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The Effectiveness of Mental Imagery on the Functional Rehabilitation of Stroke Patients with Hemiparesis

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Disciplines
Occupational Therapy

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The Effectiveness of Mental Imagery on the Functional Rehabilitation of Stroke Patients with Hemiparesis

Prepared by: Jaime Yoshino, OTS  (yosh4732@pacificu.edu)
Date: 11/18/2010
Review date: 11/2012

CLINICAL SCENARIO:

Hemiparesis is a common symptom of stroke that causes severe impairments in an individual’s ability to participate in activities of daily living and other meaningful activities. There are many current rehabilitation techniques for stroke recovery, however they can be very lengthy and costly. Also, insurance and funding limitations are shortening the amount of time a therapist is able to physically interact with the clients. Imagery is a non-invasive, cost-effective, risk-free technique that can be practiced outside of the therapy sessions and used to compliment treatment. Imaging studies showed that specific brain structures involved in actual performance of a motor task are similar to those activated during mental imagery of the same movements (Muller, Butefish, Seitz, & Homberg, 2007). I found a general conclusion that imagery can improve motor learning and relearning when combined with hands-on therapy and practice through a literature review of McBride & Rothstein (1979), Creelman (2003), and Mulder, Zijlstra, & Hochstenbach (2004). This discovery prompted an interest in the use of imagery by therapists to compliment stroke rehabilitation treatment, to help clients regain the ability to effectively participate in activities of daily living and other occupations.

FOCUSED CLINICAL QUESTION:

What are the benefits of mental imagery as an effective intervention for functional rehabilitation of stroke patients with hemiparesis?

SUMMARY of Search, ‘Best’ Evidence appraised, and Key Findings:

• Total of 5 research articles investigating the effectiveness of mental imagery on the functional rehabilitation of stroke patients with hemiparesis were analysed.
• Of the 5 research articles, 4 were randomized-controlled trials. All 4 RCT paired imagery with some form of hands-on therapy and practice of the imagined task. Two of the 4 used tape-recorded-guided imagery, and the other 2 studies used therapist-guided imagery.
• Of the 5 research articles, 1 was a before-after study showing 2 stroke patients’ improvements in motor impairments through computer facilitated imagery and mirror-box imagery over time.
• All 5 articles found significant benefits of mental imagery in stroke hemiparesis rehabilitation.
• The randomized, placebo-controlled trial by Page, Levine, and Leonard was deemed the ‘best evidence’ evaluated.
• This was the second phase after a pilot study’s results suggested mental practice paired
with occupational therapy reduced upper extremity impairment in chronic stroke patients with hemiparesis.

- The randomized, placebo-controlled trial further compared the effectiveness of rehabilitation program incorporating mental practice to a placebo condition using randomized controlled methods and a larger sample size.
- 32 subjects underwent physical practice of tasks emphasizing activities of daily living, paired with either mental practice or placebo relaxation.
- Results showed that subjects in the program incorporating mental practice improved significantly more than subjects in the relaxation program in both the Fugl-Meyer Assessment of Motor Recovery After Stoke and the Action Research Arm Test.

**CLINICAL BOTTOM LINE:**

This randomized, placebo-controlled trial tested the effectiveness of mental imagery (or mental practice) paired with physical practice of common activities of daily living, in comparison to a placebo relaxation program with physical practice. It showed the mental imagery significantly improved functional abilities over the placebo.

**Limitation of this CAT:**

This critically appraised topic has been individually prepared by a master’s of occupational therapy student as part of a university project and reviewed by a faculty member.

**SEARCH STRATEGY:**

**Terms used to guide Search Strategy:**

- **Patient/Client Group:** Stroke patients with Hemiparesis
- **Intervention (or Assessment):** Mental Imagery/Mental Practice
- **Comparison:** Null or No comparison
- **Outcome(s):** Functional Improvement

<table>
<thead>
<tr>
<th>Databases and sites searched</th>
<th>Search Terms</th>
<th>Results</th>
<th>Limits used</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINAHL (EBSCOhost) 09/2010</td>
<td>“Mental Imagery” “Imagery” “Mental Practice” AND “Stroke” AND “Occupational Therapy”</td>
<td>15 Articles 6 Repeats</td>
<td>English</td>
</tr>
<tr>
<td>MEDLINE-OVID 10/2010</td>
<td>“Mental Imagery” “Imagery” “Mental Practice” AND “Stroke” AND “Occupational Therapy”</td>
<td>43 Articles 13 Repeats</td>
<td>English</td>
</tr>
</tbody>
</table>

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INCLUSION and EXCLUSION CRITERIA

- **Inclusion:**
  - Peer reviewed articles
  - “Mental Imagery”, “Mental Practice”, “Motor Imagery”, “Imagery” as an intervention
  - Outcomes involved or related to functional improvement
  - Participants who experienced a stroke that involved hemiparesis

- **Exclusion:**
  - Articles in English Only
  - Articles published after 2000
  - All other interventions not relating to Mental Imagery
  - All other diagnoses
  - Not related to functional improvement or occupational therapy

RESULTS OF SEARCH

5 relevant studies were located and categorised as shown in Table 1 (based on Levels of Evidence, Centre for Evidence Based Medicine, 1998)

**Table 1:** Summary of Study Designs of Articles retrieved

<table>
<thead>
<tr>
<th>Study Design/ Methodology of Articles Retrieved</th>
<th>Level</th>
<th>Number Located</th>
<th>Author (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized Control Trials</td>
<td>I</td>
<td>4</td>
<td>Muller, K., Butefisch, C.M., Rudiger, J.S., &amp; Homberg, V. (2007)</td>
</tr>
</tbody>
</table>
BEST EVIDENCE

The following study/paper was identified as the ‘best’ evidence and selected for critical appraisal.


Reasons for selecting this study were:
• This study provided the highest level of evidence for answering the clinical question.
• In the study design, both the therapists conducting the evaluations and treatment, and the participants were blind to group assignment.
• The control program involved a placebo situation, so participants were truly unaware of the specific group they were assigned. As compared to other studies, where it was very evident of what treatment was being received.
• The study incorporated the use of activities of daily living in treatment.
• The article was well written, easy to understand, and covered all information critical to making an informed decision.

SUMMARY OF BEST EVIDENCE


<table>
<thead>
<tr>
<th>Aim/Objective of the Study/Systematic Review:</th>
</tr>
</thead>
<tbody>
<tr>
<td>This study is the second phase following a pilot study done in 2000. The objective of this phase 2 study is to compare the efficacy of a rehabilitation program incorporating mental practice to a placebo condition using randomized controlled methods and an larger sample size.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Design:</th>
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<tbody>
<tr>
<td>This study was a randomized placebo-controlled trial in which subjects were randomly assigned to either a rehabilitation program of mental practice with physical practice (MP+PP) or relaxation with physical practice (R+PP). Each participant underwent one-hour sessions (30 minutes of physical practice and 30 minutes of either mental practice or relaxation), twice a week, for six weeks. Baseline (PRE) testing was administered on two occasions (one week apart) and POST testing occurred one week after therapy. All testing and intervention was done by 5 therapists who underwent extensive in-service for consistency in therapy, and were blinded to group assignment. Exit interviews were also conducted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>The setting of the study was not specifically addressed. However, the article stated that all therapy was administered in the same environment.</td>
</tr>
</tbody>
</table>

| Participants: |
32 volunteer participants (N=32) that experienced a stroke responded to advertisements placed in neurology and physical therapy clinics in hospitals in the Midwestern United States. Inclusion criteria included history of no more than one stroke, ability to actively flex at least 10° from neutral at affected wrist, MCP, and IP of two digits, stroke experienced more than a year before the study, a score greater or equal to 69 on the modified Mini Mental Status Examination, and age between 18 and 80 years. Exclusion criteria included excessive spasticity defined as a score of greater or equal to three on the Modified Ashworth Spasticity Scale, excessive pain in the affected limb as measured by a score of greater than or equal to four on a 10-point visual analog scale, still enrolled in any form of physical rehabilitation, and currently participating in any experimental rehabilitation or drug studies. The 32 participants included 18 males and 14 females, had a mean age of 59.5 ± 13.4, and a mean time since stroke onset of 42.0 months. There were 19 participants with right hemiparesis and 13 participants with left hemiparesis. There were no significant differences between the two treatment groups in age, months poststroke, mean baseline Fugl-Meyer score, and mean baseline Action Research Arm Test.

**Intervention Investigated**
All subjects were randomly assigned to one of five therapists that underwent extensive in-servicing for consistency in treatment. Subjects participated in 30 minutes of physical practice and 30 minutes of mental practice or relaxation, twice a week for six weeks. During the physical practice, participants practiced activities of daily living with emphasis on bimanually performing activities of reaching for and grasping a cup or object, turning a page in a book, and proper use of writing utensils.

**Control Relaxation (R+PP):** Participants listened to a 30-minute tape to facilitate progressive relaxation. Participants were asked to flex and relax different muscles in the body.

**Experimental Mental Practice (MP+PP):** Participants listened to a 30-minute tape to facilitate mental practice of the activities practiced during the physical practice. The tape began with five minutes of relaxation that asked the participant to imagine themselves in a warm, relaxing place and to contract and relax their muscles. Next, the tape offered suggestions for internal, cognitive poly-sensory images for the participant to mentally rehearse the motor skills practiced previously. The participant was then taken through several trials of visually imagining each motor skill from a first-person perspective, as well as bringing attention to the sensations associated with the task. Lastly, the final five minutes allowed the participant to refocus into the room.

**Outcome Measures (Primary and Secondary)**
There were two primary outcome measures, the upper extremity section of Fugl-Meyer Assessment of Motor Recovery After Stroke and the Action Research Arm Test. The Fugl-Meyer section assesses several impairment dimensions using a three-point ordinal scale (0=cannot perform; 1=can perform partially, 2=can perform fully) with scores ranging from 0-66 points. It is used extensively in clinical trials to evaluate changes in motor impairment following stroke. The Action Research Arm Test is a 19-item test divided into four categories (grasp, grip, pinch, and gross movement). Each category is graded on a 4-point ordinal scale (0=can perform no part of test; 1=performs test partially; 2=complete test but takes abnormally long time or has great difficulty; 3=performs test normally) with scores ranging from 0-57. A secondary exit interview was given to the participants regarding continued spontaneous use of their affected arm for valued activities after the study.

**Main Findings:**
Table 3 shows the means scores from the PRE and POST testing of both groups for the Fugl-Meyer Assessment for Motor Recovery After Stroke (FM) and the Action Research Arm (ARA) test. The changes in mean scores are also presents, and the score that is significantly larger (as according to p values found by Wilcoxon tests) is noted by two asterisks.

<table>
<thead>
<tr>
<th></th>
<th>FM Mean (SD)</th>
<th>ARA Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRE</td>
<td>POST</td>
</tr>
<tr>
<td></td>
<td>SCORES</td>
<td>SCORES</td>
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<tr>
<td></td>
<td>(SD)</td>
<td>(SD)</td>
</tr>
<tr>
<td>MP (n=16)</td>
<td>33.03(8.37)</td>
<td>39.75(6.68)</td>
</tr>
<tr>
<td>PP (n=16)</td>
<td>35.75(9.51)</td>
<td>36.75(10.74)</td>
</tr>
</tbody>
</table>

Note: PRE indicates mean score obtained during pretesting period; POST, mean score obtained during posttest; Change, Post−[Pre1+Pre2]/2. Exact P values for the Wilcoxon test comparing the change scores for the 2 groups are P=0.0001 for the FM, and P<0.0001 for the ARA. These significant change scores are denoted by ****.


The changes in scores of the two groups were compared using the Wilcoxon rank sum test with exact probability value computation, attributed to assumed, non normal distributions. The Wilcoxon rank sum test is a method used to compare the means from two distributions for non-parametric data.

ARA: Change Means MP+PP= +7.81 and R+PP= +0.44 (P<0.0001)
FM: Change Means MP+PP= +6.72 and R+PP= +1.0 (P=0.0001)

Although participants in both groups showed reduction in arm impairments (as shown in the increase of FM and ARA scores on Table 3) the participants assigned to mental practice and physical practice showed significantly more improvement than those assigned to relaxation and physical practice.

**Original Authors’ Conclusions**

The study concluded that traditional rehabilitation programs that include mental practice in therapy have the potential to increase outcomes in motor impairment and functional rehabilitation significantly. Also, through Exit Interviews, the study concluded that mental practice could increase affected arm use and contribute to overcoming movement suppression phenomenon that occurs with hemiparesis.

**Critical Appraisal:**

**Validity**

**Potential Biases:**

- *Sample/Selection Bias (volunteer or referral bias):* Participants were all volunteers so there may be a slight favour of the treatment group, since volunteers tend to be more motivated and concerned for their health.

- *Intervention/Performance Bias (different therapist):* There were a total of five therapists involved in treatment and evaluation; there may be differences in therapy and evaluation. Although this bias may be neutralized due to in-servicing of the therapists, there may still be influence of differences in personality and treatment delivery.
Sample: To determine an appropriate sample size, a F-test and a power analysis using Sample Power ANOVA model was used. It determined 15 participants were needed in each group.

Outcome Measures:
- Fugl-Meyer has been shown to have impressive test-retest reliability (total=0.98-0.99; subtests=0.87 to 1.00), interrater reliability, and construct validity.
- Action Research Arm test has high interrater (r=0.99) and retest (r=0.98) reliability and validity.

PEDro score: 5/10

Interpretation of Results
The results from this randomized placebo-controlled study provided sturdy evidence that mental practice paired with physical practice has significant benefits in the improvement of motor impairments due to hemiparesis from stroke. This further supported similar results found in other studies that are reviewed in this CAT. In addition to this finding, it provided a connection to performance of daily activities and improvement in general use of the affected arm in activities that are meaningful to the participants.

Summary/Conclusion:
This study provided strong evidence of the benefits of mental practice when included in treatment of stroke. It was very concise and thorough in providing the critical information needed to make an informed decision about this topic. The design of the study was very effective in neutralizing biases, controlling confounding factors, and creating a placebo situation to an extremely variable experimental intervention. Also, this study integrated the use of activities of daily living as a means of treatment and concluded that mental practice can potentially have positive benefits in functional and valued tasks. Overall, this study provided comprehensive evidence in a well-designed randomized controlled trial to illustrate the significance of adding mental practice to treatment to improve functional rehabilitation of complications due to stroke.

Some things that could have been done differently include a follow up study to see whether the benefits from this treatment persist further than the treatment weeks, and possibly an entrance survey that matches the exit interview pertaining to the participant’s functional use of the hemiparetic arm. Also, in addition to the information provided, it would have been beneficial to know more about the exit interviews done and the location of the testing and treatment.

Table 4: Characteristics of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page, Levine, &amp; Leonard (2007)</td>
<td><strong>Intervention Investigated:</strong> Mental Practice. 30 minute recorded tape involving relaxation and guided imagery of creating a visual image in first-person, including sensations associated with the movements involved in each motor task practiced in physical practice sessions. <strong>Comparison Intervention:</strong> Placebo Relaxation. Progressive relaxation involving flexing and relaxing different muscles of the body. <strong>Outcome Measures:</strong> - Upper extremity section of the Fugl-Meyer Assessment of Motor Recovery After Stroke</td>
</tr>
</tbody>
</table>
| **Page (2000)** | **Intervention Investigated:** Mental Imagery. 20-minute tape involving relaxation and suggestions for external, cognitive visual images related to using the affected arm in weight bearing tasks and functional tasks practiced in the OT sessions.  
**Comparison Intervention:** 20 minute tape with information on the causes and pathology of stroke, the course of stroke, and the outcomes anticipated with therapy.  
**Outcome Measures:**  
- Upper extremity section of the Fugl-Meyer Assessment of Motor Recovery After Stroke  
**Findings:** The group whose program included mental imagery improved significantly more than those in the control program. |
| **Stevens & Stoykov (2003)** | **Intervention Investigated:** Computer facilitated imagery that involved 25 minutes of visual cues for movements of the wrist in three angles and four speeds. Mirror Box facilitated imagery that involved 30 minutes of focus on mirror image of the non-affected hand and instruction to imagine the reflected limb as the affected limb moving in space.  
**Comparison Intervention:** none. Comparison of improvement over time.  
**Outcome Measures:**  
- Upper extremity section of the Fugl-Meyer Assessment of Motor Recovery After Stroke  
- Dynomometer and Goniometer  
- 3 Subtests from the Jebsen Test of Hand Function  
- Physical Impairment Inventory of the Chedoke-McMaster Stroke  
**Findings:** Both participants showed general improvements in all outcome measures given. |
| **Liu, Chan, Lee, & Hui-Chan (2004)** | **Intervention Investigated:** Mental Imagery Program. Mental rehearsal paired with actual practice of three sets of five daily tasks.  
**Comparison Intervention:** Functional Retraining Program. Demonstration-then-practice method.  
**Outcome Measures:**  
- OT assess with 7pt Likert Scale  
- Color Traits Test  
- Fugl-Meyer Assessment of Motor Recovery After Stroke  
**Findings:** The group in the Mental Imagery Program showed significant improvement on the OT likert scale after completing two weeks, on untrained tasks tested at the end of the training program, and on trained tasks at the one-month follow-up. |
| **Muller, Butefisch, Seitz, & Homberg (2007)** | **Intervention Investigated:** MENTAL group. Rehearsed a sequence of finger movements, and imagined performance of the movement sequence in the affected hand mentally from first-person perspective without moving hand. |
**Comparison Intervention:** compared with 2 groups
- **MOTOR group:** Performed the training task with the affected hand
- **CONVENTIONAL group:** Physiotherapy of gross motor hand functions.

**Outcome Measures:**
- Neurological Motricity Index
- European Stroke Scale
- Barthel Index
- Jebsen Hand Function Test
- Force Transducer

**Findings:**
- MENTAL and MOTOR groups improved significantly more than the CONVENTIONAL group in pinch grip.
- MENTAL and MOTOR groups improved significantly in writing and simulated eating of the Jebsen test.
- No significant differences between the MENTAL and MOTOR groups in all outcome measures.

**IMPLICATIONS FOR PRACTICE**
- The studies presented in this CAT all provide evidence that mental imagery can potentially be beneficial in the improvement of motor and functional impairments involved with hemiparesis due to stroke.
- Mental imagery is a cost-effective, risk-free strategy that can be used to compliment traditional stroke rehabilitation to enhance positive outcomes of therapy.
- There seems to be a lack of uniformity in a specific method of delivery of mental imagery, as well as many terms encompassed in the area of mental imagery. This topic is very variable and individualistic.

**EDUCATION**
- Further education should be made available for both the therapists and the clients on mental imagery’s potential benefits.
- Mental imagery should be presented as an option for clients to explore, and be addressed in occupational therapy programs as a possible addition to therapy.
- It would also be beneficial to provide information about mental imagery in undergraduate classes that are focused on health professions, rehabilitation, therapy, or any other related fields.

**FUTURE RESEARCH**
- Related research includes studies focused on the neurological aspects, the physical motor learning aspects, and the physiological aspects of mental imagery. Also, mental imagery’s effect on sport-related performance is being studied.
- Future research should include more studies that focus on the functional aspects of stroke rehabilitation and if it can help improve participation in valued activities. Also, I would be interested in the effect of mental imagery on the cognitive and emotional rehabilitation in diagnoses such as stroke and traumatic brain injury.
- More research should address mental imagery’s effect on mental health issues such as schizophrenia, depression, and anxiety.
• Mental Imagery and Mental practice is a very individualistic experience, so qualitative research on the lived-experience and values of mental imagery to an individual would be an interesting research.

REFERENCES


