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Rapid Communication

An Electric Scooter Simulation Program for Training the Driving Skills of Stroke Patients with Mobility Problems: A Pilot Study

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Abstract

This paper describes an electric scooter simulation program and a first evaluation study in which we explored if it is possible to train the driving skills of future users of electric mobility scooters by means of an electric scooter simulation program in addition to conventional electric scooter training. Within this explorative study, 10 stroke survivors were randomly assigned to either the control ($n = 5$) or the electric scooter simulation intervention group ($n = 5$). Participants were assessed twice on the functional evaluating rating scale. During the followup measurement, subjective experiences regarding both forms of electric scooter training were elicited by a questionnaire. After a training period of 5 weeks, both groups improved on the Functional Evaluation Rating Scale. It can be concluded that the patients with stroke were satisfied with the electric scooter simulation training.

Introduction

Governmental policies aim at enhancing or maintaining independent living by providing services and care for people with walking disabilities. To assist these people, a great variety of mobility-supporting devices is available, ranging from walking sticks and ankle–foot orthoses to manual or powered wheelchairs. To enable people with mobility problems to travel greater distances, Dutch local authorities allocate electric scooters to them. Training is required to use these powered devices safely in daily life. However, such training is expensive in terms of human resources and can potentially be unsafe for drivers as well as for their instructors.[1] In recent decades, new technologies such as virtual reality (VR) have entered into physical medicine and rehabilitation.[2,3,4] Erren et al. studied the literature for different VR training applications as well as their clinical implication for patients with mobility problems.[5] All the included studies showed a positive result of the VR application with respect to the driving abilities. This paper describes an electric scooter simulation program and a first evaluation study in which we explored the possibility of training the driving skills of future users of electric scooters by means of an electric scooter simulation program in addition to conventional electric scooter training.

Methods

Participant

Within this explorative study, 10 stroke survivors were included from the local rehabilitation center after signing an informed consent. Patients were randomly assigned to either the control ($n = 5$) or the electric scooter simulation intervention group ($n = 5$). For the control group, the mean age was 58.0 years ($SD = 12.9$), and the time since stroke was 112.2 days ($SD = 49.5$). For the experimental group, the mean age was 61.80 years ($SD = 2.9$), and the time since stroke was 88.8 days ($SD = 30.5$). Of the 10 participants, two were cat-

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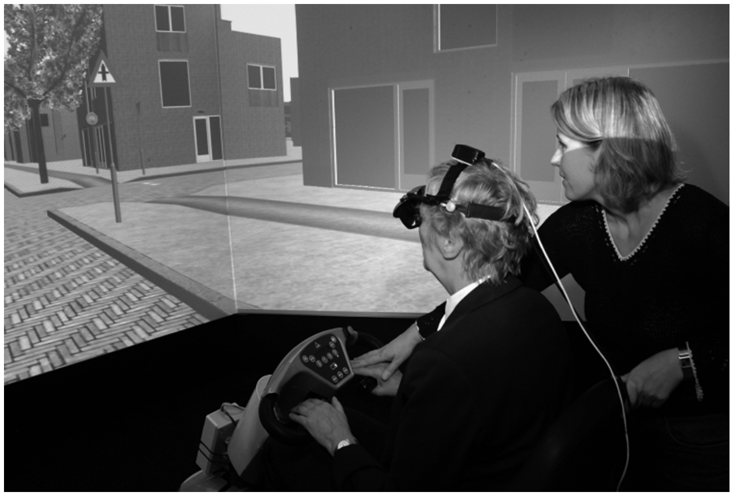

FIG. 1. Virtual environment: residential area.

egorized as chronic stroke patients (>6 months ago). These two patients were equally distributed over the control and experimental group.

Measurements

Functional Evaluation Rating Scale (FERS). To assess the driving ability in the real world, patients are evaluated by means of the FERS developed by Hasdai et al.[6] Each criterion is scored by a trained researcher on a 4-point scale: (1) very good, (2) needs improvement, (3) tries to perform, and (4) is not able to perform. The best score is 12 points; the worst result is 48 points.

Subjective experience. To gain insight into the participants' subjective experiences regarding the electric scooter training, they were administered a questionnaire based on several items used by Harrison et al.[1] and Weiss et al. [9] The questionnaire was administered as an interview by the researcher and assessed on a 4-point scale.

Electric scooter simulation program

The experimental setup for the electric scooter simulation program consists of two personal computers (a simulation server and a visualization client), a head-mounted display (e-Magin Visor Z-800), a 3-D orientation tracker (MT9, Xsens motionTechnology), an electric scooter with customized serial interface, a set of speakers, a computer display, and a mouse (Figure 1). The virtual environment was designed with the 3D animation software Lumo Scenario (http://www.lumoscenario.com). The 3D virtual environment consists of three levels with increasing complexity: level 1, a "traffic garden" in which the participant must perform some basic driving skills; level 2, a residential area; and level 3, a grocery store.

Study design and procedure

After randomization, participants were assessed twice on the FERS: a baseline assessment (T0) and a followup assessment after 5 weeks of training (T1). Stroke survivors assigned

TABLE 1. SCORES ON THE FUNCTIONAL EVALUATING RATING SCALE AT T0 AND T1

Group	*Participant*	*FERS T0*	*FERS T1*	*Progression (%)*
Control	01	17	14	8.3
	02	17	17	0.0
	03	18	—	—
	05	21	18	8.3
	08	16	12	11.1
		$M = 17.8$	$M = 15.25$	$M = 6.9$
Experimental	04	18	16	5.6
	06	21	18	8.3
	07	14	13	2.8
	09	19	14	13.9
	10	16	14	5.6
		$M = 17.6$	$M = 15$	$M = 7.2$

TABLE 2. SUBJECTIVE EXPERIENCES AT T1

Group	Participant	SJDA (max 56)	Content (max 12)	Performance (max 16)	Safety (max 12)	Comfort (max 16)
Control	01	51.3	11.0	14.0	10.7	15.7
	02	53.0	12.0	16.0	10.5	15.5
	03	56.0	12.0	16.0	12.0	16.0
	05	51.0	11.0	14.0	11.0	15.0
	08	52.0	12.0	15.0	11.0	14.0
		$M = 52.7$	$M = 11.6$	$M = 15.0$	$M = 11.0$	$M = 15.2$
Experimental	04	51.0	11.0	13.0	11.0	16.0
	06	50.5	11.5	13.5	11.0	14.5
	07	53.0	10.0	15.5	11.5	16.0
	09	51.0	9.0	14.0	12.0	16.0
	10	51.0	10.0	13.0	12.0	16.0
		$M = 51.3$	$M = 10.3$	$M = 13.8$	$M = 11.5$	$M = 15.7$

SJDA: subjective judgment driving abilities.

to the control group received a regular electric scooter training program in the real world. The five stroke survivors in the intervention group were trained by means of the electric scooter simulation program (50% of total training time) in addition to real-world training (50% of total training time). However, the total treatment intensity was equal for both groups: 30 minutes twice a week for 5 weeks. At T1, subjective experiences regarding both forms of electric scooter training were elicited by a questionnaire.

Results

FERS

The scores on the FERS for both baseline and followup of the 10 participants are presented in Table 1. Before training, the total scores of the control group ranged from 16 to 21, and the scores of the experimental group ranged from 14 to 21. After a training period of 5 weeks, both groups improved on the FERS (control: 6.9%; experimental: 7.2%).

Subjective experience

The subjective experiences of the experimental and control groups after 5 weeks of training are presented in Table 2. No significant differences on subjective judgment driving abilities, content, performance, safety, and comfort were found between the groups.

Discussion

The present study showed that an electric scooter simulation program has the potential to improve the driving abilities in stroke patients with mobility problems. In addition, it can be concluded that the patients with stroke were satisfied with the electric scooter simulation training. After 5 weeks of training, both groups (control and experimental) improved equally on the functional evaluation rating scale. The results of the present study are in accordance with previous studies regarding the use of VR in training people how to handle powered wheelchairs. Hasdai et al evaluated the ability of a basic driving simulator program (2D) to train and evaluate children with disabilities in their ability to operate a powered wheelchair.[6] After 12 weeks of simulator training, inexperienced children with progressive muscular dystrophy or cerebral palsy showed a marked improvement in their driving performance. Webster et al. showed that stroke patients with unilateral neglect who had received VR training on a 2D display hit significantly fewer obstacles on their left side than did participants in the control group.[7] Finally, Harrison et al. tried to address the efficacy of VR in training patients with neurological impairments to improve their ability to use their wheelchair independently.[1] Results showed that maneuverability tasks within a virtual environment proved more challenging than when the same tasks were completed in real life. Although this field of research appears to be in its early stages (small studies; feasibility and proof of concept studies), the above-mentioned clinical studies[1,6,7,8] show that the positive training effect in a simulator may improve performance in real-life driving situations. A plausible rationale of the advantages of learning by means of VR technology is given by Holden.[10] She states that VR has the potential to increase the number of repetitions, include augmented feedback, and motivate patients, which are all important factors for (motor) learning. In summary, the present study shows that virtual reality has the potential to improve driving skills in stroke patients.

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Disclosure Statement

The authors have no conflict of interest.

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