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# REHABILITATION OF HEMIPLEGIC PATIENTS WITH NINTENDO WII: SHORT AND LONG TERM EFFECTS ON TASK LEARNING AND COP DISPLACEMENT

[1,2]Danilo de Oliveira Silva, [1]Carolina Silva Flóride, [1]Ronaldo Valdir Briani and [1]Fernando Amâncio Aragão
[1] Dept. of Physical Therapy, Human Movement Research Laboratory - LAPEMH, State University of West Parana - Unioeste, Cascavel-PR, Brazil.
[2] Laboratory of Biomechanics and Motor Control-UNESP, Presidente Prudente-SP, Brazil.
E-mail: feraaragao@gmail.com

## SUMMARY
The postural control in hemiplegic patients is remarkably affected and game consoles emerges as a new therapeutic tool for rehabilitation. This study aimed to assess the learning performance (execution time) and COP displacement (ML) of a Nintendo Wii Fit task in hemiplegic patients just after a 10-session rehabilitation protocol and 3 months after the intervention. 10 hemiplegic (GH) and 10 controls (GC) performed three assessments at different moments; Pre, Post and 3 months (3M) after the rehabilitation protocol. The results showed that both groups had a reduction in execution time of the performed task at Post and 3M compared to the Pre assessment. However, no significant changes in COP displacement were found for both groups.

## INTRODUCTION
Hemiplegia is the most common motor disability found in post stroke patients and after a traumatic brain injury. The injury of the upper motor neuron leads to motor paralysis, spasticity which affects the motor control coordination. The inappropriate distribution of weight between the lower limbs in hemiplegia reduces the global functional capacity and the postural control since most of the body weight is concentrated in one leg [1]. Therefore, the posture and the biomechanics of body weightbearing are dramatically changed, increasing the risk of falls in hemiplegic patients [2].
Besides spasticity, neurologic injuries like hemiplegia often induces to cognitive and memory losses which require specific rehabilitation exercises focused on motor and cognitive training to induce neural plasticity [3].
Virtual reality emerges as a potential rehabilitation tool for neurological patients and can provide adequate and controlled environments where the subjects can exercise and promote the neural plasticity. Unfortunately, the immersion on virtual reality systems requires special interaction devices which make the application expensive and difficult in everyday clinical environments.
Game consoles with virtual interaction have recently been used in physical therapy. Despite the lack of knowledge providing evidences about its clinical results, an increasing number of physiotherapists are adopting the game console as a rehabilitation tool once it can provide some sensation of immersion to the patient, is cheap and easy to use.
Therefore this study aimed to assess the learning performance (execution time) and Center of Pressure (COP) displacement (ML) of a Nintendo Wii Fit task in hemiplegic patients after a 10-session rehabilitation training using the game console and 3 months after the intervention.
The hypotheses were that the subjects would learn with the game training, increasing their time performance whereas the pattern of COP displacement would be encouraged to sway towards the hemiplegic side.

## METHODS
Twenty subjects, 10 hemiplegic (HG) and 10 controls (CG) performed three assessments at different moments; Pre, Post and 3 months (3M) after the rehabilitation training.
To be included in GH the subjects must have hemiplegia for at least 6 months; have the Mini Mental State Examination score greater than 19 points; the Berg Balance Scale score greater than 36 points and perform the "Timed Up and Go" test in less than 20 seconds. To be included in GC the subjects must never had contact with the Nintendo Wii Balance Board® games; have an age between 18 and 60 years. Subjects with spasticity equal or greater than score 3 on the Modified Ashworth Scale or with vision impairments without corrections were excluded.
For the assessments, the participants were positioned on the Wii Balance Board®. The game task performed was a simulation of a ski downhill run that involves mediolateral movements (Ski Slalom® game). During the task execution, the Wii Balance Board® was placed on the laboratory force plate (AMTI OR-6, USA). Thus, the COP data displacement could be collected during the execution of the movements required to perform the task of the game. The execution time of each trial was provided by the game itself at the end of each trial. For all evaluation the subjects performed 3 trials and during the downhill run, for each flag "forgotten" (misses) a 7-second penalty time was added.
After the first evaluation (Pre), the participants began the training, which was held in a room specially designed for immersion activities using virtual reality, provided by the

Unioeste Rehabilitation Centre. Each participant has trained a total of 10 sessions of 30 minutes (including resting time of 10 minutes), 2-times a week, for 5 weeks. During the rehabilitation training many virtual reality interaction games of the Nintendo Wii Fit® package which included the Wii Balance Board® were used. At the end of the 10-session training the second evaluation was performed (Post) and three months after the second evaluation, a third evaluation (3M) was performed to verify both the short and long-term effects of the rehabilitation training, respectively. During the 3-month period after the 2nd evaluation, the participants had no contact with the games.

For the data analysis the COP data was corrected including the Wii Balance Board® height positioned on the force plate. For the statistical analysis, was realized the description of the all data and applying the normality test of Shapiro-Wilk for each of the tasks evaluated. To determine differences related to the Pre, Post and 3M moments we used the ANOVA repeated measures test. All analysis were conducted using the SPSS v.17, and the significance level for all statistical comparisons were maintained at 0.05.

## RESULTS AND DISCUSSION

Analyzing the data, regarding the displacement of COP, we did not obtain significant differences between Pre, Post and 3M assessments. In other words, after training the participants did not change the COP sway pattern and this condition persisted after three months.

However, HG improved time performance to finish the task after 10 training sessions and maintained the improvement in time performance over time (Figure 1).

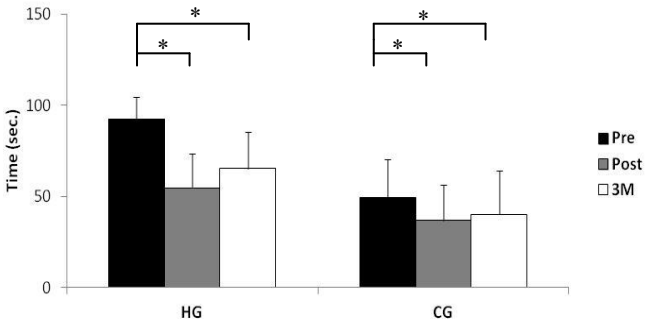


**Figure 1**: Average time and SD to complete the ski slalom game task for HG and CG groups during Pre, Post and 3-month assessments.

In this study, the data indicate that the training in virtual reality environment using games of the Nintendo Wii console, was beneficial to improve the time performance of patients with hemiplegia on the task involving mediolateral displacements and that improvement was maintained over time. This improvement is most likely to be related to the task learning. However, participants did not change the pattern of COP displacement to improve the weightbearing performance simultaneously in the proposed task. Once the COP did not change its position during the task movements, concentrating the body weight on the non-affected limb.

In this study the kinematic of the movements performed during the game task which could help to identify if the subjects were induced to create different patterns of COP displacement on the hemiplegic side were not measured. Thus to establish virtual reality games as rehabilitation exercises, studies regarding kinetic and kinematic analysis are necessary in order to consider the biomechanics of the movements required during the task performance.

Anyway, virtual reality interaction games like the Nintendo Wii console emerges as a potential and suitable tool to provide an alternative kind of exercise to be associated in the conventional physical therapy [4], however, one must be cautious when applying only theses exercises for specific clinical purposes until more studies can provide evidences that sustain the game rehabilitation as a secure and appropriate technique to be used in the rehabilitation of hemiplegic patients.

## CONCLUSIONS

In summary, the subjects of GH were able to learn and perform faster the task just after the training protocol and maintained the performance after 3 months, suggesting the long-term effects of the training. Even though, the game task did not help the GH to improve the COP asymmetric position and displacement during the game task.


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