TOWSON UNIVERSITY
COLLEGE OF GRADUATE STUDIES AND RESEARCH

IMPROVING THE MOTOR AND COGNITIVE PERFORMANCE AMONG MULTIPLE SCLEROSIS PATIENTS THROUGH THE USE OF MENTAL IMAGERY

By

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THESIS APPROVAL PAGE

This document is to certify that the thesis prepared by Melanie S. Charlotte, entitled *Improving the Motor and Cognitive Performance Among Multiple Sclerosis Patients through the use of Mental Imagery*, has been approved by this committee as satisfactory completion of the thesis requirement for the degree of Master of Arts in Experimental Psychology.

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ABSTRACT

Improving Performance Among

Multiple Sclerosis Patients Through the use of Mental Imagery

Multiple Sclerosis (MS) is characterized by a demyelination of neuronal axons within the central nervous system that results in a range of neurological deficits. Currently, researchers and physicians are providing MS patients with a variety of treatments and therapies to help manage symptoms of the disease. However, due to physical limitations, mental practice may be a useful alternative to conventional physical therapy. Mental practice involves the repeated mental simulation of a goal directed movement for improving one's actual performance. This study hypothesized that patients who undergo an eight week upper extremity mental practice intervention would improve their performance more so than those who have had no practice at all. Moreover, the study evaluated whether an increase in performance on the mentally practiced task would generalize to other domains, such as cognition and lower extremity function. Although the results were not significant, they did support the use of mental practice as a tool for rehabilitation.

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INTRODUCTION

Multiple Sclerosis (MS) is a degenerative disease that attacks the central nervous system, resulting in a range of symptoms. These symptoms typically vary between patients, as well as, over the disease course within the same patient. Because of the heterogeneity of symptoms that may occur in MS, the variability of exacerbations, and the unpredictable periods of spontaneous recovery, evaluating the patient's current disease state and their response to treatment trials can be a difficult task to manage (Thompson &Hobart, 1998). Currently, clinicians administer the Multiple Sclerosis Functional Composite (MSFC) to assess a patient's overall disease state. The MSFC evaluates upper extremity, lower extremity, and cognitive functioning by administering three different tasks: the 9-Hole Peg Test (9-HPT), the Timed 25 FT Walk (25FTW), and the Paced Auditory Serial Addition Test (PASAT). Together, these tasks assess a patient's overall disease state. Moreover, the MSFC provides researchers with insight regarding the possible change in disease state after a therapeutic intervention. Current treatments and therapies for MS include pharmacology, physical therapy, physical exercise, and occupational therapy, each one manages or reduces the severity of symptoms as well as prevents future exacerbations.

The current project examined mental practice as a possible therapeutic intervention for the rehabilitation of MS patients. The eight week intervention consisted of patients mentally practicing, actually practicing, or engaging in no practice of the Visual Guided Pointing Task (VGPT). The VGPT is a pointing task made up of five separate target displays, each one consisting of a different target width (1.25, 2.50, 2.00, 10, and 20 mm). Patients who are assigned to the actual practice group (APG) were instructed to physically perform the task, while people who were assigned to the mental practice group (MPG) were instructed to imagine themselves performing the task. Patients in the MPG were hypothesized to improve their performance from pretest to posttest when compared to patients who receive no practice at all, the no practice group (NPG). Before discussing the current project, it is first necessary to review the symptoms, assessment, and treatments of Multiple Sclerosis. It is also necessary to survey the principles of mental practice and to describe how this technique may improve patients' functioning, making it a possible method of rehabilitation for Multiple Sclerosis.

LITERATURE REVIEW

MS OVERVIEW

*The pathology of MS***.** Multiple Sclerosis is a progressive disease that results in neural degeneration and a subsequent degradation of neurologic functioning (Bitsch et al., 2000). Damage to neurons within the CNS results from a loss of myelin, the neural substance that insulates the neuron and promotes efficient neural transmission. In MS, this chronic demyelination leads to brain atrophy, whereby damaged cells can no longer communicate with each other and to other neurons within the CNS (Trapp et al., 1999). Neuronal demyelination occurs when T cells, components of the immune system which play an integral role in attacking foreign invaders, leave the peripheral circulation, cross over the blood brain barrier (BBB), and enter the CNS (Shapiro, 2002). After entering the CNS, T-cells are thought to release cytokines, a type of protein which initiate the destruction of myelin, oligodendrocytes, and axons (Shapiro, 2002; Hohlfeld & Wekerle, 2004).

The destruction of myelin creates damaged tissue (lesions) within the central nervous system, leading to the expression of a variety of cognitive, sensory, and motor deficits (Shapiro, 2002). Remyelination, a spontaneous regeneration of the myelin sheath, and neuroplasticity, the reorganization of neural connections, are two essential mechanisms employed by the CNS to compensate for neurologic degradation (Prineas et al., 1993; Komeck et al., 2000, Staffen et al., 2002). However, it has been shown that the destruction of neuronal axons leads to irreversible damage and results in permanent disability (Trapp et al., 2000).

Although there has been much progress in the understanding of Multiple Sclerosis, there are still many unanswered questions regarding the etiology and pathology of the disease. Because of the heterogeneity of the disease, including the location of the lesions, the variety of symptoms, and the disease course itself, the current perspective on MS focuses on the possibility of many etiological factors contributing to the disease initiation and progression (Compston, 2002).

Symptoms of MS. The symptoms that result from Multiple Sclerosis can occur in a variety of forms and affect numerous capacities. Typically, lesions arise within the optic nerve, spinal cord, brain stem, and white matter of the central nervous system (Shapiro, 2002). However, lesions may also occur within the cerebral cortex of the CNS (Kidd et al., 1999). Lesions found within the cortex of the CNS can produce cognitive impairments such as deficits in attention, language processing, visual and verbal memory. Besides the cognitive deficiencies, a variety of physical impairments may also occur in MS including: numbness, spasticity, and tremor; all of which affect one's motor control and coordination. Patients can also experience physiological symptoms such as bowel, bladder, and sexual dysfunction (Halper & Holland, 1997). Emotional problems have been noted among patients with MS, with the two most highly recognized being depression and anxiety (Schubert & Foliart, 1993; Zorzon, 2001). Each of the aforementioned symptoms relates to the patient's own perception of their disease state as well as their overall quality of life. Therefore symptom management has become an important aspect of the treatment of the disease (Halper & Holland, 1997).

MS assessment. With an increase in disease altering treatments and therapies, clinicians need to be able to accurately assess the current disease state of their patient. For years, the Expanded Disability Status Scale (EDSS) was the main method of assessment used for MS. The EDSS evaluates a variety of functional capacities: Pyramidal, Cerebellar, Sensory, Bowel and Bladder, Visual, Cerebral or Mental. The therapist rates the patient on a scale from zero (normal neurological functioning) to ten (death due to MS) which provides an index of a patients' current level of disability (Kurtzke, 1983). Although the EDSS has served as the main tool for assessing MS severity, researchers and clinicians recognized that it was not sensitive enough to accurately reflect changes in a patient's disease course. Therefore in 1999, The National Multiple Sclerosis Society recommended the Multiple Sclerosis Functional Composite (MSFC) as a new method of MS assessment (Cutter et al., 1999).

The MSFC is composed of three separate tasks which evaluate specific domains that are significantly affected by the disease: upper extremity, lower extremity, and cognitive function. The 9-Hole Peg Test assesses the upper extremity functioning by timing how long it takes for the patient to place nine pegs into tiny holes on a pegboard and then remove the nine pegs and place them back into the container. To assess lower extremity functioning, the patient walks a total of 25 feet as quickly as possible in the Timed 25 ft walking task. Finally, the Paced Auditory Serial Addition Task (PASAT) evaluates a patient's cognitive functioning, including speed of processing and short-term working memory. Patients listen to a compact disc that presents single digit numbers at a rate of one number per every three seconds. They are told to add together the first two numbers and orally report the answer. Then, they are instructed to listen for the next number and add it to the last digit that was previously spoken on the CD. Patients are required to continue adding the next number to each preceding one on the compact disc, making the difficult part of the task remembering the last digit. A total of 60 summations are required to complete the PASAT. The three tasks yield a composite score that indicates a patient's current level of functioning; this score has been shown to give a more accurate evaluation of a patient's disease state than the EDSS. Also, because of its overall sensitivity, its simplicity, and its quantitative measurements, the MSFC is a more appropriate measure of assessing change in disease state when compared to the EDSS (Fischer et al., 1999).

*Treatments and therapies for MS***.** Patients diagnosed with MS are typically prescribed a pharmacological disease modifying agent. Interferon-*B* (INF-*B*), an anti-inflammatory agent, is one disease modifying therapy. INF-*B*'s are divided up into two distinct classes: INF-*B* la and INF-*B* lb. Each class works on one's own interferons, which are small proteins that have anti-viral and immunomodulatory qualities. They exert their effect by modifying the cell's cytokine production and the permeability of the BBB, which in turn, affects the T-cells' ability to crossover and enter the CNS. Among the group of INF-*B*'s are Betaseron, Avonex, and Rebif, all of which have similar chemical structures and have been effective in the treatment of MS (Rudick & Goodkin, 1999).

Glatiramer acetate is another disease modifying agent that has been shown to be very effective in the treatment of MS, however it operates in a very different fashion from INF- B. It has been shown to prevent encephalomyelitis (EAE), an autoimmune inflammatory disease which shares many characteristics of MS. This inhibitory effect is results from the suppression of immune responses of myelin basic protein (MBP), which is the primary initiator of EAE. Another possible mechanism of action by glatiramer acetate may be the induction of T suppressor cells, which also results in the suppression of EAE by MBP. Copaxone, the brand name for glatiramer acetate, was approved by the FDA in 1997 and has also been shown to be effective in the treatment of MS (Rudick & Goodkin).

Along with pharmacological treatments, many MS patients also receive physical therapy, occupational therapy, and/or physical exercise programs which focus on strengthening muscles, improving motor control and coordination, and improving the completion of daily tasks. Although physical therapy and physical exercise are successful in MS rehabilitation therapies (Shapiro, 2003), at times their effectiveness is limited. First, the outcomes associated with physical therapy and exercise programs depend on the physical and motor abilities of the patient (White et al., 2004). Second, physical exercise may exacerbate the symptoms if the patient encounters physical overload; therefore, research suggests that patients be assessed on an individual basis before prescribing any type of exercise regimen (Petajan & White, 1999). Lastly, those who are profoundly affected by MS may not be eligible for such therapies due to physical constraints, extreme fatigue, or the possibility of injury (Comi et al., 2001). For those reasons, the use of physical therapy and/or exercise as a rehabilitative tool may not be suitable for some patients suffering from MS. Therefore, one alternative to physical therapy or exercise may be the use of mental practice, the mental rehearsal of a given action without the actual motor execution.

MENTAL PRACTICE AND REHABILITATION

Actual and mental practice equivalencies. Mental practice is an innovative technique which uses the persistent use of motor imagery in an effort to facilitate improvements in one's physical performance. Mental imagery and actual movement may activate congruent underlying neural processes (Jeannerod & Decety, 1995); the timing of imagined and actual movements follow similar guiding principles. Decety et al., (1989) observed walking times for three conditions: actual walking group with imaging strategy, mental walking group with imaging strategy, and actual walking group with no imaging strategy. In the experiment, walking times were calculated across three targeted distances (5, 10, and, 15m). Participants in the mental walking group with imaging strategy were instructed to construct a mental representation of the walking track and were then blindfolded and told to imagine themselves walking towards the target. Subjects in the actual walking group with the imaging strategy were instructed to construct a mental representation of the walking track, were then blindfolded and told to actually walk towards the target. Finally, in the no imaging strategy group, participants were blindfolded and simply instructed to walk toward the targeted area on the track. The results showed that the mental group had walking durations similar to those of the actual group; as targeted distances increased, walking times increased in both groups. The similar walking durations for both the mental and actual groups suggests that imagined and actual movements are governed by similar laws and principles.

Actual and imagined movement times have also been studied under the manipulation of movement direction and additional load. It was found that movement durations were similar regardless of the direction of the movement or the additional weight (Papaxanthis et al., 2001). In Papaxanthis et al.'s study, participants were assigned to the actual condition or the mental condition, whereby they had to perform or imagine performing arm movements in a horizontal or sagittal plane. In addition, subjects were placed in one of three load conditions: no load, 1kg; or 1.5 kg. Actual and imagined movements had similar durations in both the horizontal and sagittal directions, as well as across all three load conditions. Moreover, movement durations consistently increased in both the actual and imagined conditions with an increase in load. The results indicated that movement direction and additional load have no effect on movement durations under the imagined condition as compared to the actual conditions. This provides further support for the hypothesis that people have the ability to accurately imagine themselves performing a task. Also, the results suggest that actual and imagined movements share similar neural processes due to the similarity in movement durations.

Other studies have explored the electrophysiological nature of mental imagery, looking at motor evoked potentials (MEP's). The MEP's are electromyography (EMG) recordings of electrical activity conducted along the motor pathways from the brain and spinal cord to the targeted muscle groups. The MEP activity is a response to Transcranial Magnetic Stimulus (TMS), a stimulus applied to the motor cortex. Such studies reveal that the mental simulation of a goal-directed movement results in a temporal modulation in the size of motor evoked potentials (MEPs) similar to those in the actual execution of movement (Fadiga et al., 1999; Hashimoto & Rothwell, 1999). When asked to mentally perform flexion/extension movements of the right forearm, subjects' had increased MEP's activated during the imagined task when compared to the resting state and MEP's were similar to those activated during the actual task. Moreover, the increased activation of MEP's was specific to the targeted muscle group, either the flexor carpi radialis or the extensor carpi radialis, depending on the direction of the imagined movement. Because the actual output of information to the specified muscle group is withheld during motor imagery, the excitability facilitated during an imagined movement is localized within the cortex and is terminated within the spinal cord. However, the similar patterns of cortical excitability reflect similar neural activation during actual and imagined movement (Hashimoto & Rothwell, 1999).

Neuroimaging studies have also shown similar activation in cortical structures during both actual and imagined movements. Functional Magnetic Resonance Imaging (fMRI) shows that structural activation is similar between actual and imagined movements, except that the primary motor cortex and the primary somatosensory cortex, are less active during imagined movements (Porro et al., 1996). Further investigations showed that particpants who engaged in the mental simulation of a finger-to-thumb opposition task displayed fMRI activation in similar regions when compared to actual execution. These areas include the following: supplementary motor area, primary motor cortex, posterior parietal motor cortex, and ventral premotor cortex (Nair et al., 2003).

*Rehabilitation through mental practice***.** Given that actual and imagined movements use similar processes, the repeated activation of neural pathways through mental practice should produce similar learning patterns and therefore, lead to improvements in one's actual performance. The therapeutic benefits associated with mental practice have mostly been explored with stroke patients (Jackson et al., 2001; Stevens & Stoykov, 2003; Dijkerman et al., 2003). Two separate case reports of stroke patients with hemiparesis indicated that engaging in the mental practice of wrist movements, after the visualization of the movement on a videotape or the visualization of the effected limb in a mirror box apparatus, significantly decreased their movement times during actual performance (Stevens & Stoykov, 2003). During a reach and grasp task, participants who were assigned to the motor imagery group improved their performance on the task more so than those who were assigned to the control group and did not engage in any type of motor imagery (Dijkerman et al., 2003). Another study showed that mental practice resulted in an increase in performance on a line-tracing accuracy task, leading to a decrease in tracing error. Furthermore, participants who participated in the mental practice of a horizontal line-tracing task also show generalized improvements on a curved line tracing task (Yoo et al., 2001).

*Theories of mental practice***.** Learning theory may explain the increase in performance after the use of mental practice. Some have identified a strong cognitive component to mental practice, suggesting that motor representations are encoded within the central nervous system. Therefore, mental rehearsal of a movement cognitively activates these representations which, in turn, produce an increase in actual performance (Driskell et al., 1994). Another theory, psycho neuromuscular theory, hypothesizes that mentally practiced movements send nerve impulses to the targeted muscles activated during the imagined movement. Therefore, the network of activation among the motor pathways necessary to execute an actual movement undergoes a priming effect during mental practice.

The simulation theory of motor imagery proposes an off-line perspective (Currie & Ravenscroft, 1997). According to the simulation theory, increased performance results when the imager simulates the behavior in an absolute fashion, i.e., the participant completes the targeted movement without any external constraints. The imagined movements occur in the absence of feedback information, such as proprioceptive and visual, therefore allowing the imager to perfect their performance. A more recent neurological rehabilitation theory focuses on the motivational demands of mental practice and less on the physical demands (Van Leeuwen & Inglis, 1998). Because of the decreased emphasis on the physical output during mental practice, the patient can concentrate on the goal directed movement and acquire the specific skills to necessitate that movement.

THE PRESENT STUDY

The present study investigated the use of mental practice as a possible rehabilitative therapy for multiple sclerosis. The study hypothesized that if actual and imagined movements follow similar neuronal principles, then those who engage in an eight week mental practice paradigm of a pointing task will improve their performance of this task from pretest to posttest more so than those who have had no practice at all. Furthermore, the study hypothesized that these improvements will generalize to the patients' other capacities, therefore showing marked improvements on other upper extremity, lower extremity, and cognitive tasks.

METHOD

PARTICIPANTS

All 29 participants were recruited from The Mellen Center for Multiple Sclerosis Treatment and Research of the Cleveland Clinic Foundation. Due to some drop outs and ineligible participants, our final sample size was twenty five. The average age of all 25 participants was 47 years and the majority of the participants were female (Table 1). Inclusion/exclusion criteria were established to ensure that the participants were capable of completing the required tasks. Inclusion criteria included a diagnosis of Multiple Sclerosis, an Expanded Disability Status Score (EDSS) of 4.0, and a 9-Hole Peg Test (9-HPT) score of ± 1 z-score, based on normative data from the MS population. Exclusion criteria included a relapse of the disease within the past three months prior to the start of study participation, inability to perform and complete the Visual Guided Pointing Task (VGPT), and any severe cognitive impairment such as stroke or mental retardation. All participants provided informed consent and were compensated for their time.

Table 1: Demographics and Randomizations for All Participants

Participant	Sex	Age	Group
01	M	44	NPG
02	F	41	APG
03	F	44	MPG
05	M	41	NPG
06	M	45	MPG
07	F	37	MPG
09	M	59	APG
10	F	50	MPG
11	F	56	NPG
12	M	53	APG
13	F	41	APG
14	F	47	MPG
15	F	36	NPG
17	F	45	APG
19	F	52	APG

20	F	59	MPG
21	F	47	NPG
22	F	52	NPG
23	F	56	NPG
24	F	40	MPG
25	F	35	MPG
26	F	59	APG
27	F	45	NPG
28	F	46	NPG
29	F	49	MPG

EXPERIMENTAL DESIGN

The research protocol randomized patients to one of the three distinct groups: mental practice group (MPG), actual practice group (APG), and the no practice group (NPG). All patients who consented to the study were required to participate in a pretest and posttest regardless of which group they were assigned. During the pretest, patients were administered a battery of tests that are designed to evaluate upper extremity, lower extremity, and cognitive abilities. Included in this battery were the Expanded Disability Status Scale (EDSS), the Multiple Sclerosis Functional Composite (MSFC), and the Visual Guided Pointing Task (VGPT), all of which were previously mentioned. In addition, patients were administered the Controlled Word Association Test (COWAT) and the Symbol Digits Modalities Test (SDMT). The COWAT is a neuropsychological examination where patients were given three letters (F, A, and S) and were asked to verbally list all of the words that they could think of which began with the designated letter. Patients were given a 60s time period for each letter. The SDMT is task where patients match numbers with its given symbol. In order to reply the correct answer, patients referred to a key at the top of the page, which paired the numbers 1, 2, 3 ... 7 with seven distinct symbols. Patients were asked to complete as many pairs as they could within a 90s time period. Finally, patients were asked to complete the Multiple Sclerosis Quality of Life Inventory (MSQLI) in order to assess their own perception of the impact that MS has on their daily living. The MSQLI is a health related questionnaire designed specifically for MS patients and assessed a variety of domains: fatigue, pain, bladder and bowel function, emotional status, cognitive function, visual abilities, sexual satisfaction, and social relationships. After the eight week intervention, patients were administered the same battery of tests during their posttest evaluation.

INTERVENTION

Patients assigned to the MPG or the APG were required to visit the Mellen Center twice a week on Mondays and Fridays across an eight week time period. During those visits, patients were instructed to imagine performing or to actually perform the Visual Guided Pointing Task (VGPT). The VGPT is comprised of five series, each one containing five separate target displays of different sizes (1.25 mm, 2.50 mm, 2.00 mm, 10 mm, 20 mm). Using their dominant hand, participants were instructed to begin by placing the tip of the stylus on the vertical start line and to say "go" when they were ready to begin the task. At that time, participants were to make, or imagine making, wrist movement repetitions from the vertical line, to the target, and back a total of five times while being as fast and as accurate as possible. The moment they touched the vertical line on their last repetition, they were to say "stop." The "go" and "stop" cued the researcher to start and stop timing, respectively, using an electronic stopwatch. Patients who were assigned to the NPG only visited the Mellen Center for their pretest and posttest and did not participate in any intervention.

RESULTS

A 3 x 2 Multivariate Analysis of Variance (MANOVA), where group (APG, MPG, NPG) was the between subjects factor and test (pretest, posttest) was the within subjects factor provided an overall test of the various main effects and interactions in this study. The study hypothesized that for the VGPT task, those participants in the MPG condition would significantly improve their performance more so than the NPG condition, that is there would be a significant Group by Pre-Post-Test interaction. The overall multivariate test of this hypothesis was not significant, Wilk's Lambda = .835, $F(2,22) = 2.175$, $p > .05$. There was no significant Group effect, $F(2,22) = 1.728$, $p > .05$), although there was a significant overall pre-post-test change, Wilk's Lambda = .463, $F(1,22) = 25.506$, $p < .05$.

The study also hypothesized that differences found on the VGPT would generalize to the other dependent measures: COWAT, SDMT, 25 FTW. The multivariate analysis did not reveal any significant main effect of Group or Group x Test interactions for any of the outcome measures. However, individual 3 x 2 mixed design ANOVAs computed on the individual outcome measures showed a significant pre-test versus post-test change for the 9 Hole, Wilk's Lambda = .214, $F(1,22) = 5.976$, $p < .05$ measures. Figures 1 and 2 below illustrate the changes in these measures. There was no significant change across the pre and post tests for the remaining measures.

Figure 1: Change from Pretest to Posttest on the VGPT

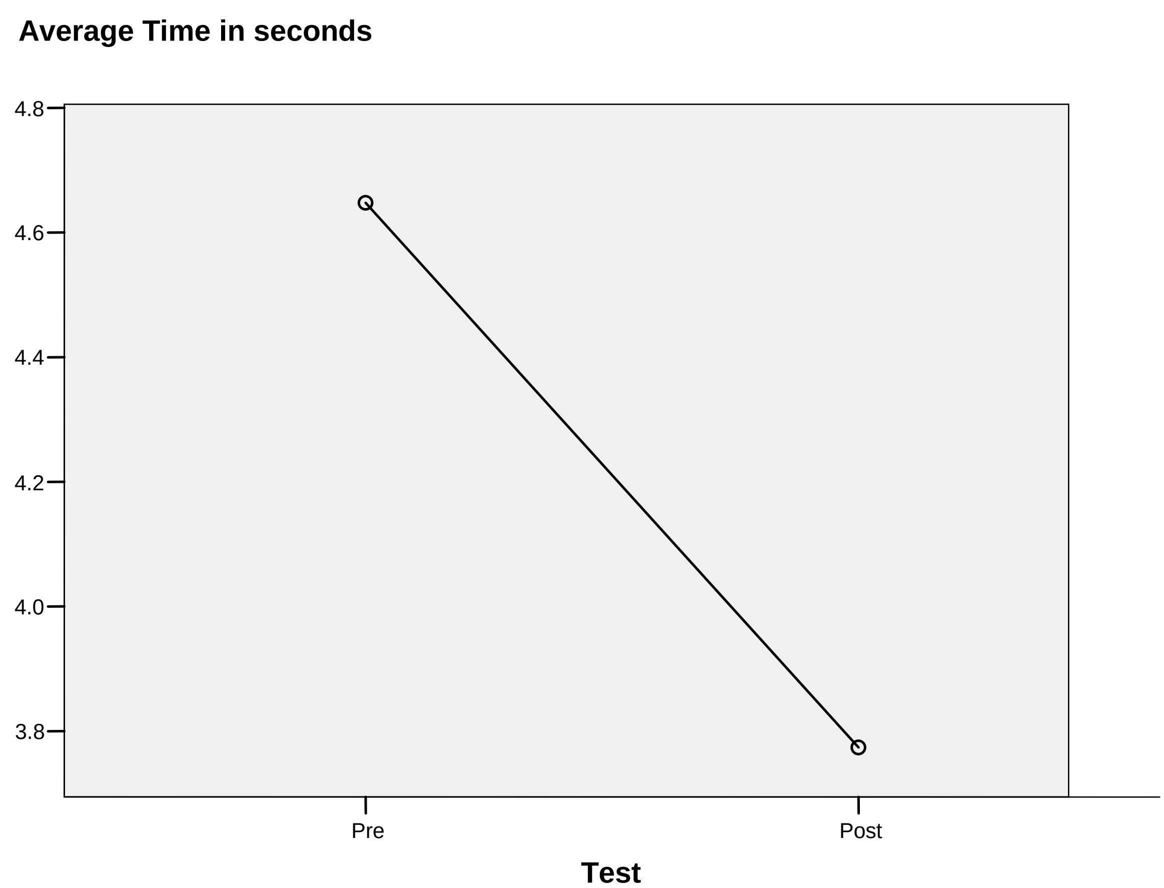
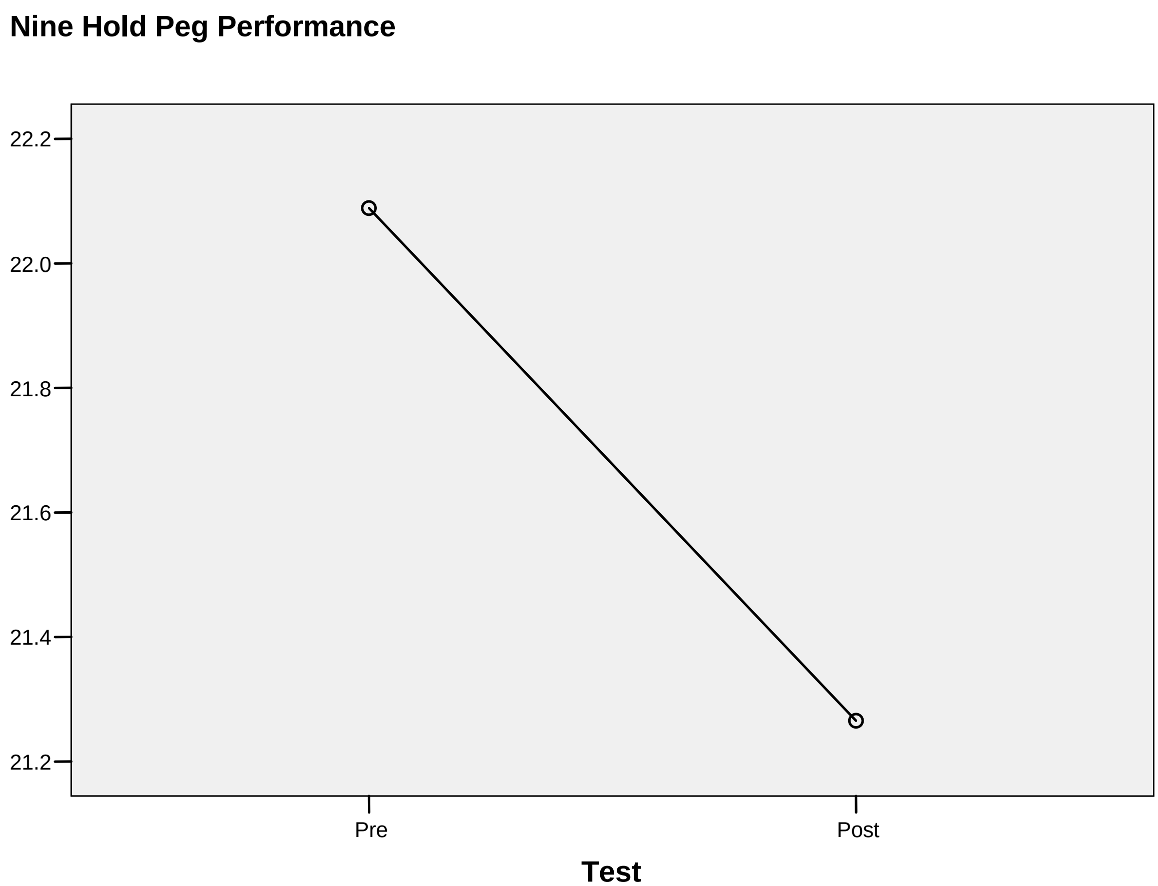


Figure 2: Change from Pretest to Posttest on 9 Hole Peg Task



Although the analysis did not find a significant difference between the groups, a post-hoc *t* test of the performance within the MPG alone revealed that individuals in this condition significantly decreased their time on the VGPT from pretest to posttest, thus improving their performance, $t(7) = 4.01$, $p < .01$. The pretest and posttest data from the MPG are presented in Table 2.

Table 2: Mean Pretest and Posttest VGPT Times (s) for the Mental Practice Group

Participant #	Pretest	Posttest

03	5.24	4.21
06	4.24	2.91
10	5.24	3.87
14	5.28	4.92
20	4.11	3.45
24	4.56	3.94
25	7.19	7.44
29	5.00	3.74

DISCUSSION

The first goal of the current study was to compare the effects of a mental practice intervention with the effects of both a physical practice intervention and no practice on the Visual Guided Pointing Task. Our results indicated that there was no interaction found for our group variable, meaning that the groups did not significantly differ from one another with regards to pretest to posttest VGPT performance. The second goal of this project was to see whether an improvement in one domain (upper extremity function) would generalize to the other domains (lower extremity and cognitive function) as well. Our results did not support this hypothesis.

Although my results did not show significant differences between the MPG and the APG, participants within the MPG did significantly improve their performance on the VGPT from pretest to posttest. A post hoc analysis revealed that participants randomized to the mental practice condition did show significant improvements from pretest to posttest. To illustrate these results further, Table 2 shows that seven out of eight participants who were randomized to the MPG and who participated in the mental practice intervention decreased their times on the VGPT from pretest to posttest. Furthermore, although not significant, the MPG did improve their performance more so than the NPG. Combined, these results suggest that, although mental practice may not be greater than actual practice itself, it is better than no practice at all; therefore, there are some benefits to this type of regimen.

Another example which illustrates the benefits of mental practice comes from Participant #06 in the MPG. This participant's pretest and posttest VGPT times were 4.24 s and 2.91 s, respectively, thus their performance improved by 1.33 seconds across the 16 session MPG regimen (Table 3). Although this improvement did not occur very rapidly, there was a consistent improvement from session to session. All of the evidence combined suggests that this improvement trend, although consistent, may not be that strong and could require many more participants to reach significance.

Table 3: Mean VGPT Times for Participant #06

Session #	Time (s)
1	4.19
2	3.58
3	3.45
4	3.28
5	3.31
6	3.22
7	2.98
8	2.99
9	2.8
10	2.85
11	2.85
12	2.77
13	2.71
14	2.6
15	*Missing*
16	2.74

This study investigated the use of a mental practice regimen because there may be other benefits to using mental practice over the traditional physical and occupational therapies. Firstly, patients who are constrained by physical limitations can easily participate in a mental practice program. Because mental practice involves no physical movements, the possibilities for injury, fatigue, and exacerbation of symptoms due to physical overload are limited. Secondly, unlike physical therapies, there are no major equipment or personnel needs in order to engage in mental practice. Therefore, not only is it more physically feasible to participate in a mental practice intervention, but it may also be more cost effective.

There are several limitations that exist within the current study. Firstly, the sample size is well under what we originally proposed. This particular patient population proved to be difficult to recruit; therefore, a future study would have to be readily able to adapt to the patients needs. Secondly, our sample had an uneven distribution of men and women. The current statistics on MS indicate that women are twice as likely to be affected by the disease, which may have contributed to our unbalanced sample. However, it would be helpful for future studies to recruit a more balanced sample.

CONCLUSION

There are several directions that this research can lead to. While our results did not show that mental practice is better than actual practice, it did reveal that mental practice does produce performance benefits. A future study with a larger sample and perhaps a longer practice regimen may reveal stronger effects between groups. Furthermore, a future study which investigates mental practice in a real-world application, for example in an occupational therapy setting where MS patients are asked to mentally practice themselves performing a grasping task, may also show even greater rehabilitative benefits. And finally, although this study investigated the use of mental practice within the Multiple Sclerosis population, this paradigm could also be investigated in other patient populations: stroke, traumatic brain injury, Parkinson's disease. Together, the current study and future studies could reveal that mental practice therapy is a good alternative to tradition therapies for patients who are limited in motor capacities.

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ABSTRACTS

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CONFERENCE PRESENTATIONS

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