# Development of a System To Train Finger Movements in PD Patients

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## Introduction

Parkinson's disease (PD) is the second most common neurodegenerative movement disorder and currently, there exists no curative treatment. Patients with PD suffer from significantly reduced coordination in finger movements, whereas studies have shown that intensive, task-specific home training affects finger movement positively. However, there is a lack of systems to increase the training intensity of finger movements at home. To fill this gap, a Smart Sensory Egg (SSE) for training finger movements was developed. This master thesis aims to develop a rehabilitation system based on the SSE to train finger coordination and movement of patients independently. It is hypothesized that the developed rehabilitation system is simple and intuitive to be used for patients suffering from neurodegenerative diseases.

## Materials and Methods

First, the existing rehabilitation system was evaluated, and the requirements were redefined. Based on these requirements, a new app was developed. A database was created with which individual training programs could be compiled from different exercises (Figure 1). Finally, the usability and feasibility of the rehabilitation system (Smart Sensor Egg and new app) were investigated in a clinical study by the System Usability Score (SUS) and the Post-Study System Usability Questionnaire (PSSUQ). As the Smart Sensor Egg trains hand and finger dexterity and coordination, the group of potential users was expanded. In addition to patients with Parkinson's disease, the system was expanded to include patients with multiple sclerosis (MS), stroke, and traumatic brain injury (TBI).

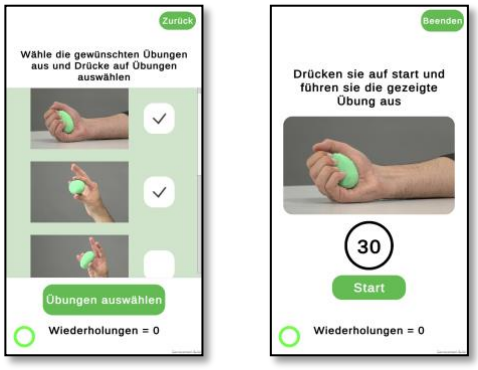


*Fig. 1 Two example scenes from the newly developed app. Left: Database from which individual training programs can be compiled. Right: Example of an exercise scene with video and exercise timer.*

## Results

In total, to assess the Usability and feasibility 15 patients (7 PD, 4 Multib, 3 Stroke, 1 TBI) (*Mdn* = 63, *IQR* = 45.5-66) and 15 healthy participants (*Mdn* = 57, *IQR* = 42-62.5) were included. The participants had a low level of cognitive impairment (MDS-UPDRS3: 22, EDSS: 1, NIHSS: 3).

Overall, high SUS scores were obtained both in healthy participants (*Mdn* = 92.5, *IQR* = 88.75-95) as well as patients (*Mdn* = 85, I*QR* = 78.75-95). No significant difference in the SUS score could be found across the different age groups (Figure 2) (chi-squared = 1.3927, p = 0.50, df = 2)

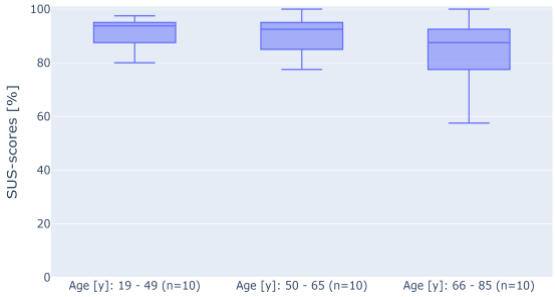


*Fig. 2 System Usability Score (SUS) of different age groups. A high SUS score is displayed across all age groups.*

## Discussion

There was no correlation between the type of disease, severity of disease, or age of patients on usability, indicating that the tested rehabilitation system is suitable for a broad population. This is further supported, that the system was in line with other usability studies of app-based dexterity training [1]. Overall, due to the high usability close to the maximum of the score scale, the rehabilitation system has great potential for the rehabilitation of patients suffering from neurodegenerative diseases.

## References

[1] L. Saric, S. E. Knobel, M. Pastore-Wapp, T. Nef, F. W. Mast, and T. Vanbellingen. Usability of two new interactive game sensor-based handtraining devices in parkinson's disease. Sensors, 22(16):6278, 2022.

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