

Evaluating functional and motivational effects of rhythmic stimulation modes applied to the Nine Hole Peg Test

F.Speth¹, M. Wahl¹

¹*Institute of Rehabilitation Science, Humboldt Universität zu Berlin, Germany*

Summary— This paper presents results of three experiments investigating functional and motivational effects of different rhythmic stimulation designs on motor behavior of the upper limb of healthy subjects. Four different stimulation designs were evaluated in comparison to no stimulation during the performance of the Nine Hole Peg Test (NHPT). The goal was to determine an effective design under metronome, waltz music, spearcon- and multisensorical- beat, to inform a further planned clinical study with patients in which rhythmic stimulation designs applied in robot arm therapy will be observed.

INTRODUCTION

Robot assisted rehabilitation is a promising approach to intensify and improve arm rehabilitation. 90% of all stroke patients suffer from a paretic arm syndrome [1]. Studies showed that rhythmic auditory stimulation applied in arm training leads to positive effects in motor recovery [2]. A combination of rhythmic stimulation and unilateral robot therapy was not observed yet.

Three experiments were conducted to evaluate functional and motivational effects of rhythmic stimulation modes applied during the NHPT. Outcomes aim to inform a further planned clinical study with stroke patients suffering from a paretic arm syndrome that are practicing with robot technologies in combination with rhythmic stimuli.

METHODS

Three experiments (E1-3) with healthy subjects ($n=20$ / $f=11$, $m=9$; age: 23- 34; mean age= 27,15 yrs \pm 3,85) were conducted: In all three experiments the NHPT was performed whereby five stimulation designs (a- no stimulation/ b- metronome/ c- spearcon beat [spearcons: processed audio samples of motivating phrases/words [3] like: “Super”, “Great”, “Yeah”]/ d- waltz music: “Voices of spring”, J. Strauss/ e- multisensorical beat: rhythmical hits on the foot combined with metronome) were applied in randomized order. A tempo of 200bpm was chosen to provide a speed up rate of 20% in relation to NHPT- time standard value table [4]. Conditions in E1-3 differed in degree of difficulty (see Fig.1) to provide comparable conditions between healthy subjects and limitations caused by arm paresis. Time (T), first to last peg contact, and performance (P), amount of mistakes related to standardized rules of the NHPT, were assessed. Mood (M) was rated via Visual Analog scale (-10: +10) in relation to initial mood directly after every single task.

RESULTS

In E1 P and T were best during “d” (E1: $T=16,8s/P=0,1$). In E2 as also in E3 best T and P was shown during “b” (E2: $T=25,1s/P=0,1$; E3: $T=73,54s/P=1,05$), followed by c (E2: $T=25,63s/P=0,15$; E3: $T=73,6s/P=1,25$). T and P was still higher during “e” (E2: $T=25,69s/E3: T=77,34s$) and “d” (E2: $T=26,69s/ E3: T=78,19s$) than in “a”. In all experiments T and P was lowest in “a” followed by “e”. M was rated to be more than 6 times better during “d” ($M=2,66$) in comparison to “a”. M was rated second best during “b” ($M=0,61$). During “c” M was rated most negative ($M=-8,2$) followed by “e” ($M=-0,41$). Data was not adjusted.

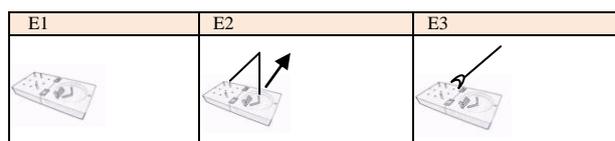


Fig. 1: E1- normal condition, E2- limitation against elastic rope force backwards, E3- limitation by usage of mechanical grasp arm

DISCUSSION

It was shown that performance qualities were better with rhythm than without. Best results were assessed during metronome stimulation under difficult conditions. Mood was rated to be six times higher during waltz music than without stimulation independently of difficulty levels. Multisensorical stimulation led to lower performance qualities in comparison to other designs in all conditions. We suggest the application of metronome stimulation, and a combination of waltz music and metronome in the clinical study to include motivational aspects and an effector for high quality performance.

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