Beta-band dynamics during motor learning

Ryan M. Hill[1], Elena Boto[1], Niall Holmes[1], Charlie Stagg[2], Mark Woolrich[3], and Matthew J. Brookes[1]

[1]Sir Peter Mansfield Imaging Centre, School of Physics and Astronomy, University of Nottingham, University Park, Nottingham, NG7 2RD, United Kingdom
[2]Wellcome Centre for Integrative Neuroimaging, Department of Psychiatry, University of Oxford, UK

University of Nottingham
Sir Peter Mansfield Imaging Centre

UNIVERSITY OF OXFORD

Overview

ryan.hill1@nottingham.ac.uk

OPMs offer a new generation of magnetoencephalography (MEG) instrumentation with better data quality, lifespan compliance, and a route to more naturalistic neuroscientific experimentation – the latter enabled because subjects are free to move during a scan. In this work, we aimed, for the first time, to assess brain oscillatory dynamics whilst a subject learned to play a musical instrument.

Methods

- 3 participants took part in the study, each scanned 5 times on consecutive days. The task involved repeatedly playing a sequence of 5 chords on a ukulele (as in Hill et al., Nature Comms., 2019)
- A visual representation of the chords was displayed on a screen and the participant had to complete the sequence in a specified time
- This task involved significant head movement, as the participant looked at chord patterns on the screen, and then to their fingers to form the chords. Nevertheless, we were able to collect high fidelity data.
- Audio was recorded in order to 'score' trials based on how many correct notes were played in the sequence
- Trials were split into the lowest scoring and highest scoring trials to compare the brain response
- Trials were defined by movement cessation, determined using a motion tracking camera

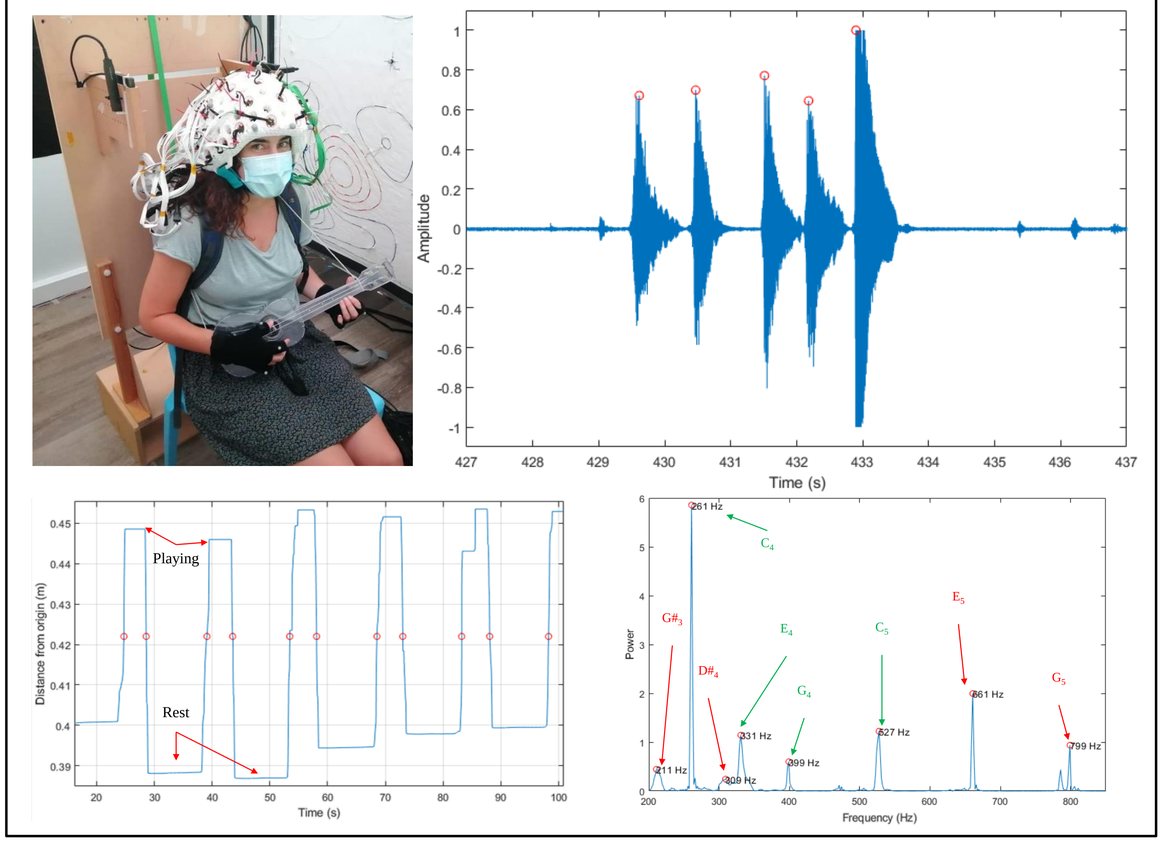

Figure 1: (Top Left) Participant setup. (Top Right) Recorded audio with chord peaks identified. (Bottom Left) Motion tracking data showing playing and rest regions. (Bottom Right) Frequency analysis of the first peak in the top right image. Note frequencies identified to score the trial.

Results

- Modulation of beta band (13-30 Hz) neural oscillations was localized to primary motor cortex
- We were able to measure the expected response which involves a drop in beta amplitude during the task followed by an increase above baseline (the beta rebound) on task cessation
- Further, we observed that the amplitude of the beta rebound, in two of the three subjects, was significantly modulated by the way in which the chords were played, with poorly played chords eliciting a smaller rebound

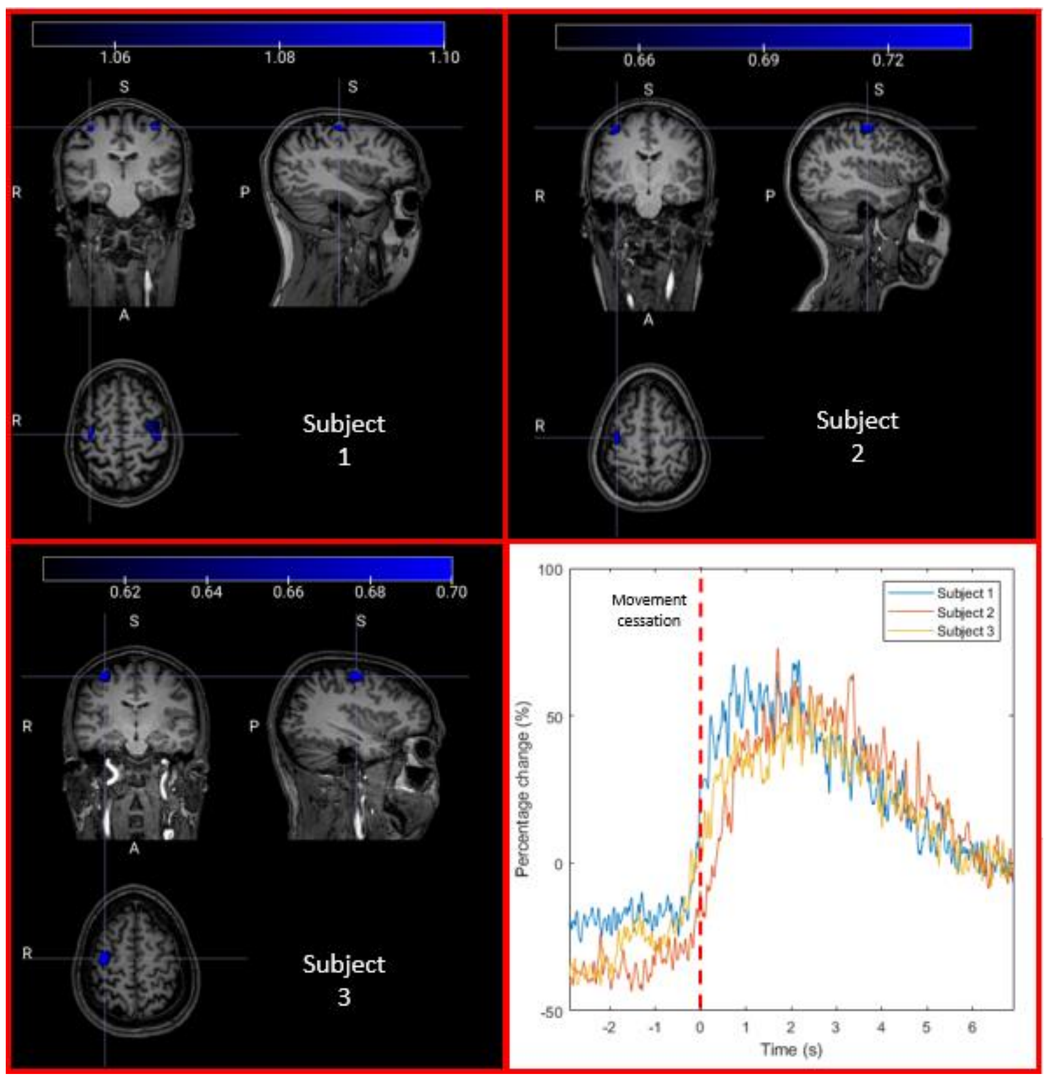

Figure 2: Functional images showing the spatial signature of beta modulation during the task for all 3 subjects. Bottom right shows time courses of beta amplitude. Note that there is a reduction in beta amplitude when the subject is playing the chords, which is localised to sensorimotor cortex.

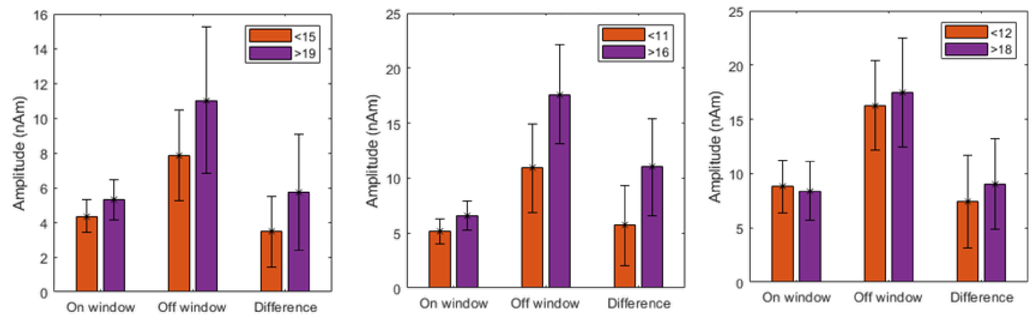

Figure 3: A comparison of the magnitude of the beta rebound for well played, and poorly played chords. Note the measured behavioural difference modulates the beta response.

Conclusions

This study demonstrates the flexibility of OPM-MEG to enable new types of motor learning, and confirms the fact that high quality data can be acquired even in the presence of large head movement.

QUSPIN
UK National Quantum Technology Hub in Sensors and Metrology
UK National Quantum Technologies Programme
EPSRC Engineering and Physical Sciences Research Council
MRC Medical Research Council
wellcome