Treating New Learning and Memory Deficits in Rehabilitation Populations:

the modified Story Memory Technique (mSMT)

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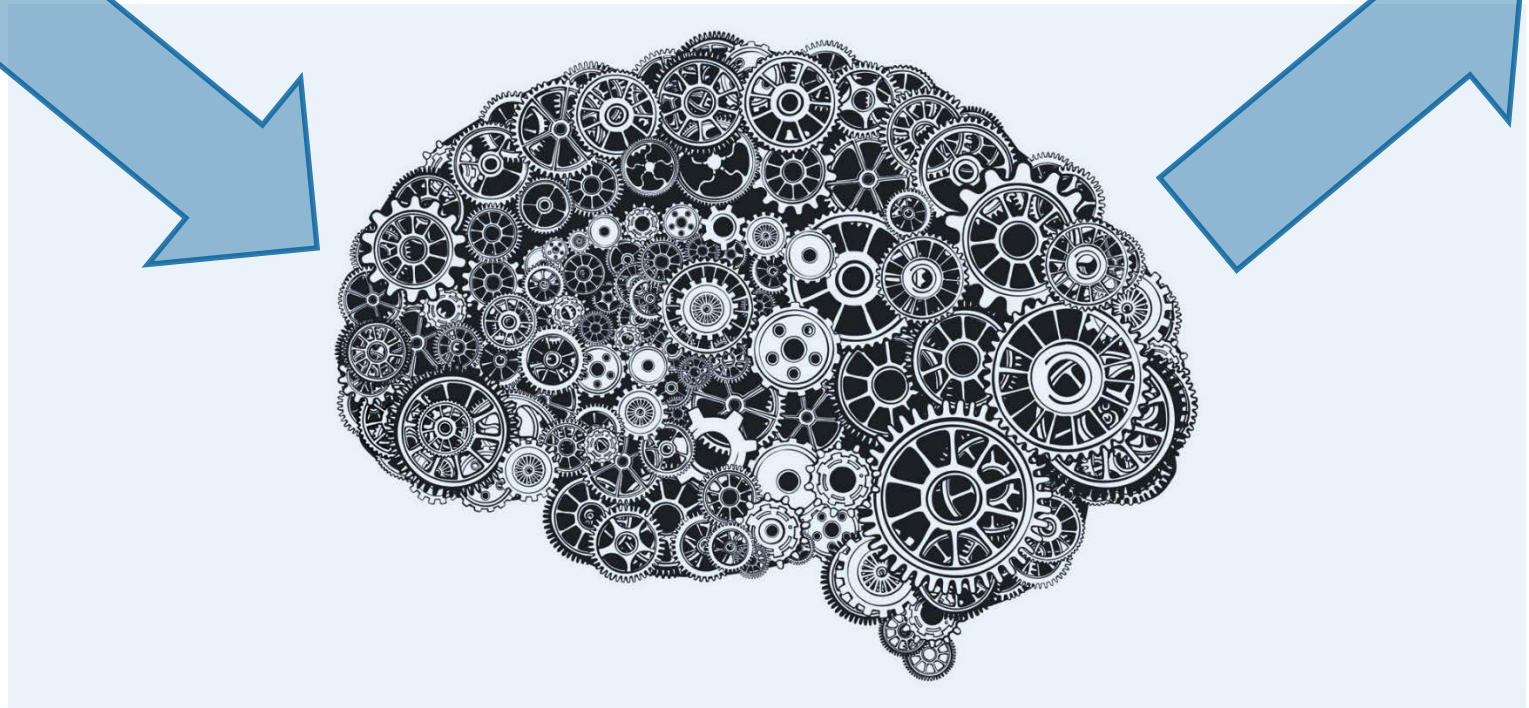
Objectives

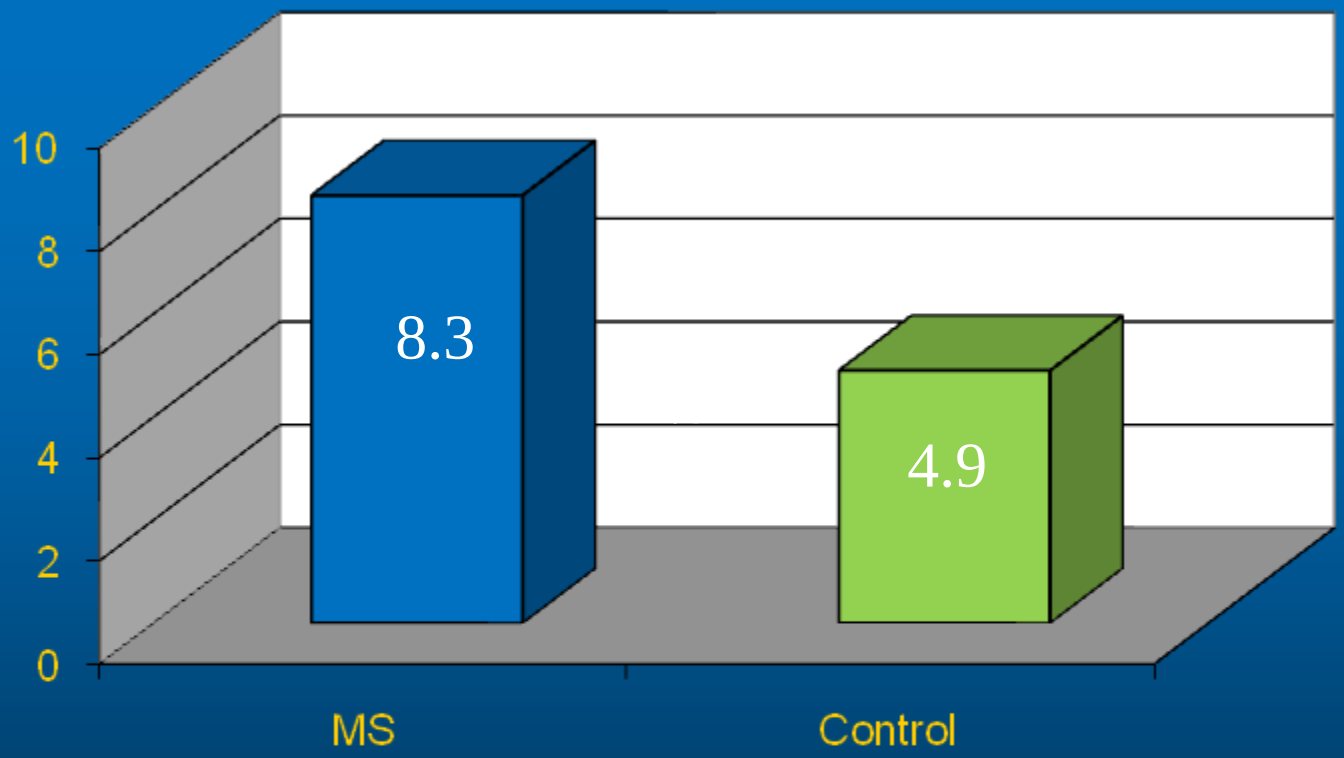
- Understand techniques for memory rehabilitation with an evidence-base
- Understand the mSMT literature
- Understand the mSMT: Nuts & Bolts

Memory Process

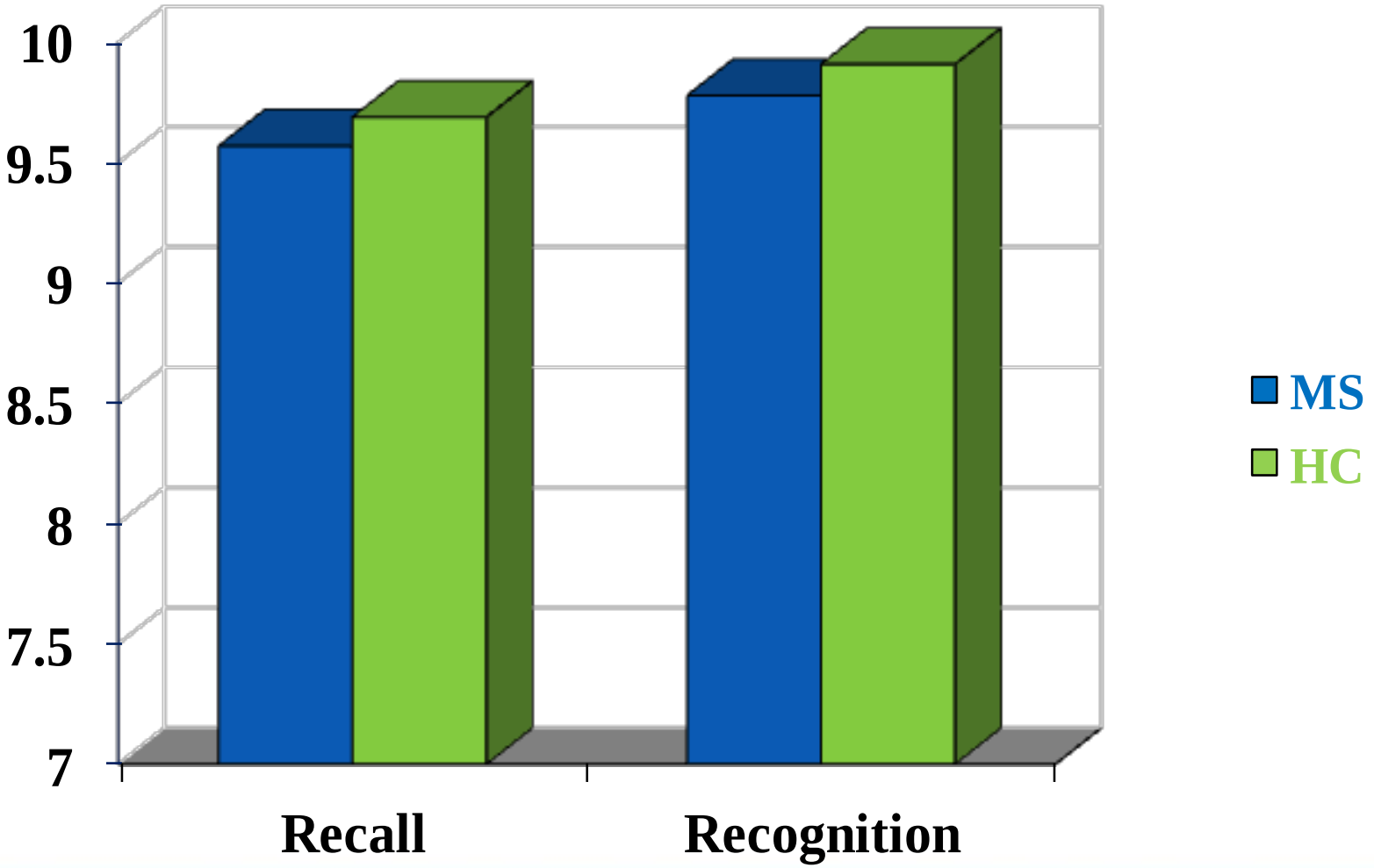
Encoding → **Consolidation** → **Retrieval**



Required Learning Trials (p<.05)



Recall and Recognition (ns)



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*replicated in TBI; DeLuca et al., 2000

What does this mean?

- The most effective treatment will target learning

The Literature

Treating Learning and Memory in TBI & Stroke

Table 5: Remediation of Memory Deficits

Intervention	Level of Recommendation
Memory strategy training is recommended for mild memory impairments from TBI, including the use of internalized strategies (eg, visual imagery) and external memory compensations (eg, notebooks).	Practice Standard
Use of external compensations with direct application to functional activities is recommended for people with severe memory deficits after TBI or stroke.	Practice Guideline
For people with severe memory impairments after TBI, errorless learning techniques may be effective for learning specific skills or knowledge, with limited transfer to novel tasks or reduction in overall functional memory problems.	Practice Option
Group-based interventions may be considered for remediation of memory deficits after TBI.	Practice Option

*Cicerone, 2011

Treating Learning and Memory in TBI & Stroke

Domain of cognitive function	Technique	A brief description
Memory	Musical mnemonics training (MMT)	This technique targets memory encoding and retrieval functions. Includes musical exercises of recalling sounds or lyrics such as songs, rhymes, or chants
	Associate mood and memory training (AMMT)	This technique focuses on three aspects – to facilitate memory recall by inducing mood-congruent state; to facilitate memory recall by accessing associated mood and memory network via music; to enhance memory formation by inducing positive emotional state

*Hegde, 2014

Evidence in TBI & Stroke supports:

- External memory aides
  - Notebooks, iPads, alarms, etc
- Music
- Imagery
- Strategy based techniques

Treating Learning and Memory in MS

15 studies	**1 practice standard: mSMT** **4 options:** • **Imagery (basis of mSMT)** • **Music** • **Self-generation** • **Spaced trials**

Disclaimer

- This talk reviews *specific interventions* for treating memory impairment;
  - this does not reflect on cognitive rehabilitation in general, which has wide support in TBI, Stroke and MS
- Data on exercise as a means of improving memory was also not reviewed

Supported techniques (internal) across populations

- Music
- Strategy based techniques
  - Generation
  - Spacing
- Imagery

Music

2 studies by same group

frontiers in
HUMAN NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
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Music mnemonics aid verbal memory and induce learning – related brain plasticity in multiple sclerosis

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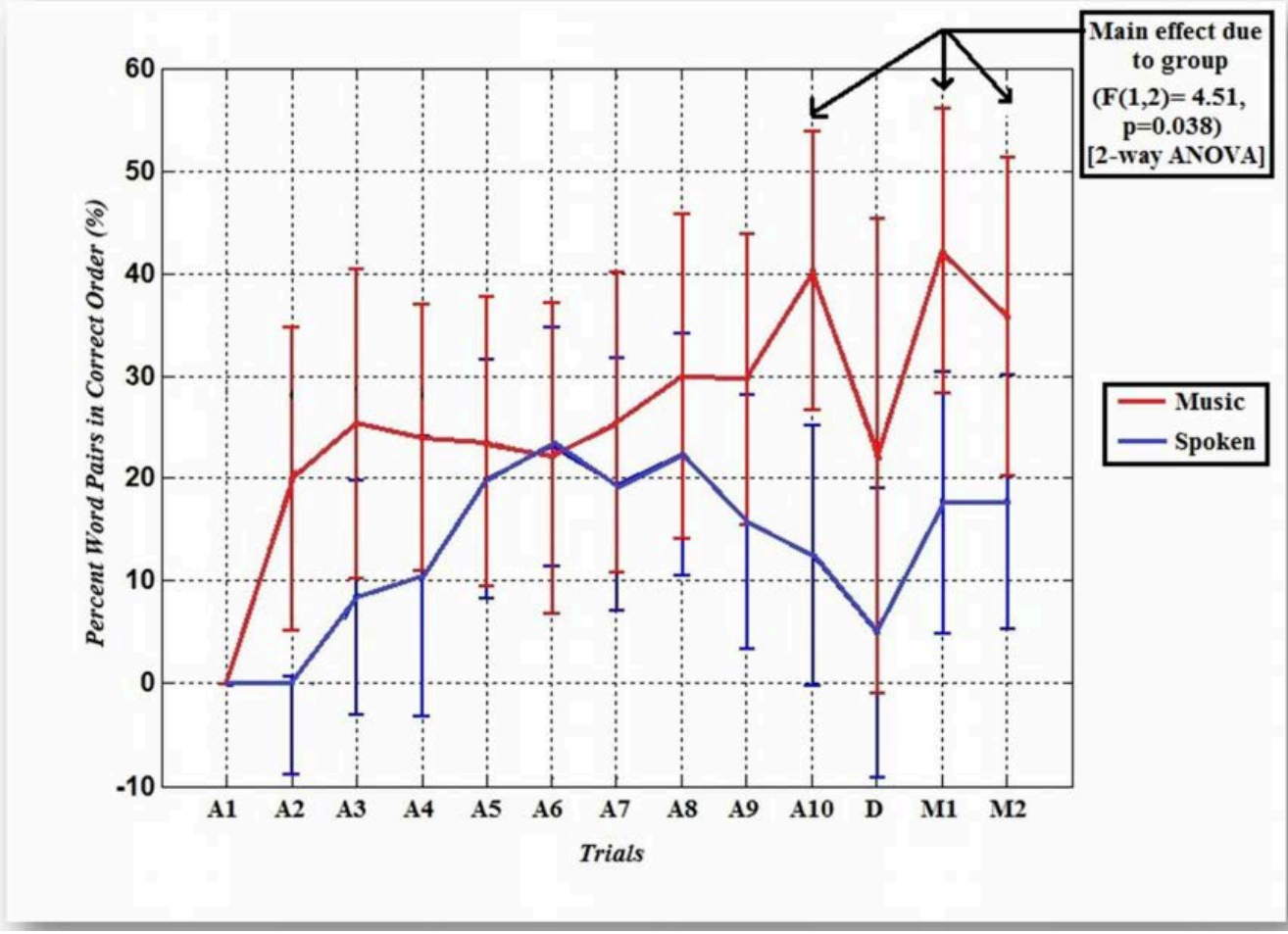
Spoken vs *sung* list of words.

Sung: recalled more word and had more frontal activity



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Strategy Training

- Consistent support for various strategies
  - Self-generation
  - Spaced learning
  - Retrieval practice
  - Errorless Learning
- Treatment gains remain over several months
- Generalization to daily life still unknown

"more than 100 years of distributed practice research has demonstrated that …spaced (versus massed) learning consistently shows benefits, regardless of retention interval."

Combining strategies is more effective than using one method alone

Self-generation
& Spaced Learning

STEM

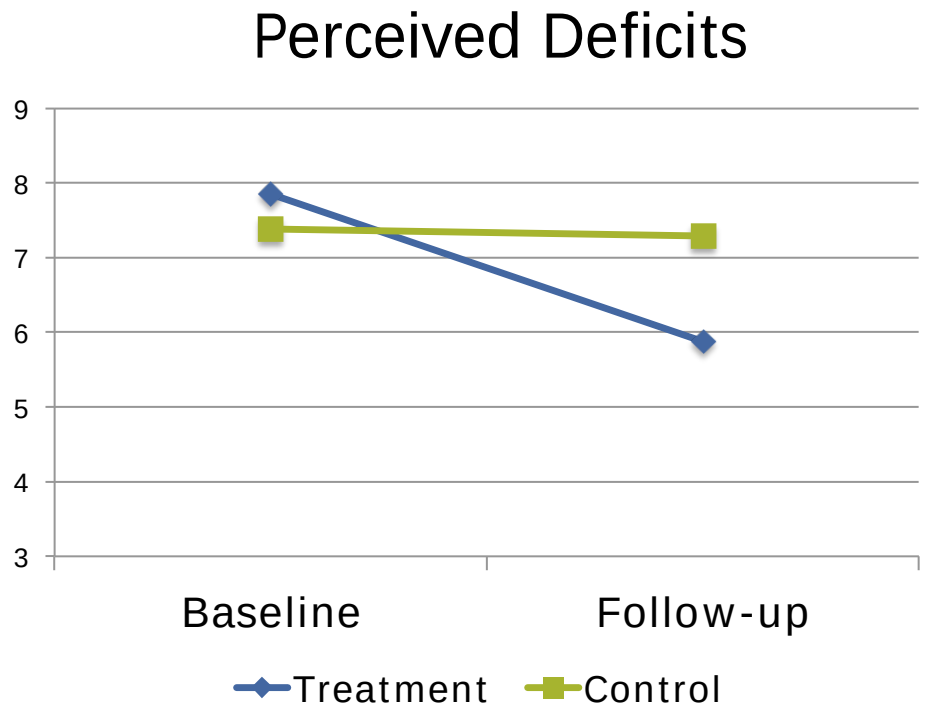
Strategy-based Treatment to Enhance Memory (STEM)

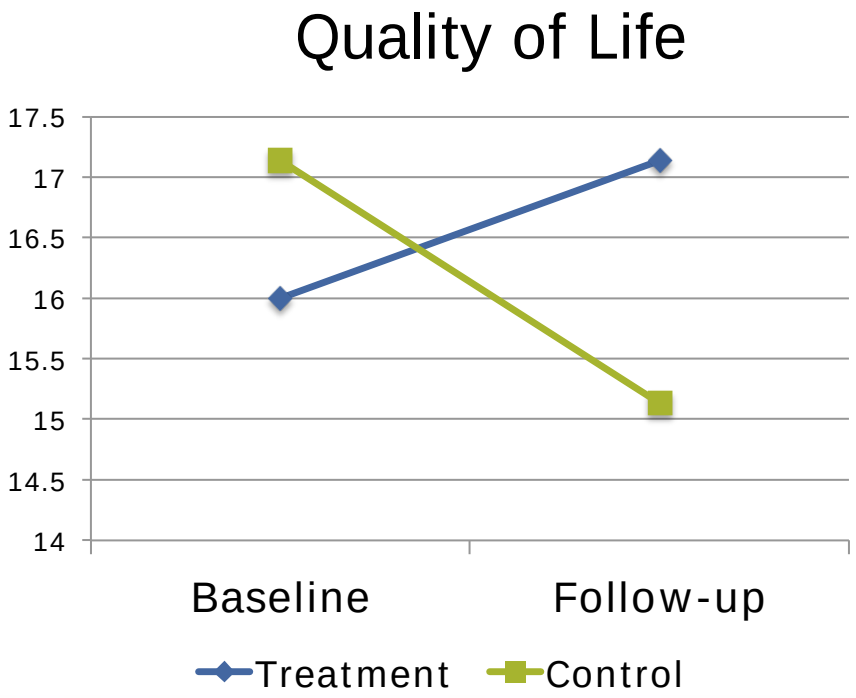
- Teaches persons and significant others how to apply novel techniques in daily life

- Teaching application of:
  - Generation effect
  - Spacing effect
  - Testing effect

- 8 session treatment protocol for:
  - Persons with MS
  - Significant Other

STEM Results





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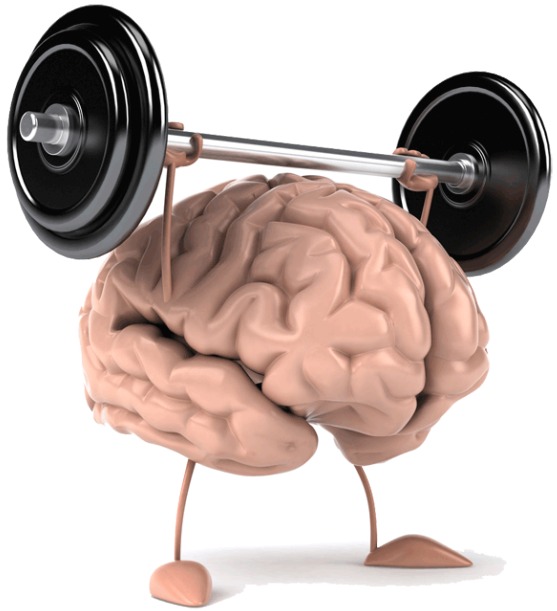
STEM

- Running large RCT in TBI
- Large RCT in MS is under review

Imagery

mSMT



Multiple Sclerosis 2005; 11: 58–68
www.multiplesclerosisjournal.com

Treating learning impairments improves memory performance in multiple sclerosis: a randomized clinical trial†

Nancy D Chiaravalloti[1,2,2], John DeLuca[2,2,3], Nancy B Moore[2] and Joseph H Ricker[2,2]
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ARTICLES

An RCT to treat learning impairment in multiple sclerosis

The MEMREHAB trial

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Olga M. Nikelshpur, PhD
John DeLuca, PhD

ABSTRACT

Objective: To examine the efficacy of the modified Story Memory Technique (mSMT), a 10-session behavioral intervention teaching context and imagery to facilitate learning, to improve learning and memory abilities in persons with multiple sclerosis (MS).

Methods: This double-blind, placebo-controlled, randomized clinical trial included 86 participants

Can context and imagery facilitate learning?

- Memory Retraining Treatment Protocol
  - Randomized Control Trial
  - Modified Story Memory Technique (mSMT)
  - 10 sessions
    - ✓2 times per week for 5 weeks
    - ✓30 to 90 minutes in duration
- Does it work?
  - Assessments before and after treatment
  - Neuropsychological assessment, neuroimaging, assessment of daily life

Studies on the mSMT

- MS
- Multiple Sclerosis and Related Disorders, *7*, 76-82; 2016.
- Multiple Sclerosis Journal, 21(12), 1575-1582; 2015.
- Brain imaging and behavior, 8(3), 403-406. 2014.
- Brain imaging and behavior, 8(3), 394-402. 2014.
- Neurology. 10;81(24):2066-72; 2013
- Journal of Neurology, 259(7), 1337-1346; 2012

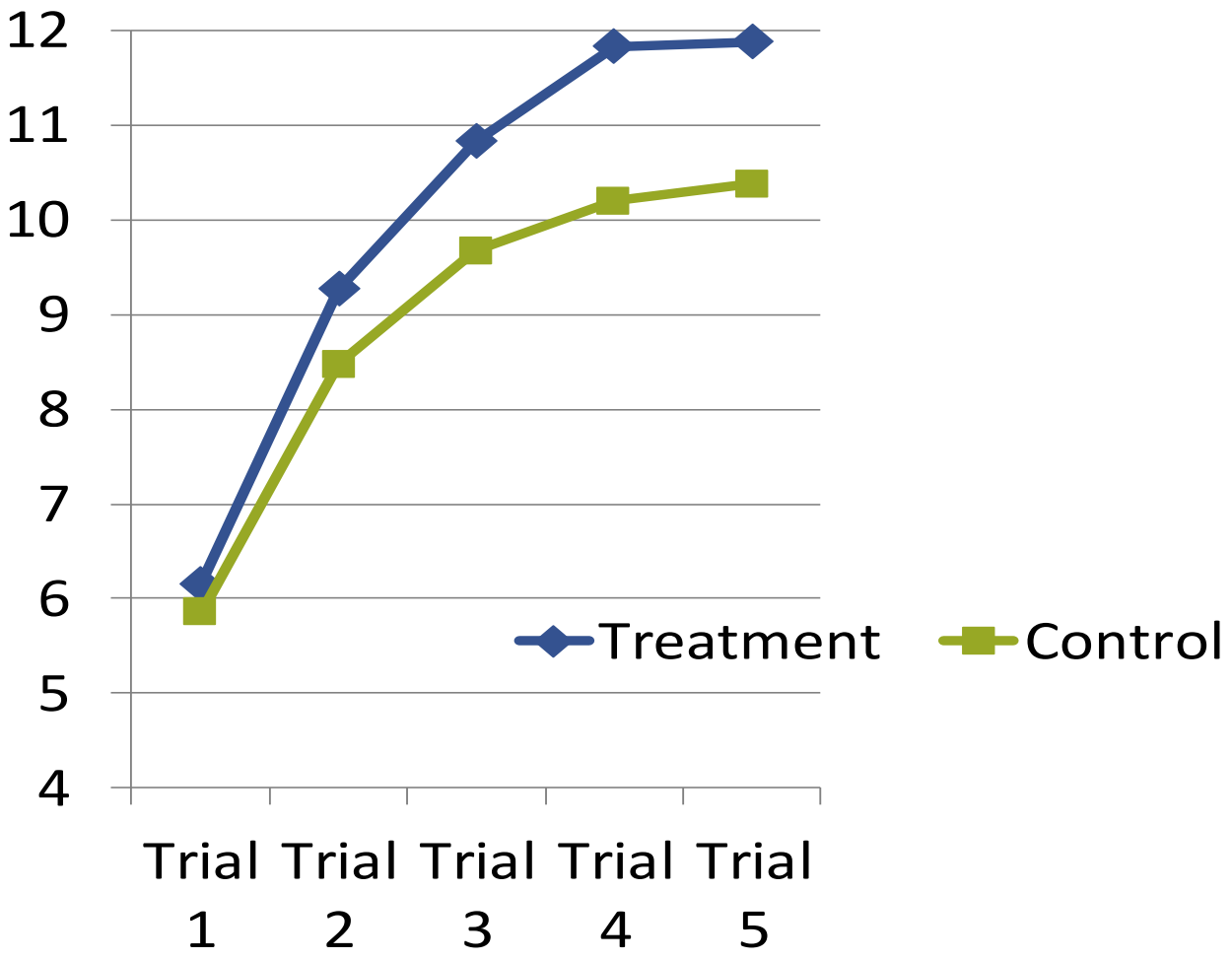
- TBI
- Archives of Physical Medicine and Rehabilitation, 97(6), 1026-9; 2016.
- Neurorehabilitation and Neural Repair, 30(6), 539-550; 2016.
- The Journal of Head Trauma Rehabilitation, 30(4), 261-269; 2015.

Randomized Clinical Trials

- Design
  - Double blind, placebo controlled RCT
  - Assessments before and after treatment
    - Memory
  - Screened into study based on learning impairment
  - Subsample: pre and post neuroimaging
- 2 populations
  - TBI: Funded by NIDILRR (n=95)
  - MS: Funded by NIH (n=86)

MS: Learning by Group

CVLT Learning Trials



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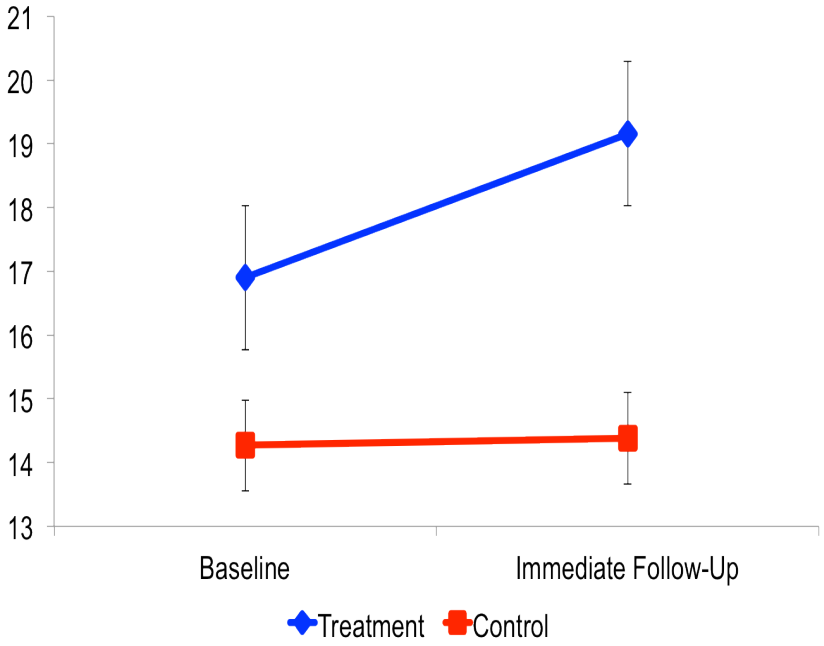
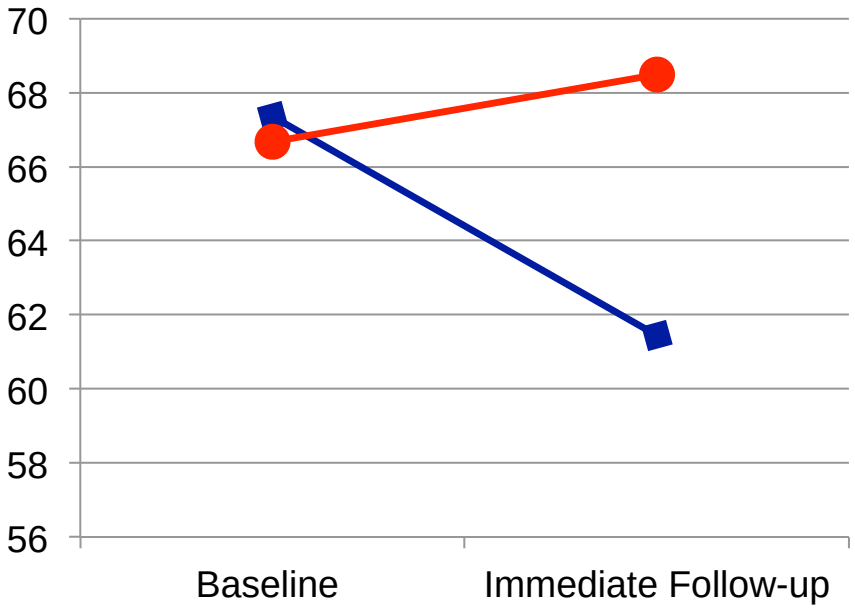
Everyday Life After Memory Retraining in MS

Patient Self-Report

FAMS General Contentment



FrSBe Total Score*, Family Form



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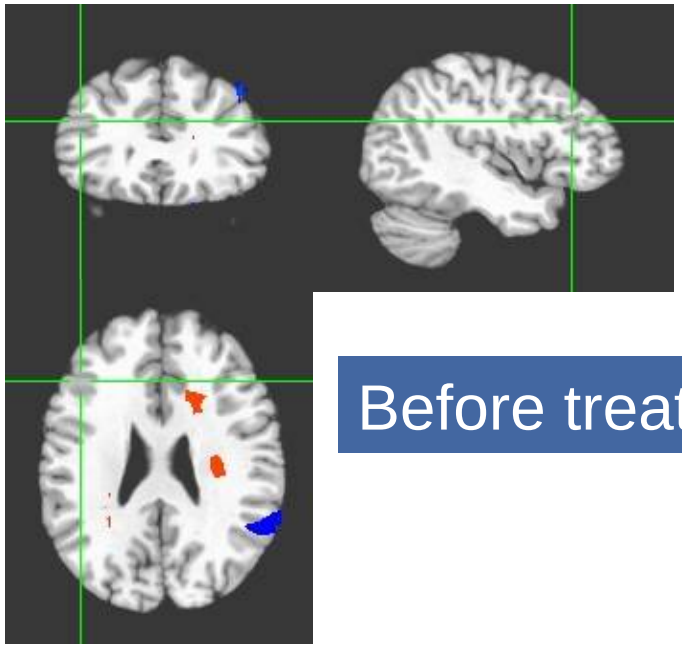
Chiaravalloti et al (2013), *Neurology*

Changes on Functional MRI Scans
Before and After mSMT treatment

fMRI shows increased activity after treatment—

only in areas underlying the treated function



Before treatment

After treatment

Little difference between groups

Treatment group robustly more active

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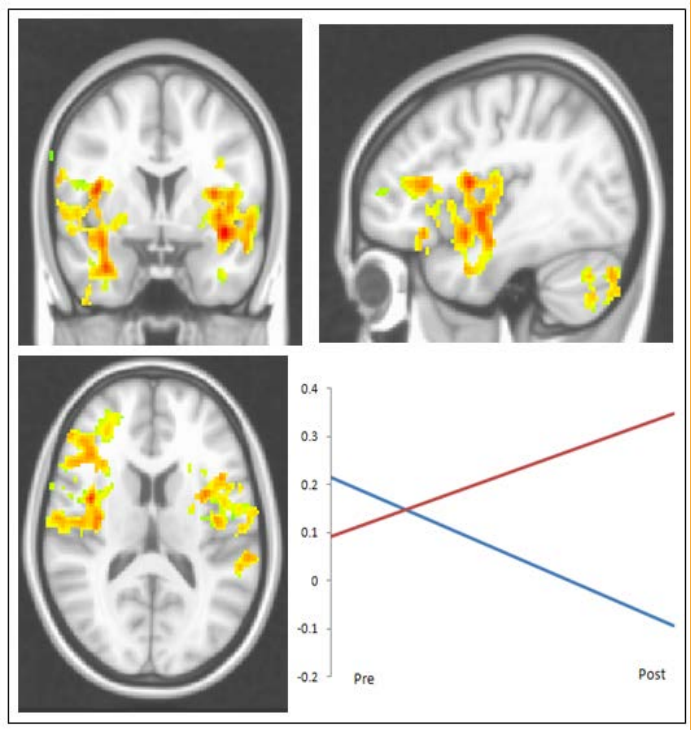
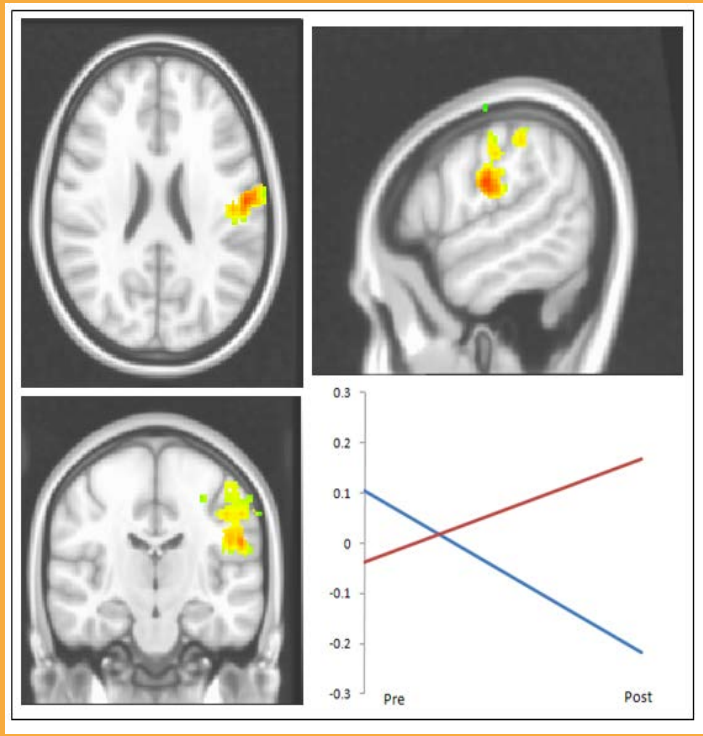
Resting State Functional Connectivity
After Memory Retraining in MS



Increased connectivity
from L Hippocampus to
Insula bilaterally in treatment group
after treatment



Increased connectivity from
R Hippocampus to cluster comprised of L
post-central gyrus, precentral gyrus, middle
frontal gyrus, and cingulate gyrus in
treatment group after treatment

Red line tx; blue line controls

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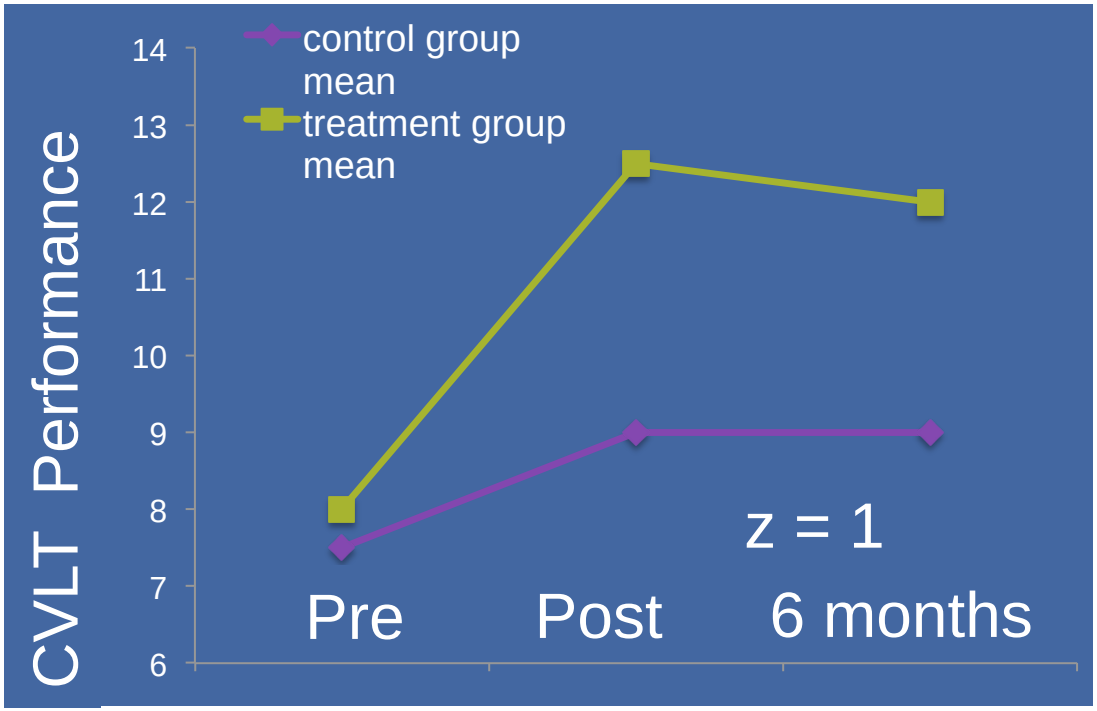
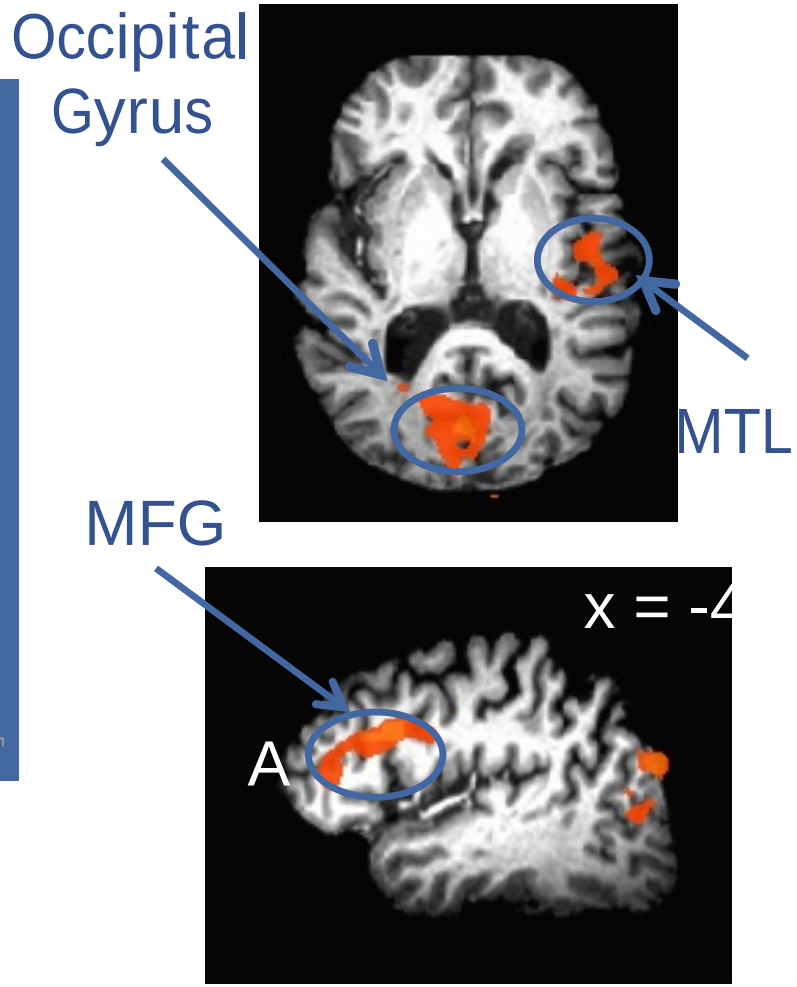
Leavitt et al, *Brain Imaging & Beh*, 2013

mSMT Long-Term Effects





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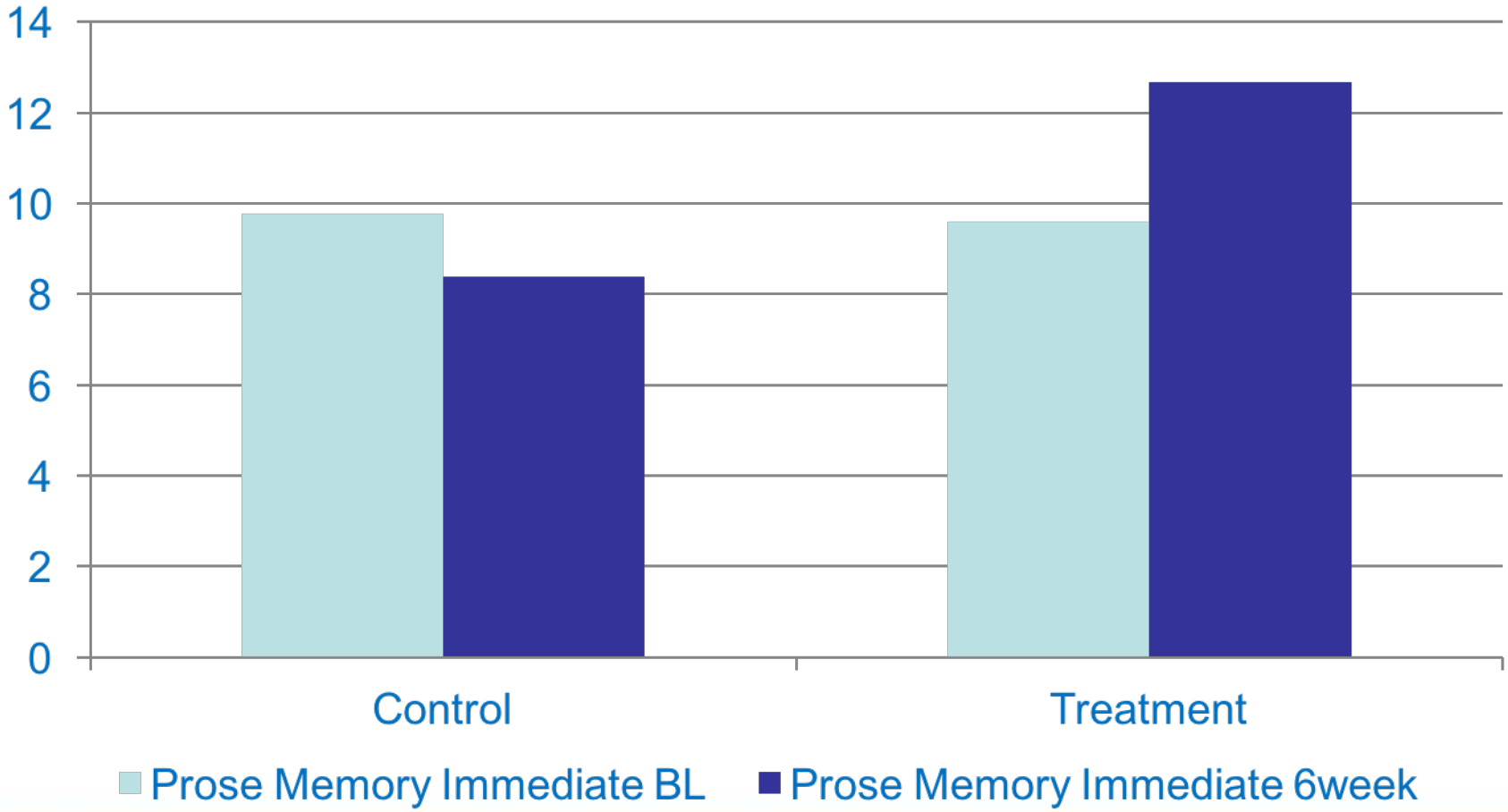
TBI: Learning Performance

pre to post treatment



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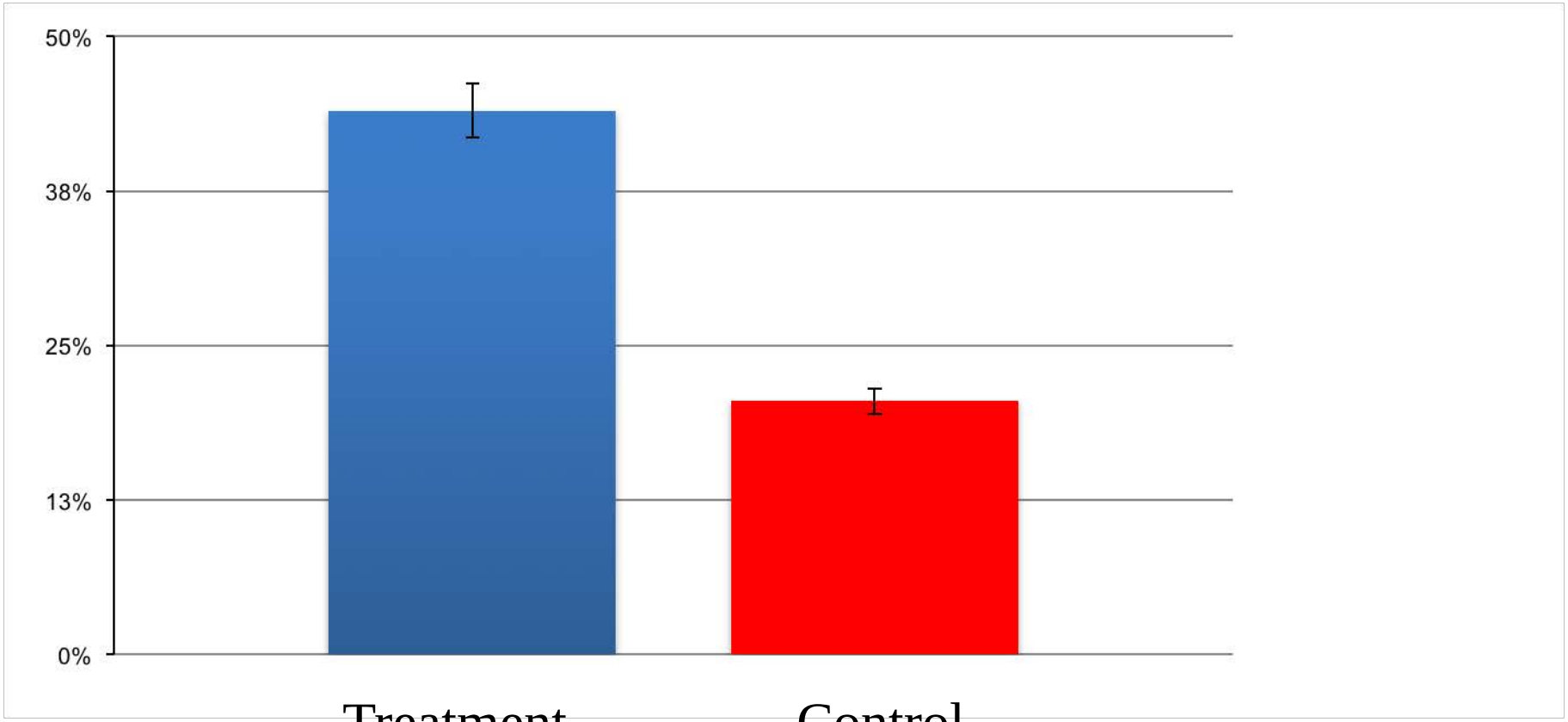
Paragraph Learning

% of Participants improving on RBMT – everyday memory



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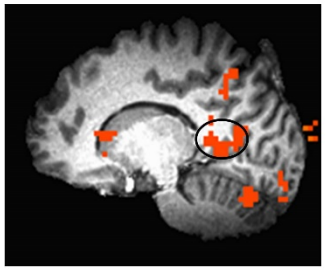
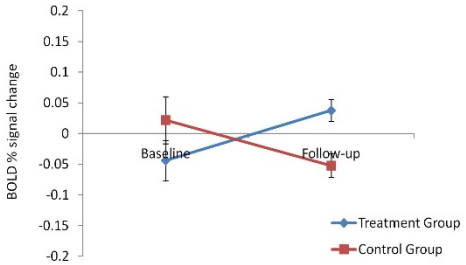
TBI: Between-group differences

A.





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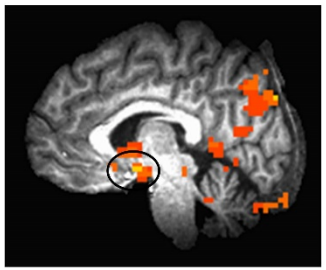

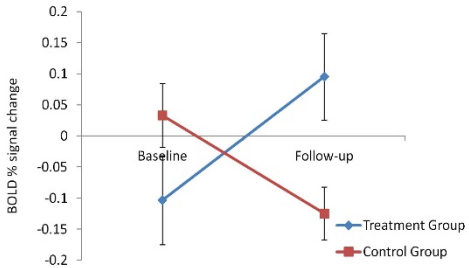

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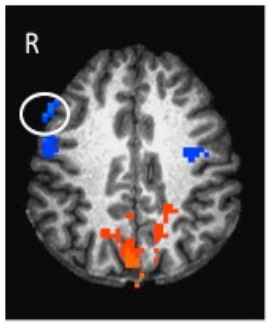

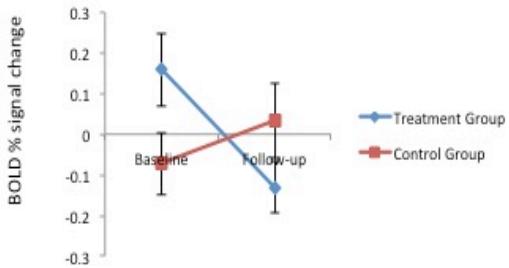

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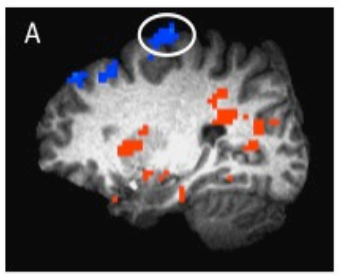

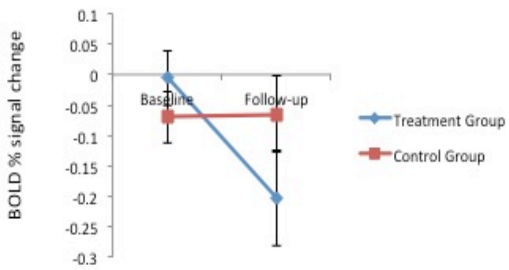

Significant changes in Default Mode Network (DMN) regions

Significant Change in Executive control network (ECN)

Imaging Findings

- Increased activation post-treatment
  - Default Mode Network (DMN) (Buckner et al., 2008)
    - Suppressed (i.e. deactivated) during a performance of a cognitively demanding task
    - Learning task is less cognitively demanding post-treatment
- Decreased ECN activation in treatment group
  - Encoding is less cognitively demanding & more efficient post-treatment
    - Applying new, more efficient strategies to learning

Efficacy of mSMT

- Treatment is effective
  - ❖Behavioral data
  - ❖Everyday life data
  - ❖Neuroimaging data
- Populations
  - ❖MS and TBI
  - ❖Ongoing
    - ongoing
    - Pediatrics
    - Group treatment
- Translated
  - ❖Spanish & Chinese
  - ❖Strong pilot data in Spanish

Nuts and Bolts

Modified Story Memory Technique

- Two skills taught
  - Imagery (sessions 1-4)
  - Context (sessions 5-8)
- Generalization
  - How you use skills in daily life (sessions 9 and 10)

mSMT

Session 1-4 Imagery

Instructions

- Each story contains Capitalized words to remember
- Create mental images of each story line
- Picture the Characters, setting, etc.

*the context is provided- teaching imagery

Story Example
skill: imagery

Mr. Jones pulled a fresh APPLE from a tree. This made him think of his childhood summers with the flowers in BLOSSOM and his mother churning BUTTER sitting on a CHAIR drinking COFFEE. Mr. Jones was a DIAMOND salesman but his father worked in a FACTORY using a pitch FORK and a HAMMER. On Saturdays his mother would KISS him and send him to the MARKET. The goods there reminded him of a PALACE. On Sundays he went to church to visit his PRIEST making sure to get a SEAT in the first row. One day Mr. Jones' father left boarding a STEAM boat with a TICKET that his WIFE had bought. Her BETRAYAL by not using DISCRETION in their personal lives led him to mistrust members of the opposite GENDER.

mSMT

- Guidance for Imagery

  -concentrate on forming a mental image of a chunk of the story
  -several pieces of information in 2 images
  -verbal information transformed into pictures

mSMT

Session 5-8 Context

Instructions

- Make up story using a provided list of words
- Create easy to visualize story

*Continue using imagery – adding meaningful context.

List Example
skill: context / organization

AUTOMOBILE	MOTHER
BOTTLE	PHYSICIAN
CASH	PUPIL
CHURCH	SKIN
CORN	STRENGTH
DOOR	TREE
FLOOD	WOMEN
GARDEN	ADAGE
HOTEL	COMPETENCE
LETTER	ESSENCE

mSMT

AUTOMOBILE BOTTLE CASH CHURCH

Sunday after CHURCH I need to take my AUTOMOBILE to the bank to get CASH for a BOTTLE of wine.

mSMT

- Free Recall- List all of the Capitalized words

- Cued Recall
    - Contextual Cues
    - Semantic Cues

mSMT

Sunday after _____ I need to take my _____ to the bank to get _____ for a _____ of wine.

mSMT

LAWN SIDEWALK SNOW

Example of poor context:

There was SNOW on the SIDEWALK next to the LAWN.

Example of more effective context:

In the winter, the green LAWN was covered in SNOW from shoveling the SIDEWALK

mSMT

Session 9-10 Everyday life

Instructions

- Words from shopping list, to-do list, or directions
- Make up story using a provided list of words
- Create easy to visualize story

Funding Sources