Virtual Rehabilitation – Implications for Persons with Stroke

Akademisk avhandling

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av

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I.

Broeren, J., M. Rydmark, A. Bjorkdahl and K. S. Sunnerhagen (2007). "Assessment and training in a 3-dimensional virtual environment with haptics: a report on 5 cases of motor rehabilitation in the chronic stage after stroke." Neurorehabil Neural Repair **21**(2): 180-9.

II.

Broeren, J., K. S. Sunnerhagen and M. Rydmark (2007). "A kinematic analysis of a haptic handheld stylus in a virtual environment: a study in healthy subjects." J Neuroengineering Rehabil **4**: 13.

III.

Broeren J, L. Claesson, D. Goude, M. Rydmark, K. Stibrant Sunnerhagen (2007). "Virtual Rehabilitation in an activity centre for community dwelling persons with stroke; the possibilities of 3D computer games." Submitted

IV.

Broeren, J., H. Samuelsson, K. Stibrant-Sunnerhagen, C. Blomstrand and M. Rydmark "Neglect assessment as an application of virtual reality (2007)." Accepted for publication in Acta Neurologica Scandinavica

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Virtual Rehabilitation – Implications for Persons with Stroke

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ABSTRACT

Aims: The purpose of this thesis was to investigate the effects of Virtual Reality technology and haptics for stroke rehabilitation. Aims were to assess motor training in the so called chronic phase after stroke and to evaluate whether any improvement detected in the VR environment is reflected in daily life. We wanted to establish normative kinematic reference values and to test a method for assessing visuospatial neglect.

Methods: One hundred and six subjects participated in four different studies. Twenty-nine had a stroke and 77 were healthy individuals. In paper I, a single-subject experimental design (AB) provided intervention effects on five hemiparetic stroke subjects. The intervention consisted of playing a three-dimensional computer game. Paper II was explorative and was intended to acquire normative data. Fifty-eight healthy subjects performed three-dimensional hand movements in a virtual environment using two types of handgrip postures, i.e. pen grip and cylinder grip. Paper III used a pre/post-test design with comparison with a control population. The rationale was to place a VR system in a non hospital environment to see whether playing three-dimensional computer games would improve upper extremity motor function. The intervention involved 11 stroke subjects who received extra computer training in addition to their current activities. The control group was comprised of 11 stroke subjects who continued their usual rehabilitation (no extra computer training) during this period. An additional group of 11 right-handed aged matched individuals served as reference subjects. Paper IV was explorative with comparisons with traditional neglect tests. Eight subjects with right hemisphere brain damage and eight healthy controls were included. Four stroke subjects had visuospatial neglect and four had recovered clinically from initial symptoms of visuospatial neglect. The performance of the stroke subjects was compared with that of a reference group consisting of eight subjects with no history of neurological deficits.

Results: All studies demonstrate that this VR application can provide a quantitative analysis of hand movements. In paper I, improvements in time (extension), velocity and hand trajectory (hand path ratio) for all subjects was noted. One subject improved in occupational performance, i.e. improvement reflected in activities of daily living. In paper II, we established normative kinematic values. The test-retest for the two different handgrips between two test occasions showed a high reliability for the healthy subject for the kinematic variables. There was a training effect between the first test occasion and the third test occasion. Paper III is consistent with Paper I, but the results have extended these findings, showing that virtual rehabilitation can be beneficial not only to younger participants but also to elderly people in terms of enhancing their motor performance. In Paper IV we showed that the visuospatial neglect test gave additional information compared to traditional tests. Both the subjects with neglect and the subjects clinically recovered from neglect showed aberrant search performance in the cancellation task in the virtual environment, such as mixed search pattern, repeated target pressures and deviating hand movements.

Conclusion: The VR upper extremity tests take less than a minute to complete and produce objective kinematic data. The general experience using the VR application approach suggests that this intervention concept is promising in stroke rehabilitation, with a wide range of applicability.

Key words: Haptics, Neglect, Outcome Measures, Paresis, Stroke, Rehabilitation, Virtual Reality.

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