Hemodynamic brain-computer interfacing for the severely disabled: information-encoding paradigms, sensory-input modalities and functional brain-imaging methods

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Abstracts:
Hemodynamic brain-computer interfaces (BCIs) based on real-time functional magnetic resonance imaging (fMRI) are currently being explored in the context of developing alternative (motor-independent) communication and control means for the severely disabled. In such systems, the BCI user (guided by visual, auditory or tactile cues) encodes a particular intention through generating a specific mental activity – resulting in a distinct brain state that can be decoded in real-time from the measured brain activation. To hemodynamically encode separate intentions, mainly mental-imagery paradigms have been used – systematically modulating either magnitudinal (Goebel et al., 2004; Sorger et al., in press), spatial (Yoo et al., 2004; 2012; Lee et al., 2009) or temporal (Bardin et al., 2011, Sorger et al., 2009; 2012) fMRI-signal features. Visual-, auditory- and tactile-attention paradigms have been tested in this context as well (Monti et al., 2013; Naci et al., 2013; Sorger et al., 2010; 2014). Recently, not only conventional but also (ultra) high-field fMRI has been employed for hemodynamic brain-computer interfacing. The ultimate goal, however, is the transfer of the methodology to more mobile and cost-effective functional near-infrared spectroscopy (fNIRS) – a functional brain-imaging technique also measuring brain hemodynamics.