New avenues towards mobile brain computer interfaces

SUMMARY

The focus of this thesis was to create and advance methods for real-time BCI applications for two functional brain-imaging modalities, fMRI and fNIRS, both relying on the hemodynamic brain response. First the automatized selection of target areas for rt-fMRI BCI applications was described followed by the technological advancements in MR-image acquisition allowing for more sensitive and specific neurofeedback presentations, and at the end the mobile BCI applications using Turbo-Satori and fNIRS – a method which also has high temporal resolution.

Chapter 2 described two methods to automatize the selection of ROIs for BCI applications. Even though the manual expert selection still achieved better accuracies as compared to automatic selection, future developments may close this gap, e.g., by adding real-time adaptations to the ROI selection, and allow for fully automatized procedures were the BCI operator only has a quality-control and participant-handling task.

Chapter 3 shaded light on the technological advancements in fMRI neuroimaging methods allowing for much shorter TRs. It was shown that there is a clear benefit of using very short TRs, namely the potential to explain more variance with respect to the known sources contributing to the MR signal and a clearer picture of the underling hemodynamic couplings and the HRF. This is especially important for neurofeedback applications allowing to control for BOLD changes artificially induced by physiological adaptations (conscious or unconscious).

The last chapter focused on applying high-sampling rates in mobile applications, that would allow performing experiments, for example, investigating real-world social interactions, in which free movement is a substantial element (e.g., playing an instrument or doing sports), which are not possible to conduct in an MRI environment because participants need to lie down and cannot move. A software toolbox called Turbo-Satori was developed and introduced, serving as the real-time analysis software for fNIRS data allowing performing real-time fNIRS BCI and Neurofeedback experiments.