A new tool for functional brain imaging with lifetime compliance

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The human brain undergoes significant functional and structural changes in the first decades of life, as the foundations for human cognition are laid down. However, non-invasive imaging techniques to investigate brain function throughout neurodevelopment are limited due to growth in head size and substantial head movement in young participants. Experimental designs to probe brain function are also limited by the unnatural environment that typical imaging systems impose. By using optically-pumped magnetometers (OPMs), we have previously developed a wearable magnetoencephalography (MEG) system that removes the need to remain still during an experiment, allowing for more naturalistic tasks to be performed [1,2]. However, this required bespoke, 3D-printed helmets for each participant which were heavy, uncomfortable and costly. Here, we use generic, modified bicycle helmets that are suitable for a range of ages to securely house the sensors on the participant's head. We demonstrate how our redesigned system can be used to scan individuals across the lifespan through several experiments. First, we perform a maternal touch paradigm in young children (2- and 5-years old) in which the mother strokes the child's right thenar eminence for 2 s followed by a 3 s rest. Next, we design an interactive game in which a 14-year-old participant 'shoots' targets as a crosshair moves across a screen by moving their finger up and down. The finger movement is detected by a motion tracking camera to mark the onset and offset of movement in the data, as well as cueing events in the paradigm. Finally, we present a motor learning paradigm where a 24-year-old participant plays a sequence of 5 chords on a ukulele. The participant has 5 s to play the chords and must stop regardless of whether the sequence was completed. This paradigm exploits the large range of motion that is possible using our OPM-MEG system.

[1] E. Boto et al, Moving magnetoencephalography towards real-world application with a wearable system, Nature, **555**, 657-661 (2018).
[2] N. Holmes et al, A bi-planar coil system for nulling background magnetic fields in scalp mounted magnetoencephalography, NeuroImage, **181**, 760-774 (2018).