

# Improving dexterity in children with cerebral palsy

## Preliminary results of a randomized trial evaluating a glove based VR-system

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**Abstract**— We investigated the effectiveness of a glove-based virtual reality system (YouGrabber) on arm and hand function in 17 children and juveniles with cerebral palsy (CP). The intervention group (n=10) received 12 sessions of training, while the control group (n=7) performed computer games. Analyzed were grip strength and lateral-grip strength, the box-and-block test (BBT) and the nine-hole-peg test (9HPT) of the more affected hand. The BBT tended to improve more in the intervention compared to the control group ( $P = 0.07$ ). Effect sizes of most measures were considerably larger in the intervention group. Our preliminary data suggest that children and juveniles with CP might profit from a 3 week training with the YouGrabber system to improve hand and arm function.

**Keywords:** *YouGrabber, cerebral palsy, handfunction*

### I. INTRODUCTION

Improving upper extremity function is considered a high priority in patients with neurological disorders, as reaching, grasping and fine object manipulation are important for independence in daily life. Also children and juveniles with cerebral palsy (CP), impairments in upper extremity function are frequently observed and require rehabilitation. Recent developments in the field of robotics and virtual-reality based systems can complement the conventional occupational and physiotherapeutical intervention [1-3]. In the current study, we evaluated the effectiveness of a glove-based virtual-reality system that allows to practice specific movements of the upper limbs and provides immediate feedback about motor performance. While this system appears feasible in children and juveniles with neurological disorders [4] there is no randomized clinical trial investigating its effectiveness. Therefore, the aim of this randomized study was to investigate the effectiveness of this glove-based virtual reality system versus playing computer games in children and juveniles with CP on arm and hand function.

### II. METHODS

Included were patients with CP, aged between 6 and 18 years, the cognitive ability to understand instructions and with one or both arm and hands affected. Seventeen children (8 females) were included and randomly assigned to an

experimental group (n = 10), or a control group (n = 7). Both groups received 12 sessions during 3 weeks (45 minutes per session) and were supervised by a therapist.

In the experimental group, the children were trained with the YouGrabber system (YouRehab, Zurich, Switzerland). This system consisted of two data-gloves, which measured both finger flexion and extension using bend sensors. Full bimanual 3D tracking of the hands and arms was achieved by an infrared camera mounted above the table the children sat at covering an area of approximately 1.0 x 0.75 m. The data-acquisition sample frequency of the system was 25 Hz. The young patients performed three different gaming scenarios (“toy catching”, “catch the carrot” and “tomato juggling”) which were developed to perform repetitive specific arm and hand movements, including hand grasping and releasing, wrist pronation and supination and arm reaching combined with internal and external shoulder rotation. Direct feedback was provided by the virtual scenario displayed on a large monitor in front of the patients, while additional haptic feedback was provided by a vibration motor attached to the glove. During each gaming scenario a cumulative score was provided on the screen to motivate the young patients. Difficulty levels were adjusted by the therapist to keep the level of the game challenging, but not too difficult.

A control group (n = 7) performed computer games. Normally, these computer games are performed to train cognitive functions. They required no skilled motor function, besides making mouse clicks. In the two groups, no additional specific arm and hand training was provided during the duration of the study.

Four assessments were performed prior to and after the interventions, both for the more and less affected arm and hand: (i) grip strength and (ii) lateral-grip strength using dynamometry; (iii) the box-and-block test (BBT), which assesses the number of blocks that can be grasped and transferred from one side of the box to the other side, assessing grasping and more proximal arm function; and (iv) the nine-hole peg test (9HPT), which assesses skilled pinch grip and therewith finger dexterity. For each subject, we calculated the average value of the four tests and this value was included in the statistical analyses. Here, we present only data for the

more-affected hand. Due to the small sample size, non-parametric analyses were performed (Mann-Whitney U test) and for each group, effect sizes (mean improvement / SD improvement) were calculated [5]. Effect sizes are considered poor (0.2 – 0.5), moderate (0.5 - 0.8) and large (> 0.8) [6].

### III. RESULTS

The two groups did not differ at baseline with respect to age and the various measures (Table I).

TABLE I. BASELINE CHARACTERISTICS OF THE INTERVENTION AND CONTROL GROUP

Variable	Baseline characteristics [mean ± SD]		
	Intervention group	Control group	Significance
Age [years]	10.5 ± 2.9	11.4 ± 1.9	P = 0.48
Grip strength [kg]	7.9 ± 8.4	10.6 ± 4.5	P = 0.19
Pinch-grip strength [kg]	3.0 ± 1.8	3.6 ± 1.3	P = 0.32
BBT [number]	23.9 ± 17.3	23.7 ± 11.6	P = 1.00
9HPT [seconds]	68.7 ± 74.1	86.8 ± 88.6	P = 0.31

Only the BBT showed a tendency for an increased improvement in performance of the intervention group compared to the control group (Table II), while effect sizes were considerably larger in the intervention group compared to the control group for grip strength (0.77 vs. 0.18), BBT (1.14 vs. 0.07) and 9HPT (0.49 vs. 0.06).

TABLE II. IMPROVEMENT IN OUTCOME OF THE INTERVENTION AND CONTROL GROUP

Variable	Improvement [mean ± SD]		
	Intervention group	Control group	Significance
Grip strength [kg]	1.0 ± 1.3	0.3 ± 1.7	P = 0.48
Pinch-grip strength [kg]	0.0 ± 0.3	-0.3 ± 0.6	P = 0.19
BBT [number]	3.2 ± 2.8	0.2 ± 3.0	P = 0.07
9HPT [seconds]	-17.0 ± 34.3	0.4 ± 6.6	P = 0.15

### IV. CONCLUSIONS

Preliminary results found a tendency that the BBT improved more in the intervention group compared to the control group. Moreover, the effect sizes indicated that despite the lack of statistical difference, positive effects were considerably larger in the intervention group compared to the control group. We suggest that the glove-based VR system could be a valuable additional tool for therapists to improve upper extremity function in children and juveniles with CP.

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### REFERENCES

- [1] Q. Qiu, D.A. Ramirez, S. Saleh, G.G. Fluet, H.D. Parikh, D. Kelly, S.V. Adamovich. The New Jersey Institute of Technology Robot-Assisted Virtual Rehabilitation (NJIT-RAVR) system for children with cerebral palsy: a feasibility study. *J. Neuroeng. Rehabil.* Vol.6: p.40, 2009.
- [2] G.G. Fluet, Q. Qiu, D. Kelly, H.D. Parikh, D. Ramirez, S. Saleh, S.V. Adamovich. Interfacing a haptic robotic system with complex virtual environments to treat impaired upper extremity motor function in children with cerebral palsy. *Dev. Neurorehabil.* Vol. 13(5): pp. 335-45, 2010.
- [3] S.E. Fasoli, M. Fragala-Pinkham, R. Hughes, N. Hogan, H.I. Krebs, J. Stein. Upper limb robotic therapy for children with hemiplegia. *Am. J. Phys. Med. Rehabil.* Vol. 87(11): pp. 929-36, 2008.
- [4] D. Wille, K. Eng, L. Holper, E. Chevrier, Y. Hauser, D. Kiper, P. Pyk, S. Schlegel, A. Meyer-Heim A. Virtual reality-based paediatric interactive therapy system (PITS) for improvement of arm and hand function in children with motor impairment--a pilot study. *Dev. Neurorehabil.* Vol. 12(1): pp. 44-52, 2009.
- [5] J.A. Husted, R.J. Cook, V.T. Farewell, D.D. Gladman. Methods for assessing responsiveness: a critical review and recommendations. *J Clin Epidemiol.* Vol.53(5): pp. 459-468, 2000.
- [6] D.E. Beaton, S. Hogg-Johnson, C. Bombardier. Evaluating changes in health status: reliability and responsiveness of five generic health status measures in workers with musculoskeletal disorders. *J. Clin. Epidemiol.* Vol.50(1): pp.79-93, 1997.