Incorporating Mental Imagery into Brain Injury Rehabilitation

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Objectives

• Provide a comprehensive understanding of motor imagery
• Review current research supporting use of motor imagery in rehabilitation
• Describe the process of performing motor imagery as a treatment strategy
• Identify appropriate patients and guidelines to create and incorporate a motor imagery treatment plan
Identifying Imagery

- Mental practice
  - Mental Imagery
  - Motor Imagery

- Research is evolving as varied disciplines begin to identify best practices

- Medicine field = motor imagery
History

- Has been researched for decades
  - Early motor imagery studies from the 1960’s
  - Pub Med search
    - “Mental Practice” = 48,499 articles
    - “Motor Imagery” = 2,816 articles

- Sports rehabilitation
  - PETTLEP Imagery
    - Physical
    - Environment
    - Task
    - Timing
    - Learning
    - Emotion
    - Perspective

What is Motor Imagery?

- "Internally reactivated action"
  - Sharma et al 2006
- "Cognitive rehearsal of movement"
  - Wang et al 2016
- "Goal directed mental rehearsal"
  - Hwang et al 2010
- "Imagination of moving specific body parts"
  - Schuster et al 2011
- "An act of expressing movement internally"
  - Oh et al 2017
Types of Imagery

- Internal Motor Imagery vs. External Motor Imagery
- Implicit Motor Imagery vs. Explicit Motor Imagery
- Graded Motor Imagery
Internal vs. External

• Internal Motor Imagery
  • Kinesthetic/ Explicit/ 1st person
  • Subjects imagine sensation of motion in own body

• External Motor Imagery
  • Visual/ 3rd person/ (form of mirror therapy)
  • Subjects view self as an external observer

Photos courtesy of: https://unsplash.com/search/photos/
Implicit vs. Explicit

• Implicit motor imagery
  • represented motor tasks in imagery are performed without awareness and are perceptually driven
    • L/R discrimination
    • Hand grasp

• Explicit motor imagery
  • feeling of the movement was experienced consciously
    • Adds kinesthetic components

Photos courtesy of: https://www.pexels.com/
Graded Motor Imagery

Photos courtesy of: http://www.gradedmotorimagery.com/left-right-discrimination.html
http://mrri.org/tag/mirror-therapy/; https://www.pexels.com
Implicit Motor Imagery

Explicit Motor Imagery

Mirror Therapy

Graded activation of cortical networks

Progressively complex levels
How and Why?

Photo courtesy of: https://www.frontiersin.org/files/Articles/269507/frym-05-00042-HTML/image_m/figure-1.jpg
Neuroplasticity

- The *life long* capacity of the brain to *change and rewire* itself in response to the stimulation of *learning and experiencing*.

- **Skill acquisition** through **practice**

  - **Practice variables**
    - Repetition, repetition, repetition
    - Task intensity/difficulty
    - Task complexity
    - Relevancy
Neuroplasticity

- Motor Imagery vs. Motor Practice
  - Similar autonomic response
  - Similar temporal organization
    - Equivalent timing or “temporal coupling”
  - Activate overlapping neural networks
    - fMRI shows overlapping regions are activated during motor imagery (MI) and motor execution (ME)
  - Functionally equivalent to motor control planning and preparation stages
Figure 1: Brain activation in the control and patient groups under different conditions. 
(a) Control subjects during motor execution; (b) controls during motor imagery; (c) patients during motor execution; (d) patients during motor imagery. All voxels were significant at p<0.01, corrected for FDR at the whole-brain level.
Neuroplasticity

Motor imagery causes neural activity, which in turn could be utilized to “exercise” the brain without physical performance.

Photo courtesy of: http://www.cognopedia.com/images/thumb/7/7d/Motor_imagery.jpg/180px-Motor_imagery.jpg
Upper Extremity & ADL Outcomes

• Greater learning and carryover of new ADL tasks

• Improved upper extremity:
  • strength
  • gesture quality
  • task performance speed

• Increased effectiveness of pinch grip
  • Changes are greater than or equal to Minimal Clinically Important Difference (MCID):
    • Fugl – Meyer Assessment (FMA)
    • Wolf Motor Function Test (WMFT)
    • Action Research Arm Test (ARAT)

Photo courtesy of: https://www.neurorehabdirectory.com/stroke-recovery-using-constraint-induced-movement-therapy-cimt/
http://www.reha-stim.de/cms/index.php?id=125
Trunk Control

- Improved trunk muscle activity in conjunction with physical practice
- Improved proprioception
Lower Extremity & Gait Outcomes

- Gait quality
  - Stride length
  - Hip flexion torque
  - Speed
  - Single limb support time
  - Decreased double limb support
- Leg Strength
- Dynamic balance
- Fear of falling/ confidence

Changes are greater than or equal to Minimal Clinically Important Difference (MCID):
- Tinneti
- Functional Reach
- TUG
- 10M walk test
- Fugl-Myer
Figure 1. Physical activity, people present, and location data from observations between 8 am and 5 pm averaged across all cases.

A. Physical activity

- Walk: AC4 6.8%
- Transfer: AC3 6.0%
- Sit out of bed: AC2 28.0%
- In bed talk/eat: AC1 25.2%
- In bed no activity: AC0 28.0%
- Off the ward: AC0 6.0%

B. People present during activity

- Other 3.6%
- Therapists 5.2%
- Doctor 1.6%
- Nurse 13.9%
- Family 15.3%
- Alone 60.4%

C. Location of activity

- In or beside bed 88.5%
- Bathroom 3.6%
- Hall 2.7%
- Off the ward for tests 5.0%
- Therapy room 0.2%
Patient and Provider Challenges

- Time constraints within treatment
- Patient activity tolerance
- Motivation
- Choosing the best option

Photo courtesy of: https://www.mackenziecorp.com/are-there-time-constraints-associated-with-the-research-project-2/

Photo courtesy of: https://me.me/i/this-is-as-far-as-i-m-willing-to-go-3241279

Photo courtesy of: https://www.mirror.co.uk/lifestyle/health/feeling-tired-heres-10-reasons-6579569

Photo courtesy of: https://strategicdynamicsfirm.com/crafting-good-better-best-value-statements/
Consider the Pros...

- Feasible
- Clinically relevant
- Low cost
- Easy to perform
- Can be done without supervision
- May Reduce fear
- Can be done early and often
- Improves functional independence
- No effect on physical fatigue
- Enables practice of complex tasks
- Gives patient control and autonomy over treatment tasks/goals
- Similar autonomic changes noted in some research
Who is appropriate?
Criteria

- Patient can attend to task for approx. 10 minutes
- Able to follow 3 step command
- Can form a vivid image
- Able to recall meaningful task from before brain injury
- Intact primary motor cortex
- Screen for cognitive function
• The location of the lesion affects how vivid MI is:
  • Cerebellum/basal ganglia
  • Parietal cortex
  • Prefrontal cortex

• Right sided lesions had a difficult time with both implicit and explicit images
  • More impulsive response

• Acute lesions
  • Spontaneous recovery
How to Screen for Cognitive Function

- Hand Laterality Judgment Test (HLJT)
- Kinesthetic and Visual Imagery Questionnaire (KVIQ)
- Movement Imagery Questionnaire – 3 (MIQ-3)

Working memory & attention skills
Example of MIQ-3 Questions

• Sample question – External Visual Imagery:

  • STARTING POSITION: Extend the arm of your non-dominant hand straight out to your side so that it is parallel to the ground, palm down.
  • ACTION: Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement, and make the movement slowly.
  • MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just observed from an external perspective. Now rate the ease/difficulty with which you were able to do this mental task and the angle the image was observed from (see additional sheet provided for full list of different angles)

Rating: __________

### Visual Analog Scale

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Very hard to see</td>
<td>Hard to see</td>
<td>Somewhat hard to see</td>
<td>Neutral (not easy nor hard)</td>
<td>Somewhat easy to see</td>
<td>Easy to see</td>
<td>Very easy to see</td>
</tr>
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### Kinesthetic Analog Scale

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Importance of Coupling MI with Physical Practice (PP)

• Repetition:
  • Coupling MI and PP creates a priming effect
  • Fewer repetitions to learn a new task are required

• Task Intensity:
  • Utilize MI when complex motor tasks can not be yet physically performed

• Task Complexity:
  • When MI is combined with PP – less PP is required to achieve optimal task performance

• Relevancy
  • Physical and mental tasks must be both pertinent and meaningful
<table>
<thead>
<tr>
<th>MI Delivery &amp; Task Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Protocols</strong></td>
</tr>
<tr>
<td><strong>1. Separate sessions</strong></td>
</tr>
<tr>
<td>1a: PP + MI audio recording</td>
</tr>
<tr>
<td>1b: PP + Caregiver guided MI</td>
</tr>
<tr>
<td><strong>2. Combined/Embedded</strong></td>
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<tr>
<td>Caregiver guided MI</td>
</tr>
<tr>
<td><strong>3. Alone</strong></td>
</tr>
<tr>
<td>Caregiver guided MI</td>
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ADL Task Training

VS.

Walking

Protocol

• No universally accepted protocol found
  • Initial relaxation
    ▪ Research is conflicting
  • Interventions predominantly combine motor imagery with physical practice
  • Combined training sessions:
    ▪ 30-60 minutes
      ○ 10-20 minutes average spent on MI
    ▪ 2-5x/week
    ▪ 2-10 weeks
      ○ Average: 6 weeks
Introducing MI

• Goal:
  • Introduce MI
  • Familiarize patient with concept and process
  • Apply MI to 1-2 tasks with scripts to learn movement strategies and gain confidence
  • Task is not demanding
  • Add MI to treatment plan via recording or audiovisual

• Bottom line: Performance preparation
• Goal:
  • Simple tasks increase in number and complexity
  • Increase number of repetitions through MI
  • Initially small number of MI that gradually increase so it is greater than PP

• Bottom line: Skill learning - Mental rehearsal promotes the next physical execution of the task and the physical rehearsal provides sensory feedback to promote vividness of the task rehearsed mentally
Self Practice

• Goal:
  • Increase the number of repetitions to improve motor learning
  • Establish a home exercise program
  • Development of dynamic interactive application
  • Continued open line of communication for manipulation checks

• Bottom line: give patient a sense of empowerment
How do I use MI?

• Basic principles to remember:
  • Make it a familiar task
  • Can be done anywhere
  • Can be done at anytime
  • The degree the image will vary and change as healing happens
  • Tailor it to a goal, the more meaningful it is, the more power it has!
Clinical Example

• Identify the patient
  • 47 year old female admitted to NRH after right basal ganglia stroke
  • Upon initial evaluation:
    • Left sided weakness in both upper extremity and lower extremity
    • Required assistance for functional mobility and unable to walk

• Introduce MI to the patient and establish any barriers
  • Initial videos on YouTube for ambulation was suggested

• Choosing a task
  • Walking into the kitchen
Clinical Example

• Gathering information for the script
  • Sights:
    ▪ Wooden floor that transitioned to linoleum
  • Sounds:
    ▪ Sound of music coming from her daughters room
  • Smells:
    ▪ Cookies baking in oven

• Developing the script
  • 3rd person, gross motor task
Clinical Example

• Script
  • Guided 1:1
  • Relaxation prior to MI

• Combined MI and PP
  • MI was performed after PP (either treadmill training or gait training)
  • Progressed to videos of her walking on the treadmill

• Manipulation checks
Clinical Example

• Progress to self practice
  • Recorded her MI script on her iPhone
  • Increased mental repetitions

• Outcomes at discharge
  • Utilized left ankle brace and was walking 200’ with a cane and steadying assist
  • Performing full flight of stairs with 1 hand rail and supervision
  • Length of stay: 20 days

• Follow – up after discharge
  • No longer using ankle brace or cane, walking independently

• Patient perspective
  • Felt “empowered”
  • Kept her “busy” during downtime
• Gold standard protocol

• Additional rehabilitation diagnoses
  • Parkinson’s Disease & Parkinsonism
  • Multiple Sclerosis
  • Spinal Cord Injury
  • Amputation
  • CRPS
  • Chronic Pain
Tips for Guiding MI

• Create a quiet environment
• Keep the patient comfortable
• Be articulate
• Speak at appropriate volume
• Get to know your patient
Thank You!
Questions
References


References
Continued

References Continued

• Malouin F. and Richards, C. Mental Practice for relearning locomotor skills. Physical Therapy February 2010 vol. 90 no. 2 240-251