# Improving disabled arm control through gaming

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## Introduction

Cerebrovascular stroke is one of the main causes of adult disability and currently plenty of research attempts to alleviate long-term disability of stroke subjects. Neurorehabilitation methods for subjects with residual disability favor massed practice to regain lost motor function via enchancement of cerebral processes of neuroplasticity and learning. The purpose of the present study was to assess the motor learning process when chronic stroke subjects had to use their affected hand and arm in an implicit learning task. A unique computer game was utilized in the task.

## Methods

Nine stroke (5 left/4 right hemiparesis) subjects participated in the task performed with an EMG-controlled computer game. Their lesions were diagnosed with MRIs at the time of insult and they were chronic(38.6±48 months from onset) at the time of task performance. Their arm motor deficit was assessed with Arm Research Action Test (ARAT) and Wolf Motor Function Test (WMFT). A unique game was designed (Mega Electronics Ltd., Finland) to suit to paretic hand movements where surface electromyogram (EMG) in 4 channels from arm muscles (right and left flexor carpii radialis and right and left extensor carpii radialis) controlled movement of an object on the screen. EMGs were preamplified with a gain of 305 using a bandwidth of 8-500 Hz by ME6000 biomonitor. The biomonitor transmitted the EMG signals to move the object on the computer screen. EMGs were calibrated using the maximum individual range of motion. The idea of the task was to move the object through a maze as fast as possible avoiding any touch of the borders of the maze pathway on the screen. Tasks for affected, nonaffected, right, left, dominant and nondominant hands were performed in equal numbers. Same tasks were performed by 10 healthy subjects in order to obtain control data.

## Results

Paretic hands of the stroke subjects were severely affected: ARAT scores (mean±SE) were for the left paresis 23±3 and for the right paresis 32±6; normal score 57, and paretic arm WMFT functionality score was 56±5; normal score 80. The hand grip force in the affected side was 11±7 N in subjects with stroke and 29±1.5 N in healthy subjects. Learning was assessed with the distance needed to move the object before reaching the target. Considering the rapidity of learning the game, stroke subjects took longer time, however, after reaching the succesful performance of the affected hand, it was not slower than the dominant hand of the control subjects.

## Conclusion

Movement rehabilitation based on the concept of enhancing neural plasticity in the injured brain through the learning of new motor control strategies is substantiated by our findings. New rehabilitation methods emphasize the end result of motor behavior and not so much the isolated training of actual muscle synergies needed to reach a goal. Using an EMG-controlled computer game allowed us to test the learning ability of the patients and healthy subjects in the same task regardless of the major motor deficits of the patients and major differences in motor behavior among subjects. We were able to register the success in learning the motor task irrespective of the individual motor deficit because the voluntary output of each individual muscle was calibrated according to its own maximum range of motion. We offer an addition to existing EMG methods to control various functional electrical stimulation techniques.