Symposium: Brain-Computer Interfaces in neurological disease: Applications and rehabilitation approaches

For the treatment of chronic or acute neurological disease, such as stroke, multimethodological interventions are usually implemented in clinics or outpatient medical care. These approaches such as neuropsychology, speech therapy, occupation therapy and physiotherapy are proven to be effective and therefore, are usually available for patients in need. However, these approaches mostly target the periphery and therefore, indirectly support changes in the brain. Brain-computer interface based approaches on the other hand, directly use brain activity. Thereby, they can be used as a neurofeedback based rehabilitation tool and specific brain activations can be trained to support plasticity in the damaged brain. Additionally, BCIs can be used for communication in case of motor impairment as brain signals can be translated into messages and thus, allow for interaction with the environment. Using BCI as a communication tool is useful for patients who are paralyzed due to for example Amyotrophic Lateral Sclerosis or patients with other neurological disease affecting communication such as Cerebral Palsy. The latter group is challenging to be included in BCI studies as involuntary and sudden movements might produce artefacts and thereby, prevent high signal quality. Data assessment and sensors need to be smart and special methods of data filtering are required.

In this symposium, we will present BCI based neurofeedback rehabilitation approaches in stroke patients, BCI based communication in people with Cerebral Palsy and we will discuss the specifications and specialties a BCI system needs to fulfill when assessing data in patients with chronic neurological disease.

Speakers:

- Natalie Mrachacz-Kersting, Associate Professor, Aalborg University
- Sonja Kleih, Post-Doctoral Researcher, University of Würzburg
- Cornelia Kranczioch**,** Head of the Brain Function, Maintenance & Recovery Group, University Oldenburg
- Reinhold Scherer, Professor, Essex University

Abstracts:

Professor Scherer:

Title: User-centred design meets thought-based interaction

When successfully implemented, brain-computer interface (BCI) technology has a significant impact on the life of people; all the more for persons with paralysis that cannot use conventional

human-computer interaction devices. However, the transfer of BCI technology from the laboratory to real applications was not so successful. Individual and environmental factors always present new challenges. In this talk, I describe our user-centred design efforts to develop BCIs for people with cerebral palsy.

Dr. Mrachacz-Kersting:

Title: Brain Computer Interfaces for Neurorehabilitation in sub-acute stroke patients

Abstract: Brain-Computer Interfaces (BCIs) have emerged as a promising tool for the restoration and replacement of lost motor function in patient populations such as those suffering stroke. A variety of control signals have been extracted from the ongoing electroencephalographic (EEG signal) both in the frequency and time domain. In this talk I will present the approach we have taken from the basic idea and the underlying neurophysiology to the final BCI tested in clinical populations. I will demonstrate why knowledge of the mechanisms behind memory and learning is vital for the development of rehabilitation technology, specifically BCIs, and further how factors such as plasticity induction, fatigue or even tremor may greatly impact on the system accuracy.

Dr. Kranczioch:

Title: Neurofeedback training at home in chronic stroke with mobile EEG

Motor imagery (MI) with neurofeedback is a promising add-on therapy for motor recovery after stroke. To advance its use outside the lab, we implemented a frequent and efficient neurofeedback training that was run at patients' homes. In a feasibility study, three chronic stroke patients practiced every other day over a 4-week period and participated in pre- and post-training assessments of behavior, brain function and brain structure. Two of the patients showed changes in neural activation patterns in line with an increasing involvement of the ipsilesional hemisphere, though to different degrees. Of these two, one showed a substantial clinical improvement of upper limb motor function. Though preliminary, these results show great promise for the benefit of mobile, wireless EEG for neurorehabilitation applications.

Dr. Kleih:

Title: BCI-based Neurofeedback in patients with post-stroke aphasia

In the here presented work, we used a P300 based Brain-Computer Interface (BCI) system as a rehabilitation application for patients who were diagnosed with post-stroke aphasia. Results are highly varying inter-individually with some patients showing an improvement in spontaneous

speech and other showing no changes after as compared to before the BCI based intervention. Chances, challenges and limitations of this approach will be presented.