Wearable neuroimaging: combining and contrasting magnetoencephalography and electroencephalography

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Functional neuroimaging techniques, such as magnetoencephalography (MEG), require participants to remain very still during measurements to avoid loss of data quality. This limits utility in some experimental cohorts that can be scanned, particularly children, and the experimental questions that can be addressed. For these reasons, the use of 'wearable' neuroimaging, in which participants can move freely during scanning, is attractive. The most successful example of wearable neuroimaging is electroencephalography (EEG), which employs lightweight and flexible instrumentation that makes it usable in almost any experimental setting. However, EEG has major technical limitations compared to MEG, and therefore the development of wearable MEG, or hybrid MEG/EEG systems, is a compelling prospect. We have previously developed a new generation of prototype MEG system [1], based on optically-pumped magnetometers (OPMs) [2] which can be mounted on the scalp and if background fields are appropriately nulled [3] MEG data can be acquired even when individuals move their head freely. However, most OPMs are relatively large and require individualised 3D-printed helmets to mount the sensors. Further, the cabling is relatively heavy, making OPM-MEG hard to deploy. We have combined and compared EEG and MEG measurements made using a new generation of OPMs, which are smaller and lighter than previous commercially-available OPMs. We show that this new generation of commercial OPMs can be mounted on the scalp in an 'EEG-like' cap, enabling the acquisition of high fidelity electrophysiological measurements, even without trial averaging. We show that these sensors can be used in conjunction with conventional EEG electrodes, offering the potential for the development of hybrid MEG/EEG systems. We compare concurrently measured signals, showing that, whilst both modalities offer high quality data in stationary subjects, OPM-MEG measurements are significantly less sensitive to artefacts produced when subjects move.

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[2] J. Osborne et al, Fully integrated, standalone zero field optically pumped magnetometer for biomagnetism, Proc. SPIE **10548**, (2018).
[3] N. Holmes et al, A bi-planar coil system for nulling background magnetic fields in scalp mounted magnetoencephalography, NeuroImage, **181**, 760-774 (2018).