A Wearable Multi-channel NIRS Imaging System for Brain Imaging in Freely Moving Subjects

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Although (f)NIRS has often been cited as portable and suitable for unconstrained experimental settings, probably most of the NIRS setups employed in neuroscientific research still offer a restrained setting. Typically, the subject is tethered by not very flexible or lightweight fiberoptic cables to a more or less stationary instrument[1].While restrained settings with a portable but stationary instrument might be well feasible for bedside monitoring, they hamper imaging in a more natural environment, e.g. during sports or physical therapy, or when imaging children. Developments towards miniaturized probe arrays or instruments have been reported before, however, usually at the cost of limited measurement channels or restricted specific portions of the head[2-4]. We here present a new, miniaturized, portable diffuse optical NIR tomography system that allows brain imaging in freely moving subjects. The performance of the instrument is demonstrated on N=7 subjects in a hand gripping motor paradigm on a bicycle performed during three conditions: (i) outdoor bicycle riding, (ii) indoor stationary paddling and (iii) rest.

NIRS imager and controlling notebook computer were contained in a backpack worn by the subjects. Eight sources and eight detectors were arranged in two groups around positions C3 and C4 of the extended international EEG 10-20 system to ensure coverage of the primary motor areas of both hemispheres. The paradigm during biking consisted of 10 repetitions of 20 s of self-paced (approx. 1 Hz) left-hand clamping followed by 40 s of rest.

Results show a significant relative HbR decrease over the contra lateral sensory motor cortex in each condition revealing a clear focal activation to left hand clenching. The observed time courses show the prototypical increase in HbO and decrease in HbR in response to neural activation. The HbR decrease is largest in the outdoor cycling condition and lowest at rest

To the best of our knowledge, this is the first outdoor demonstration of NIRS brain imaging on freely moving subjects. A truly portable and miniaturized NIRS technique opens new perspectives to study sensory or cognitive paradigms in realistic environments and furthermore promise clinical uses as a monitoring tool in neuro-rehabilitation and intensive care units.

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