Development of a System To Train Lower Limbs in Stroke Patients

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Introduction

Stroke is the second-leading cause of death in the world. Rehabilitation is crucial after a stroke and involves various interventions and is dependent on the location of the lesion. These interventions aim to improve strength, balance, coordination, endurance, the flexibility of both upper and lower limbs, speech and many cognitive functions. Exergaming has gained popularity in recent years among the many intervention methods available. Scientific evidence shows that combining physical training with a video game in rehabilitation increases training intensity while improving patients' enjoyment. Moreover, an exergaming system can be developed to continue rehabilitation at home. However, no mobile device-based system that can be used anywhere is currently available to train lower limbs. Therefore, this master's thesis aimed to develop a new, easy-to-go exergaming tool for stroke patients, which can be used to train lower limbs independently at home.

Materials and Methods

As a first step, the Smart Sensory Mat (SSM) was constructed (Fig. 1, left) based on the Smart Sensory Egg (SSE), an existing rehabilitation system. The corresponding app was developed with three games for lower limb training (figure 1, right). Finally, the newly developed system was tested in a clinical evaluation for its usability and feasibility by the System Usability Score (SUS) and the Post-Study System Usability Questionnaire (PSSUQ).

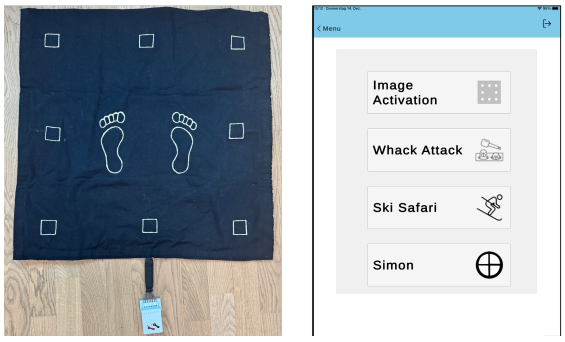

Fig. 1 Left: Layout of the Smart Sensory Mat. Right: Game menu scene from the SSM training app to choose between the games Whack Attack, Skisafari, or Simon.

Results

In the clinical evaluation for the usability and feasibility of the SSM, four stroke and one TBI patients (age Mdn = 61, IQR = 60-67) and seven healthy participants (age Mdn = 62, IQR = 60.5-63) were included. The patients had a low level of cognitive impairment (MoCA = 21 (IQR = 19-24), NIHSS = 1 (IQR = 1-7.5)). Overall, the SUS from patients (Mdn = 75, IQR = 75-85) and healthy participants (Mdn = 90, IQR = 82.5-93.75) indicate good usability (Fig. 2). No statistically significant correlations were found between the SUS scores and demographic characteristics (age, MoCA, NIHSS, duration post-stroke).

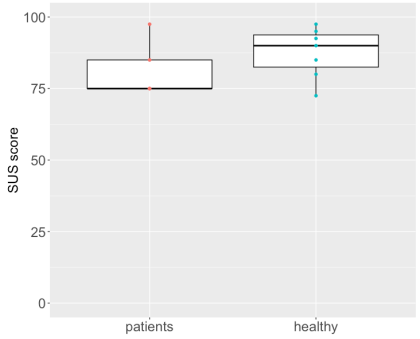

Fig. 2 Strip chart with a boxplot of the System Usability Score from patients and healthy participants.

Discussion

The SSM demonstrates exceptional usability for both stroke patients and healthy individuals. These findings align with a previous study [1] on usability with a similar rehabilitation system. There were no correlations between demographic factors - such as age, severity of the disease, duration since the stroke, and usability. This suggests that the SSM is likely to be an appropriate tool for a broad range of stroke patients.

References

[1] J. Seinsche, E. D. de Bruin, E. Saibene, F. Rizzo, I. Carpinella, M. Ferrarin, S. Moza, T. Ritter, and E. Giannouli. A Newly Developed Exergame-Based Telerehabilitation System for Older Adults: Usability and Technology Acceptance Study. JMIR Human Factors, 10:e48845, 12 2023.

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