The Acute Effect of Modified Constraint-Induced Movement Therapy on Improving Upper Extremity Motor Performance

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Abstract

Purpose: Motor performance is a sufficient indicator that Constraint-Induced Movement Therapy (CIMT) improves the neuromuscular system in stroke, hemiplegia, and cerebral palsy patients. Research is limited in the time needed to improve motor performance and in individuals with fully functioning extremities. The purpose of this study was to examine if an acute, modified version of CIMT would increase the efficiency of participants' motor program in their non-dominant arms.

Methods: 20 subjects (mean age 20.9 ± 1.2) without diagnosed injuries in their upper extremities participated. They signed an informed consent form and were given the Edinburgh Handedness Inventory. Subjects completed a pre-intervention choice reaction time test. For two weeks, they attended four, one hour therapy sessions in a controlled environment, in which their dominant arm was constrained. Immediately following the last therapy session, subjects completed a post-intervention choice reaction time test, followed by an additional test 24 hours later.

Results: A repeated measures ANOVA was conducted to find statistical difference between all choice reaction time tests. Results revealed significance between the pre-intervention test and post-intervention test taken immediately after the last session (P=0.006). In addition, results revealed significant difference between the pre-intervention test and post-intervention test completed 24 hours later (P=0.029).

Conclusion: This CIMT protocol improved motor performance directly following the therapy. The motor performance was maintained 24 hours later in subjects. Thus, subjects were given adequate therapy to enhance neuromuscular recruitment that created an enduring motor program for 24 hours. Results suggest acute modified CIMT creates motor programs relatively quickly; however the total sustainable time of the program is unknown. Future research studies are needed to assess the long term effects of modified CIMT.

Introduction

Constraint-Induced Movement Therapy (CIMT) has been shown to be effective on developing neuromotor functions in patients with hemiplegia, stroke, and cerebral palsy. Modified versions of CIMT have been created to provide adequate therapy with a shorter duration. These modified versions consist of therapy for two hours per day, 10-15 days consecutively.[1] Past research demonstrates the effectiveness of modified CIMT therapy through the use of specific tests that measure the efficiency of movement and motor performance in patients' affected arm. Motor performance can specifically be defined as the ability of the neuromuscular system to perform specific tasks**.** An effective measurement of motor performance is through kinematic variables such as reaction time. Kinematic studies of functional manipulation tasks can provide insight into the mechanism behind the effects of modified CIMT on the affected hand movement. Kinematic measures enable the assessment of spatial and temporal movement characteristics and could thereby provide insights into the spatial and temporal control of movement.[1] Kinematics provides a direct measurement of upper extremity function during activities of daily living.[2] Overall, motor performance is a sufficient indicator that a modified version of CIMT is effective in improving one's neuromuscular system. However, it is unclear if smaller amounts of time would be effective in improving motor performance. Research is also limited on motor performance in individuals with fully functioning extremities. Therefore, the aim of this study was to examine the effectiveness of an acute, modified version of CIMT for improving upper extremity motor performance.

Methods

There were 20 participants (8 men, 12 women; mean age 20.9 ± 1.2*)* recruited for this study. After recruitment, subjects were brought into the laboratory and given the Edinburgh Handedness Inventory to ensure they were not ambidextrous. For one hour a day, two days per week, over a two week period, the participants were enrolled in a modified CIMT session. A sling and swath wrapping technique was used with a sling and a six inch ace bandage to restrain their dominant hand. Each therapy session consisted of seven daily life activities: doing a puzzle, making a sandwich, pouring water, bouncing a ball, practicing handwriting, buttoning and folding sweaters, and weight lifting. Each participant was given specific instructions for each of the activities. Six of the activities were completed in a specific set time and one activity included a fixed number of sets and repetitions (Figure 2). Intervention was counterbalanced by randomizing the order of activities for each participant for each therapy session. Changes in motor performance were evaluated using the kinematic variable of reaction time. In this study, reaction time was measured on the Multi-Operational Apparatus for Reaction Time board (MOΨART) through a choice reaction time test. The choice reaction time test uses a light as a stimulus over one of the keys; the subject then had to react by pressing the corresponding key as quickly as possible. Subjects were familiarized with the choice reaction time test on the MOΨART board to decrease any learning effect. Participants did 10 trials on the MOΨART board before the first therapy session, directly after the final therapy session as well as 24 hours after completing their last therapy session.

Figure 1

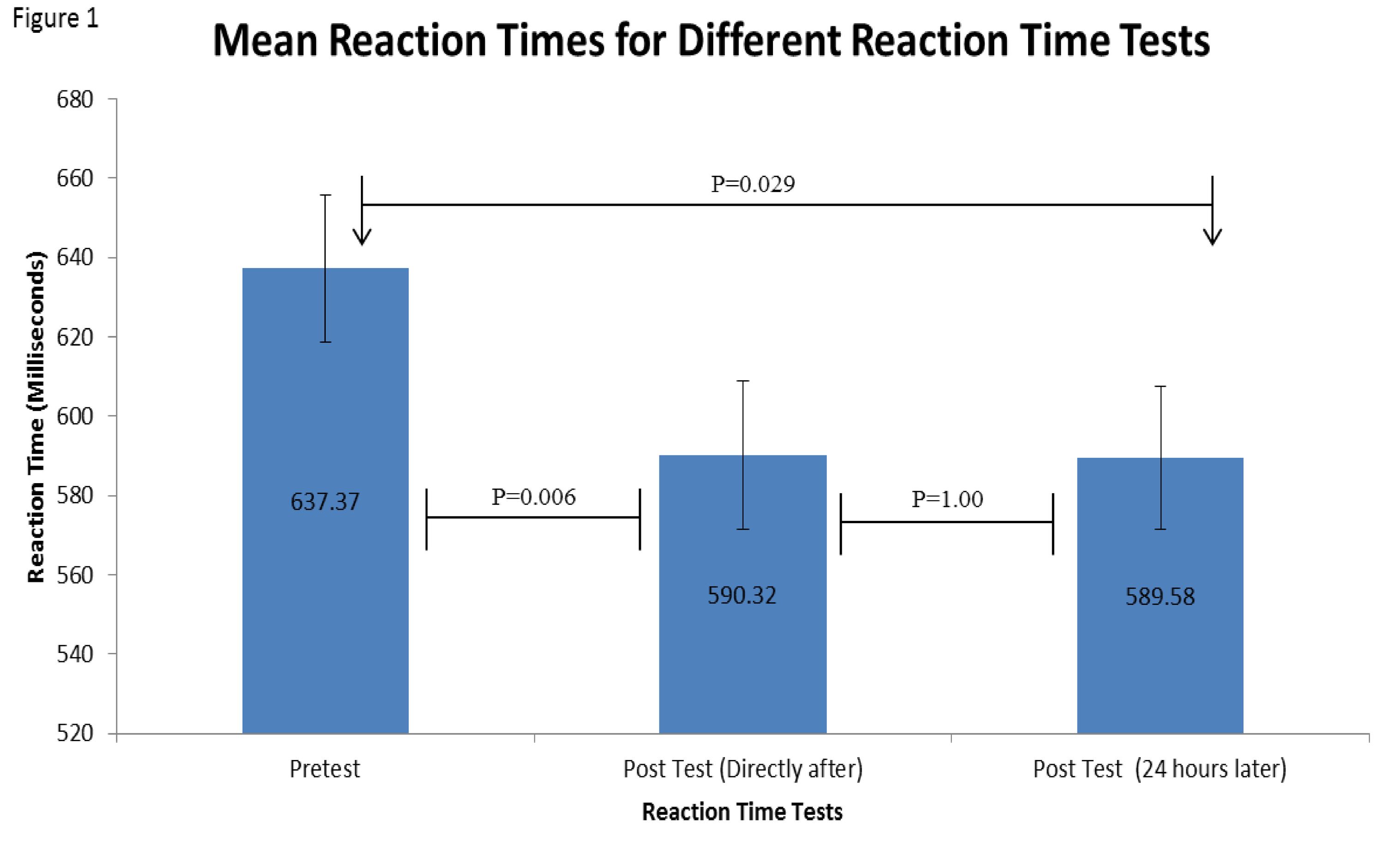
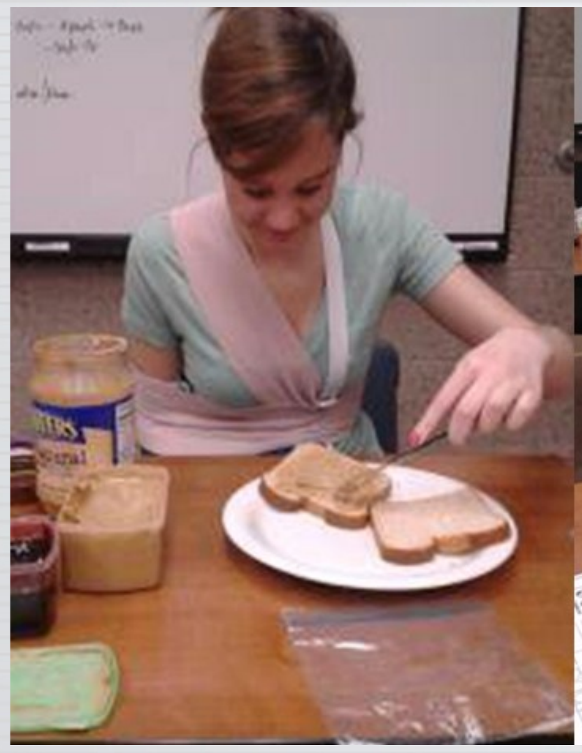


Figure 2. **Therapy Activities**	**Duration**
Puzzle	15 min to complete
Making a sandwich	10 min to complete and eat
Pouring water into cups	Continuous pouring for 2 min
Bouncing a ball	Continuous bouncing for 2 min
Writing worksheets	Continuous writing of worksheet #1 for 5 min
	Continuous writing of worksheet #2 for 5 min
	Continuous writing of worksheet #3 for 5 min
Buttoning and folding jackets	Continuous buttoning for 7 min
	Continuous folding for 3 min
Lifting weights	3 sets of bicep curls with 10 repetitions (5 lb.)
	3 sets of wrist curls with 10 repetitions (5 lb.)



Results

A repeated measures ANOVA was conducted to find statistical difference between all choice reaction time tests (F=1383.152, P<0.01). Mean reaction time along with standard error for the pre-intervention test was 637.37 ± 18.549, post-intervention test immediately after was 590.32 ± 18.690, and post-intervention test 24 hours later was 589.25 ± 17.94 (Figure 1). A Post Hoc ANOVA test revealed a significant difference on reaction time immediately following the last therapy session (P=.006) as well as 24 hours later (P=.029). The same Post Hoc ANOVA revealed no significance between the post–intervention test directly after therapy and the post-intervention test 24 hours later (P=1.00) (Figure 1).

Conclusion

This study demonstrates experimental data observing the changes that occurred in motor performance, based on reaction time in individuals following the two week modified CIMT program. The data revealed that there was an overall significance between choice reaction times (F=1383.152, P<0.01). Specifically, participants' improved their motor program in their non-dominate extremity between the pre-test and post-test directly after therapy (P=0.06). Furthermore, the motor program was maintained as data shows significant difference between the pre-test and post-test after 24 hours (P=0.029). Additionally, data demonstrated the motor programs were maintained since there was no significant difference between the two post-intervention tests (P=1.00). Repetition within the CIMT protocol enables individuals to effectively pre-plan motor programs and have more efficient neuromuscular rate coding. This study demonstrated an improved motor performance through sustained neuromuscular rate coding 24 hours later. Evidence of this motor performance was seen in subjects' shorter reaction times. These results are consistent with other modified CIMT studies. However, this protocol was acute in relation to modified CIMT which includes two hours of therapy per day for 10-15 days consecutively.[1] These results suggest that future CIMT studies may not need to be conducted for modified CIMT program's time and duration. Past research has also demonstrated that 65% of patients were not likely to wear the restraining device for the appropriate amount of time during CIMT.[3] It may be more beneficial to a CIMT program to conduct therapy for a shorter duration. As a result, individuals are less likely to remove the sling as often due to the inconvenience and discomfort. It is still unclear however if this acute modified CIMT is effective in a population of individuals with non-functioning extremities, such as hemiplegia, cerebral palsy, or stroke. This study also only included a 24 hour follow-up and did not observe any long term effects. Future research is needed on sustainability of a motor program with the use of an acute modified CIMT program.

References

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