Naturalistic hyperscanning with wearable magnetoencephalography and matrix coil magnetic field control

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The evolution of higher cognitive function in humans is reliant on complex social interactions which form the behavioural foundation of who we are as individuals, yet, their supporting neural substrates remain poorly understood. Hyperscanning allows simultaneous assessment of brain function in two interacting individuals, but present technologies are extremely limited by performance (e.g. EEG), or unnatural scanning environments (e.g. MRI).

Wearable magnetoencephalography based on arrays of optically pumped magnetometers (OPM-MEG) has shown potential to allow large participant motion, enabling exciting neuroscientific studies whilst providing high-quality data. However, the strict zero magnetic field environment which is required by OPMs means systems are not only housed inside a magnetically shielded room (MSR) but also require active magnetic shielding in the form of electromagnetic coils. Typically, coil systems are designed to cancel the remnant magnetic field of the MSR in a small volume, severely limiting opportunities for flexible experimental design, participant movements and hyperscanning.

Here we present the first naturalistic MEG hyperscanning studies enabled by our "matrix coil" active shielding system. The matrix coil is formed from a series of 48 square unit coils placed around two participants, the individual coil currents are chosen to simultaneously null the magnetic field in the MSR at two locations thus enabling the scanning of two freely moving participants. Results obtained when two participants undertook a guided-touch task and an interactive ball game demonstrate the unique effectiveness of our hyperscanning method, which has the potential to extend dramatically our understanding of human social interaction.

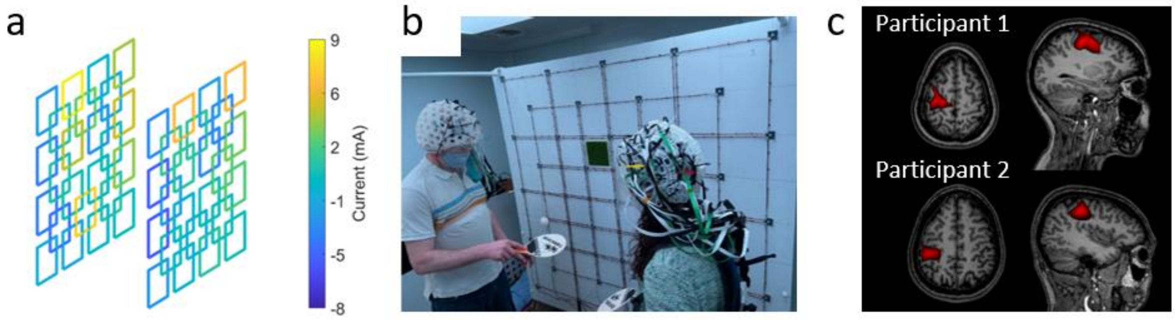

Figure 1: OPM-MEG scanning of real-time interactions. a) The 48-coil bi-planar matrix coil system. The current in each coil is individually controlled to generate the required field in order to cancel the remnant magnetic field inside the MSR. b) Two participants each held a table-tennis bat in their right hand and hit the ball back and forth to each other; a 5 s rally was followed by 7 s rest. c) The spatial pattern of measured data suggests activation in the sensorimotor regions during the rally.