Repetitive arm training with music and error sonification for therapy following stroke

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Summary—**Repetitive training during neuro-rehabilitation can enhance functional gains. However, the tedious nature of numerous repetitions limits the motivation to train. To improve motivation and task engagement, we introduced music and error sonification of repetitive paretic arm training tasks. We expected significant improvements in arm function for the auditory feedback group (group 1), compared to a control group exposed to background music only (group 2). Six chronic stroke patients in each group trained ten times within 3-4 weeks. Performance measures in both groups improved following training, although statistical analysis showed no significant differences between groups. Clinical measures were not improved significantly possibly due to small groups. Further research is needed to understand the mechanisms.**

INTRODUCTION

One method of regaining full arm function after stroke is to practice and repeat movements as much as possible [1]. This process can be cumbersome and may cause a loss of motivation and engagement during training. Listening to music has been shown to improve motivation and cognitive recovery after stroke [2]. Additionally, music listening has the potential to trigger the dopaminergic reward system [3], which is beneficial in motor learning and control [4]. Thus, we introduced reward via music listening to exploit these positive effects.

METHODS

The two groups consisted of six chronic ischemic stroke patients (aged between 38 and 85 years, 10 men, 2 women) each, all of whom were able to move their paretic arm on a table without assistance from the examiner or the patient's healthy arm. The participants were pre-assessed, trained (10x), post-assessed and tested for retention 30 days following the last training. Assessments and retention included: upper extremity Fugl-Meyer test (UEFM), Wolf Motor Function Test (WMFT), tracing and drawing of three patterns (triangle, circle and figure eight). Tracing is defined as following the visible target pattern, while drawing is defined as following the pattern from memory, with only the target patterns' center points visible. During ten training sessions within 3-4 weeks the participants were asked to trace two different patterns (triangle and circle, 10min each) while listening to their favorite music and receiving error feedback (group 1

only). The paretic hand and forearm were attached to a wooden handle with an infrared-emitting marker on top to track their movements. Therefore we used an optical 3D tracking system (accuTrack 500, Atracsys LLC, Le Mont-sur-Lausanne, Switzerland). The error was calculated as the shortest distance between the target line and the measured marker position and was used to calculate the error feedback, which group 1 received during training.
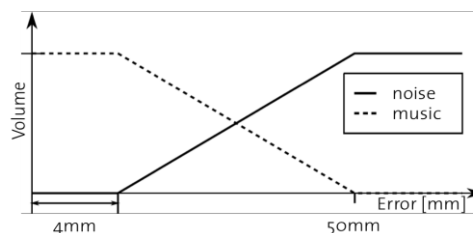

Figure 1 Error sonification map for group 1. Group 2 only listened to background music.

RESULTS AND DISCUSSION

Both groups improved from pre-assessment to post-assessment and maintained their improvement 30 days later. This result was expected, as both repetitive practice is known to improve skills [1] and reward (i.e. music) assists in retention as in [4]. Between groups, statistical analysis - using repeated measures ANOVA (sessions, groups) - revealed no significant differences in the main outcome measures: mean error, error variance, summed error, mean time or mean jerk. It is most likely that the patient population was too small to show an appreciable effect in performance measures. Also no clinically significant improvement could be measured with the UEFM and WMFT. The lack of significant changes in clinical scores is not surprising since the tests are not very sensitive to the trained movements and the training period may be too short. The strategy employed here requires further study to examine clinical efficacy, especially as patients highly appreciated the music-supported training.

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