Treating New Learning and Memory Deficits in Rehabilitation Populations: the modified Story Memory Technique (mSMT)

Nancy D. Chiaravalloti, Ph.D.
Nancy Moore, MA
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)

- MS: 8.3
- Control: 4.9
Recall and Recognition (ns)

*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**

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Level of Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>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). Use of external compensations with direct application to functional activities is recommended for people with severe memory deficits after TBI or stroke. 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. Group-based interventions may be considered for remediation of memory deficits after TBI.</td>
<td>Practice Standard</td>
</tr>
<tr>
<td></td>
<td>Practice Guideline</td>
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<td></td>
<td>Practice Option</td>
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<td></td>
<td>Practice Option</td>
</tr>
</tbody>
</table>

*Cicerone, 2011*
## Treating Learning and Memory in TBI & Stroke

*Hegde, 2014*

<table>
<thead>
<tr>
<th>Domain of cognitive function</th>
<th>Technique</th>
<th>A brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>Musical mnemonics training (MMT)</td>
<td>This technique targets memory encoding and retrieval functions. Includes musical exercises of recalling sounds or lyrics such as songs, rhymes, or chants</td>
</tr>
<tr>
<td></td>
<td>Associate mood and memory training (AMMT)</td>
<td>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</td>
</tr>
</tbody>
</table>
Evidence in TBI & Stroke supports:

- External memory aides
  - Notebooks, iPads, alarms, etc
- Music
- Imagery
- Strategy based techniques
### Treating Learning and Memory in MS

<table>
<thead>
<tr>
<th>15 studies</th>
<th>1 practice standard: mSMT</th>
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<tbody>
<tr>
<td></td>
<td>4 options:</td>
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<tr>
<td></td>
<td>• Imagery (basis of mSMT)</td>
</tr>
<tr>
<td></td>
<td>• Music</td>
</tr>
<tr>
<td></td>
<td>• Self-generation</td>
</tr>
<tr>
<td></td>
<td>• Spaced trials</td>
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</tbody>
</table>
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
Music mnemonics aid verbal memory and induce learning – related brain plasticity in multiple sclerosis

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⁵ Department of Neurology, SRH Rehabilitation Hospital Bad Wimpfen, Bad Wimpfen, Germany

Spoken vs sung list of words.

Sung: recalled more word and had more frontal activity.

Main effect due to group (F(1,2) = 4.51, p=0.038) [2-way ANOVA]
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

Perceived Deficits

Baseline  | Follow-up
---|---
Treatment | Control

Quality of Life

Baseline  | Follow-up
---|---
Treatment | Control
STEM

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

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

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ARTICLES

An RCT to treat learning impairment in multiple sclerosis

The MEMREHAB trial

Nancy D. Chiaravalloti, PhD
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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.
  - *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.
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

- Treatment
- Control

Trial 1, Trial 2, Trial 3, Trial 4, Trial 5
Everyday Life After Memory Retraining in MS

**Patient Self-Report**
FAMS General Contentment

- **Baseline**
- **Immediate Follow-Up**

**FrSBe Total Score*, Family Form**

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
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

Leavitt et al, *Brain Imaging & Beh*, 2013
mSMT Long-Term Effects

CVLT Performance

- Control group mean
- Treatment group mean

Pre, Post, 6 months

z = 1

Occipital Gyrus

MTL

MFG

x = -4

A
TBI: Learning Performance
pre to post treatment

- Control: Prose Memory Immediate BL
- Treatment: Prose Memory Immediate 6week

p < 0.05
% of Participants improving on RBMT – everyday memory

- Treatment: 50% (p<.05)
- Control: 13%

p<.05
TBI: Between-group differences

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
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**

<table>
<thead>
<tr>
<th>AUTOMOBILE</th>
<th>MOTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTTLE</td>
<td>PHYSICIAN</td>
</tr>
<tr>
<td>CASH</td>
<td>PUPIL</td>
</tr>
<tr>
<td>CHURCH</td>
<td>SKIN</td>
</tr>
<tr>
<td>CORN</td>
<td>STRENGTH</td>
</tr>
<tr>
<td>DOOR</td>
<td>TREE</td>
</tr>
<tr>
<td>FLOOD</td>
<td>WOMEN</td>
</tr>
<tr>
<td>GARDEN</td>
<td>ADAGE</td>
</tr>
<tr>
<td>HOTEL</td>
<td>COMPETENCE</td>
</tr>
<tr>
<td>LETTER</td>
<td>ESSENCE</td>
</tr>
</tbody>
</table>
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
Sunday after ______ I need to take my ______ to the bank to get ______ for a ______ of wine.
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