ORIGINAL ARTICLE

Retention of Motor Changes in Chronic Stroke Survivors Who Were Administered Mental Practice

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ABSTRACT. Page SJ, Murray C, Hermann V, Levine P. Retention of motor changes in chronic stroke survivors who were administered mental practice. Arch Phys Med Rehabil 2011;92:1741-5.

Objective: To determine retention of motor changes 3 months after participation in a regimen consisting of mental practice (MP) combined with repetitive task-specific (RTP) practice.

Design: Prospective, blinded, cohort, pre-post study.

Setting: Outpatient rehabilitation hospital.

Participants: Individuals (N=21) in the chronic stage of stroke (mean age ± SD, 66.1±8.1y; age range, 56–76y; mean time since stroke at study enrollment, 58.7mo; range, 13–129mo) exhibiting mild to moderate impairments of hand function.

Interventions: All individuals had been randomly assigned to receive a 10-week regimen consisting of MP emphasizing paretic upper extremity (UE) use during valued activities. Directly after each of these sessions, subjects were administered audiotaped MP. We assessed this group's paretic UE motor levels before, after, and 3 months after intervention.

Main Outcome Measures: The UE section of the Fugl-Meyer Assessment of Sensorimotor Impairment (FM), the Action Research Arm Test (ARAT), the Arm Motor Ability Test (AMAT), and the Box and Block Test (BB).

Results: None of the scores significantly changed from the period directly after intervention to the 3-month posttesting period (FM: t=.817; ARAT: t=.923; AMAT: t=.898, t=.818, and t=.967 for the Functional Ability, Quality of Movement, and Time scales, respectively; BB: t=.892).

Conclusions: Changes in paretic UE movement realized through MP combined with RTP (MP + RTP) participation are retained 3 months after the intervention has concluded. This is the first study examining retention of motor changes after MP + RTP participation, and one of only a few studies examining long retention of motor changes after any intervention targeting stroke-induced hemiparesis.

Key Words: Hemiplegia; Neuronal plasticity; Occupational therapy; Physical therapy (specialty); Rehabilitation; Stroke.

WHILE RECENT EMPHASIS has been placed on prevention of stroke risk factors and improved acute stroke treatments, only a minority of patients are administered these promising treatments,[1] and there continues to be a steady stroke incidence.[2] These challenges, combined with an aging population and diminishing lengths of rehabilitative stay, are expected to yield a rising number of stroke survivors exhibiting residual impairments.[3]

Upper extremity (UE) hemiparesis is one of the most frequent, disabling, stroke-induced impairments. Repetitive task-specific practice (RTP) has emerged as a commonly used,[4] efficacious[5] strategy for UE hemiparesis. Moreover, RTP efficacy is significantly increased when augmented by mental practice (MP),[6-9] during which the UE movements performed during RTP are cognitively rehearsed. The muscular and neural activations exhibited during MP are similar to those observed during physical performance of the same movement,[10] while cortical plasticity is observed after MP combined with RTP (MP + RTP) participation.[11]

MP + RTP efficacy has previously been determined by comparing subjects' paretic UE movement levels before regimen participation to their levels after MP + RTP use.[6-9,11] However, as with many medical treatments, identifying the approaches that confer sustained benefits—even after the intervention has concluded—is desirable in stroke rehabilitation. Thus, the purpose of this study was to determine whether motor changes observed after MP + RTP participation were retained 3 months after the intervention had concluded. It was hypothesized that the current subjects, who had already exhibited significant increases in UE movement from participation in an MP + RTP regimen, would exhibit nonsignificant changes in measures of paretic UE movement from the time of posttesting directly after the intervention to 3 months after the intervention had concluded. This would be indicative of retention of the benefits of the intervention.

Despite recent interest in MP, this is the first study to examine retention of motor changes after MP, and one of only a few studies that have measured retention of motor benefits for any approach addressing UE hemiparesis.

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List of Abbreviations

AMAT	Arm Motor Ability Test
ARAT	Action Research Arm Test
BB	Box and Block Test
CIT	constraint-induced movement therapy
FM	Fugl-Meyer Assessment of Sensorimotor Impairment
MP	mental practice
RTP	repetitive task-specific practice
UE	upper extremity

METHODS

Participants

The subjects described herein had previously consented to participate in a randomized, controlled, MP + RTP trial. All were administered MP + RTP, and, as a group, had been shown to benefit from the intervention when compared with a matched control group. As part of consent for the trial, the subjects were being longitudinally tracked.

They had been made aware of the trial with advertisements placed in local therapy clinics in the midwestern United States. On volunteering for participation in the trial, subjects were screened using the following inclusion criteria: (1) 10° of active flexion in the paretic wrist, as well as in 2 digits in the paretic hand; (2) stroke experienced more than 12 months before study enrollment; (3) a score of at least 70 on the Modified Mini-Mental State Examination[12]; (4) age of 18 through 75 years; (5) only experienced 1 stroke; and (6) discharged from all forms of physical rehabilitation or progressive exercise regimens, or both. Additionally, to be included in the current, longitudinal analysis, subjects had to have been willing and/or able to return to the laboratory for additional testing 3 months after conclusion of the MP + RTP intervention. Exclusion criteria were (1) excessive spasticity in the paretic UE, as defined by a score of at least 2 in the paretic elbow, wrist, and/or fingers as determined by the Modified Ashworth Spasticity Scale[13]; (2) excessive pain in the paretic UE, as measured by a score of at least 5 on a 10-point visual analog scale; (3) participating in any experimental rehabilitation or drug studies; and (4) a history of a parietal stroke (because some data suggest that the ability to estimate manual motor performance through MP is disturbed after parietal lobe damage).

Assessments

The UE section of the Fugl-Meyer Assessment of Sensorimotor Impairment (FM)[14] ascertains UE impairment by requiring the subject to actively attempt isolated proximal movements (eg, shoulder abduction, internal rotation) followed by successively more distal movements (eg, mass grasp, pincer grasp) using the paretic UE, as well as testing UE reflexes. The rater evaluates each movement attempt using a 3-point ordinal scale (0, cannot perform; 2, can perform fully), and the items are summed to provide a maximum score of 66. The FM has been shown to have high test-retest reliability (total, .98–.99; subtests, .87–1.00), interrater reliability, and construct validity.[15,16]

To measure paretic UE limitation, the Action Research Arm Test (ARAT)[17] was administered. The ARAT is a 19-item test divided into 4 categories (grasp, grip, pinch, gross movement), with 16 of the 19 ARAT items measuring distal regions of the arm (eg, pinching a ball bearing or marble between the thumb and each finger of the affected hand). Given that subjects qualifying for this study exhibited some active distal movement, and that the intervention concentrated on acquisition of additional distal movements, the ARAT was an excellent match for this study. When subjects attempt 1 of the ARAT items, the rater evaluates the quality of the movement using a 4-point ordinal scale (0, can perform no part of the test; 1, performs test partially; 2, completes test but takes abnormally long time or has great difficulty; 3, performs test normally) for a total possible score of 57. For this test, subjects were seated in a comfortable chair with a straight back, while the ARAT items that they had to grasp were placed on an adjustable table in front of them. Table height was adjusted according to the needs of each subject. The ARAT has high intrarater (r=.99) and retest (r=.98) reliability and validity,[18,19] all in stroke-induced hemiparesis.

The Arm Motor Ability Test (AMAT)[20] is a 13-item test in which activities of daily living are rated according to a Functional Ability scale that examines paretic limb use (0, does not perform with paretic UE; 5, does use arm at a level comparable to less affected side) and a Quality of Movement scale (0, no movement initiated; 5, normal movement). The AMAT movements are also timed, which allows for examination of changes in time taken to perform the movement.

Finally, the Box and Block Test (BB)[21] was also administered. The BB is a timed grasp and release test, in which subjects are seated in front of a box with a large partition separating the box into 2 equal squares. Colored blocks are situated on 1 side of the partition, and subjects are asked to move as many blocks from 1 side to the other with the paretic hand in the course of 1 minute. Since the MP + RTP intervention partially targets reaching, grasping, and releasing objects, the BB was thought to be an appropriate instrument in this study.

The above measures were chosen because of their successful use in previous MP studies,[6,7,11] and because of their responsivity to motor changes in chronic stroke.[22] Subjects were also administered other assessments of paretic UE use and quality of life, which will be reported elsewhere.

Testing and Intervention

After screening, consenting using approved consent forms, and pretesting, all subjects participated in a 10-week regimen consisting of MP + RTP. While more information is available elsewhere,[6-9,11] the intervention consisted of the following elements:

1. *RTP:* RTP was administered 3d/wk in ½-hour increments. During RTP sessions, subjects engaged in 25 to 30 minutes of a prespecified task, with each task practiced in 2-week increments. Tasks were derived from a list of approximately 60 activities that stroke patients commonly wish to relearn, collected by this laboratory over the past decade (see Table 1 for list of activities). Temporal and spatial parameters of tasks were changed during successive therapy sessions, making the particular task more challenging. Global feedback regarding the patient's performance of the task during the session was usually provided at the end of the RTP session.
2. *MP:* Immediately after each RTP session, each subject listened to a 20- to 30-minute audiotape in a secluded room adjacent to the RTP treatment area. The tape first consisted of approximately 5 minutes of progressive relaxation (ie, tighten and relax successive muscles from inferior to superior), immediately followed by the subjects imagining themselves in a familiar environment that was appropriate for performance of the task to be

Table 1: Tasks That Were Physically/Mentally Practiced, and Weeks During Which They Were Practiced

Functional Task That Was Physically/Mentally Practiced	When Administered
Reaching for and grasping a cup or object	Weeks 1, 2
Turning a page in a book	Weeks 3, 4
Proper use of a writing utensil	Weeks 5, 6
Proper use of an eating utensil	Weeks 7, 8
Using a hairbrush or comb	Weeks 9, 10