ACADEMIA | Letters

The Rehabilitative Effects of Guided Motor Imagery on Gait and Balance in Older Adults

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INTRODUCTION

Falls are a leading cause of injury, disability, nursing home admission, and death among older adults (Bohl, Gill, Shumway-Cook, Tinetti). Each year about one-third of community-dwelling adults, 65 years of age or older, fall at least once. Among those aged 80 years or older, the percentage is 50% (Inouye). As a result, identifying cost-effective interventions to reduce the risk of falls among older adults continues to be a focus of intense inquiry (Bruce, Matchar)

Strengthening exercises, balance training, and gait training are evidence-based interventions used by physical therapists to reduce fall-risk (Matchar). However, the efficacy of motor imagery (MI) has been investigated as another means of improving functional performance. MI is the cognitive practice of a physical skill in the absence of gross motor movement (Fansler, Nakano). Positive results have been reported for more than two decades on the use of MI to improve several aspects of motor performance in athletes (Driediger, MacIntyre, Taktek) and non-athlete adults to improve motor performance (Dickstein, Nakano). Few studies have focused on the use of MI in the following conditions: independent of physical practice, in the treatment of gait or balance dysfunctions in older adults without a primary neuromuscular condition (such as stroke or PD) (Deutsch), or in the treatment of gait and balance dysfunctions concurrently.

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Motor Imagery:

Learning or improving motor skills relies upon neuroplasticity (Warner). Motor imagery techniques involve imagining oneself correctly performing a particular motor skill while simultaneously focusing on the physical demands of the skill's performance. This imagined movement recruits a subcortical network similar to that recruited for movement execution (Hardwick). Such recruitment manifests action potentials and minute muscular contractions, which facilitates movement (Debarnot, Ehrsson, Warner). MI allows patients to mentally rehearse movements, begin the healing process, and potentially reduce total recovery time (Warner).

Vividly imagined motor ability is theorized to affect a person's perceptions of actual ability, including belief in their ability to perform the activity, in a way similar to that of actually having demonstrated the performance(Debarnot, Ehrsson). Researchers suggest that much motor success is predicated upon perceptions, attitudes, and expectations, all of which can be altered with the proper mental imagery and guidance (Benz, Berdik, Evans, Warner). Neuroimaging studies have found white matter to increase and the following motor areas of the brain to be active during motor imagery interventions: the SMA, left primary motor cortex, the left prefrontal cortex, the right thalamus and the cerebellum, all of which are highly correlated with successful gait performance (Debarnot, Nakano).

METHODS

Participants:

Men and women aged 65 years or older with self-reported difficulties with gait and balance were recruited from the independent and assisted-living residents of a local retirement center in North Carolina. Participants were excluded if they had cognitive or vestibular impairments (such as advanced dementia or vertigo), if they had had physical therapy (PT) for balance or gait within 3 months prior to the study, or if they were completely unable to stand or walk. The use of an assistive gait device did not exclude participants from this study.

Eleven participants were accepted into the study. One participant dropped out of the study due to scheduling difficulties, and one after developing pneumonia; leaving 9 participants ranging in age from 73 to 95 years old.

Study Design:

Participants were randomly assigned to one of two groups: MI or PT. The MI group comprised 4 females and 1 male, with an average age of 85 years old. The PT group consisted of 3 females

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and 1 male, with an average age of 90 years old.

Participants were asked to take part in 3 treatment sessions over a one-week period and return 1 week later for retention testing.

Treatment Interventions:

The PT group was treated by a licensed physical therapist and APTA-certified Geriatric Clinical Specialist who employed active gait and balance therapeutic activities within a 20-minute treatment session, 3 days during 1 week. The interventions were chosen to represent conventional gait and balance interventions: single-leg stance, standing on a foam pad with eyes open and eyes closed, lower extremity strengthening, braiding, and gait with obstacles. Although activities were similar across participants, the level of difficulty was individualized to create a challenging intervention for each participant.

Participants in the MI group were treated by listening to an MI script that guided participants through the mental practice of functional balance and gait. Participants were instructed to sit upright in a chair with feet flat on the floor and to keep their eyes closed during the script reading. They were informed that no physical movement was required during the intervention. The script was read by one of the experimenters to the participants on 3 days during 1 week. Each treatment for the MI group lasted about 15 minutes.

No home regimen was prescribed for either group.

Assessments:

The subjects were each assessed with performance outcome measures pre-intervention for baseline, post-intervention to determine effectiveness, and 1 week following intervention completion to assess retention.These assessments were chosen specifically for gait and balance to determine the subjects' fall-risk and assess confidence in independently performing such tasks (Middleton, Wallace).

The assessments used were the Activities-Specific Balance Confidence (ABC) Scale for self-reported confidence and fear of falling, the Timed Up and Go (TUG) test as a widely accepted outcome measure for fall-risk and mobility, and the Short-Form Berg Balance as one of the most commonly used outcome measures for functional balance. The data were analyzed using one-way ANOVA, MCDs, and visual assessment for trends between groups.

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RESULTS

Both groups demonstrated improvement in both post-test and retention measurements of the ABC scale as compared to baseline values. The PT group significantly ($p<0.02$) improved to 'non-faller' status by post-intervention testing, and transitioned back to 'faller' status upon retention testing (Baseline= 55 to Post-Test= 73 to Retention= 66). The MI group exhibited more consistent improvement between all three testing periods and improved to 'non-fallers' by retention testing (Baseline= 59 to Post-Test= 66 to Retention= 67). Scores < 67% indicate fall-risk, which can accurately classify people who fall 84% of the time (Lajoie). SEM= 1.197 (Nemmers), MDC=11.12 (Dal Bello-Haas).

At baseline, the average scores of both groups exceeded the cut-off score of 13.5 seconds for increased fall risk (Shumway-Cook). Both groups demonstrated improvement in TUG scores between baseline and retention test values. However, they also both presented worsened scores at post-test assessment (PT: Baseline= 15 seconds to Post-Test= 17 seconds to Retention= 14 seconds; MI: Baseline= 20 seconds to Post-Test= 21 seconds to Retention= 18 seconds). The degree of improvement was similar in both groups. The improvement between both groups during the TUG test, produced non-significant changes in gait speed ($p=0.12$). MDC = 3.6s (Steffen). Excellent test-retest reliability in community-dwelling older adults (ICC= 0.96; Sd= 1.39) (Smith).

On the Short-Form Berg Balance, the PT group demonstrated little change across the study (Baseline= 17; Post-Test= 18; Retention= 18) whereas, the MI group showed improvement at both post-test and retention (Baseline= 17; Post-Test= 19; Retention= 21). During the Short-Form Berg Balance test, only the MI group demonstrated improved changes that were beyond the standard error of measurement (2.772), $p=.064$, although still below the MDC of 8 points (Conradsson),

CONCLUSION

This pilot study analyzed MI independent of physical practice and compared it to traditional PT interventions.The results of this study showed similar effectiveness and performance trends between MI and traditional PT treatments in improving the functional measures of gait and balance in a short period of time. A difference was seen in the retention testing segment, in which the MI group's performance trend showed greater improvement than that of the PT group, suggesting the ability of mental practice to foster motor learning.

Additionally, clinically implementing motor imagery may increase time efficiency for the physical therapist, considering that MI only takes 15 minutes to apply. Beyond the clinic,

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patients may be able to continue their progress at home with a script for their home exercise program or through telemedicine (Paravlic), thereby furthering success, shortening hospital and clinic lengths of stay, and maintaining the healing progress even well after they have been discharged (Fansler, Paravlic). MI is safe to conduct independent of in-person therapist supervision, is simple to implement, inexpensive, and has no known negative effects or contraindications (Gabbard, Tamir), making it especially useful in vulnerable populations, such as the elderly (Warner).

The evidence presented here, paired with previous imagery studies demonstrates that the modality of MI may be considered as an adjunct to traditional physical therapy interventions (Gabbard). The implications of MI's success means much for people who are unable to initiate physical rehabilitation or who are uncomfortable and unwilling to engage in physical practice due to pain, fear, fatigue, or other reasons.

This study is unique in comparison to other imagery studies in its assessment of motor imagery within a dual-gender population of older adults and its analysis of dynamic gait and balance together as a whole functional task. Further, this study focuses on the retention of skills, when not many other studies have done so, as well as assessing patient confidence and perceptions, which have not yet been well-analyzed (Ferraye). However, given the small sample size of this study and the short timeframe of interventions, further investigation is recommended to determine the full extent and nature of MI's effectiveness in improving gait and balance among older adults. Research with other patient populations also suggests that future investigation might examine the effects of combining MI with action observation to improve functional balance (Emerson). Despite the limitations of this study, the results do allude to the clinical utility of motor imagery as a valuable modality.

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