



TECHNICAL INNOVATIONS IN STROKE REHABILITATION - AN INTERDISCIPLINARY APPROACH TO THE ADVANCEMENT OF BRAIN-COMPUTER INTERFACES (BCI) IN CONJUNCTION WITH FUNCTIONAL ELECTRICAL STIMULATION (FES)

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DoI: <https://doi.org/10.5281/zenodo.7783050>

Introduction: Stroke is one of the most common causes of death in Germany and in industrialized countries. An estimated 24,300-26,000 people suffer a stroke in Germany every year. Affected people often suffer particularly from functional motor impairments of the upper extremities. Newer approaches such as BCI-FES systems aim to establish a communication channel between the brain and external devices without neuromuscular interventions. Brain electrical activity is measured, processed, translated into control signals, and an external electrical impulse is triggered painlessly.

Methods: Three main work packages were implemented across three faculties at the University of Applied Sciences Zwickau. The faculty of physical engineering/computer science was responsible for the conceptual design of the software application for a self-learning BCI. The faculty of electrical engineering developed the stimulation generator for the electronic impulses. The faculty of health and healthcare sciences was responsible for usability and health services research. In a mixed-methods design (explorative design), first eight guided expert interviews were conducted in a hospital with a supra-regional stroke unit, which served to explore necessary requirements for a BCI-FES system from the users' point of view. Subsequently, the explored requirements were tested for their generalizability in a quantitative survey. The results of the qualitative sub-study were incorporated into the hypothesis generation and questionnaire construction of the quantitative sub-study. An invitation to the quantitative online survey was sent by e-mail to 95 chief and senior physicians from the field of neuromedicine in rehabilitation facilities nationwide. Data were analyzed descriptively.

Results: Physicians were largely receptive to the new technical rehabilitation systems. They considered it not only important that the system works. They also want to understand how the system works as well as how it makes sense, and in doing so, they are willing to invest their time to try out the new features of the technical rehabilitation systems. The system should be motivating for the patient, easy to use, quick to apply, evidence-based, and provide meaningful movement. Concerns were expressed that patients in the acute phase after a stroke, on the one hand, do not understand the system's procedures and, on the other hand, have too high expectations of the system. Stroke patients in rehabilitation phase C and all patients who are able to understand the language requirements were considered the most appropriate patient group.

Discussion: BCI-FES systems have the potential to be used in the future as an adjunct to existing approaches in the rehabilitation of stroke patients. The reduction of the currently still high preparation time of the prototype in relation to therapy times as well as an improved definition of correct electrode placement will contribute significantly to make the system successively more practical. Thus, a user-friendly and -defined therapy can be ensured by BCI-FES systems.