PhD Project in the Hummel Laboratory of Clinical Neuroengineering

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Project: ‘Home-based application of non-invasive brain stimulation to enhance learning’

Stroke is the leading cause of long-term disability with a significant impact on the professional and private life of the patients and on the society. Despite the development in the acute therapy, the long-term outcome is still limited. It has been clearly shown, that the amount of neurorehabilitative training correlates with the improvement in function [1]. Furthermore, evidence has been provided, that the effects of training and learning can be enhanced by non-invasive brain stimulation [2-4]. Taken together these two points, the ideal case scenario for treatment to achieve large amount of training time combined with brain stimulation would be a home-based neurorehabilitative training combined with self-application of non-invasive brain stimulation to enhance functional regeneration of the patients.

In the present project, we plan to develop and test experimentally strategies of home-based training combined with self-application of transcranial direct current stimulation in patients suffering from brain injury, such as an ischemic stroke, to enhance functional regeneration. To develop novel strategies to enhance recovery after a stroke it is mandatory to better understand the underlying mechanisms. Therefore, multimodal imaging by means of transcranial magnetic stimulation (TMS) [5-7], structural and functional MRI [8-12], will be used to determine the effects underlying the processes of learning and functional regeneration.

The goal of the present PhD project is to develop a home-based neurorehabilitative training combined with self-application of non-invasive brain stimulation in chronic stroke patients with a relevant impairment of the upper extremity. A further goal will be the development of a remote control for self-application of NIBS. To better understand the underlying mechanisms of this intervention, we will use a multimodal systems neuroscientific approach. This project has great potential towards translation from ‘bench’ to the real clinical world. Furthermore, there will be important insights into neuroplastic changes to support functional regeneration and lastly, there will also be a relevant part for technical development for the home-based, self-application and its remote control.
Fig. 1: Concept of home-based neurorehabilitative treatment combined with self-application of NIBS

References

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Project: ‘Modulation of interregional interactions by means of non-invasive brain stimulation in stroke patients’

Stroke is the leading cause of long-term disability with a significant impact on the professional and private life of the patients and on the society. Despite the development in the acute therapy the long-term outcome is still limited.

To develop novel strategies to enhance recovery after a stroke it is mandatory to better understand the underlying mechanisms. It became more and more clear that the ictal event during a stroke does not only have local effects but also remote effects by disturbance of interregional connectivity. Thus, future therapies might have a much stronger impact on recovery, if they take this into account and try to reinstate the physiological network interactions.

Non-invasive brain stimulation (NIBS) has the potential to enhance neuroplasticity, local activation and also interactions between brain areas [1, 2]. First evidence has been, that impaired hand function and rehabilitative training and functional regeneration can be enhanced by application of NIBS to the motor cortex [3-6].

Functional and structural imaging provided clear evidence that interregional interactions within the motor system bi-hemispherically are significantly involved in the process of functional regeneration. Thus, modulation of interregional interactions relevant for functional regeneration might enhance the magnitude of regeneration in stroke patients.

The goal of the present PhD project is to apply NIBS by means transcranial electric stimulation (tECS) to enhance interregional interactions and functional regeneration. To determine the effects of this approach, a multimodal systems neuroscientific approach will be used with structural and functional imaging [7-9] and behavioral evaluation in chronic stroke patients.
Fig. 1: Overview of analyses of structural integrity within the motor network in stroke patients adapted from Koch, Schulz and Hummel (2016)[10]

References