Project title: *Developing brain-computer interface-based gaming applications for the severely disabled integrating neuro- and computer-science methods*

Project leader: Bettina Sorger, PhD

Function: Assistant professor

Collaborators: Prof. Dr. Rainer Goebel (Faculty of Psychology and Neuroscience, Maastricht University)
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Proposal (250 words):

Introduction: Severe motor paralysis is a rare but terrifying condition dramatically hampering the quality of life of affected patients. In extreme cases, patients can only rely on so-called brain-computer interfaces (BCIs), systems in which the patient's brain signals are used to control and interact with the environment. In such systems, brain signals are acquired by means of functional neuroimaging methods. BCI research has made promising progress over the past years. However, much room for improvement and extension is left.

Hypothesis and Objectives: Substantial progress in the field of brain-computer interfacing can be made by creatively combining advanced neuro- and computer-science methods. As an example, the proposed PhD research will design, develop and experimentally test novel BCI-based gaming applications to provide entertainment possibilities for the severely disabled.

Setting and Methods: The possibility to use brain signals to control a game will be realized by exploiting brain hemodynamics (which our research group has particularly focused on in the last 15 years), as measured with fMRI and fNIRS, and employing mental imagery and selective attention to generate distinct brain signals. Single- and dual-player BCI-based interactive gaming applications will be developed, the latter making hyperscanning (*i.e.*, simultaneous measuring two individuals) necessary. To realize flexible and attractive BCI-based gaming applications, we will implement suitable computer algorithms as well as virtual and augmented reality.

Impact: The newly developed BCI methods and applications will not only be beneficial for patients having lost crucial motor functions, but might also result in uses for healthy individuals, *e.g.*, in the context of neuroenhancement and entertainment.

Requirements candidate:

- High affinity with/interest in (neuro)science and technology
- Background in neuroscience, computer science or technical engineering
- Proactive/collegial working attitude
- Good English communication skills

Keywords:

Neuroscience, Brain-Computer Interfacing, Functional Brain Imaging, Real-time Data Analysis, Machine Learning, Mind Reading, Gaming Computer Science, Virtual Reality, Augmented Reality

Top 5 selected publications [***impact factor; number of citations***]**:**

1. **Sorger, B.**, Dahmen, B., Reithler, J., Gosseries, O., Maudoux, A., Laureys, S., Goebel, R. (2009). Another kind of 'BOLD response': answering multiple choice questions by generating differential single-trial fMRI responses. *Progress in Brain Research*, 177, 275-292. [**4.2**; **80**]
2. Goebel, R., Zilverstand, A., **Sorger, B.** (2010). Real-time fMRI-based brain-computer interfacing for neurofeedback therapy and compensation of lost motor functions. *Imaging in Medicine*, 2, 407-414. [no IF, **17**]
3. **Sorger, B.**, Reithler, J., Dahmen, B., Goebel, R. (2012). A real-time fMRI-based spelling device immediately enabling robust motor-independent communication. *Curr Biol*, 22, 1333-1338. [**9.7**; **55**]
4. Riecke, L., Peters, J.C., Valente, G., Kemper, V.G., Formisano, E., **Sorger, B.** (2017). Frequency-selective attention in auditory scenes recruits frequency representations throughout human superior temporal cortex. *Cereb Cortex*, 27, 3002-3014. *[**7.9**; **4**]*
5. **Sorger, B.**, Kamp, T., Weiskopf, Peters, J.C., N., Goebel, R. (in press). When the brain takes 'BOLD' steps: Real-time fMRI neurofeedback can further enhance the ability to gradually self-regulate regional brain activation. *Neuroscience*. *[**3.3**; **3]***