The good placement

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Summary

A brain-computer interface (BCI) is a system that measures and converts brain activity into artificial output that replaces, restores or enhances natural central nervous system output. Thus, BCIs have the potential to ultimately restore communication and control in the absence of words/gestures and other motor actions to people with severe neuromuscular disabilities. Functional near-infrared spectroscopy (fNIRS) is a promising functional-neuroimaging modality for this objective that has been used for BCIs in healthy participants and in few occasions, in clinical settings. This is because there are substantial challenges associated with fNIRS-based BCIs in everyday situations, such as home-use or hospital settings. This dissertation outlined progress to overcome some of these obstacles. In **Chapter 2**, we evaluated factors that can improve the feasibility of ecologically-friendly fNIRS-based BCIs. We evaluated short task-duration periods alongside augmented-reality (AR) technology that enables a more immersive setup. Further, we evaluated the feasibility of using a single mental-imagery task and fNIRS channel to select an option in each level. For that, we used a temporal en- and decoding approach. This proof-of-concept study revealed that participants can successfully control the BCI system with a single fNIRS channel and motor-imagery task when using a relatively short task duration (6s) while achieving a promising mean classification accuracy of 74%. Positive reports from study participants suggest that AR is a promising and feasible technology to enhance user experience for fNIRS-BCI applications. This work conveys fundamental steps towards developing fNIRS-based AR-BCI systems to be used as communication and control devices in a clinical setting or for home-use. In **Chapter 3**, we investigated how different quantities of individualized MRI-based data influence the optode placement and in turn, fNIRS signal quality and sensitivity to detect brain activation. This work revealed that acquiring additional individual MRI data leads to better outcomes and that not all the modalities tested are necessary to achieve a robust setup. Finally, in **Chapter 4** we assessed whether the quantity of unwanted physiological noise present in the fNIRS signal depends on the proximity and density of vascular structures around optodes. Further, we tested if this relationship affects one particular physiological noise-correction approach: short-separation regression (SSR). This approach uses short-distance fNIRS channels (SDCs) to regress out physiological noise from normal-distance channels (NDCs). We examined three sources of

physiological noise: Mayer waves, respiration and heartbeat. Our analyses indicated that the Mayer-wave amplitude captured by SDCs was related to the presence and density of vascular structures in their vicinity for oxyhemoglobin data only. We did not find any evidence that the reduction of physiological noise in NDCs after SSR is related to the presence of vascular structures. This chapter therefore extends our knowledge of the relationship between the vasculature features and the presence of physiological noise in fNIRS channels. Taken together, the three empirical studies provide insights that can contribute to the advancement of data acquisition and analysis strategies to improve the applicability of fNIRS-BCIs to everyday situations.