation involving the **right posterior middle premotor cortex** and **right inferior frontal gyrus**.

However,

- Belin et al. (1996)
  - Studied 7 nonfluent aphasic patients
  - Measured changes in relative cerebral blood flow (CBF) during hearing and repetition of simple words, and during repetition of MIT-loaded words
  - Results: without MIT, right hemisphere regions were activated, but with MIT, Broca's area and left prefrontal cortex were activated

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CILT

- **Constraint-Induce Language Therapy (CILT)**
- • Alternative name: Constraint-Induced Aphasia Therapy (CIAT) and CI
- CILT is a therapy technique that aims to increase verbal production via restricting other means of communication such as gestures or drawing
- Theoretical underpinnings come from Constraint-Induced Movement Therapy
- For language, learned nonuse is presumed to result from combined "failure" to successfully communicate via verbal communication and success of gesture and/or drawing use
- CILT is designed to overcome learned non-use which is believed to be a big factor in chronic aphasia (Pulvermuller, et. al 2001)

Principles of CILT

- Constraint: avoid the **compensation**
- Forced use of **verbal language**
- Massed practice: involves a **high intensity treatment** schedule consisting of 3-4 hr treatment periods per day for 2 weeks.
- Difficulty of material: Complex vs. simple cards with increasing foils
- Activity must be a situation that requires verbal communication with others, can be a partially scripted scenario, game, or problem solving activity.

Inclusion Criteria

- Left hemisphere, Nonfluent aphasia with restricted verbal output
- However, there is limited research that examines efficacy with people with the following characteristics: Acute, Fluent, Cognitively Impaired PWA

Evidence for CILT

- **Cherney et al (2008)**
- Reviewed 10 studies to examine effects of CILT with patients with acute and chronic aphasia.
- Results: Overall, "in chronic and acute aphasia, studies provided evidence for high-intensity treatment and the positive effects of CILT."
- Researchers stated that it was difficult to adequately complete the review independent of addressing treatment intensity, which is a key principle of CILT.

- **Pulvermuller, et al (2001)**
- Results: found that improvements can be made in only a few days using CILT. The same basic principles relevant to improving extremity function with motor CI therapy may also be relevant to improving language function. Mass practice for short time intervals is better than less frequent training.

Evidence for CILT

Meinzer et al (2005)

- This study replicates and extends the work done by Pulvermuller with two treatment groups; one trained with normal CIAT and an extended treatment group (CIATplus) which included CIAT, extra training sessions of everyday communication skills, and improved assistance with family members.
- Results: There were no significant differences between CIAT and CIATplus within their language test results. Difference seen between the groups were how well the participants communicated with family members and friends.

- **Richter et al (2008)**
- "Analyzed the predictive value of (Right Hemisphere) brain activation for subsequent therapy and the relation between therapy outcome and therapy induced changes in the brain activation."
- Results: Moderate effect size showing improvement language task performance and a decrease in right hemisphere activation as a function of improved therapy outcomes.

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Principle of complexity to promote generalization in rehabilitation

- Complexity Account of Treatment Efficacy, CATE (Thompson & Shapiro, 2007)
- In sentence production
- Object relative sentence -> Object clefts, WHO questions
  - *The man saw the artist who the thief chased*
  - *It was the artist who the thief chased*
  - *Who did the thief chase?*
- In phonology
  - Geirut (2002, 2003)
  - Trained on complex phonological clusters (e.g., /tw) shows greater use in untrained words and generalization than training on affricates (/tS-/)

PRINCIPLE OF COMPLEXITY TO PROMOTE GENERALIZATION IN REHABILITATION

- In Naming (Kiran, 2007)

CATE in sentence production

- Treatment targets sentence production (and comprehension) in individuals with agrammatic aphasia
- CATE is based on **linguistic theory**
  - Sentences trained in therapy are chosen based on their lexical and semantic properties
  - When the linguistic underpinnings of complex sentences are considered, successful generalization across sentences that are **different in surface structure but similar in underlying linguistic properties** will occur
  - When more complex sentence structures are trained first, successful generalization to less complex structures **in a linguistically related subset** will occur
  - Establish and improve knowledge/access to thematic role information using canonical (SVO) target sentences

INCLUSION CRITERIA

- Individuals with aphasia and sentence production deficits

- Typical profile:
  - **Asyntactic comprehension**
    - Comprehension of active/subject relative clauses relatively spared
    - Impaired comprehension of complex noncanonical sentences, passive sentences, and object relative clauses
  - **Sentence production lacking grammatical structure**
    - Produce short, simple SV and SVO structures; great difficulty producing complex sentences with NP out of canonical order
    - Overreliance on nouns/impoverished verb use
  - Decreased MLU (3.0-5.5 words)

TUF TREATMENT APPROACH

- Sentence production and comprehension is tested pre-treatment
- Treatment is applied to one or a limited number of sentence structures in one or more contexts (these are the "trained" structures)
- E.g., Object relative sentence -> Object clefts, WHO questions
  - *The man saw the artist who the thief chased*
  - *It was the artist who the thief chased*
  - *Who did the thief chase?*

  - Wh-questions and NP movement
  - Argument and adjunct movement
- Untrained structures in untrained language contexts are tested periodically for generalization
  - Steps are taken to achieve generalization if it has not occurred

- Treatment Protocol
- A picture depicting the target sentence is placed in front of the patient (e.g., *The aunt saw the girl who the boy kissed.*).
- Cards with each constituent part of each clause in the sentence (i.e., agent, theme, verb) are placed in front of the patient, arranged in two active sentences (e.g., THE AUNT SAW THE GIRL and THE BOY KISSED THE GIRL) with the WHO card set aside.
- The clinician explains the steps required to make the target sentence, showing the patient how to identify thematic roles and demonstrating Wh-movement or NP-movement.
- The patient uses the cards to reassemble the sentence and then reads the sentence aloud. The clinician will assist with this step, if necessary.

Dickey & Thompson, 2007

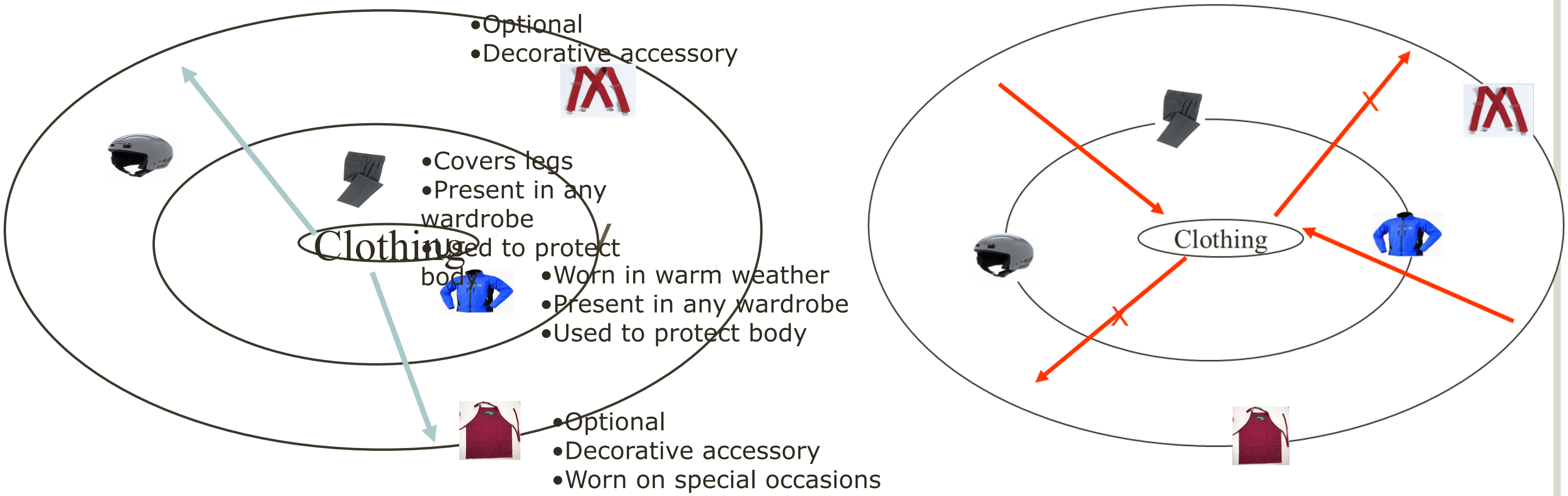
Evidence for efficacy

- Thompson & Shapiro, 1994 and Thompson et al., 1997 found that several participants showed better generalization when first trained on object clefts, relative to those first trained on wh-questions

- Thompson et al. 2003 found that object relatives were more complex than object clefts, and that training object relatives resulted in generalization to untrained object clefts and wh-questions

- Thompson et al., 2000 examined neural correlates of TUF improvements in 6 patients with agrammatism
  - Patients performed sentence verification tasks for both syntactically complex object clefts and simpler cleft constructions
    - Findings show that the neural networks underlying language processing can be modified even in patients who are several years post-stroke

Complexity in naming



Kiran, 2007; Kiran & Bassetto, 2008; Kiran, 2008

Selective generalization patterns

- Training more complex items, which encompass variables relevant to simpler items, facilitates greater access to untrained item than training simple items
  - exposure to items sharing some features of the prototype as well as differing features = activation of both typical and atypical entries
  - exposure to items with features similar to a semantic prototype = high probability of activating only a limited set of items with comparable features

Kiran, 2007; Kiran & Bassetto, 2008; Kiran, 2008

Inclusion Criteria

- Naming difficulties can result from deficits at different stages of the naming process: decoding, storage, selection, retrieval, or encoding
- Naming errors may due to
  - impaired access to semantic networks
  - disruption in semantic networks

Treatment Protocol

Sorting word cards by related locat

Church, Courthouse and Hospital

Select target word (N = 10)

Minister

Select 6 written semantic features from distracters for each target

Is alive

Has a physical presence

Can be seen

Conveys important messages

Can be touched

Exists outside the mind

Respond to 15 auditorily presented questions

(5 accurate, 5 inaccurate, 5 distracter)

Is it associated with heaven?

Is it a place to pray?

Does it live in trees?

Word recall of trained items

What are we talking about? Minister

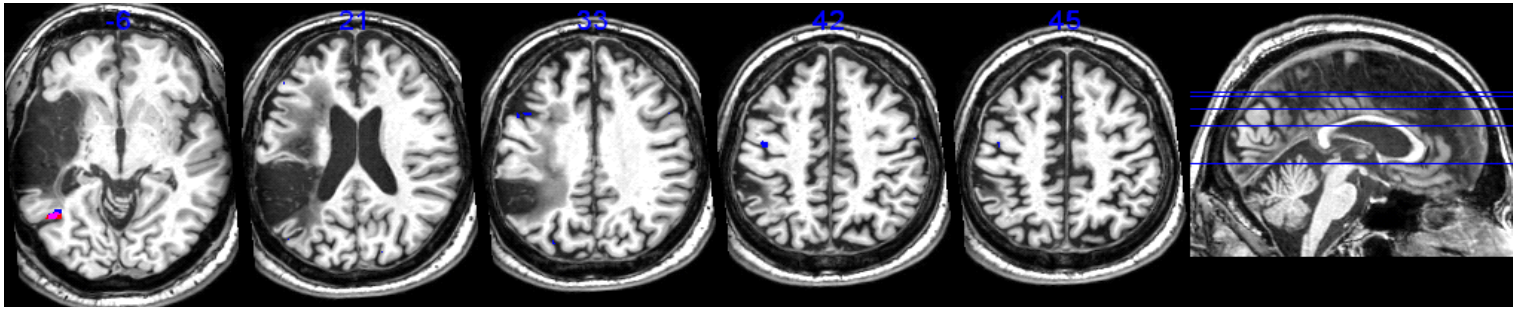
Kiran, Sandberg, & Abbott, 2009

Evidence for efficacy

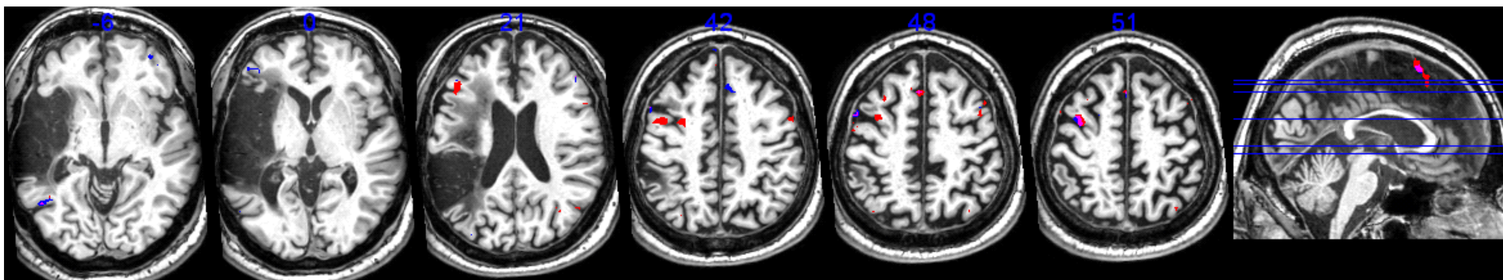
Study	Stimuli	Results
Kiran & Thompson, 2003	Birds, Vegetables	3/4 patients show generalization atypical ->typical, 2/4 no generalization typical -> atypical
Kiran, 2008	Clothing, Furniture	3/5 atypical ->typical, 4/5 typical -X> atypical 1/5 no learning, no generalization
Kiran & Johnson, 2008	Well defined categories- Shapes, Females	2/3 atypical ->typical 1/3 typical -X> atypical 2/3 no learning, no generalization
Kiran, Sandberg, & Sebastian, 2010	Ad hoc categories – Garage sale, Camping	5/6 atypical ->typical 2/6 typical -X> atypical 1/6 typical - > atypical 2/6 no learning, no generalization
Kiran, Sandberg, & Abbott, 2009	Ad hoc categories – Church, Courthouse	2/4 abstract -> concrete 3/4 concrete -X> abstract 1/4 no learning, no generalization

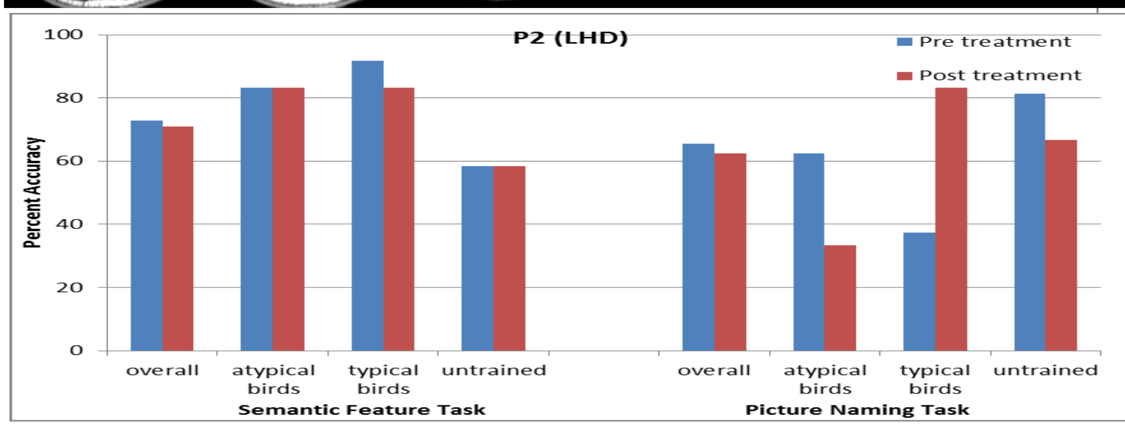
Additional evidence for complexity

Picture Naming>Scrambled. Pre-treatment (blue), post-treatment (red), overlap (pink), threshold = 4.5, FWE < .05



Semanti c feature>Scrambled. Pretreatment (blue), post-treatment (red), overlap (pink), threshold = 4.5, FWE < .05





Kiran et al., under revision

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SFA PROTOCOL

- SFA is carried out in a few simple steps (Boyle & Coelho, 1995)
- The patient attempts to name a pictured object. Regardless of whether or not the patient is successful, the clinician moves on to step 2.
- The clinician places the picture in the middle of the table or a board with six semantic feature types listed around the perimeter: category, use, action, physical attribute, location, and association. If the patient cannot provide a feature, the clinician provides the feature.
- Success in naming each item correctly is reinforced, regardless of when it occurs. However, feature analysis is always carried out in its entirety before moving on to the next item.

Inclusion Criteria

- Naming difficulties can result from deficits at different stages of the naming process: decoding, storage, selection, retrieval, or encoding
- Naming errors may due to
  - impaired access to semantic networks
  - disruption in semantic networks

Group

Household item

Use

Removes wrinkles from clothing

Action

Moves back and forth, presses

Properties

Made of plastic and metal

Location

Found in laundry room

Association

Clothing, laundry, cleaning

Evidence for efficacy

- Boyle and Coelho (1995)
  - 1 patient, showed improvements
- Coehlo, McHugh, & Boyle (2000)
- Davis and Staunton (2005)
  - Single patient showed improvements on trained items. This study examined words per minute and CIUs
- Boyle (2004)
  - Improvement on some, but not all discourse measures and the measures that improved differed for each of 2 participant
- Wambaugh & Ferguson (2007)- Feature Analysis for Verbs
  - Effect size suggestive of positive treatment effect for trained items, but did not achieve levels desired for clinically significant change
- Rochon et al., (2008) Phonological Component Analysis
  - Phonological components related to the target item (i.e., rhymes with, first sound, first sound associate, final sound, number of syllables).

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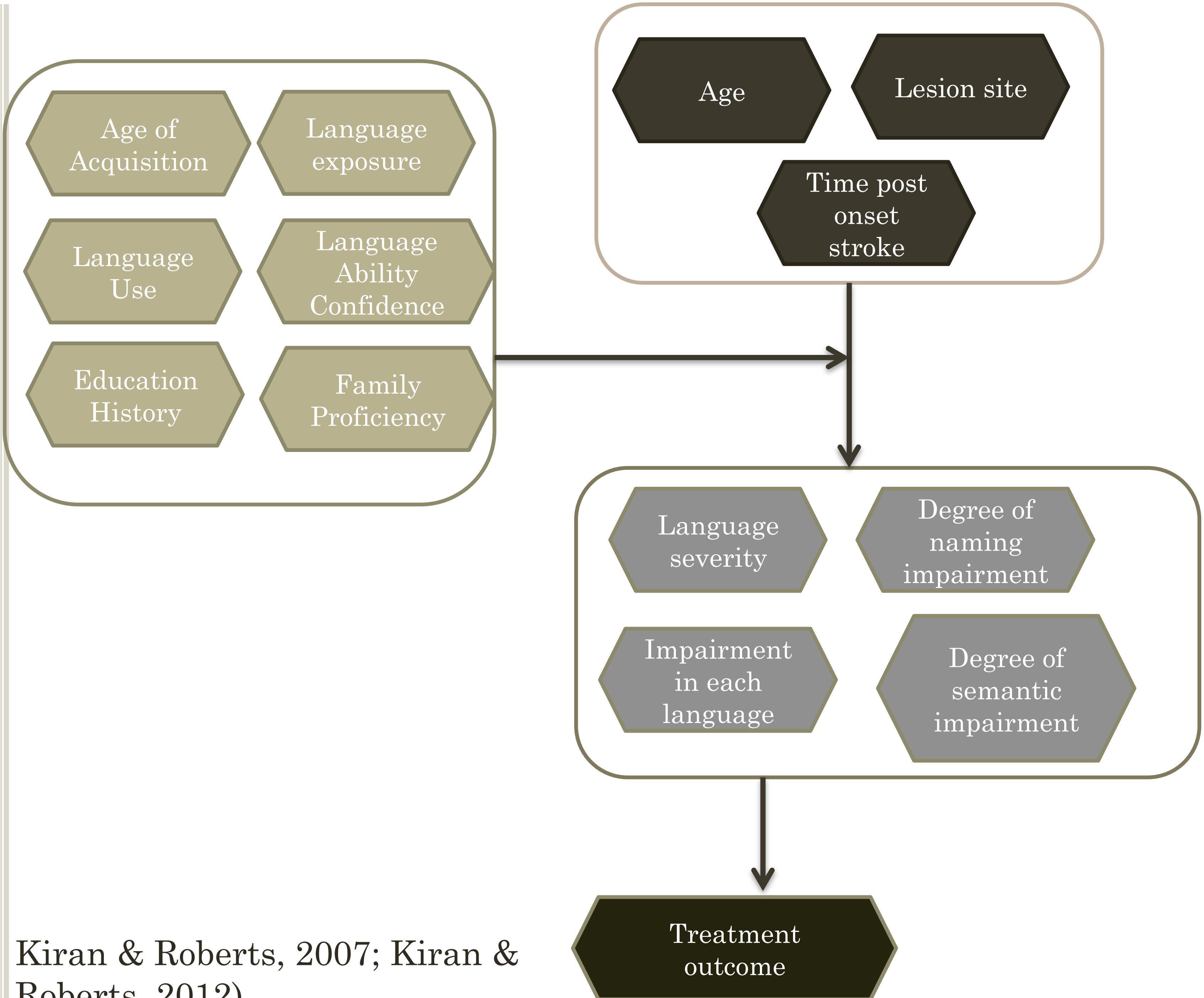


Kiran & Roberts, 2007; Kiran & Roberts, 2012)

Evidence for between and within language transfer

- 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)

Inclusion criteria for semantic bilingual naming therapy

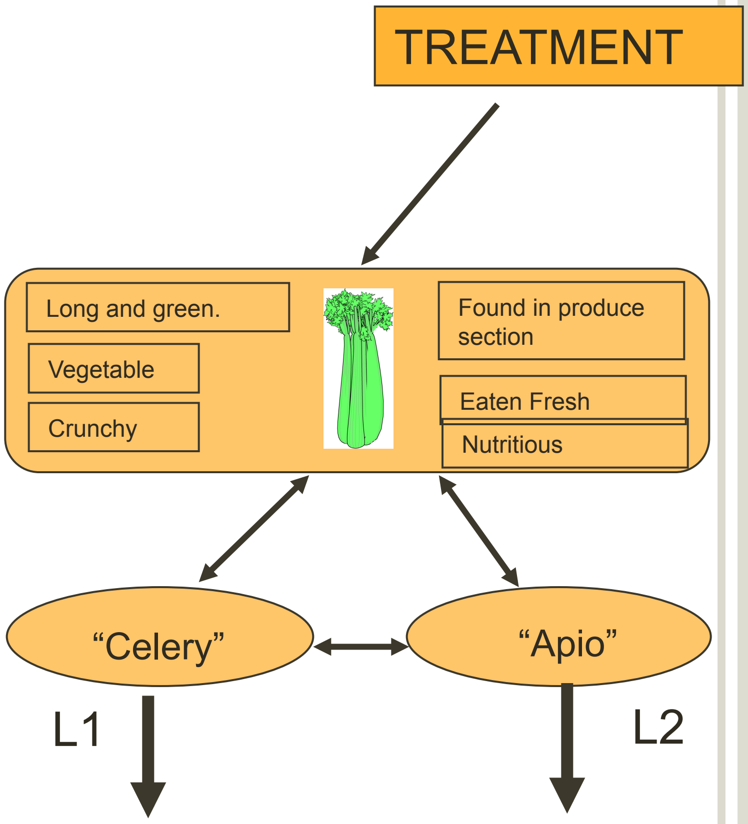
- Who are proficient in two languages prior to the onset of aphasia (bilingual)
- equal ability to speak, comprehend, and read in both languages prior to aphasia OR:
- stronger in one language prior to aphasia
- Naming deficits in both languages

Kiran et al, under review

TREATMENT PROTOCOL

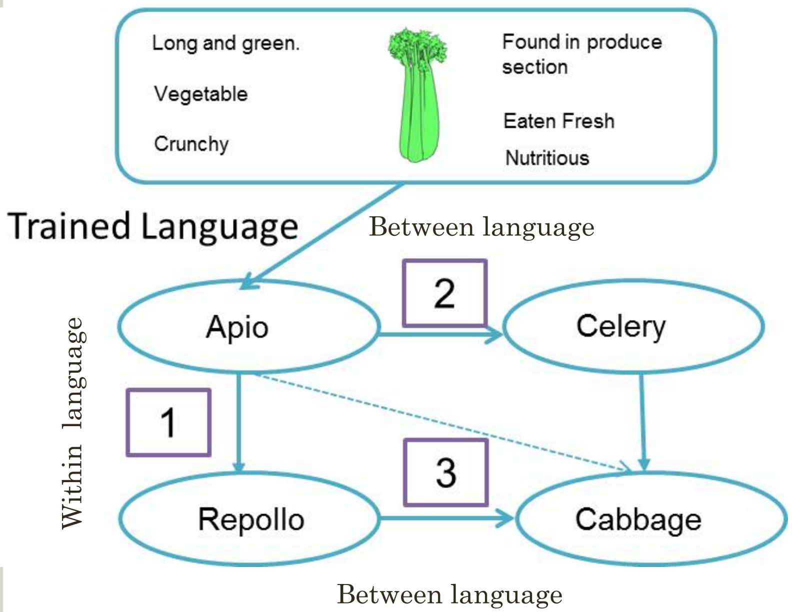
1. Name picture
2. If incorrect, told correct name
3. Choose 6 correct features from 12 cards
4. Answer 15 yes/no questions about the item
5. Named item again with feedback

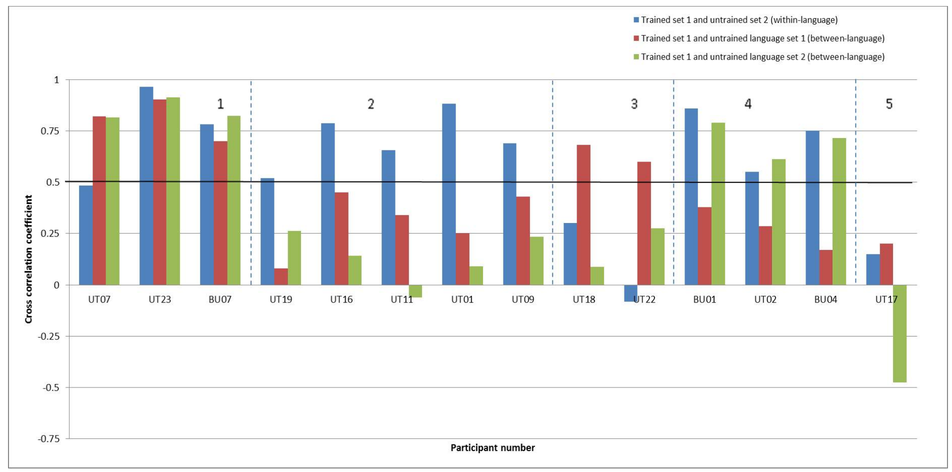
- Treatment always provided only in one language (either English/Spanish) and amount of improvement examined



Edmonds & Kiran, 2006; Kiran & Roberts, 2009

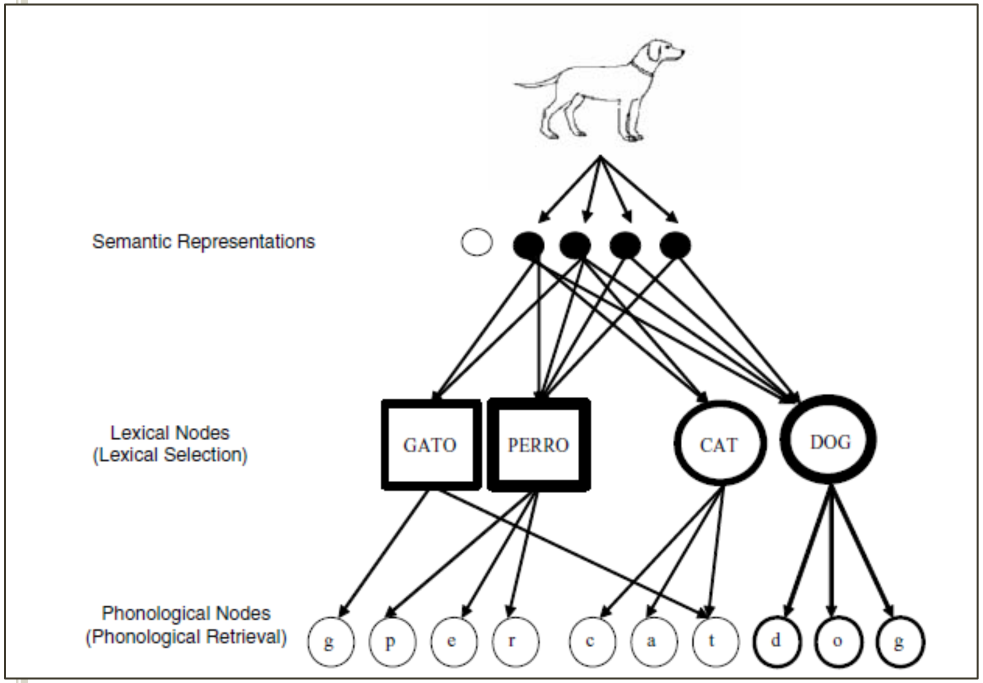
WITHIN AND BETWEEN LANGUAGE GENERALIZATION

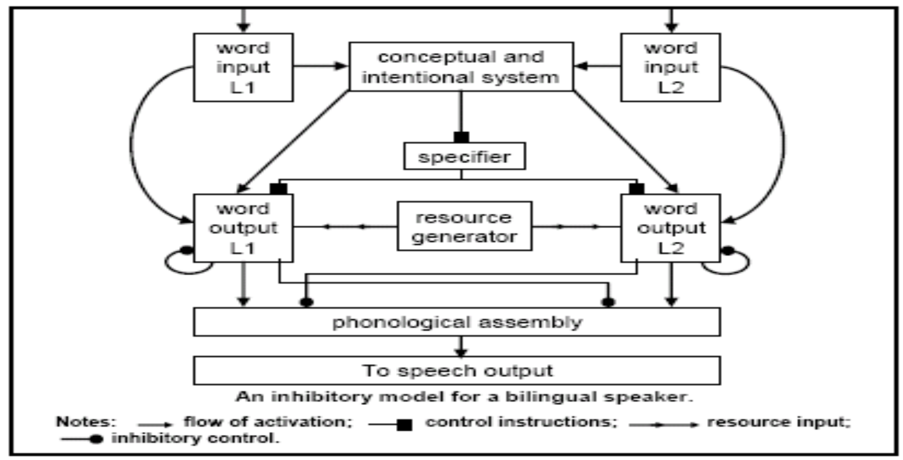




Edmonds & Kiran, 2006; Kiran & Roberts, 2009

Language and cognitive mechanisms at play





Costa, La Heij & Navarette, 2006

(Green, 1986; 1998)

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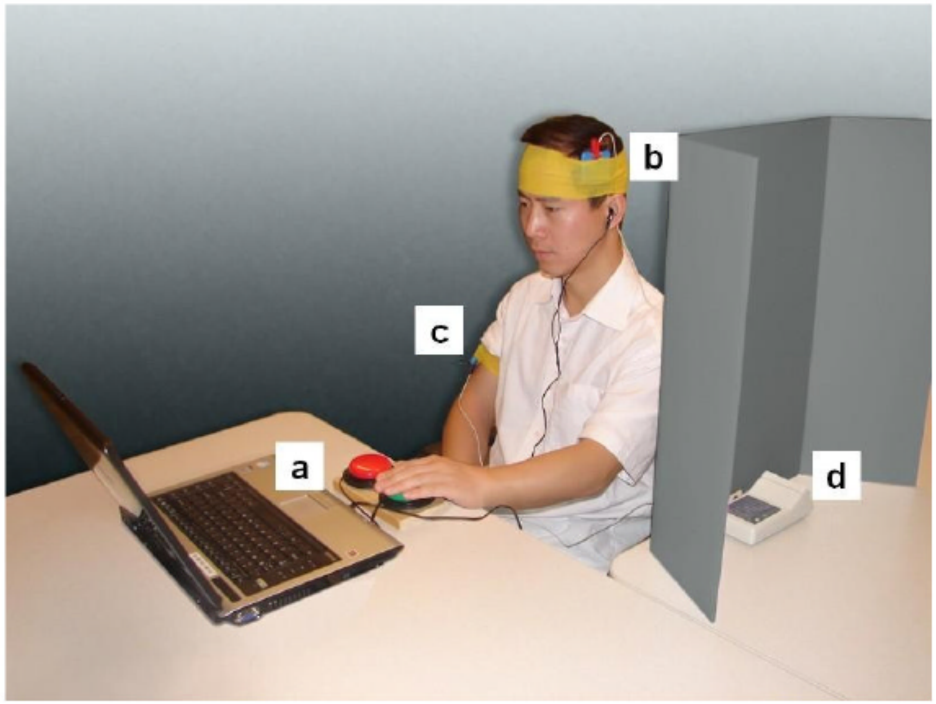
TRANSCRANIAL DIRECT CURRENT STIMULATION



Example of the treatment set-up. Patients trained on a computerized picture-word matching task (a) while receiving transcranial direct current stimulation (tDCS). During both anodal tDCS and sham tDCS treatment phases, the anode electrode (b) was placed over the pre-designated area on the scalp overlying the left frontal cortex, while the reference cathode electrode (c) was placed over the right shoulder. The constant current stimulator (d) was placed out of the patients' sight behind a partition.

Baker, Rorden & Fridriksson, 2010

EVIDENCE FOR EFFICACY

- Baker, Rorden & Fridriksson, 2010
  - Ten patients with chronic stroke-induced aphasia received five days of A-tDCS (1 mA; 20 min) and five days of sham tDCS (S-tDCS; 20 min, order randomized)
  - Treatment: computerized anomia treatment.
  - tDCS positioning was guided using *a priori* functional MRI results on a naming task.
  - Results revealed significantly improved naming accuracy of treated items following A-tDCS as compared to S-tDCS.
  - Patients who demonstrated the most improvement were those with perilesional areas closest to the stimulation site.
- Cherney et al., (2012)
  - 3 participants received anodal, cathodal and sham stimulation
  - Patients showed improvements in regions including perilesional regions

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SCHEMATIC OF TREATMENT FOR EACH PARTICIPANT

Pre –treatment assessment:
Western Aphasia Battery, BNT, Bilingual Aphasia

Baselines: Naming across consecutive sessions & languages

Treatment on 1 set of examples in 1 language

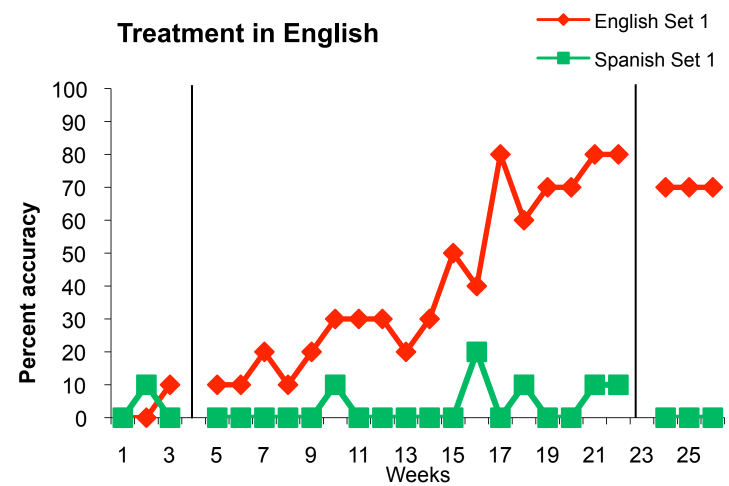
Session 1: Training
Session 2: Testing & Training

Week 1
Week 2
Week 3
Week 4

Session 1: Training
Session 2: Testing & Training

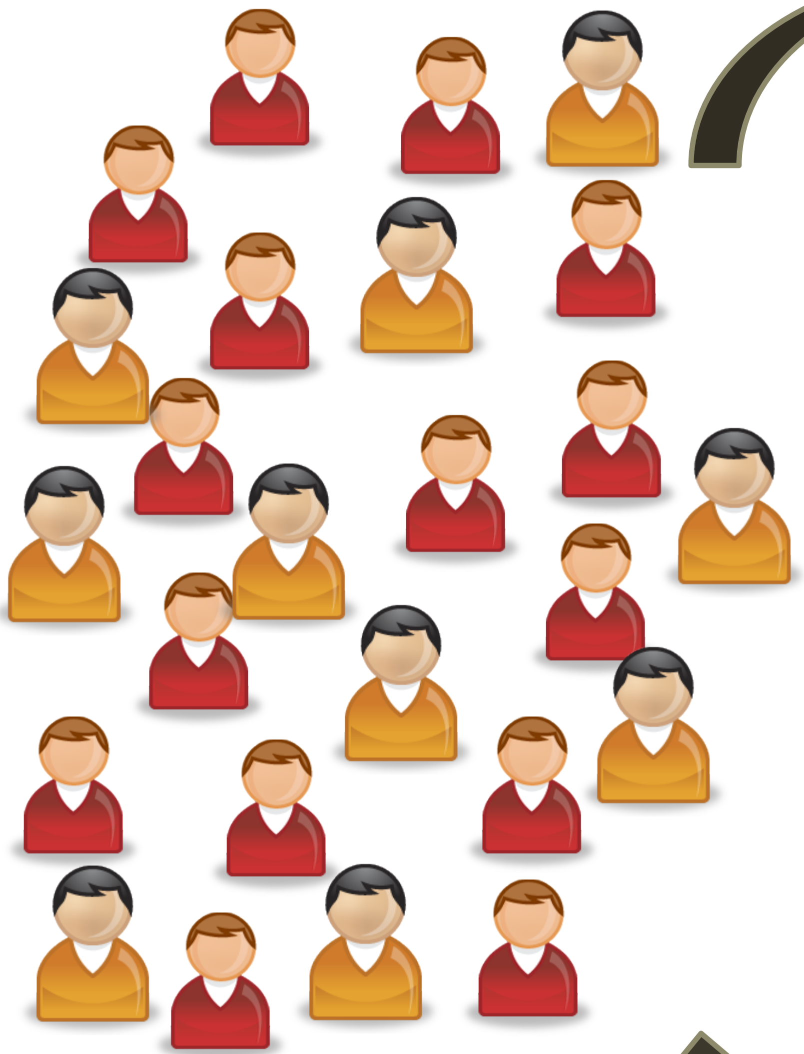
Until 80% accuracy achieved on items trained

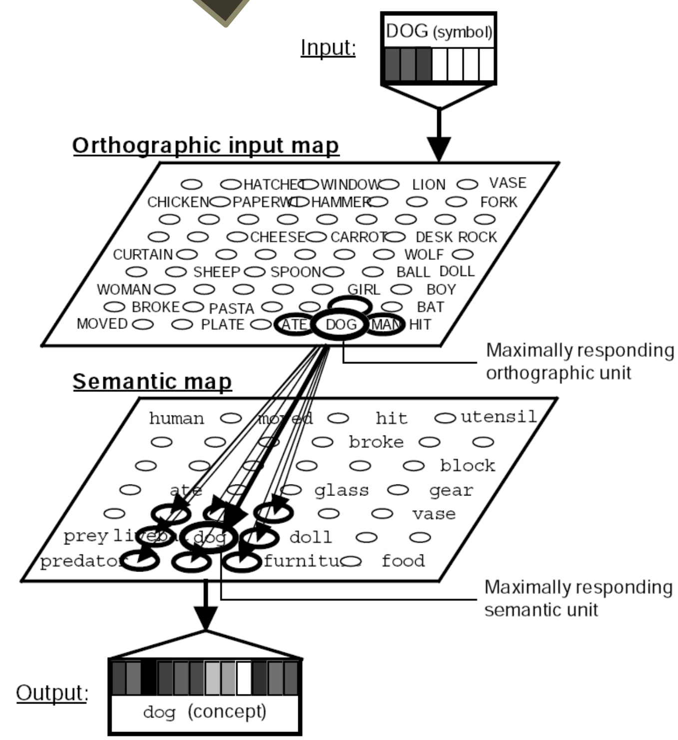
Post –treatment assessment:
Standardized language tests



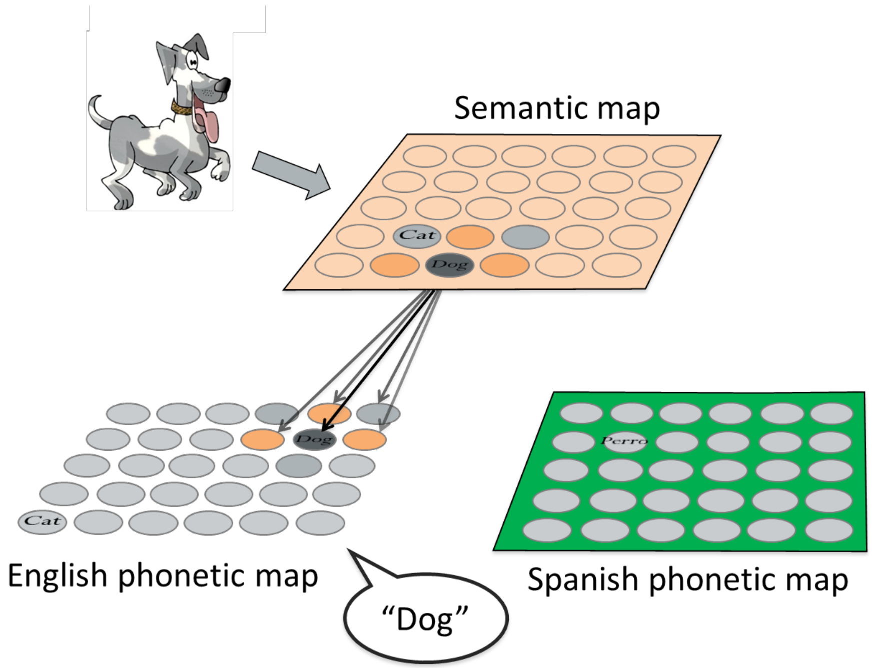
Edmonds & Kiran, (2006) *JSLHR*

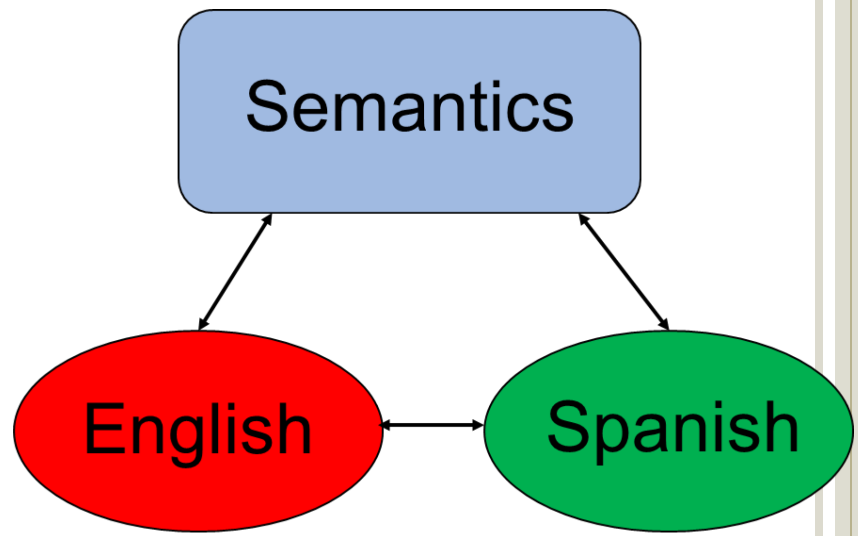
PREMISE OF COMPUTATIONAL MODELING

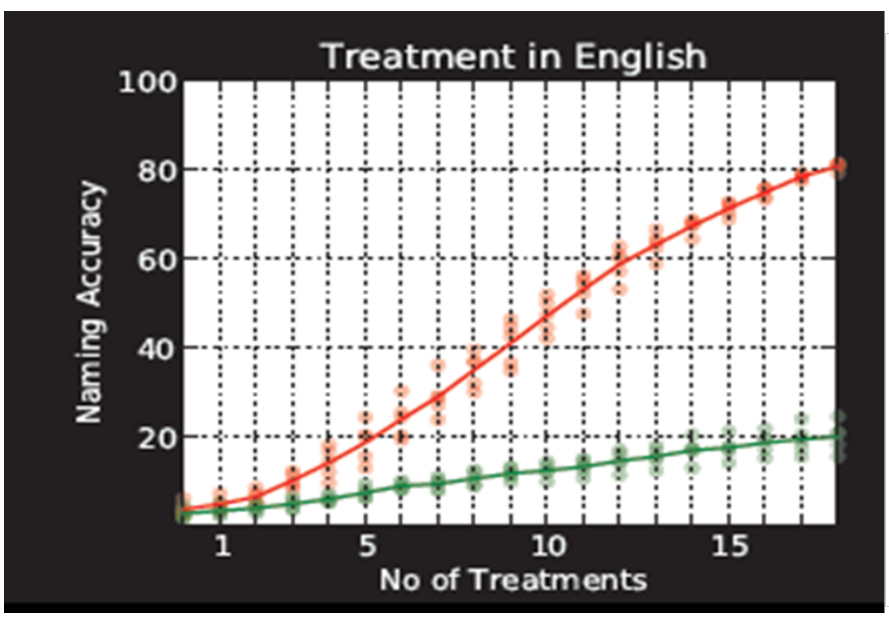


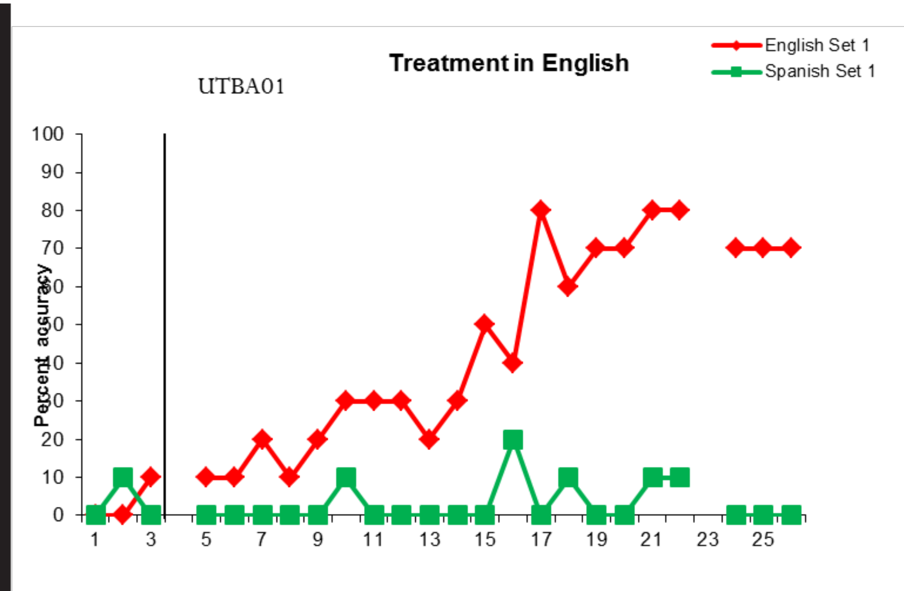


Kiran, Grasemann, Sandberg & Mikkulainen, 2012









Kiran, Grasemann, Sandberg & Mikkulainen, 2012

Evidence for efficacy

- 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
- 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…

Kiran, Grasemann, Sandberg & Mikkulainen, 2012

To summarize

- Several advances in therapies for language deficits in aphasia

- New approaches include
  - Promoting generalization
  - Neurobiological and pharmacological treatments
  - Predicting outcomes through computational modeling