MEG-UKI 2024 Conference

Book of Abstracts

Monday 28th - Thursday 31st October 2024

Contents

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Welcome to MEG-UKI 2024

We're very excited to welcome you to Birmingham for a few days of science and collaboration to celebrate the latest and greatest in MEG.

MEG-UKI is a very special meeting for me, I recently realised I have been attending for more than a decade and it is certainly one of the most influential factors in my career so far. My introduction to MEG research was presenting posters and talks at MEG-UKI in UCL, Cambridge and Nottingham. I remember feeling surprised and lucky to take my first steps into MEG research in such a supportive and encouraging environment. I would surely be doing something else somewhere else if not for this community and this meeting.

We are extremely proud of the programme of talks and poster presentations this year. It reflects the true breadth of topics covered by this field, from sensor physics through to clinical translation and cognitive psychology. More importantly, we hope it reflects the breadth of individuals working in MEG today and in the future. The field gets larger and more diverse each year and I believe that broad representation of ECRs is a large part of that growth.

Finally, I'd like to thank our sponsors for their support of the meeting. We would have very little to talk about without the hardware, equipment and software that we use to collect and analyse our data. Conferences are one of the rare times we can build new connections with industry partners – whether that involves buying imaging systems or asking advice about careers in outside academia. Take a moment to say hello!

So, enjoy the meeting, support your colleagues and be generous with your feedback. I hope you are energised with new connections and new ideas on your journey home.

Andrew Quinn,
On behalf of the MEG-UKI 2024 Organising Committee

Key Information

Registration and Query Desk

Day	Opening Times
Wednesday 30th October	8:30am – 6pm
Thursday 31st October	8:45am – 5:30pm

Conference Social Event

Event	Date/Time	Venue
Conference Dinner	**Wednesday 30th October** 6:30pm – Late	The Fry Suite, Edgbaston Park Hotel, G23 on the campus map

Conference Programme

Wednesday 30th October - MEG-UKI Day 1

Time	Session/Activity	Venue
8:30 - 9:30	Registration and Arrival Refreshments	Great Hall
9:30 - 9:45	**Welcome Talk** Chair: Andrew Quinn	Bramall Concert Hall
9:45 - 10:45	**Main Session 1 – Cognitive** Chair: Yali Pan 9:45 - 10:00 - **Oliver Vikbladh**, University College London - Consolidation of Sequential Planning 10:00 - 10:15 - **Ashley Goneso**, Aston University - Relating attention deficits to the neural basis of attention during working memory tasks. 10:15 - 10:30 - **Lijuan Wang**, University of Birmingham - Fast hierarchical processing of orthographic and semantic parafoveal information during natural reading 10:30 - 10:45 - **Min Wu**, University of Oxford - Neural dynamics during unimanual and bimanual motor learning	Bramall Concert Hall
10:45 - 11:15	Refreshment Break	Great Hall
11:15 - 11:30	**Main Session 2 – Hardware** Chair: Tom Marshall 11:15 - 11:30 - **Denis Schwartz**, Université de Lyon - Helium Optically Pumped Magnetometers: Lightweight and versatile sensors for MEG (Talk sponsored by MAG4Health & BrainBox) 11:30 - 11:45 - **Harry Cook**, University of Birmingham - An optically pumped magnetic gradiometer – neuroscience	Bramall Concert Hall
11:45 - 12:15	**Poster Talks 1** Chair: Tara Ghafar **Dr Olaf Hauk,** Cambridge - Word-category-selective EEG/MEG responses in English language with Fast Periodic Visual Stimulation (FPVS) **Dr George O'Neill**, UCL - Volume conductor models for magnetospinography **Dr Alicia Rybicki**, CHBH - The neural correlates of selective visual attention in natural scenes **Dr Lauren Gascoyne**, Nottingham - A National Facility for OPM-MEG **Ms Vaishali Balaji**, Dusseldorf - Spontaneous Fluctuations in Alpha Peak Frequency Along the Posterior-to-Anterior Cortical Plane **Miss Charlie Reynolds**, CHBH - Seeing Speech in a New Light: Augmenting Speech Performance using Rapid Invisible Frequency Tagging (RIFT) and MEG **Miss Zimo Huang**, UCL - Human hippocampal theta oscillations code distance	Bramall Concert Hall

	to goal during spatial navigation **Dr Catherine Preston**, York - Measuring signals in utero using OPM-MEG **Dr Matias Ison,** Nottingham - Investigating Neural and Cognitive Mechanisms of Free Viewing Tasks Using Concurrent MEG/OPM-MEG and Eye Tracking **Dr Coen Zandvoort**, Oxford - Breathing modulates cortical activity in newborns	
12:15 - 14:00	Lunch and Poster Session	Great Hall
14:00 - 14:45	**Main Session 3 – Clinical** Chair: Ana Pesquita 14:00 - 15:15 - **Michael Trubshaw**, University of Oxford - Cortical neurophysiology distinct from healthy ageing in neurodegenerative disorders 14:15 - 14:30 - **Rebecca Williams**, University of Cambridge - Living in a World of "Close Enough": Apathy and the Bayesian Brain 14:30 - 14:45 - **Sukhvir Wright**, Aston University - "Network -opathy" in autoimmune encephalitis - bench to bedside insights	Bramall Concert Hall
14:45 - 15:45	**Keynote Session** - **Maria Wimber**, University of Glasgow - How the reconstruction of simple event memories dynamically unfolds in human brain and behaviour Chair: Ben Griffiths	Bramall Concert Hall
15:45 - 16:15	Refreshment Break	Great Hall
16:15 - 17:15	**Main Session 4 – Cognitive** Chair: Ole Jensen 16:15 - 16:30 - **Yulia Bezsudnova**, UCL/University of Birmingham - Temporal and spatial features of common semantic categories in words and picture 16:30 - 16:45 - **Eelke Spaak**, Donders Institute - Rapid Invisible Frequency Tagging (RIFT): Perceptual Foundation, Phase Coding, and Prospects for Naturalistic Neuroscience 16:45 - 17:00 - **Danying Wang**, University of Glasgow - Single trial theta phase synchronisation predicts human episodic memory formation 17:00 - 17:15 - **Eleonora Marcantoni,** University of Glasgow - Enhancing memory in humans via MEG-closed-loop Rhythmic Sensory Stimulation (RSS) tuned to the frequency of hippocampal theta oscillations	Bramall Concert Hall
17:15 - 18:00	Business Meeting	Bramall Concert Hall
18:30 - Late	Conference Dinner	Fry Suite, Edgbaston Park Hote

Thursday 31st October - MEG-UKI Day 2

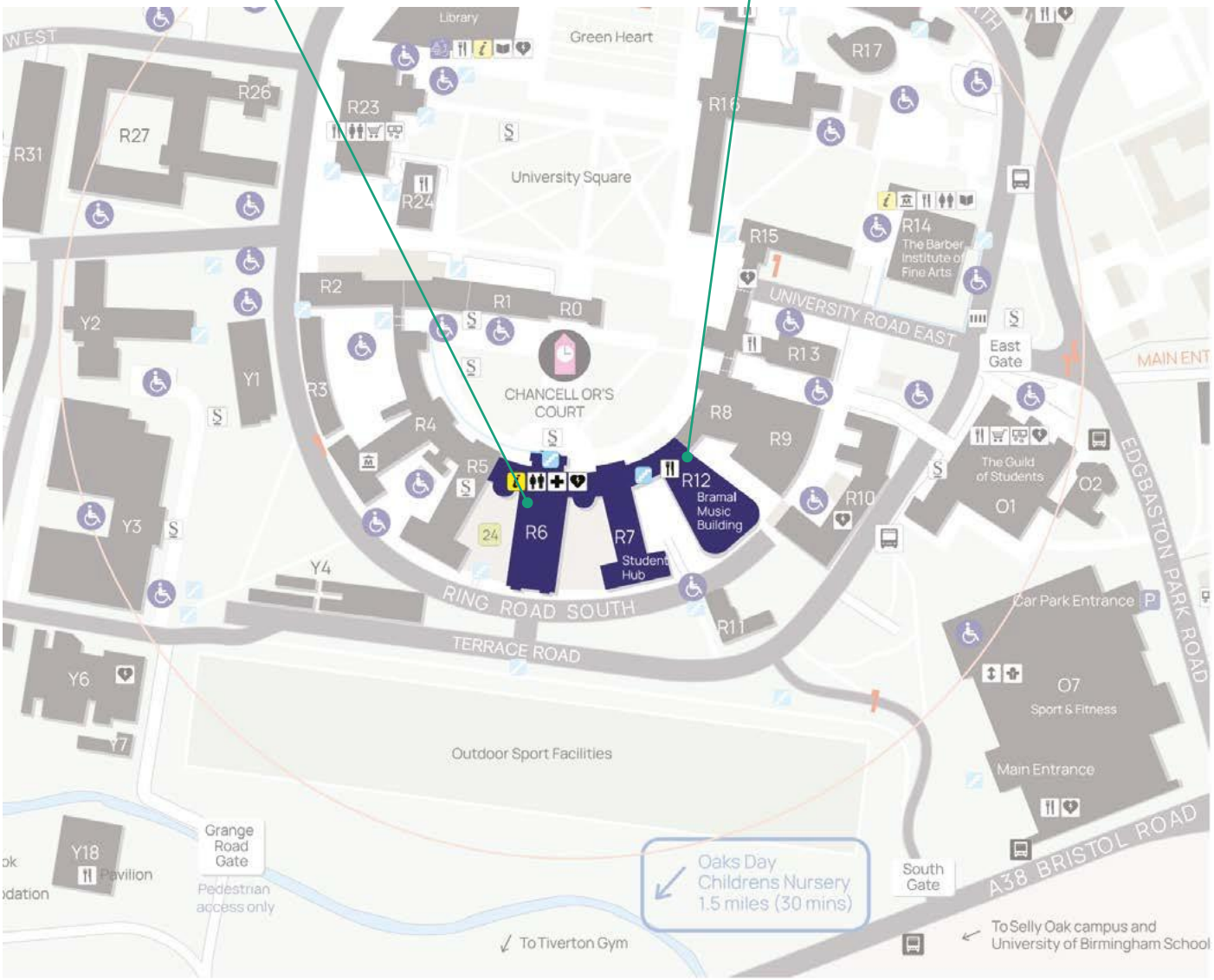
Time	Session/Activity	Venue
8:45 - 9:15	Registration and Arrival Refreshments	Great Hall
9:15 - 10:15	**Main Session 5 - Cognitive** Chair: Barbara Pomiechowska 9:15 - 9:30 - **Oiwi Parker Jones**, University of Oxford- Decoding speech at scale 9:30 - 9:45 - **Krish Singh**, Cardiff University - Welcome to WAND: Description and preliminary results from our new public 171-participant dataset: MEG, 3T, 7T, Connectome and questionnaires 9:45 - 10:00 - **Lukas Rier**, University of Nottingham - The neurodevelopmental trajectory of beta and gamma oscillations 10:00 - 10:15 - **Dan Bush**, University College London - Fronto-temporal network dynamics during human fear conditioning	Bramall Concert Hall
10:15 - 10:45	Refreshment Break	Great Hall
10:45 - 11:45	**Main Session 6 – Analysis** Chair: Oscar Ferrante 10:45 - 11:00 - **Enrico Amico**, University of Birmingham - Brain fingerprinting in MEG: Evaluation, pitfalls, and interpretations 11:00 - 11:15 - **Jose Sanchez Bornot**, Ulster University - Brain source and functional connectivity with MEG/EEG analysis: improving Alzheimer's disease early detection using the BioFIND dataset 11:15 - 11:30 - **Rukuang Huang,** University of Oxford - Modelling variability in functional brain networks 11:30 - 11:45 - **Luke Tait**, Cardiff University - Optimal signal-to-noise projection of neural responses in health and disease	Bramall Concert Hall
11:45 - 12:30	**Poster Talks 2** Chair: Ben Griffiths **Dr. Mats van Es**, Oxford - Efficient and reproducible batch processing of M/EEG data using osl in Python **Dr Camille Fakche**, CHBH - Neuronal evidence for category parafoveal previewing during the 200 ms intersaccadic interval **Dr Marlou Nadine Perquin**, Cambridge - Magnetoencephalography versus blood-based biomarkers of Alzheimer's Disease **Dr Christine Embury**, UCL - Mapping eloquent cortex using OPM-MEG in children with epilepsy **Dr Pin-Chun Chen**, Oxford - Simultaneous EEG-MEG Sleep Recording and Source Localization Reveal Precise Spatiotemporal Distribution of Spindle Activity During Sleep **Dr Oscar Ferrante**, CHBH - Predictive suppression relies on late attentional mechanisms **Dr Jiaqi Li**, CHBH - Probing Spatiotemporal Neural Dynamics of Working Memory Reactivation CHBH **Ms Lucy Madeleine Werner**, Dusseldorf - The impact of subthalamic	Bramall Concert Hall

	nucleus deep brain stimulation in the beta range on cortical beta oscillations and motor performance **Ms. Fahimeh Akbarian**, VUB (Belguim) - Modulation of 1/f spectral slope dynamics during an auditory oddball task **Dr Ana Luisa Pesquita**, University of Birmingham - Using OPM-MEG to Study the Infant Brain: Auditory Oddball Responses to Speech and Pure Tones in 2-Month-Olds	
12:30 - 14:00	Lunch and Poster Session	Great Hall
14:00 - 14:45	**Main Session 7 – Clinical** Chair: Alicia Rybicki 14:00 - 14:15 - **Elena Stylianopoulou**, Cardiff University - MEG-derived measures of oscillatory network changes induced by Midazolam and Remifentanil 14:15 - 14:30 - **Ben Sanders**, University of Nottingham - Measurement of neural oscillations in MS patients in seated and standing conditions 14:30 - 14:45 - **Girijesh Prasad**, Ulster University - Non-invasive BCI for Neuro-rehabilitation	Bramall Concert Hall
14:45 - 15:45	**Keynote Session 2 - Rik Henson,** MRC CBU, - Cambridge The value of sharing MEG data from the CamCAN cohort of healthy adult ageing Chair: Tara Ghafari	Bramall Concert Hall
15:45 - 16:15	Refreshment Break	Great Hall
16:15 - 17:30	**Main Session 8 – Cognitive** Chair: Alice Waitt 16:15 - 16:30 - **Kirandeep Kaur,** Aston University - Interactive Brain Project: A story of the marriage between MEG and fMRI, and combining both for accurate mapping of brain activity 16:30 - 16:45 - **Holly Schofield**, University of Nottingham - Building a 384-channel OPM-MEG system 16:45 - 17:00 - **Nic Alexander**, University College London - Using OPM-MEG to Investigate How Autobiographical Memories Are Formed in a Naturalistic Setting 17:00 - 17:15 - **Runhao Lu,** University of Cambridge - Aperiodic and oscillatory systems underpinning human domain-general cognition	Bramall Concert Hall
17:15 - 17:30	Conference Close and Prizes Chair/s: Andrew Quinn, Tom Marshall, Tommy Clausner	Bramall Concert Hall

Venue Plan

R6 - Great Hall
Registrations
Posters
Catering

R12 - Bramall Music Building
Talks



Campus Map

Edgbaston Campus Map

Red Zone
- R0 The Harding Building
- R1 Law Building
- R2 Frankland Building
- R3 Hills Building
- R4 Aston Webb – Lapworth Museum
- R5 Aston Webb – B Block
- R6 Aston Webb – Great Hall
- R7 Aston Webb – Student Hub
- R8 Physics West
- R9 Nuffield
- R10 Physics East
- R11 Medical Physics
- R12 Bramall Music Building
- R13 Poynting Building
- R14 Barber Institute of Fine Arts
- R15 Watson Building
- R16 Arts Building
- R17 Ashley Building
- R18 Strathcona Building
- R19 Education Building
- R20 J G Smith Building
- R21 Muirhead Tower
- R23 University Centre
- R24 Staff House
- R26 Geography
- R27 Biosciences Building
- R28 Murray Learning Centre
- R29 The Alan Walters Building
- R30 Main Library
- R31 Collaborative Teaching Laboratory
- R32 Teaching and Learning Building
- R33 Fry Building
- R34 Cuore

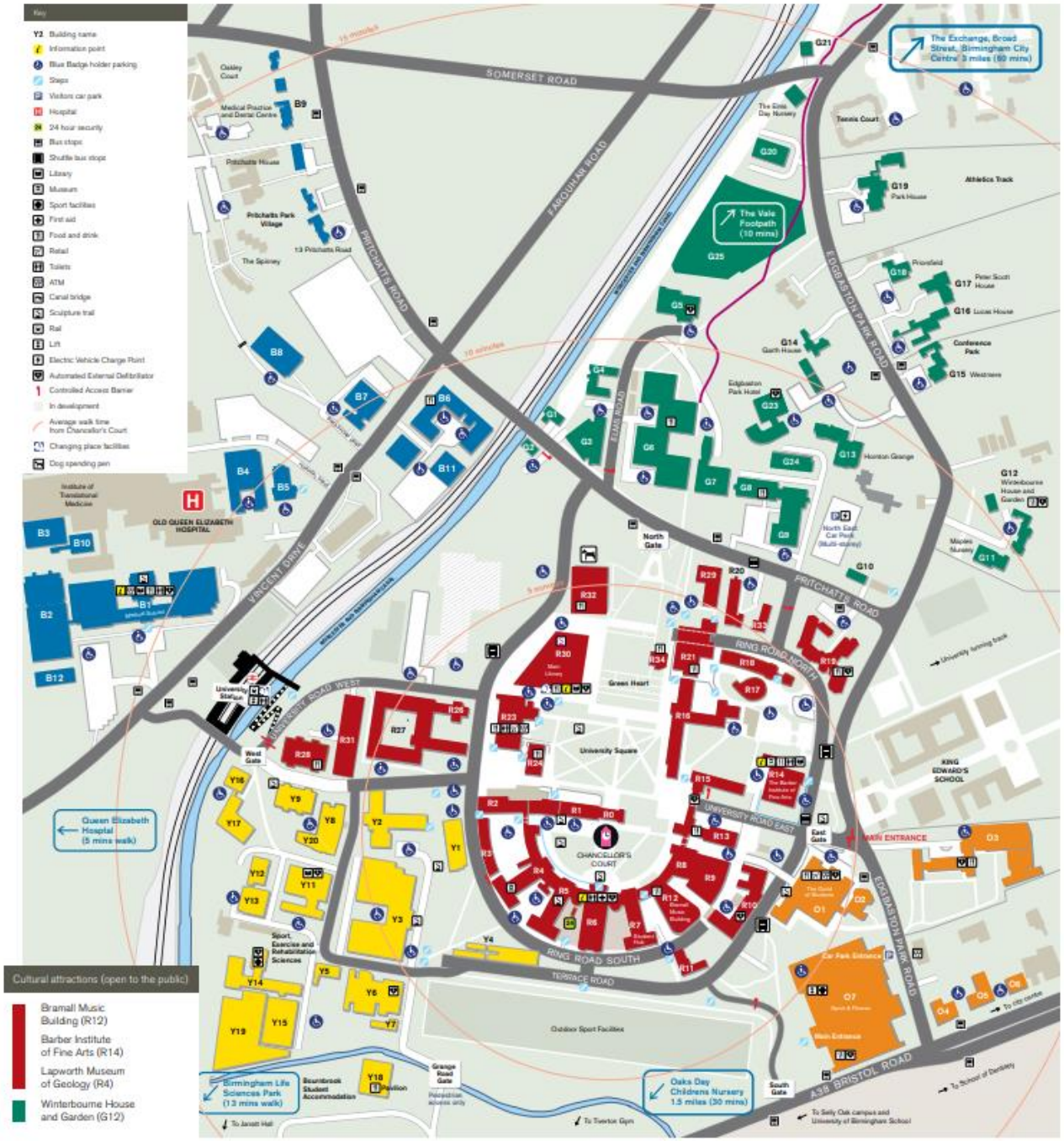
Blue Zone
- B1 Medical School
- B2 Institute of Biomedical Research including IBR West
- B3 Wellcome Clinical Research Facility
- B4 Robert Aitken Institute for Clinical Research
- B5 CRUK Institute for Cancer Studies and Denis Howell Building
- B6 Research Park
- B7 90 Vincent Drive
- B8 Henry Wellcome Building for Biomolecular NMR Spectroscopy
- B9 Medical Practice and Dental Centre
- B10 Advanced Therapies Facility
- B11 BioHub Birmingham
- B12 Health Sciences Research Centre (HSRC)

Orange Zone
- O1 The Guild of Students
- O2 St Francis Hall
- O3 University House
- O4 Ash House
- O5 Beech House
- O6 Cedar House
- O7 Sport & Fitness

Green Zone
- G1 32 Pritchatts Road
- G2 31 Pritchatts Road
- G3 European Research Institute
- G4 3 Elms Road
- G5 Computer Centre
- G6 Metallurgy and Materials
- G7 IRC Net Shape Laboratory
- G8 Gisbert Kapp Building
- G9 52 Pritchatts Road
- G10 54 Pritchatts Road – Institute for Global Innovation
- G11 Maples Nursery
- G12 Winterbourne House and Garden
- G13 Hornton Grange
- G14 Garth House
- G15 Westmere
- G16 Lucas House
- G18 Priorsfield
- G19 Park House
- G20 Wolfson Advanced Glasshouses
- G22 Elms Day Nursery
- G23 Edgbaston Park Hotel and Conference Centre
- G24 Centre for Human Brain Health
- G25 EcoLab

Yellow Zone
- Y1 The Old Gym
- Y2 Haworth Building
- Y3 Engineering Building
- Y4 Terrace Huts
- Y5 Estates West
- Y6 Maintenance Building
- Y7 Grounds and Gardens
- Y8 The School of Engineering
- Y9 Computer Science
- Y11 Chemical Engineering
- Y12 Biochemical Engineering
- Y13 Chemical Engineering Workshop
- Y14 Sport, Exercise and Rehabilitation Sciences
- Y15 Civil Engineering Laboratories
- Y16 Institute of Occupational and Environmental Medicine
- Y17 Public Health
- Y18 Bournbrook Student Accommodation
- Y19 NBIF
- Y20 UKRRIN

UNIVERSITY OF BIRMINGHAM



Keynote Speakers

Professor Rik Henson

Biography:

My primary interest concerns how our brains enable our cognition, particularly memory, and how this changes in old age and dementia. To investigate this, I develop cognitive tasks and relate them to data from brain imaging, including structural and functional MRI and EEG/MEG.

https://www.mrc-cbu.cam.ac.uk/people/rik.henson/personal/

Cognitive Neuroscience at the University of Cambridge, based at the MRC CBU

The value of sharing MEG for studying ageing in the CamCAN cohort of healthy adult ageing.

In 2011-12, Phase 2 of the CamCAN cohort (www.cam-can.org) collected MEG data (VectorView system) from N~700 population-derived, healthy adults aged 18-88, in addition to MRI (including T1, DWI, fMRI), cognitive, lifestyle and genetic data. In 2016, the data were made available on approval (after request from https://camcan-archive.mrc-cbu.cam.ac.uk/dataaccess/), and have been downloaded by >2500 researchers around the world (as well as being available on DPUK servers). In 2023-24, Phase 5 of CamCAN acquired repeat MEG (Triux) data on N~130 of the same volunteers, i.e, after a ~12 year lag (as well as repeat MRI, cognitive, lifestyle data, etc), which will be made available soon for longitudinal analysis. The baseline and follow-up MEG data were recorded during ~8mins of eyes-closed rest and ~8mins of a simple audio-visual-motor task, while the follow-up also recorded MEG data during ~8 mins of movie-watching (fMRI data also exist on the same three "tasks"). MEG data on more specialised cognitive tasks (e.g., auditory mismatch, scene repetition, Stop Signal/GoNogo, picture naming, word recognition and auditory stories) are available on subsets of N~120 participants in Phase 3 and/or Phase 5. In this talk, I will review some of the papers published on these MEG data, illustrating their potential value.

Professor Maria Wimber

Biography

Maria Wimber is a Professor of Cognitive Neuroscience & Memory at the Centre for Cognitive Neuroimaging (CCNi), University of Glasgow. Her group's work is centred around the question how the human brain reconstructs memories of past events, and how these memories adaptively change over time and with repeated use. Her group uses behaviour, EEG/MEG, fMRI, and intracranial EEG to isolate the neural footprints of memories and track their dynamic changes over time. Maria obtained her PhD from the University of Regensburg in 2008, working on neural mechanisms of forgetting. Following two postdocs, one at the University of Magdeburg and one at the MRC Cognition & Brain Science Unit in Cambridge, she took up a tenure-track position at the University of Birmingham in 2013, before moving to sunny Scotland in 2020.

https://www.gla.ac.uk/schools/psychologyneuroscience/staff/mariawimber/

https://www.gla.ac.uk/schools/psychologyneuroscience/research/ccni/

School of Psychology & Neuroscience, Centre for Cognitive Neuroimaging (CCNi), University of Glasgow

How the reconstruction of simple event memories dynamically unfolds in human brain and behaviour

How does the human brain recreate vivid mental images of past events? The talk will give an overview of our work investigating how memory reconstruction dynamically unfolds in time, using pattern analysis of electrophysiological and fMRI data as well as behavioural reaction time analyses. The results highlight two prominent characteristics of memory recall. First, when the hippocampus reactivates a previously stored visual memory, the information flow in neocortex tends to follow a reverse feature processing hierarchy compared to initial perception, starting with the reconstruction of high-level conceptual image features and ending with low-level perceptual detail. We also find consistent evidence for a representational shift towards conceptual features ("semanticisation") over longer consolidation periods and with repeated, active recall. Second, memory reactivation is rhythmic, as visible in brain and behaviour, in line with models suggesting that the hippocampal theta rhythm orchestrates the timing of memory reactivation relative to incoming sensory input. Our most recent findings demonstrate that phase coding along the theta rhythm can help segregate overlapping, competing memories. Together, these findings emphasise the dynamic and reconstructive nature of our memories.

Invited Speaker Abstracts

O1 - Using OPM-MEG to Investigate How Autobiographical Memories Are Formed in a Naturalistic Setting

Dr Nicholas Alexander

Autobiographical memories encode our life experiences, yet neuroimaging research has predominantly focused on their retrieval due to the limitations of head-immobilising scanners, such as MRI, which preclude the study of natural memory formation. In this study, we used a wearable optically pumped magnetometer (OPM)-based magnetoencephalography (MEG) system to capture neural activity during the encoding and retrieval of virtual reality autobiographical experiences in a naturalistic setting. Participants engaged in various activities, such as interacting with exhibits at a museum, all within the virtual environment. The following day, they were asked to recall and describe those experiences while also undergoing OPM-MEG.

This highly-rich data set presented numerous opportunities for analyses, especially as we knew the ground truth for the experiences the participants had. The reliability of our method was supported in the first instance by our finding of activation of the widely-known autobiographical memory network during retrieval. However, here we focused on the encoding phase in particular. Indeed, this multi-stage approach allowed us to analyse OPM-MEG signals from the encoding phase and re-factor them according to the behavioural data from the retrieval session, 24-hours later–so-called subsequent memory effects.

Considering oscillatory power, for example, theta power in right fusiform gyrus extending into medial temporal lobe, was positively associated with the number of true details remembered. Further analysis showed significant connectivity between the hippocampus and medial prefrontal cortex. Another interesting example of an oscillatory power analysis concerned event boundaries. We showed that high frequency activity at event boundaries predicted subsequent memory recall. Specifically, we found increased gamma activity in the hippocampus 3-7 seconds after an event ended. By contrast, such activity was absent for poorly remembered experiences.

Overall, our results highlight how OPMs can capture insightful new information about the brain signals associated with autobiographical memory formation, about which we know so little.

O2 - Enrico Amico – Abstract not received

O3 – Fronto-temporal network dynamics during human fear conditioning

Daniel Bush[1]
[1]UCL Department of Neuroscience

Remembering the whereabouts of dangerous locations is crucial for the survival of mobile agents. In rodents, the exploration of an anxiogenic environment is associated with increased 6-12Hz theta band power in the medial prefrontal cortex and ventral hippocampus. To ascertain whether these effects are also observed in the human brain, we asked participants to perform a contextual fear conditioning task in MEG. In this task, participants 'pick' a single visible flower in each trial across two distinct virtual reality environments. Picking flowers in one half of one environment can lead to a 'bee sting' (i.e. electric shock), and participants are asked to give an expectancy of shock rating before picking each flower. We found that oscillatory power originating from the hippocampus and medial prefrontal cortex during movement onset covaried with expectancy of shock in the 1-4Hz low theta, 5-8Hz high theta, and 12-20Hz beta bands. In addition, we found increased functional connectivity between contralateral temporal lobes and increased low theta – beta phase-amplitude coupling within both hippocampi. These results are consistent with rodent data, as well as recent evidence that beta band power and coherence in the anterior temporal lobe is strongly correlated with self-reported emotional state.

O4 - An optically pumped magnetic gradiometer for the detection of human biomagnetism

Mr. Harry Cook

We realise an intrinsic optically pumped magnetic gradiometer based on non-linear magnetooptical rotation. We show that our sensor can reach a gradiometric sensitivity of 18 fT/cm/√Hz and can reject common mode homogeneous magnetic field noise with up to 30 dB attenuation. We demonstrate that our magnetic field gradiometer is sufficiently sensitive and resilient to be employed in biomagnetic applications. In particular, we are able to record the auditory evoked response of the human brain, and to perform real-time magnetocardiography in the presence of external magnetic field disturbances. Our gradiometer provides complementary capabilities in human biomagnetic sensing to optically pumped magnetometers and opens new avenues in the detection of human biomagnetism.

O5 - Relating attention deficits to the neural basis of attention during working memory tasks.

Jan Novak[1], **Miss Ashley Goneso**[1], Dr Caroline Witton[1], Dr Johanna Zumer[1]
[1]Aston University,

Alpha oscillations have been linked to attention in many attention-demanding tasks (e.g. Jensen & Mazaheri, 2010). However, most studies have been conducted in neurotypical adults. Alternatively, children with attention difficulties, including attention-deficit / hyperactivity disorder (ADHD), are often studied during the resting-state and/or with EEG with limited spatial resolution. This study aims to determine the reliability of the neural sources relating to control of attention in children (age 8-11), both with and without ADHD.

The current work analyses the neural sources during a working memory task, varying by load, and their correlation to the standard clinical assessments of ADHD. Test-retest reliability is assessed across two MEG sessions. The data for both adults and children show the expected decrease in posterior alpha during the encoding period; this alpha decrease has high test-retest reliability in both adults and children. Maintenance-period frontal theta shows a decrease instead of an expected increase. Maintenance theta and alpha are replicable over two sessions in adults, even when split between high and low loads; however, preliminary analyses in children's data shows greater variability in maintenance alpha and theta. Preliminary analyses indicate no significant relationship between the Conners Continuous Performance Test and MEG power during the working memory task in either adults or children.

By using MEG, this study aims to localise sources and connectivity in an attention-demanding working memory task, linking their reliability to measures used in clinical ADHD research. Future work will link functional connectivity (MEG) with structural connectivity (DTI) and assess test-retest reliability.

O6 - Modelling variability in functional brain networks using deep generative models

Mr Rukuang Huang

There is a growing interest in studying the dynamics of functional networks, which have previously been linked to cognition, demographics and disease states. The sliding window approach is one of the most common approaches to compute dynamic functional networks. However, it cannot detect cognitively relevant and transient temporal changes at the time scales of fast cognition, i.e. on the order of 100 milliseconds, which can be identified with generative modelling based methods such as HMM (Hidden Markov Models) and DyNeMo (Dynamic Network Modes) in combination with electrophysiological data. We attempted to address two of the limitations of these generative models.

Firstly, time-varying estimates of power and functional connectivity (FC) are calculated under the assumption that they share the same dynamics but there is no principled basis for this assumption. We propose Multi-Dynamic Network Modes (M-DyNeMo) that allows for the possibility that power and the FC are uncoupled. Using magnetoencephalography (MEG, rest and task), we show at rest that the dynamics of the power and FC are independent and that a task structure modulates the dynamics of power and FC, inducing a coupling. This new method reveals novel insights into the evoked network response to task and ongoing activity that previous methods fail to capture, challenging the assumption that power and FC share the same dynamics.

Secondly, DyneMo assumes the same set of dynamic functional networks for all sessions, i.e. the networks are estimated at the group level. This does not allow for the discovery of, nor benefit from, subpopulation structure in the data. We propose the use of embedding vectors (c.f. word embedding in Natural Language Processing) to explicitly model individual sessions. We show by applying this approach to current models, improved performance can be achieved, and the learnt embedding vectors reflect meaningful sources of variation across a population.

O7 - Interactive Brain Project: A story of the marriage between MEG and fMRI, and combining both for accurate mapping of brain activity

Dr Kirandeep Kaur

Interacting effectively with others and conducting ourselves appropriately in social contexts is essential for establishing and maintaining meaningful interpersonal relationships. Recent research suggests that executive functions (e.g., working memory) and their associated functional brain networks (e.g., fronto-parietal network) combine with one another in systematically dynamic ways to coordinate interactive behaviour, but this has not yet been investigated directly. This talk presents an ongoing study that will determine precisely how these neurocognitive mechanisms support interpersonal behaviour. We are performing functional brain imaging with both fMRI and MEG on a large sample of young adults while they interact with another individual on a new joint-action task designed to emulate the reciprocal characteristic of cooperative or competitive social interactions. By combining data from both imaging modalities, we will capitalise on the spatial accuracy of fMRI to localise the brain networks associated with working memory, task switching and response inhibition, and then utilise the temporal resolution of MEG to map dynamic functional connectivity among these networks during performance on the interactive task. I will share our proposed methodology of fMRI-informed MEG analysis.

O8 - Aperiodic and oscillatory systems underpinning human domain-general cognition

Mr Runhao Lu[1], Ms Nadene Dermody[1], Prof John Duncan[1], Prof Alexandra Woolgar[1]
[1]MRC Cognition and Brain Sciences Unit, University of Cambridge, Cambridge, United Kingdom

Domain-general cognitive systems are essential for adaptive human behaviour, supporting various cognitive tasks through flexible neural mechanisms. From decades of fMRI studies, we know that a particular network of frontoparietal brain regions plays a role in supporting many different kinds of cognitive activity, with increased activity and information coding in response to increasing task demands. However, the electrophysiological mechanisms underlying this domain-general response to demand remain unclear. Here we used irregular-resampling auto-spectral analysis (IRASA) to separate the aperiodic and oscillatory components of concurrent MEG/EEG signals and analysed them with multivariate pattern analysis (MVPA) to investigate their roles in domain-general cognition. We found that both aperiodic (broadband power, slope, and intercept) and oscillatory (theta, alpha, and beta power) components coded both task demand and content across three cognitive tasks. Aperiodic broadband power in particular strongly coded task demand, in a manner that generalised across all subtasks, suggesting that modulation of aperiodic broadband power may reflect a domain-general response to multiple sorts of cognitive demand. Source estimation suggested that increasing cognitive demand decreased aperiodic activity across most of the brain, with the strongest modulations partially overlapping with the frontoparietal multiple-demand network. In contrast, oscillatory activity in the theta, alpha and beta bands showed more localised patterns of modulation, primarily in frontal (beta, theta) or occipital (alpha, theta) regions. The spatial pattern of demand-related modulation was significantly correlated across space in individuals, with positive correlations between theta and beta power, while both were negatively correlated with alpha power. These results provide novel insights into the electrophysiological underpinnings of human domain-general cognition, suggesting roles for both aperiodic and oscillatory systems, with changes in aperiodic broadband power being the clearest domain-general electrophysiological correlate of demanding cognitive activity.

O9 - Enhancing memory in humans via MEG-closed-loop Rhythmic Sensory Stimulation (RSS) tuned to the frequency of hippocampal theta oscillations

Simon Hanslmayr, Robin Ince, Satu Palva, **Miss Eleonora Marcantoni**, Dr Danying Wang, Lauri Parkkonen

Hippocampal theta oscillations are considered critical for binding multisensory information into episodic memories. Recent studies suggest that entraining theta oscillations through 4Hz audio-visual rhythmic sensory stimulation (RSS) can significantly enhance memory performance in humans. However, this “one-size-fits-all” approach neglects individual brain activity differences, which could explain result variability. To address this limitation, we developed a new pipeline to estimate the individual hippocampal theta frequency during memory tasks and dynamically align stimulation parameters accordingly.

Our pipeline involves a few steps. First, hippocampal signals are extracted using LCMV beamformer. Theta activity is then separated from the broadband signal by applying Generalized Eigenvalue Decomposition (GED). Next, the Cyclic Homogeneous Oscillation detection method (CHO) is applied to detect oscillations in the reconstructed signal and identify their centre frequency. This frequency is used to adjust the flickering rate of sensory stimuli.

We first validated the feasibility of combining GED and CHO to reliably estimate frequency on rodent LFP data, aiming to replicate the well-established correlation between running speed and hippocampal theta frequency. The results indicate that the pipeline was able to reproduce previous findings ($R = 0.27$, $p < .001$). Next, the full pipeline, including source reconstruction, was tested offline on a MEG dataset involving 4Hz RSS during an associative memory task. Our objective was to assess whether the pipeline could accurately identify the entrainment effect induced by stimulation. Our results indicate that hippocampal oscillations during stimulation were significantly closer to 4Hz compared to pre- and post-stimulation (main effect of time $F_{6,120} = 24.99$, $p < .001$, $\eta^2 = 0.315$).

Together, the present results suggest that we can reliably extract and detect theta frequency from hippocampal signals in real time. Next, we will validate the pipeline using a concurrent MEG-iEEG dataset, which will provide deeper insights into our approach's accuracy and reliability.

O10 - Non-invasive BCI for Neuro-rehabilitation

Girijesh Prasad

A Brain-Computer Interface (BCI) utilizes neuro-physiological correlates of voluntary mental tasks to facilitate direct communication between human brain and computing devices. One of the main application areas of BCI systems is in post-stroke neuro-rehabilitation. Due to stroke, brain regions may get damaged and post-stroke neurorehabilitation exercises/tasks need to be performed with very high focus so as to activate relevant brain regions appropriately for recovery through plastic reorganization. To accomplish this, we are developing a neuro-rehabilitation system, using a robotic exoskeleton and a BCI. Current BCI systems however, lack sufficient performance robustness. In this talk, the presentation will discuss our computational intelligence based robust BCI design and its application in post-stroke neuro-rehabilitation. It will be discussed how integrating an EEG/MEG-EMG based BCI and exoskeleton results into a personalized neuro-rehabilitation system, facilitating mental state monitoring while ensuring active and engaging exercises leading to enhanced recovery of the paralyzed upper limbs. Finally the remaining R&D challenges will be highlighted.

O11 - The neurodevelopmental trajectory of beta and gamma oscillations

Dr Lukas Rier

Neural oscillations mediate the coordination of activity within and between brain networks, supporting cognition and behaviour. How these processes develop throughout childhood is not only an important neuroscientific question but could also shed light on the mechanisms underlying neurological and psychiatric disorders. However, measuring the neurodevelopmental trajectory of oscillations has been hampered by confounds from instrumentation. In this talk I will outline how we used optically pumped magnetometer-based magnetoencephalography (OPM-MEG) – which is adaptable to head size and robust to participant movement – to collect high-fidelity electrophysiological data in individuals aged between 2 and 34 years and measured changes in neural oscillations during brain development in two studies:

Firstly, we analysed data collected in 51 individuals during a somatosensory task, where we measured both stimulus-induced modulation of beta oscillations in sensory cortex, and whole-brain connectivity, showing that both modulate significantly with age. Secondly, we combined data collected at two sites (University of Nottingham, UK, and The Hospital for Sick Children, Toronto, Canada) to measure gamma oscillations induced by visual stimuli in > 100 individuals. Here, we found significant changes in spectral content with age, with low amplitude, broadband gamma oscillations in children and high-amplitude narrow-band gamma activity in adults. Cortical microcircuit modelling of gamma activity revealed age-dependent changes in excitation-inhibition balance in superficial neurons.

O12 - Magnetoencephalography brain biomarkers of Alzheimer's disease: an ongoing study based on the BioFIND dataset

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Magnetoencephalography (MEG) is widely used to study neurodegenerative disorders, particularly Alzheimer's disease (AD). AD is linked to amyloid-beta and tau protein formation, which disrupts brain anatomical and functional networks, leading to memory and cognitive impairments. Due to its noninvasive nature and excellent temporal resolution, MEG is valuable for examining functional changes in the AD brain. We evaluated a pipeline, based on nested cross-validation with Monte-Carlo replications, with MEG-derived sensors and source-based spectral features to discriminate healthy controls (HC) versus mild cognitive impairment (MCI) brain activity features. We also compared the effectiveness of combining MEG and MRI features extracted for 324 participants (158 MCI, 166 HC) in the BioFIND dataset. A robust selection of brain source activity biomarkers was implemented through five independently tested inverse solutions, including a linearly constrained minimum variance (LCMV) beamformer and exact low-resolution electromagnetic tomography (eLORETA). Several machine learning classifiers were also evaluated, including Support Vector Machine (SVM) and Logistic Regression with L1 penalty (GLMNET). Initial results showed that combining MRI features with source-based MEG features yielded the best performance based exclusively on spectral features (Acc=76.31±1.47%) using the GLMNET classifier. MEG features alone, particularly those extracted from LCMV and eLORETA analyses, demonstrated good performance (Acc=74.77±1.57%), surpassing MRI- and sensor-based analyses using an SVM classifier (Acc=72.74±1.34% and Acc=69.29±1.68% respectively). However, ongoing more advanced analyses relying on features extracted from LCMV and eLORETA and derived functional connectivity solutions (coherence - COH, imaginary COH - iCOH, wPLI, AEC, EIC) have surpassed these and previous benchmarks for the BioFIND dataset (Acc=94.91±0.01%, F1=94.63±0.01%, MCC=94.96±0.01% for MEGMAG-LCMV-wPLI; Acc=93.29±0.01%, F1=93.14±0.01%, MCC=93.30±0.01% for MEGMAG-LCMV-EIC; Acc=92.16±0.01%, F1=92.16±0.01%, MCC=93.30±0.01% for MEGGRAD-LCMV-EIC), while using a similar pipeline. Our findings highlight the potential of using MEG signals to find MCI biomarkers, supporting critical early intervention. They also provide evidence on potential "best" approaches to analysing magneto-electroencephalography-based brain activity.

O13 - Measurement of Neural Oscillations in Multiple Sclerosis Patients in Seated and Standing Conditions

Benjamin Sanders[1], Christopher Gilmartin[2,3], Emily McCann[3], Lauren Gascoyne[1], Jorge Cabrera[3], James Leggett[1], Niall Holmes[1], Ryan Hill[1], Lukas Rier[1], Natalie Rhodes[1,6], Daniel C. Ford[1], Holly Schofield[1], Cody Doyle[4], James Osborne[4], David Bobela[4], Vishal Shah[4], Kathryn Radford[5], Matthew J. Brookes[1] and Nikos Evangelou[2,3].

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Background: Impaired movement is a hallmark of multiple sclerosis (MS); indeed over 40% of patients report difficulty walking. However, monitoring the neural substrates that underlie natural movements is difficult due to limitations of conventional neuroimaging. Here, we aimed to exploit OPM-MEG to measure brain activity, both in task and resting states, in MS patients and healthy controls while seated and standing.

Methods: 20 patients and 20 healthy controls have taken part in this ongoing study. All participants undertook a visuomotor task (circular grating and finger abduction) and a resting state experiment. Data were recorded using a 192-channel OPM-MEG system with miniaturised electronics (QuSpin) integrated into a wearable backpack – allowing patients to stand freely with minimal cabling. All experiments were performed in a magnetically shielded room and matrix coils were used to control background fields (Cerca Magnetics). Data were analysed in source space using a beamformer.

Results: Results show the post-movement beta rebound (visuomotor task) in primary motor cortex is reduced significantly ($p<0.05$) in patients compared to controls, while seated but not standing. In resting state, we found diminished beta power in motor regions in the standing condition versus seated in patients ($p<0.05$) but not in controls. Additionally, a decrease in beta connectivity to motor regions was seen in controls when standing compared to seated ($p<0.05$).

Conclusion: Results delineate previously observed effects in MS while seated and demonstrate that standing fundamentally changes sensorimotor activity. The study also highlights the high promise of OPM-MEG as a tool to study patients with movement problems.

O14 - Towards a 384-channel OPM-MEG system

David Bobela[3], Joe Gibson[1], James Osborne[3], Prof Matthew Brookes[1], **Miss Holly Schofield**[1,2], Dr Ryan Hill[1], Miss Zoe Tanner[1,2], **Dr Niall Holmes**[1]
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Optically-pumped magnetometers (OPMs) offer a step change in MEG instrumentation, with flexible, wearable arrays that reduce sensor-to-scalp distance, allow naturalistic paradigms and improve compliance. However, the technology remains in its infancy and extant systems have fewer measurement channels than the ~300 used in cryogenic instrumentation. This is despite theoretical studies (Boto et al., 2016, Iivanainen et al., 2017) suggesting they would benefit from more. If OPM-MEG is to realise its potential, then delivery of viable high channel density systems will be critical.

We aimed to resolve this by building a 384-channel OPM-MEG system. Our system comprised 128 triaxial OPMs (QuSpin Inc., Colorado, US) controlled by integrated miniaturised electronics. The 128 triaxial sensors provide 384 independent assessments of magnetic field. Sensors were housed in a high-density helmet. One participant (female, aged 24 years) was scanned using two paradigms: a visuo-motor task (known to elicit visual-gamma and motor-beta activity) and an emotional face paradigm (known to elicit evoked responses). Analyses included source localisation and reconstruction of time frequency induced effects in source space.

Gamma, beta and evoked effects were all successfully measured, with high SNR. Removal of channels from the analysis, to allow for comparison with lower channel counts on the same data, showed a linear reduction in SNR – confirming the value of the high channel count. In sum, this initial construction and successful demonstration of our system paves the way for future high-density OPM-MEG systems which can significantly outperform the current state of the art in cryogenic instrumentation.

O15 - Helium Optically Pumped Magnetometers: Lightweight and versatile sensors for MEG

Dr Denis Schwartz

The Helium Optically Pumped Magnetometers (4He-OPM) are innovative sensors operating at room temperature, enabling the monitoring of magnetic brain activity in both patients and neurotypical subjects. Compared to traditional Magnetoencephalography (MEG) systems, these new sensors offer several advantages: lightweight design, on-scalp sensors in close proximity to the brain, reduced cost, and enhanced versatility. Following a brief description of these new sensors, we will present recent findings obtained in basic neuroscience research involving Mismatch Negativity and beta burst analysis. We will then discuss the medium and long-term prospects of this technology for biomagnetism research.

O16 - Welcome to WAND: Description and preliminary results from our new public 171-participant dataset: MEG, 3T, 7T, Connectom and questionnaires

Prof. Krishna Singh

In this talk I will describe a new, fully publicly open, multimodal neuroimaging and cognitive resource called the Welsh Advanced Neuroimaging Database (WAND).
WAND consists of data from over 170 healthy volunteers (aged 18-63 years), including resting-state and task-based CTF-Omega MEG, structural and functional MRI and MR Spectroscopy at both 3T and 7T, Connectom 3T MRI with ultra-strong (300 mT/m) gradients, transcranial magnetic stimulation (TMS) and trait questionnaire and cognitive data.
Data, organised using the Brain Imaging Data Structure (BIDS), can be downloaded through our GIN repository, a data access management system designed to reduce local storage requirements by providing data only as required for analysis.
The unique nature of the scanner data included in WAND provides significant new opportunities for investigating relationships between brain structure and function and how this relates to individual differences in human traits and cognitive performance.

In my talk, I shall give some preliminary examples of work we have conducted with this dataset:
1) An investigation of how multiple measures of structural connectivity, derived from high-resolution multi-parameter white-matter microstructure measures from the Connectom scanner, can predict frequency-specific oscillatory connectivity patterns derived from MEG data in the same individuals.

2) An investigation of how MEG-derived measures of activity and connectivity, both during visual tasks and at rest, might provide insight into why some people are visually hypersensitive.

WAND dataset web address:
https://doi.org/10.12751/g-node.5mv3bf

O17 - MEG-derived measures of oscillatory network changes induced by Midazolam and Remifentanil

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The functional effects of sedative drugs in the human brain are not well understood. We used resting-state MEG to reveal the effects on oscillatory brain network activity of two sedative agents with different sites and mechanisms of action. Remifentanil is a potent ultra-short-acting sedative analgesic and mu-receptor agonist, used for anaesthesia and pain treatment. Midazolam is also a short acting sedative benzodiazepine acting as a positive allosteric modulator of the GABA-A receptor.
18 healthy male adults (18-43 years) were studied. Participants received either Remifentanil or Midazolam on separate days, with resting-state MEG (10 minutes' duration) before and after drug administration.

LCMV Beamformer source reconstructions in 8 frequency bands were mapped to the 90 regions of the AAL atlas. Both static connectivity and activity maps were constructed as well as estimates of dynamic connectivity. For each of the 8 frequency bands, t-tests were performed to investigate differences pre and post administration of each drug.

Both drugs modulated activity in the lower frequency bands (<30Hz) only. Remifentanil showed focal alpha and beta reductions in the frontal and parietal lobes, occipital theta reductions, increases in alpha and beta in the thalamus and extensive alpha and beta enhancement in the posterior cortices. In contrast, Midazolam showed widespread increases/decreases in all frequency bands from delta to beta, particularly in the medial and lateral frontal lobes, consistent with the wide distribution of GABA-A receptors. Importantly, Midazolam induced theta reductions in hippocampus/parahippocampal gyrus, which has been previously seen in animal models and proposed as a causal mechanism for the amnesia often induced by midazolam.

Knowing more about the oscillatory network changes induced by Midazolam and Remifentanil during the resting state, could offer important clinical insights, and a better understanding of their mechanisms of action in the brain.

O18 - Optimal signal-to-noise projection of neural responses in health and disease

Dr Luke Tait

Stimulating the brain using sensory triggers (e.g. auditory or visual stimuli) and using MEG/EEG to measure the resulting neuronal responses can give deep insight into the circuitry of the cortex underpinning healthy cognition and disease. A common approach to mapping these responses involves beamforming, which aims to estimate a virtual electrode at a given location in the cortex (i.e. an estimate of the course of neuronal activity at that location). The dipole of interest is typically chosen by selecting a location which maximises (for example) relative change of the magnitude of the response. However, this approach is limited, particularly with regards to distributed or highly correlated sources such as bilateral auditory responses.

Here we present an alternative approach to generate virtual electrodes which have the theoretical maximum signal-to-noise ratio, demonstrating pipelines for both evoked (time-domain) and induced (time-frequency) responses. These projection-based virtual electrodes (PBVEs) can be applied directly to sensor-space electrodes, giving the advantage of not requiring an MRI head model. Alternatively, it can be applied to source localised data to give spatial maps/responses minimally influenced by noise. This approach is applied to a range of MEG datasets in normative controls and patient groups.

O19 - Cortical neurophysiology distinct from healthy ageing in neurodegenerative disorders

Dr Michael Trubshaw

Neurodegenerative diseases are often simplistically likened to accelerated aging. These diseases disrupt healthy communication within brain networks, resulting in a variety of clinical syndromes. In this study, we utilised magnetoencephalography (MEG) to directly compare three neurodegenerative disorders with healthy aging, aiming to identify both common and distinct neural changes.

We conducted task-free MEG recordings from groups of individuals diagnosed with Alzheimer's disease (AD, n=29), Parkinson's disease (PD, n=25), and amyotrophic lateral sclerosis (ALS, n=33), comparing them to age- and sex-matched healthy controls (n=191). We assessed frequency band power (indicating local neuronal recruitment), power spectral density (PSD) shape (reflecting complexity), and connectivity (indicating long-range communication) in pairwise comparisons.

Compared to the healthy aging group, the PD, AD, and ALS cohorts exhibited a decrease in beta power and a slowing of oscillatory activity. Notably, within the AD group, older patients demonstrated lower beta power compared to their younger counterparts. The PSD slope (1/f exponent) was uniquely diminished in ALS, contrasting with an increase observed in PD and AD. Both AD and ALS exhibited enhanced global gamma connectivity, while AD also showed decreased beta connectivity and increased delta connectivity.

The neurodegenerative diseases analysed here displayed reduced beta power and oscillatory slowing that diverges from the typical aging process. These changes may indicate both compensatory mechanisms and primary pathological losses of function. Comparisons among the diseases highlighted certain cortical neurophysiological differences that may explain the variety of clinical syndromes. MEG holds significant promise as a source of biomarkers that could aid in defining and predicting phenoconversion, as well as providing outcome measures for future preventive intervention trials in asymptomatic at-risk populations.

O20 - Consolidation of Sequential Planning

Dr Oliver Vikbladh

Thriving in changing environments requires the capacity to evaluate novel courses of action. This ability is hypothesized to depend on sequential planning via step-by-step simulations of the future, using cognitive maps or schemas of task contingencies. However, it is still unclear if, how and where in the brain such flexible planning is enacted. In parallel, it is thought that consolidation transforms memory representations over time to promote adaptive behavior. Here, we hypothesize that consolidation strengthens cognitive maps of task contingencies used for simulation during sequential planning. To test this, we developed a novel behavioral task and new multivariate methods for analysis of MEG data. Using choice and reaction time data we dissociated flexible sequential planning from alternative non-sequential strategies, and identified this behavior with robust neural markers of step-by-step simulation, localized to the anterior medial temporal lobe. Retesting a week later we showed that consolidation enhanced sequential planning and strengthened markers of sequential simulation in the prefrontal cortex, consistent with systems consolidation theory. By revealing that consolidation improves future simulations for flexible planning we open up a new frontier for the investigation of the functional interactions between memory and decision-making.

O21 - Single trial theta phase synchronisation predicts human episodic memory formation

Simon Hanslmayr[2], Kimron Shapiro[3], **Dr Danying Wang**[1], Miss Eleonora Marcantoni[2]
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Episodic memories contain associations between multisensory information. Binding multisensory information into episodic memory is thought to depend on synaptic connectivity, which relates to neuronal synchronization. Studies using rhythmic sensory stimulation demonstrated that episodic recall is modulated by theta phase synchrony between visual and auditory activity. Here, we used the same paradigm while recording participants' brain activity using MEG. Luminance and amplitude of 3-s videos and sounds were modulated at theta frequency (4 Hz) with 0° phase offset (in-phase) or 180° phase offset (out-of-phase). Average memory performance for the video-sound pairs did not differ between the in-phase and the out-of-phase conditions. However, after accounting for trial-by-trial variability by back-sorting trials into four phase bins according to their actual phase differences between visual and auditory source activity at 4 Hz, an effect of phase-offset on memory was observed. Recall accuracy in the phase bin centred at 0° was significantly higher than in the phase bins centred at 90°, 180° and 270°. Control analysis showed that this difference in memory was not caused by item effects. An analysis on pre-stimulus alpha power suggests a link between the pre-stimulus alpha power and trial-by-trial variability in phase-entrainment and subsequent recall performance. Specifically, trials that responded well to sensory stimulation showed lower levels of pre-stimulus alpha power compared to trials that responded less well to the stimulation. Furthermore, trials with lower pre-stimulus alpha power were associated with significantly higher recall accuracy than those with higher pre-stimulus alpha and this relationship has only been shown in the in-phase but not the out-of-phase conditions. Together, these results replicate previous findings in showing that theta-phase synchrony modulates multi-sensory associative memory, and extend those findings by showing that trial-by-trial variability in phase-entrainment is linked to memory outcome and attentional states, indexed by alpha-power.

O22 - Fast hierarchical processing of orthographic and semantic parafoveal information during natural reading

Steven Frisson[1], Dr Yali Pan[1], **Lijuan Wang**[1], **Professor Ole Jensen**
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Readers extract orthographic and semantic information from parafoveal words before fixating on them. While this has to be achieved within an intersaccadic interval, the neuronal mechanisms supporting this fast parafoveal word processing within the language network remain unknown. We co-registered MEG and eye-tracking data in a natural reading paradigm to uncover the neuronal mechanisms supporting parafoveal processing. Representational similarity analysis (RSA) revealed that parafoveal orthographic neighbours (e.g., “writer” vs. “waiter”) showed higher representational similarity than non-neighbours (e.g., “writer” vs. “police”), emerging ~68 ms after fixation onset on the preceding word (e.g., “clever”) in the visual word form area. Similarly, parafoveal semantic neighbours (e.g., “writer” vs. “author”) exhibited increased representational similarity at ~137 ms in the left inferior frontal gyrus. Importantly, the degree of orthographic and semantic parafoveal processing predicted individual reading speed. Our findings suggest fast hierarchical processing of parafoveal words across distinct brain regions, which enhances reading efficiency.

O23 - Living in a World of "Close Enough": Apathy and the Bayesian Brain

Frank Hezemans[3], Laura Hughes[1,2], Amirhossein Jafarian[1], Michelle Naessens[1], **Miss Rebecca Williams**
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Background/Aims: Apathy is a reduction in goal-directed action that is pervasive in neurodegenerative disease. There are currently no treatments. Here we propose and test a new model of apathy focused on a reduction in confidence (cf. precision) of beliefs regarding action outcomes. We explore this new framework using MEG, and psychophysical analysis of performance and expectation in a goal directed task, with the aim of identifying neural mechanisms underpinning apathy. Preregistration available at https://tinyurl.com/wbt6rpx9.

Methods: 50 healthy adults participated in a goal directed task (Hezemans et al, 2020) in MEG. During the task participants pressed on a force sensor to propel a virtual ball across the screen to land on a target. In a subset of trials, the ball disappeared during its trajectory and participants estimated the end position. Apathy was assessed using the Apathy Motivation Index (AMI).

MEG preprocessing was conducted in SPM12 taking inspiration from the exemplar pipeline laid out by the BioFIND cohort (Vaghari et al, 2022). Only non-catch trials, in which the ball completed its full trajectory, were included in the analysis. MEG sources were reconstructed using a beamformer and contrasts generated every 250ms across the 2s epoch when the virtual ball stopped (thresholded at p[uncorrected]<0.001, k=100).

Results: There was strong evidence confirming the negative correlation between prior precision and apathy (B=12.2, p<.01). Source localization informed the selection of three nodes in the left motor, supplementary motor, and prefrontal cortex from which local field potentials were extracted. Power spectral densities in all three regions showed a significant increase in beta power around ball stop (-250ms to 250ms) compared to baseline (-750ms to -500ms), followed by a decrease in beta power in the left prefrontal cortex (250ms to 750ms) compared to ball stop. Network analysis, integrating this model with behavioural and MRS data, is ongoing.

Conclusion: Apathy may be the result of imprecise prior beliefs on action outcomes, underpinned by beta communication across a motor-prefrontal decision-making hierarchy. Future psychopharmacological-MEG studies will further explore the neurophysiological correlates of apathy both in health and apathy-associated with frontotemporal lobar degeneration.

O24 - Network-opathy in autoimmune encephalitis – bench to bedside insights

Dr Sukhvir Wright

Institute of Health and Neurodevelopment, Aston University, Birmingham, UK and Department of Neurology, Birmingham Children's Hospital, Birmingham, UK

Worldwide, one person every minute is diagnosed with encephalitis; an autoimmune aetiology is as common as an infectious cause. Patients with autoimmune encephalitis (AE) present with neuropsychiatric features, seizures, cognitive and sleep dysfunction, and movement disorders. While we are succeeding with early diagnosis, initiation of immunotherapy and even prevention of relapses, longer-term outcomes remain frustratingly static. Chronic symptoms include ongoing sleep disruption, neuropsychiatric disorders, and persistent cognitive deficits. Children are disproportionately adversely affected.

We have created multiple AE preclinical rodent models using juvenile Wistar rats that display acute symptoms, e.g., seizures and cognitive dysfunction, identifying convergent electrophysiological changes at the synaptic and local circuit level. In addition, we have observed cortical thinning following antibody infusion, and disruption to sleep-like resting behaviour.
In preliminary studies of paediatric AE patients, at least 18 months after diagnosis, we have found:

- a high incidence of neuropsychiatric symptoms including emotional problems, hyperactivity, abnormal prosocial behaviours, and sleep disruption;
- local cortical thinning in structural MRI studies in brain areas where thickness has been linked to emotional difficulties and general intellectual impairment;
- specific convergent group-level network alterations associated with lower working memory using magnetoencephalography (MEG).

The alignment between the animal models (bench) and paediatric patient data (bedside) will enable cross-species multiscale exploration of pathological mechanisms underlying chronic AE symptoms associated with persistent network changes ("network-opathy"). Combining this clinical and pre-clinical synaptic, circuit and network data will allow us to predict outcomes and optimise timing for precision treatments to improve long-term outcomes in paediatric AE.

O25 - Differential beta and gamma activities in unimanual and bimanual motor learning

Dr Min Wu[1], Dr Marleen Schoenfeld[1], Dr Carl Lindersson[1], Dr Catharina Zich[1], Porf Charlotte Stagg[1]
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Beta and gamma activities have been studied in relation to motor execution and learning during unimanual movements, but their roles in complex bimanual tasks remain largely unexplored. This study aimed to investigate how beta and gamma activities differ between unimanual and bimanual movements, and how these neural signatures evolve during the learning process. Our motor task incorporated varying levels of bimanual interaction: unimanual, bimanual-equal, and bimanual-unequal. Magnetoencephalography data were collected during task performance, and beta and gamma activities were assessed. The results revealed slower and less accurate movements when increasing task complexity from unimanual to bimanual-equal, and then to bimanual-unequal movements. Significant beta event-related desynchronization (ERD) and gamma event-related synchronization (ERS) were observed during movement, as well as beta ERS after movement, across all conditions. Notably, bimanual movements exhibited greater beta ERD, beta ERS, and gamma ERS compared to unimanual movements. With practice, participants demonstrated faster and more accurate movements, accompanied by enhanced beta ERS responses. Furthermore, learning-related improvements in movement time correlated with changes in beta ERD, while reductions in errors correlated with increases in beta ERS. These findings underscore the distinct behavioural and neural demands of unimanual versus bimanual movements and highlight the important role of beta activities in motor performance and learning.

O26 - Rapid Invisible Frequency Tagging (RIFT): Perceptual Foundation, Phase Coding, and Prospects for Naturalistic Neuroscience

Dr Eelke Spaak[1]
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Recent years have seen the emergence of a visual stimulation protocol called Rapid Invisible Frequency Tagging (RIFT) in cognitive neuroscience. In RIFT experiments, visual stimuli are presented at a rapidly and sinusoidally oscillating luminance, using high refresh rate projection equipment. Such stimuli result in strong steady-state responses in visual cortex, measurable extracranially using EEG or MEG. The high signal-to-noise ratio of these neural signals, combined with the alleged invisibility of the manipulation, make RIFT a potentially promising technique to study the neural basis of visual and attentional processing. I will highlight some recent innovations in and successful applications of RIFT, from various labs. From my own lab, I will showcase one study, in which we set out to resolve two fundamental outstanding issues regarding RIFT; as well as to open up a new avenue for taking RIFT beyond frequency tagging per se. First, we provided robust evidence that RIFT is indeed subjectively undetectable, going beyond previous anecdotal reports. Second, we demonstrated that full-amplitude luminance or contrast manipulation offer the best tagging results. Third and finally, we demonstrated that, in addition to frequency tagging, phase tagging can reliably be used in RIFT studies, opening up new avenues for constructing RIFT experiments. Together, this provides a solid foundation for using RIFT in visual cognitive neuroscience; in particular, for moving the field towards the use of more naturalistic stimuli.

O27 – Temporal and spatial features of common semantic categories in words and picture

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The timing of semantic processing during object recognition remains a debated topic in neuroscience. To investigate this, we used multivariate pattern analysis (MVPA) on human electrophysiological responses (MEG) to object images from different semantic categories [1]. While MVPA reveals distinct neural activity patterns across categories, it raises concerns about potential contributions from low-level visual features[2]. To address this, we applied a cross-decoding approach to MEG data from two different modalities: images and corresponding written words. Using stimuli from three categories presented in randomized order, we trained classifiers on one modality and tested them on the other. When trained on words, we successfully classified pictures between 150–430 ms post-stimulus, while training on pictures allowed classification of words between 225–430 ms. A searchlight analysis revealed left-lateralized cross-modal activation, suggesting linguistic representations are involved. These findings suggest semantic activation begins around 150 ms for images and 230 ms for words.

O28 - Oiwi Parker Jones - abstract not received

Poster Presentations

P1 - Comparison of auditory mismatch fields in whole-head OPM- and SQUID-MEG

Mr Jacob Bussell[1], Prof. Matthew Brookes[2], Dr Gavin Perry[1], Miss Elena Stylianopoulou[1], Prof. Krishna Singh[1]
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MEG systems using optically pumped magnetometers (OPMs) are developing rapidly and have the potential to dramatically improve on traditional SQUID-based MEG systems in sensitivity, adaptability to different participant groups, and cost-effectiveness (Brookes et al., 2022). Their utility in comparison to traditional SQUID-based MEG systems has been reported previously, but many of these utilise smaller numbers of OPM sensors than are found in many SQUID systems (Marhl et al., 2022; Borna et al., 2020). Whilst sensitivity and signal-to-noise ratios can be investigated using smaller sensor arrays, it is important to also compare whole-head OPM systems to traditional SQUID systems on cognitive tasks that could benefit from being investigated with OPMs. In this study, 4 adult participants performed a three-stimulus auditory oddball paradigm, where they listened to a series of pure sine wave tones at different pitches and durations. They were instructed to silently count the number of target deviant tones they heard and not respond to the standard or non-target deviant tones. The same paradigm was conducted with the same participants in a 192 channel (64 triaxial sensors) OPM-MEG system and a CTF-275 channel SQUID-MEG system. The mismatch fields generated from the oddball paradigm are compared to evaluate the consistency of within-participant and between-participant measures between the OPM- and SQUID-MEG systems. We discuss a future development of this project using OPM-MEG to investigate age-related differences in sensory processing, something that is not ordinarily possible using SQUID-MEG due to the difficulties with scanning participants with smaller heads.

P2 - Using OPM-MEG to Investigate How Autobiographical Memories Are Formed in a Naturalistic Setting

Dr Nicholas Alexander[1], Robert Seymour[1], Yan Wu[1], George O'Neill[2], Stephanie Mellor[1], Tim Tierney[1], Chetan Gohil[3], Gareth Barnes[1], Eleanor Maguire[1]
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Autobiographical memories encode our life experiences, yet neuroimaging research has predominantly focused on their retrieval due to the limitations of head-immobilising scanners, such as MRI, which preclude the study of natural memory formation. In this study, we used a wearable optically pumped magnetometer (OPM)-based magnetoencephalography (MEG) system to capture neural activity during the encoding and retrieval of virtual reality autobiographical experiences in a naturalistic setting. Participants engaged in various activities, such as interacting with exhibits at a museum, all within the virtual environment. The following day, they were asked to recall and describe those experiences while also undergoing OPM-MEG.

This highly-rich data set presented numerous opportunities for analyses, especially as we knew the ground truth for the experiences the participants had. The reliability of our method was supported in the first instance by our finding of activation of the widely-known autobiographical memory network during retrieval. However, here we focused on the encoding phase in particular. Indeed, this multi-stage approach allowed us to analyse OPM-MEG signals from the encoding phase and re-factor them according to the behavioural data from the retrieval session, 24-hours later–so-called subsequent memory effects.

Considering oscillatory power, for example, theta power in right fusiform gyrus extending into medial temporal lobe, was positively associated with the number of true details remembered. Further analysis showed significant connectivity between the hippocampus and medial prefrontal cortex. Another interesting example of an oscillatory power analysis concerned event boundaries. We showed that high frequency activity at event boundaries predicted subsequent memory recall. Specifically, we found increased gamma activity in the hippocampus 3-7 seconds after an event ended. By contrast, such activity was absent for poorly remembered experiences.

Overall, our results highlight how OPMs can capture insightful new information about the brain signals associated with autobiographical memory formation, about which we know so little.

P3 - Auditory cortical responses to sound onsets and offsets in the ageing human brain

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Age-related hearing loss (ARHL), characterised by the gradual decline in hearing with age, has been associated with various behavioural deficits, including temporal processing deficits and communication difficulties. Further, individuals with ARHL show significant changes in auditory cortical responses including hyperactivity to sound onsets, latency shifts and increased neural synchronisation. While optimal listening involves synchronising with incoming auditory information and detecting sound boundaries, most studies on ageing have focused on sound onsets rather than sound offset responses.

Here, we analysed two magnetoencephalography (MEG) datasets to examine the influence of ageing on auditory cortical responses to both sound on- and offsets. In the first dataset, we recorded MEG responses from younger (20 to 40 years) and older adults (61 to 80 years) who listened to an isochronous sequence of 100ms tones, presented at a 1.5Hz rhythm. In the second dataset, we analysed a sub-study of the Cambridge Centre for Ageing and Neuroscience dataset inventory (CamCAN) that recorded MEG responses across the lifespan (18 to 80 years) to isolated tones of 300ms duration.

MEG analysis of tone-evoked responses revealed asymmetrical cortical processing of sound on- and offsets in the ageing human brain. Across both datasets older adults showed an increase in amplitude to sound onset at ~50 ms and ~100 ms compared to younger adults. However, cortical responses to sound offsets were diminished in older adults across both datasets. These functional changes in auditory cortical activity to sound on- and offsets may help to explain age-related changes in hearing such as a decrease in temporal sensitivity or difficulties in tracking speech.

P4 - Investigating neural signals for travel direction using OPM-based MEG

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Human spatial navigation relies on the brain's ability to integrate sensory inputs and self-motion to create spatial maps of the environment, crucially involving allocentric (world-centered) and egocentric (self-centered) representations. While these processes have been well-studied in rodents and flies, the neural basis of allocentric and egocentric travel directions in humans remains poorly understood. It has been recently discovered that impairments in estimating travel direction are a potential indicator of dementia, highlighting the importance of understanding this process.

Recent advancements in optically pumped magnetometers (OPMs) provide a non-invasive and portable solution, allowing high-resolution brain activity to be captured during both stationary and mobile states. This poster explores the decoding of brain signals associated with allocentric and egocentric travel directions using OPM-based MEG systems, through an experiment in which participants engaged in imagined movement and real rotations.

We successfully source-localised imagined movement-related signals to the medial temporal and frontal lobes, including increases in theta power compared to an imagined stationary control condition. We also applied machine learning techniques to classify brain signals corresponding to different allocentric and egocentric travel directions and analysed the effect of vividness of imagination. This work demonstrates the feasibility of using OPMs to study dynamic brain processes associated with navigation, opening new doors for understanding the neural encoding of spatial orientation.

P5 - Neural Representation of Predictable Distractors in Visual Search

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Statistical regularities in the environment can influence how attentional resources are allocated spatially. When the location of a salient distractor becomes predictable, it captures less attention due to alterations to both proactive and stimulus-evoked suppression mechanisms. However, it remains unclear whether this suppression affects all dimensions of the distractor, including irrelevant ones, or only those that contribute to its salience. In this study, we used magnetoencephalography and multivariate analysis to explore how spatially predictable distractors are suppressed during a statistical learning visual search task. Participants were asked to respond to a target stimulus while ignoring a colour-singleton distractor. Unknown to the participants, the distractor was presented more frequently on one side of the visual field compared to the other. We applied classification analysis to decode both the distractor-defining dimension (colour) and an unrelated dimension (spatial frequency). Preliminary results reveal significant classification of the distractor-defining dimension, suggesting stimulus-evoked suppression that varies with distractor probability during stimulus presentation. Classification of the irrelevant dimension also showed significant results, indicating proactive suppression that differs between distractor probabilities before stimulus onset. Overall, these findings highlight distinct roles for proactive and reactive suppression in statistical learning: proactive suppression targets the most salient dimensions, while reactive suppression filters out other dimensions associated with the distractor.

P6 - Differential low- and high-frequency oscillatory activity and functional connectivity at rest are directly related to quality of sleep and cognitive performance

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Sleep quality and cognition vary as a function of lifestyle, genetics, and health, and provide insight into quality of life, daily affect, and long-term health outcomes. Prevalence of poor sleep quality as high as 38% has been found in adult populations, with age implicated as a significant correlate of deteriorating sleep quality. Furthermore, sleep quality is a major risk factor in predicting later-life age related cognitive decline, and sleep disturbance is a putative precursor to severe cognitive impairment and is predictive of dementia onset. Currently, our understanding of how neurophysiology, cognition, and sleep quality interact is in its infancy, and investigating this relationship would improve our understanding of the neurophysiological mechanisms serving the development of age-related cognitive decline and sleep disturbance. Here, we used data from the from the Cam-CAN dataset with a partial least squares (PLS) approach, and a multivariate cross decomposition model to map resting state magnetoencephalography (MEG) data (X) and cognitive/sleep scores (Y) of healthy controls (n=541, age 18-89) onto a set of common latent variables (LV). 'Normative modelling' was applied to MEG data, removing the effects of age, sex, and handedness. Permutation testing (10000 resamples) was used to test the significance of the LVs resulting from the full PLS model, with two significant LVs identified ($p<0.05$). The loadings of the first LV show that better self-reported sleep quality and higher cognitive scores are directly related to reduced low frequency and elevated high frequency cortical oscillatory activity, pivoting around the alpha (8-12Hz) band. Moreover, globally decreased delta-theta and increased alpha-beta functional connectivity, with the X and Y scores of the first LV significantly correlated ($r=.29$, $p<0.001$). Using a multivariate mapping approach, the common neurophysiology underlying sleep and cognition are uncovered independently from the effects of age.

P7 - Unsupervised machine learning of brain activity from healthy participants reveals distinct subtypes that exhibit differences in lifestyle factors and intellectual functioning

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Unexplained variation in neurophysiology highlights the need for consideration of covariates of neural activity. A deeper understanding of natural variation would provide greater sensitivity and context in longitudinal and cross-cohort comparisons. We utilise age, sex, and handedness normative modelled magnetoencephalography (MEG) data of spectral power and functional connectivity (FC) to calculate the inter-subject correlation matrix, on which we perform unsupervised machine learning, finding three robustly differentiated subtypes within a large cohort of healthy controls (n=569). Subtypes are evenly split across demographics, with the ideal number of clusters determined in a data-driven manner. Accuracy of subtype membership was 96.6% ± 1.6%, evaluated via cross-validation (5-fold, 10 iterations), with care taken to avoid column based data leakage (due to symmetric input). Each subtype was linked back to unseen health, consumption, sleep, exercise, and cognitive data, and distinct group profiles were found. Group level differences in language ($F=5.6$, $p<0.01$), fluency ($F=15.0$, $p<0.001$), memory ($F=3.3$, $p=0.035$), and total cognitive scores ($F=11.2$, $p<0.001$), as well as frequency of alcohol consumption ($F=5.1$, $p<0.01$) are present across groups, motivated by specific subtype profiles. The neural activity of each group is distinct and highlights potential neurophysiological differences related to individual health, cognitive, and lifestyle factors. In particular, increased occipital theta and diffusely decreased gamma power, as well as globally increased theta FC are found in a subtype associated with worse cognitive scores and sleep duration.

P8 - Predicting brain age across the adult lifespan with spontaneous oscillations and functional coupling in resting brain networks captured with magnetoencephalography

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The functional repertoire of the human brain changes dramatically throughout the developmental trajectories of early life and even all the way throughout the adult lifespan into older age. Capturing this arc is important to understand healthy brain ageing, and conversely, how injury and diseased states can lead to accelerated brain ageing. Regression modelling using lifespan imaging data can reliably predict an individual's brain age based on expected arcs of ageing. One feature of brain function that is important in this respect, and understudied to date, is neural oscillations - the rhythmic fluctuations of brain activity that index neural cell assemblies and their functioning, as well as coordinating information flow around networks. Here, we analysed resting-state magnetoencephalography (MEG) recordings from 367 healthy participants aged 18 to 83, using two distinct statistical approaches to link neural oscillations & functional coupling with that of healthy ageing. Spatially and spectrally consistent associations between healthy ageing and neurophysiological features were found across the applied methods, showing differential effects on neural oscillations, with decreasing amplitude of low frequencies throughout the adult lifespan, and increasing high frequency amplitude. Functional connectivity within and between resting-state brain networks mediated by alpha coupling generally decreased throughout adulthood and increased in the beta band. Predictive modelling of brain age via regression showed an age dependent prediction bias resulting in overestimating the age of younger people (<40 years old) and underestimating the age of older individuals. These findings evidence strong age-related neurophysiological changes in oscillatory activity and functional networks of the brain as measured by resting-state MEG and that cortical oscillations are moderately reliable markers for predictive modelling. For researchers in the field of predictive brain age modelling with neurophysiological data, we recommend attention is paid to predictive biases for younger and older age ranges.

P9 - Calibration technologies for wearable magnetoencephalography

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Optically pumped magnetometers (OPMs) are compact and lightweight sensors that can measure magnetic fields generated by current flow through neuronal assemblies in the brain. Such sensors enable construction of magnetoencephalography (MEG) instrumentation, with significant advantages over conventional MEG devices including adaptability to head size, enhanced movement tolerance, lower complexity and improved data quality. However, realising the potential of OPMs depends on our ability to perform system calibration – which means finding sensor locations, orientation sensitivities, and the relationship between the sensor output and magnetic field (termed sensor gain). Such calibration is complex in OPM systems since, for example, OPM placement can change from subject to subject unlike conventional MEG (where sensor locations/orientations are fixed). Here, we present two methods for calibration, both based on generating accurate and well-known magnetic fields across a sensor array. Our first device (the HALO) is a head mounted system that generates dipole-like fields from a set of coils. Our second (the matrix coil) generates fields using coils embedded in the walls of a magnetically shielded room. Our results show that both methods offer an accurate means to calibrate an OPM array (e.g. sensor locations within 2-mm of the ground truth) and that the two methods agree strongly with each other. When applied to human MEG experiments, both methods offer improved signal-to-noise ratio compared to an assumed calibration. Overall, we demonstrate the critical requirement of OPM calibration and take the field a significant step closer to routine use of OPMs for MEG recording.

P10 - Impact of divided attention during driving: Preliminary Findings from an OPM-MEG Study

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Driving is a complex visuomotor activity that requires the coordination of multiple human cognitive systems such as attention, perception, memory, decision-making, and motor control. Conventional neuroimaging methods have a limitation in studying the natural dynamics of driving due to a requirement for minimal head movement during recording. To overcome this problem, we use magnetoencephalography with Optically-Pumped Magnetometers (OPM-MEG) which provides a non-invasive, safe, and motion-robust measure of brain activity during tasks involving naturalistic movement. Here, we combine OPM-MEG along with eye-tracking technology to examine neural mechanisms associated with driving in a car-following task including a secondary divided-attention component, within a simulated driving environment. In the experiment, 10 participants were asked to follow a lead vehicle while avoiding collisions with oncoming traffic and simultaneously responding to shape stimuli presented in the right or left visual field. We recorded motor responses, eye movements, and ongoing neural activity during the task. Preliminary findings from the behavioural data indicate that divided attention impairs driving performance at the single subject level. To explore the neural correlates underlying this effect, raw OPM-MEG data were synchronised with eye movements and processed using robust noise-reduction techniques such as bad channel rejection and, homogenous field correction (HFC). In the initial analysis, we aim to characterize eye movements such as blinks, and motor responses to validate our processing pipeline. In subsequent analyses, we plan to correlate specific patterns of neural activity with changes in attentional state and driving performance. This will help us understand how cognitive and motor systems interact and may shed light on why driving performance declines in certain situations.

P11 - Compare OPM and SQUID MEG System with Common Semantic Properties for Words and Pictures via MVPA

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Optically pumped magnetometer (OPM) is a new type of Magnetoencephalography (MEG) that facilitates more flexible sensor arrangement and smaller distance from sensor to scalp, resulting in average 5 times stronger neuromagnetic signal than that captured by a superconducting quantum interference devices (SQUID) sensor. Meanwhile, the noise level of OPM sensor is also higher and therefore the overall signal to noise ratio remains close to that of SQUID. Practically, many studies have unveiled a comparable performance of the two systems in a cognitive neuroscience paradigm. However, it is not well examined how the spatial resolution, i.e. the number of MEG sensors over the brain, will affect the performance of the two systems, especially in a multivariate pattern analysis (MVPA) approach. To explore this, we port the paradigm from a previous study using TRIUX MEGIN Elekta Neuromag SQUID system to an OPM system of FieldLine HEDscan. Eleven subjects are recruited and undergo the same paradigm in both systems with a least interval of one week. We present visual stimuli from two different modalities: pictures and their corresponding written words. Each stimulus comes with two orthogonal binary properties and MVPA is used to classify these properties from MEG data. Classification results derived from subsets of SQUID magnetometers are compared to that of OPM. With equivalent spatial resolution, the OPM shows a comparable MVPA performance as the SQUID one.

P12 - Imaging integrative memory processing with wearable MEG

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Memory inference refers to the process whereby directly observed associations between stimuli (e.g. A-B, B-C) are subsequently used to infer indirect associations (A-C). Previous neuroimaging studies suggest that this depends on theta band oscillations in the medial temporal lobes (MTL) and medial prefrontal cortex, as well as theta band functional connectivity between those regions.

To test this hypothesis, we collected MEG data from a cohort of patients with medically refractory epilepsy (n=8 to date) performing a memory inference task using on-scalp optically pumped magnetometer (OPM) arrays. Behavioural results show that these patients can retrieve both direct and inferred associations with significantly above chance accuracy. However, one challenge with this dataset is the heterogeneity of sensor coverage across the cohort, with the total number of channels on the scalp ranging from 59-121 across participants. This and the relatively low number of participants make group level random effects analyses difficult. To address this problem, we examined changes in oscillatory power individually for each participant and then looked for conjunction across the group. We demonstrate that this method identifies basic sensory responses during the experiment, such as beta resynchronisation over motor cortex after button pressing and reduced alpha power over visual cortex during image presentation.

Applying the same analyses to memory-related contrasts has so far identified three effects. First, an increase in theta band power in the medial and anterior temporal lobes during cued memory retrieval vs baseline. Second, greater theta power in the anterior temporal lobe for old vs new image stimuli during retrieval. Third, a reduction in alpha power in retrosplenial cortex when participants were asked which of four images had previously been associated with the cued image. In sum, these results demonstrate the feasibility of using OPMs to study integrative memory processing within and beyond the MTL.

P13 - Parallel and dynamic attention allocation during natural reading

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During natural reading, our attention constantly shifts from word to word. However, how this attention shift interacts with reading process remains unclear. Specifically, we explored how parafoveal information attracts attention and how foveal information detains attention. We co-registered MEG and eye movements in a one-line sentence reading task. The lexical frequency of the target word in each sentence was manipulated (low/high, e.g., “waltz” vs. “music”). Simultaneously, we tagged the target word at 60Hz and the post-target word at 65Hz. This method allowed us to measure the dynamics of attention influenced by both parafoveal processing (the parafoveal lexical effect) and foveal processing (the foveal load effect). We observed that when previewing a low-lexical-frequency target word, more attention shift towards the parafovea (indexed by 60Hz tagging responses during pre-target fixations, a replication of Pan et al. 2021); however, after fixating on this target word, less attention shift to the post-target word (indexed by 65Hz tagging responses during target fixations). These results suggest that attention is distributed across multiple words simultaneously and is flexibly modulated by both foveal and parafoveal processing.

P14 - From Concept to Cradle: Developing an OPM-MEG Setup for Infant Neuroscience

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Humans undergo significant brain development in infancy. Optically pumped magnetometers (OPM-MEG) offer a unique opportunity to study this. OPM-MEG is both infant-friendly and capable of providing high spatial and temporal resolution in a single modality, allowing researchers to gain unprecedented insights into early brain and cognitive development. Unlike conventional MEG systems, which require extreme cooling to around -265°C and use rigid, one-size-fits-all helmets, OPM-MEG employs room-temperature sensors that are lightweight and can be easily positioned close to the scalp. This design makes OPM-MEG particularly suitable for studying infants and young children. While this technology has gained traction in adult studies, its application in infant research is still in its early stages. Our team, comprising experts from physics and developmental neuroscience, has established one of the world's first OPM-MEG laboratories dedicated to infant research. Here, we describe our novel OPM-MEG setup for infants along with customized protocols for infant testing. We discuss the challenges and opportunities of this innovative approach, highlighting its potential to address longstanding questions in developmental neuroscience.

P15 - Interhemispheric beta band connectivity dynamics during motor sequence planning and execution

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An over-reliance on the ipsilateral hemisphere during unimanual motor tasks can be maladaptive, as shown post-stroke with the overactive ipsilesional motor cortex hindering re-lateralization of brain functions and movement recovery. Further, reduced interhemispheric dependence during motor production of unimanual movements has been linked to faster reaction times. Yet, it remains unclear whether this association applies to rapidly unimanual sequences of movements, which underly many everyday motor skills, e.g. handwriting. This study aims to investigate how interhemispheric interactions evolve dynamically during skilled sequence planning and production. We analysed electroencephalography (EEG) data collected during a unimanual multi-finger sequence production task (N = 19). Inter-hemispheric functional connectivity (coherence and Weighted Phase Lag Index) between electrodes above the contralateral and ipsilateral motor cortices within the beta-band frequencies (13-30 Hz) was calculated across the sequence planning and production trial phases. Mean baseline corrected functional connectivity showed a pronounced decrease in beta power coherence around movement execution, suggesting a precisely timed peak in uncoupling of contra- from ipsilateral motor activity for sequence initiation. This short-lived decrease in interhemispheric connectivity was more pronounced for motor sequences produced at double the speed. The results may be relevant to the development of neurofeedback applications to enhance the speed of motor skill production in stroke and Parkinson's disease rehabilitation and motor skill training.

P16 - Measuring from the brainstem using Optically Pumped Magnetometers; A proof-of-concept study

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The brainstem plays a crucial role in the maintenance of functional systems, but measuring brainstem in-vivo is challenging. EEG and MEG are well-suited to investigate oscillatory dynamics, but subcortical structures are small and far removed from the surface. Traditional MEG offers superior spatial resolution compared to EEG but sets a lower limit of 2-4 cm on the sensor-to-scalp distance. Optically Pumped Magnetometers (OPMs) can be placed directly on the scalp and offer the potential of brainstem recording with minimal constraints on subject movement, but it's not yet known whether we can measure from the brainstem with OPMs. We therefore set out to test this using a specific auditory brainstem response task, a pure-tone auditory stimulation at 333Hz. Previous studies have shown that the hierarchically organised structures on the auditory pathway act as a low-pass filter, such that above a certain limit, cortical structures cannot phase-lock to the auditory stimuli (upper limit ~200 Hz). Note that our paradigm presented a challenge for our OPMs as its optimal sensitivity begins to fall off at 150Hz at a rate comparable to a first-order filter.

Phantom recordings using a magnetic dipole confirmed the system is capable of detecting magnetic activity at 333Hz, at the amplitude of the typical neural response to our paradigm observed in previous MEG studies. Distortion-less and unmodulated delivery of the audio stimulus using a 2-meter hard plastic tube was verified by an artificial ear. Empty room recordings confirmed there were no stimulus related artefacts. We tested a total of 12,000 trials of pure-tone stimulus in one participant but did not observe a response. Future studies are needed with more participants, alternative OPM systems, more optimised stimulus delivery, or lower pure-tone frequencies to test the limit of recording the brainstem magnetic fields using OPMs.

P17 - Tracking the neurodevelopmental trajectory of beta band oscillations with optically pumped magnetometer-based magnetoencephalography

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Neural oscillations mediate the coordination of activity within and between brain networks, supporting cognition and behaviour. How these processes develop throughout childhood is not only an important neuroscientific question but could also shed light on the mechanisms underlying neurological and psychiatric disorders. However, measuring the neurodevelopmental trajectory of oscillations has been hampered by confounds from instrumentation. In this paper, we investigate the suitability of a disruptive new imaging platform – optically pumped magnetometer-based magnetoencephalography (OPM-MEG) – to study oscillations during brain development. We show how a unique 192-channel OPM-MEG device, which is adaptable to head size and robust to participant movement, can be used to collect high-fidelity electrophysiological data in individuals aged between 2 and 34 years. Data were collected during a somatosensory task, and we measured both stimulus-induced modulation of beta oscillations in sensory cortex, and whole-brain connectivity, showing that both modulate significantly with age. Moreover, we show that pan-spectral bursts of electrophysiological activity drive task-induced beta modulation, and that their probability of occurrence and spectral content change with age. Our results offer new insights into the developmental trajectory of beta oscillations and provide clear evidence that OPM-MEG is an ideal platform for studying electrophysiology in neurodevelopment.

P18 - Aberrant functional connectivity in very pre-term children during motor control

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Individuals born very pre-term (<32 weeks' gestation) are at an increased risk of delayed motor development. While altered resting-state functional connectivity in very pre-term children is well-documented, task-based functional connectivity during motor control remains largely unexplored. This study investigated the functional connectivity patterns during a visuomotor task in 28 full-term (FT) and 22 very pre-term (VPT) children, aged 3-7 years, using Magnetoencephalography (MEG). VPT children showed significantly longer button response times than FT controls. Whole-brain and Region of Interest (ROI) analyses revealed significant differences in connectivity patterns and strength between the groups in the 70-90Hz gamma frequency range across pre-movement, motor execution, and post-movement phases. VPT children demonstrated aberrant, widely-distributed networks across all motor action stages, not observed in FT children. FT subjects showed stronger connectivity during the pre-movement phase, whereas VPT subjects displayed enhanced connectivity during and after motor execution. ROI analysis demonstrated altered connectivity patterns and strength in VPT children, including delayed bilateral primary motor cortex (M1) connectivity and attenuated lateral occipital cortex to premotor cortex connectivity during pre-movement and execution phases. Connectivity strength varied significantly between the left premotor and right primary cortices during motor execution, and between the left motor and right occipital cortices post-movement. The latter also correlated significantly with gestational age. These findings reflect the long-term impact of gestational age on connectivity patterns in the VPT population, indicating complex, potential compensatory mechanisms in their motor networks and functional reorganization during cortical development. This study highlights the potential for early detection and intervention strategies for children born very pre-term (VPT) to mitigate long-term neuromotor impairments. Understanding these altered functional connectivity patterns could pave the way for developing tailored therapeutic approaches. Future studies are required to further elucidate the developmental trajectories and functional implications of these altered connectivity patterns during motor control in the VPT population.

P19 - Investigating the Impact of Perinatal Conditions on Behavioural Outcomes and Neural Oscillations in Preterm and Full-term Children

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Introduction: Preterm birth, occurring before 37 weeks of gestation, poses substantial health challenges due to incomplete maturation, affecting motor and cognitive function. This study uses Magnetoencephalography (MEG) to examine the influence of perinatal conditions on neural oscillations and behavioural responses in children aged 5.00-7.08 years (M =5.77, SD =0.59) during a video-game task. Aim: This research aims to (a) explore motor-induced power differences in the primary motor cortex based on gestational age and gender, (b) investigate correlations between these neural activities and perinatal conditions and (c) assess response times and error rates. Method: MEG data from 50 children (22 preterm, 28 full-term) were analysed using time-frequency representation (TFR) with the Morlet wavelet transform. Statistical analyses were adjusted using the False Discovery Rate (FDR). Pearson correlation coefficients were calculated to examine the relationships between perinatal factors, psychometric scores, and neural activity. Results: In Time-frequency analysis (p corrected < 0.025) full-term children exhibited stronger γ-ERS, β rebound-ERS, α-ERS and θ-ERS except for a stronger β-ERD in preterm children. Males exhibited stronger γ-ERS, while females had stronger α-ERD and β-ERD. Correlational analysis ($p < 0.05$) revealed significant links between gestational factors and specific neural frequencies. Behavioural analysis (p corrected < 0.025) showed that full-term children responded faster than preterm children. Discussion: These findings suggest that although preterm children may catch up behaviourally with full-term peers as shown in K-ABC motor tests, significant neural power differences persist. The study underscores the lasting impact of perinatal factors on neural development, highlighting the importance of early interventions for preterm children.

P20 - The Neural Oscillatory Basis of Perspective-Taking in Autistic and non-Autistic Adolescents using MEG

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Taking another's perspective is a high-level mental skill underlying many aspects of social cognition. Perspective-taking is usually an embodied egocentric process whereby people mentally rotating themselves away from their physical location into the other's orientation. This is accompanied by increased theta-band (3–7 Hz) brain oscillations within a widespread fronto-parietal cortical network including the temporoparietal junction. Individuals with autism spectrum disorder (ASD) have been reported to experience challenges with high-level perspective-taking, particularly when adopting embodied strategies. To investigate the potential neurophysiological basis of these autism-related individual differences, we used magnetoencephalography in combination with a well-replicated perspective-taking paradigm in a group of 18 autistic and 17 age-matched non-autistic adolescents. Findings revealed that increasing the angle between self and other perspective resulted in prolonged reaction times for the autistic group during perspective-taking. This was accompanied by reduced theta power across a wide network of regions typically active during social cognitive tasks. On the other hand, the autistic group showed greater alpha power decreases in visual cortex compared with the non-autistic group across all perspective-taking conditions. These divergent theta and alpha power effects, coupled with steeper response time slopes, suggest that autistic individuals may rely more on alternative cognitive strategies, such as mental object rotation, rather than an egocentric embodied approach. Finally, no group differences were found when participants were asked to track, rather than take, another's viewpoint, suggesting that autism-related individual differences are specific to high-level perspective-taking.

To conclude, I will present preliminary data from a recent project in which we developed a real-world perspective-taking setup in combination with wearable OPM-MEG. This has widespread implications for the future of real-world, naturalistic social neuroscience.

P22 - Electrophysiological underpinnings of information transfer between memory systems

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Different types of memories are usually thought of as depending on distinct neural circuits that operate independently. However, some recent work suggests that these memory systems can interact under specific circumstances. One paradigm that has been repeatedly used to explore such interactions has found that performance of a finger-tapping task (SRTT) influences wordlist learning, and vice versa, only when these tasks share a common abstract structure. Importantly, the SRT is implemented as a procedural memory task while the wordlist learning task is a common task used to explore declarative memory, i.e. the two tasks rely on very different networks and processes. A recent TMS-MEP study utilizing these paradigms uncovered a direct link between word-list performance and primary motor cortex excitability. However, the detailed neural dynamics are as of yet unknown.

The current study further investigates the neural basis of transfer across memory systems by examining human MEG data throughout different stages of the learning process, both online and offline. This allows us to explore this previously uncovered role of the motor cortex more closely, as well as the dynamics of the wider underlying neo-cortical network. This work contributes to a wider trend that challenges traditionally modular models of learning and supports a more integrated approach to memory and the brain.

P23 - Investigating emotional processing in infants using OPM-MEG

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During the first year of life, infants experience rapid brain development and growth. However, the postnatal origins of many crucial functions, including emotional processing of faces and voices, remain unclear. Previous neuroimaging studies are limited by experimental challenges, and few have been conducted in infants under 5 months. One particular barrier with MEG is the large, inflexible cryogenic helmet for SQUID sensors, which increases movement artefacts and limits sensor sensitivity due to distance from infants' scalps. Compared with MEG, electroencephalography is vulnerable to signal dispersion in scalp tissue, resulting in poorer spatial resolution. Optically-pumped magnetometers (OPM-MEG) overcomes spatial and temporal limitations of current infant brain imaging methods in a single modality. By housing modular sensor units in different helmet sizes, OPM-MEG accommodates different ages and head sizes, thus optimising sensor measurement sensitivity.

We aim to record OPM-MEG in approx. 40 infants aged 2-4 months whilst they complete two 15-minute tasks. Firstly, a passive face viewing task of adult female faces presenting happy, angry and neutral facial expressions. Secondly, a passive listening task presenting female voices reading semantically neutral short sentences in the same emotions.

We will apply the FLUX MNE-Python pipeline to analyse neural dynamics associated with the perception of different emotional faces and voices, and frequency spectrum modulation in visual and auditory cortices. To evaluate how much infants integrate sensory modalities, we will compare responses between faces and voices. Multivariate analyses will be applied to classify neuronal dynamics associated with each emotion.

This will be one of the first OPM-MEG studies with human infants. We hope to uncover neurodevelopmental features of emotional processing in early life and establish practical guidance for using OPM-MEG with infants. Moreover, this programme has the potential to lead to future investigations identifying the nature of neurodiversity in emotional perception during early postnatal development.

P24 - The theta rhythm coordinates motor responses during a spatial navigation task

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Theta band activity is observed in the rodent hippocampus throughout translational movement, coordinating spatial representations of current location and potential future paths. In addition, it has been shown that animals' limb movements are phase locked to the hippocampal theta rhythm. In the human brain, hippocampal theta is also strongly implicated in episodic memory function; whilst the temporal distribution of button press responses across episodic memory retrieval exhibits theta rhythmicity. Here, we asked if button presses would show similar theta rhythmicity in a spatial memory task, whether rhythmic properties would vary with the number of potential future paths, and whether this was coordinated with theta band activity across the brain recorded using MEG. To do so, we asked participants to navigate around a 4 x 4 grid of images, taking the shortest possible path between a given start and goal location in each trial. Critically, there was either one shortest potential path (1-path) or three shortest potential paths (3-path) between start and goal locations in each trial. First, we observed significant theta band rhythmicity in button pressing during 3-path (but not 1-path) trials. Second, we found that button pressing was phase locked to source reconstructed hippocampal theta oscillations in both 1-path and 3-path trials, but with a lower theta frequency in 3-path vs 1-path trials. Finally, we found that source reconstructed theta oscillations in primary motor cortex, contralateral to the active hand, were also phase locked to button pressing and to theta band oscillations in the ipsilateral hippocampus. Together, our findings suggest a dynamic coordination between motor responses and the rhythmic sampling of potential future paths during spatial navigation. This highlights the role of theta oscillations in linking motor behaviour with higher level cognitive representations.

P25 - Neurophysiological signatures of ADHD: associations with sleep and cognitive performance

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Attention Deficits/Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder characterised by inattention, impulsivity and hyperactivity (American Psychological Association, 2013; World Health Organisation, 2013). While extensive research has evidenced behavioural impairments in ADHD (Nigg, 2005; Kropotov, 2016), findings of neural correlates are varied (Kropotov, 2016). This study will aim to examine a neurophysiological signature associated with brief and localised neuronal deactivations, characterised by high-amplitude slow wave oscillatory activity: 'local sleep'. Previous research has evidenced associations between local sleep and mind-wandering/lapses of attentional control (Andrillon et al., 2021; Wienke et al., 2021), as well as with greater daytime sleep pressure driven by poor sleep quality (Vyazovskiy et al., 2011; Nir et al., 2017). Given both attention deficits and sleep disturbance are commonly reported factors in ADHD symptomology (Scarpelli et al., 2019; Minao et al., 2019), this study aims to assess the role of local sleep in the experience of mind-wandering and impaired attentional control in ADHD. Additionally, this study will examine the relationship between local sleep and focal alpha band activity, traditionally linked with attention and mind-wandering. Specifically, this study will demonstrate feasibility of detecting local sleep waves using MEG in children (aged 8-11), as most previous studies have used EEG. Task-free resting state MEG data (eyes-open and eyes-closed) will be assessed to compare local sleep occurrence between children showing ADHD traits (measured by the CBCL and Conners-3) and neurotypical controls. Demonstrating a significant role of local sleep in underlying neural functioning would drastically reshape how ADHD is interpreted and build towards an objective biological measure to complement current symptom-based diagnostic components as well as real-time detection of mind-wandering likelihood.

P26 - Living in a World of “Close Enough”: Apathy and the Bayesian Brain

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Background/Aims: Apathy is a reduction in goal-directed action which is pervasive in neurodegenerative disease. There are currently no treatments. We propose and test a new model of apathy based on the reduction in confidence (cf. precision) of beliefs regarding action outcomes. We test this new framework using MEG, and psychophysical analysis of performance and expectation in a goal-directed task. Preregistered at https://tinyurl.com/wbt6rpx9.

Methods: 50 healthy adults undertook a goal-directed task (Hezemans et al, 2020) in MEG. They pressed on a force sensor to propel a virtual ball across the screen to land on a target. In a subset of trials (“catch trials”), used to estimate prior precision, the ball disappeared during its trajectory and participants estimated the end position. Apathy was assessed using the Apathy-Motivation Index (AMI).

MEG preprocessing used SPM12 following an exemplar pipeline (Vaghari et al, 2022). MEG sources were reconstructed using a beamformer and whole brain maps were generated across 2s epochs, timelocked to the virtual ball stop. Contrasts (FWE cluster thresholded at p[uncorrected]<0.001, k=100) compared 500ms windows of interest around ball stop against a baseline.

Results: There was strong evidence confirming the negative correlation between prior precision and apathy (B=12.2, p<0.01). Source localization informed the selection of three nodes in the left motor, supplementary motor, and prefrontal cortex from which local field potentials were extracted. Power spectral densities in all three regions showed a significant increase in beta power around ball stop (-250ms to 250ms) compared to baseline (-750ms to -250ms). Network analysis, using dynamic causal modelling, is ongoing.

Conclusion: Apathy results from imprecise prior beliefs about one’s action outcomes. There is strong prefrontal beta-power at the time at which the action goal is fulfilled. Future psychopharmacological-MEG studies will further explore the neurophysiological basis of apathy, both in health and apathy-associated with frontotemporal lobar degeneration.

P27 - Brain-responsive music enables non-invasive, targeted and unobtrusive neurostimulation

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Objective We are developing a new closed-loop brain stimulation method by embedding, within music, auditory elements that respond to the listener's brain activity. Here we show that this brain-responsive music has systematic and targeted effects on neural oscillations implicated in a variety of neurological and mental health disorders.

Approach We recorded magnetoencephalogram (MEG) or electroencephalogram (EEG) signals from participants as they listened to music synthesized by commercial audio software. Brain signals were bandpass filtered, phase-shifted and used to control the timbre and/or timing of notes within the music.

Main results Listening to brain-responsive music induced peaks and troughs in spectral power at frequencies that depended systematically on the phase-shift applied to the brain signal. Phase-dependent modulation was greatest at the centre frequency of the filter. As a result, by calibrating these parameters we could achieve selective enhancement or suppression of either theta (5 Hz) or alpha (10 Hz) oscillations. Moreover, by choosing different sensor locations we could target power modulation to either frontal or temporal cortex. The phase-dependent power modulation observed with brain-responsive music was significantly attenuated when participants listened to identical music as a conventional, open-loop stimulus. Finally, we demonstrate that brain activity could be modulated by more complex compositions combining a variety of brain-responsive musical elements controlled by a wireless, wearable EEG headband suitable for home use.

Significance Brain-responsive music provides an unobtrusive and targeted method of modulating neural oscillations in the listener's brain and may enable both creative and therapeutic applications of Brain Computer Interface technologies.

P28 - Attention Overcomes Lateralisation to Globally Enhance the Processing of Task-Relevant Information: A M/EEG Study

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Selective attention is known to enable the brain to prioritise task-relevant information. However, the interaction between this top-down controlled prioritisation and the brain's inherent hemispheric dominance remains unclear. We investigated this question using concurrent magnetoencephalography (MEG) and electroencephalography (EEG) recording combined with multivariate pattern analysis (MVPA). In our task, participants viewed two visual objects from different categories on each side of the screen, selected the target based on its semantic category (fish, boat or chair), and reported its colour (red, green or blue). The categories of both the target and non-target object could be decoded from the pattern of activity across sensors, from approximately 80 ms after stimulus onset. Category coding was initially similar for target and non-target, but target object coding was stronger than non-target coding from around 370 ms. Subsequently, we performed source reconstruction and decoded object categories using data from the left and right visual, posterior parietal, and prefrontal cortices. We found that each hemisphere coded for visual information from both sides of space, though contralateral decoding was significantly stronger. We then examined the interaction between hemispheric dominance and attention by conducting a two-way ANOVA. The lateralisation effect was observed from approximately 80 to 600 ms, while the attention effect was observed from approximately 370 to 800 ms. Although the attention effect emerged later and was weaker during the early stage, it became more prominent than the lateralisation effect in the later stage of information processing. This pattern was observed in the visual cortex and posterior parietal cortex, but not in the prefrontal cortex, where overall decoding performance was lower across conditions. Our findings suggest that while hemispheric lateralisation dominates the early stage of visual processing, as the task progresses, the brain gradually discards irrelevant information to form a more global state focused on encoding task-relevant information.

P29 - FLUX: A pipeline for MEG analysis

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FLUX is an open-source pipeline designed to streamline the analysis of magnetoencephalographic (MEG) data. While various community-developed toolboxes offer a wide range of analytical options, they also introduce challenges related to reproducibility due to the many degrees of freedom in analysis choices. FLUX addresses these challenges by providing a standardized, transparent, and straightforward pipeline that promotes consistency. While providing a standard, FLUX still offers customizable options based on the specific study, making it adaptable to different research needs. Key advantages of FLUX include its applicability in training and education, making it easier for new researchers and clinicians to utilize MEG data effectively. Furthermore, multi-site studies will benefit from standardized operational procedures and analysis methods, enabling consistent data collection and analysis across locations. By standardizing procedures, FLUX enhances the reproducibility of scientific findings.

FLUX is fully compatible with the Brain Imaging Data Structure (BIDS), ensuring that analysis steps and settings are explicitly defined, fostering open science and transparency. The FLUX pipeline is implemented as Jupyter notebooks with documented code and graphical outputs. Moreover, FLUX is open-source based on MNE-Python making it highly beneficial for researchers in low-income countries, as the tools are freely available. Additionally, the code is open to contributions from the broader community, encouraging collaborative development.

FLUX defines basic steps such as preprocessing as well as more complex analyses like time-frequency analysis of power, source modelling, and multivariate pattern analysis all of which are demonstrated in a step-by-step procedure applied to an MEG data set. The long-term objective of FLUX is to include the application of Optically Pumped Magnetometers (OPM), and further enhance its utility for both clinical and cognitive neuroscience. Through these developments, FLUX aims to foster the replicability of OPM and MEG research, supporting the advancement of human neurophysiological data analysis.

P30 - Distinguishing entrainment, resonance and SSVEPs using subharmonic stimulation

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Rhythmic brain stimulation research often aims to establish causal links between neural oscillations and cognition. However, the very act of stimulation obscures endogenous oscillations. This makes it challenging to differentiate neural entrainment, resonance, and steady-state evoked responses (SSVEPs) and ultimately deduce the mechanistic impact of stimulation on the brain and behaviour. Here, I discuss "subharmonic stimulation" as a methodological solution to this problem. Subharmonic stimulation delivers rhythmic stimulation at a subharmonic of the target oscillation, moving SSVEPs out of the target frequency band and allowing entrainment to be distinguished from resonance through phase-coupling analyses. Using three datasets of human MEG and scalp EEG, I demonstrate how subharmonic stimulation can (i) distinguish endogenous visual gamma-band and alpha-band oscillations from SSVEPs based on spectral and topographic characteristics, (ii) reveal phase-coded information in gamma-band oscillations, and (iii) enhance behavioural performance in cognitive tasks. These findings highlight how subharmonic stimulation provides mechanistic clarity for the impact of brain stimulation on neural oscillations and cognition, offering exciting new opportunities for brain stimulation research both within the lab and in the clinic.

P31 - Modelling variability in functional brain networks using deep generative models

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There is a growing interest in studying the dynamics of functional networks, which have previously been linked to cognition, demographics and disease states. The sliding window approach is one of the most common approaches to compute dynamic functional networks. However, it cannot detect cognitively relevant and transient temporal changes at the time scales of fast cognition, i.e. on the order of 100 milliseconds, which can be identified with generative modelling based methods such as HMM (Hidden Markov Models) and DyNeMo (Dynamic Network Modes) in combination with electrophysiological data. We attempted to address two of the limitations of these generative models.

Firstly, time-varying estimates of power and functional connectivity (FC) are calculated under the assumption that they share the same dynamics but there is no principled basis for this assumption. We propose Multi-Dynamic Network Modes (M-DyNeMo) that allows for the possibility that power and FC are uncoupled. Using magnetoencephalography (MEG, rest and task), we show at rest that the dynamics of power and FC are independent and that a task structure modulates the dynamics of power and FC, inducing a change in coupling. This new method reveals novel insights into the evoked network response to task and ongoing activity that previous methods fail to capture, challenging the assumption that power and FC share the same dynamics.

Secondly, DyNeMo assumes the same set of dynamic functional networks for all sessions, i.e. the networks are estimated at the group level. This does not allow for the discovery of, nor benefit from, subpopulation structure in the data. We propose the use of embedding vectors (c.f. word embedding in Natural Language Processing) to explicitly model individual sessions. We show by applying this approach to current models, improved performance can be achieved, and the learnt embedding vectors reflect meaningful sources of variation across a population.

P32 - Identifying and Mitigating Directional Noise in OPM-Based MEG for Enhanced Neural Signal Detection

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The wearability and robustness of optically pumped magnetometers (OPMs) make them a promising avenue for exploring neuroscience-based research questions requiring the movement of the head. However, current OPM sensors are susceptible to environmental and directional noise, hindering experiments requiring participant movement, since the neural signals may be buried behind these sources of noise. This poster focuses on identifying directional cues in the interference component of acquired OPM data, in order to mitigate and eliminate the associated noise before localizing the brain's neural signals. We test physics based and data-driven models with the aim of identifying features which can be used to classify the direction of the head within the room. The results demonstrate the presence of directional features in the data, thereby supporting future efforts to identify and eliminate such features for enhanced source localization, pinpointing neural activity in the brain with better precision. These efforts reinforce broader motivations for making OPM-based MEG systems robust to movement and vibrational noise.

P33 - Distort to inform: can OPMs distinguish between true and distorted anatomical models?

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MEG signals derive predominantly from pyramidal neurons, which follow the cortical surface. Previous work, using head-casts to minimise co-registration errors in conventional MEG, has shown that MEG functional estimates depend on precise anatomical models (Little et al., 2018). Specifically, the idea behind this approach is to quantify the reconstruction performance of different algorithms by applying them over progressively more deformed anatomical models (i.e., cortical meshes) and evaluate the resulting model evidence (i.e., free energy). In this context, one should expect model evidence to be maximised when the estimated current distribution lies on the true cortical mesh. Here we extended the practical value of this approach by using OPMs with custom-built scanner-casts that do not constrain the participant's movement. In addition, we leveraged diffeomorphic brain shape modelling (Ashburner et al., 2019) to provide more realistic surrogate brains deformed along a parameter space consistent with the normal population. Mean surface distortions ranged from 0.6 to 4 mm. We used two source reconstruction algorithms (Empirical Bayes Beamformer - EBB and Minimum Norm - IID). We found that, for auditory, motor evoked responses and blindly partitioned data (using a Hidden Markov Model), the model evidence of both EBB and IID scaled with the degree of anatomical distortion. Initial results suggest that for seated (closed-loop) recordings, it is possible to distinguish the true cortical surface from surfaces with a mean distortion of more than 1 mm. This work allows us to objectively quantify the validity of any OPM analysis pathway from hardware gain distortions to co-registration error to inversion assumptions.

P34 - BSD: a Bayesian framework for parametric models of neural spectra

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Background. Analyzing neural power spectra is essential for understanding brain function and dysfunction, often represented through rhythmic oscillations and aperiodic components. Existing methods like FOOOF offer valuable insights but face limitations in statistical analysis and group-level comparisons.

Aims. This work introduces Bayesian Spectral Decomposition (BSD), a Bayesian framework designed to overcome these limitations by enabling more robust modeling, parameter estimation, and group-level regression analysis of neural spectral power, specifically incorporating continuous covariates such as age.

Methods. BSD's efficacy was established through simulations, comparing its performance against the FOOOF method for peak detection. The framework was then applied to a group-level study using EEG spectra from 204 healthy subjects in the LEMON dataset. Bayesian techniques such as variational inference and Parametric Empirical Bayes (PEB) were used to model and analyze neural spectra.

Results. Simulated data demonstrated BSD's superiority over FOOOF in spectral peak detection, particularly in scenarios with intermediate peak heights. Application to EEG data illustrated the framework's utility in parameter estimation, model selection, and assessing the relationship between neural spectra and aging.

Conclusion. BSD offers a powerful, flexible approach for analyzing neural power spectra, outperforming existing methods like FOOOF in key areas. Its capacity for group-level analysis and covariate regression makes it particularly useful for large M/EEG datasets in both clinical and basic neuroscience, providing a robust platform for future research into brain function and disorders.

P35 - Bridging subject variability patterns between MEG and fMRI studies

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Recent methods for modelling brain activity are providing new insight into functional brain connectivity and networks. These methods are capable of capturing meaningful variation across the population in both MEG and fMRI studies, showing potential for prediction of cognitive or clinical traits. Due to the inherent differences in the measurement of brain activity, the direct linking between MEG and fMRI remains a challenge. Nevertheless, by leveraging patterns of subject variability, the connection between MEG and fMRI can be better understood. Here, we propose to extract the meaningful subject variability patterns from MEG and fMRI as subject-specific fingerprints and develop an approach that can map a subject in a MEG study to similar subjects in an fMRI study, by making use of the Cam-CAN dataset, in which both MEG and fMRI are available in the same subjects. Once the subjects are mapped, the functional brain connectivity patterns between MEG and fMRI can be linked at the individual level. As well as giving new insights into the relationship between MEG and fMRI, this approach could also provide a way to bridge findings from bespoke MEG studies to larger population-level fMRI datasets like UK Biobank. If successful, this would allow bespoke MEG studies access to a broad spectrum of demographic characteristics from UK Biobank, including behavioural measurements, and genetic factors relevant to brain development, aging, and disease. This approach has the potential to be applied to any individual level neuroimaging study and would provide a general tool for use by the wider neuroimaging community.

P36 - Decoding motor sequence identity from MEG patterns

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Non-invasive brain-computer-interfaces (BCIs) hold promise for restoring communication and control in individuals with motor disabilities yet are limited by the complexity of commands they can reliably decode. This study introduces a novel approach to expand BCI command sets by decoding complex motor sequences from preparatory neural activity across the brain using Magnetoencephalography (MEG).

We utilised an existing MEG dataset (N=16) employing a delayed sequence production task. Here participants produced four five-element finger sequences consisting of two distinct orders and two different target timing structures from memory following several days of training. The first finger press and timing were matched across the four sequences within each participant such that the decoding before and at sequence initiation could not be attributed to differences in finger identity and timing of the first press, but to sequential planning. We utilised cross-validated Linear Discriminant Analysis (LDA) and a customized Deep Learning (DL) model based on MEGNet for sequence classification using non-overlapping gliding time windows of 10ms from baseline to the period after sequence execution.

Our analysis revealed significant above chance decoding accuracies during both sequence planning and production, with peak sequence classification accuracy immediately preceding the onset of the first movement. Topographical analysis of LDA weights highlighted the spatial distribution of discriminative information, revealing key motor areas contributing to sequence identification throughout preparation and execution.

These findings demonstrate the utility of MEG for the decoding of more complex sequential actions from preparatory activity with relevance to more intuitive and efficient non-invasive BCIs technology for neurofeedback and neural prosthetics.

P37 - Modelling functional brain networks during human sleep

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Understanding brain networks requires computational methods that learns how the brain's dynamics organize into recurrent activations of transient brain networks. While recent studies have identified brain networks during rest and task, exploration into their dynamics during sleep remains limited. This study assesses the application of DyNeMo (Dynamic Network Modes), a novel approach that utilizes a generative model for electrophysiological data and a Bayesian inference framework, to analyze sleep electroencephalogram (EEG) data.

The sleep EEG data used in this study is from 19 participants, gathered by Schreiner et al. The sensor-level data was source reconstructed and parcellated into 38 anatomically defined regions of interest.
The power maps and amplitude envelope correlation (AEC) revealed distinct static networks across sleep stages. Alpha power (8-12Hz) is strongest in posterior regions during wake, while frontal delta power (0.5-4Hz) and posterior theta power (4-8Hz) increased as sleep deepened. Additionally, enhanced sigma power (12-15Hz) and AEC connectivity were observed in the frontal regions during N2 and N3.

While the static analysis revealed distinct power and connectivity patterns across sleep stages, the dynamic analysis using DyNeMo further elucidated the spatiotemporal characteristics of the networks. DyNeMo inferred eight distinct modes from the dataset, these modes were characterized using power and coherence, revealing distinct oscillatory power and functional connectivity patterns. One mode represented a visual network with alpha-band activity, while another was identified as a temporal network. Some modes showed strong delta-band power. Additionally, a mode linked to spindles exhibited significant sigma-band power in the frontal cortex. These findings align with patterns observed in static analysis and other sleep studies.

The DyNeMo-based sleep stage classification has a 60.5% accuracy, highlighting DyNeMo's potential for advancing our understanding of dynamic networks during sleep. This study concludes that DyNeMo is a reliable tool for analyzing sleep data, revealing insights into dynamic network patterns.

P38 - Identifying novel neuromarkers for detection of Amyotrophic Lateral Sclerosis from resting state magnetoencephalography: a functional connectivity study

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In this study, functional connectivity (FC) analyses were carried out on resting state magnetoencephalography (MEG) data from 26 healthy and 26 Amyotrophic lateral sclerosis (ALS) patients during eyes-closed (RS-EC) and eyes-open (RS-EO) conditions for five minutes each to identify functional differences in brain connectivity between the two groups. After bandpass filtration (0.5-100 Hz) and artefact correction, the MEG data were segmented to 0.4 seconds of non-overlapping time windows, then source transformed using a linearly constrained minimum variance beamformer. A total of 126 sources were reconstructed and FC on the source level time-series has been computed using phase synchrony measure for alpha and beta rhythms, as these are associated with awake-resting state and focus respectively. Significant alterations in FC were identified using Wilcoxon's signed rank test with a 5% threshold. Connections exhibiting weaker (hypo-connectivity) and stronger (hyper-connectivity) FC in ALS compared to healthy have been identified for potential neuromarker detection. It has been found that areas with cognitive control, muscle control, vision, concentration, emotional and sensory association exhibit hypo-connectivity while the primary sensorimotor cortex and somatosensory area show hyper-connectivity in the ALS cohort. Previous study encompassing 4-30 Hz frequency band has reported hyper-connectivity in posterior cingulate cortex or the right visual and occipital regions as potential biomarkers for ALS during RS-EO condition, but to the best of authors' knowledge, no hypo-connectivity study has been reported yet for source-level MEG and thus, hypo-connectivity in aforesaid regions unfold new scope for further research, especially during RS-EC condition which has not been explored much. Node strength of both hypo and hyper-connected networks have been used to classify ALS and Healthy in Alpha and Beta bands and it has been observed for both states, hypo-connectivity exhibit at least 2.3% higher classification accuracy compared to hyper-connected regions when using SVM-RBF as the classifier.

P39 - Efficacy of optically pumped magnetometers in detecting activity from the cerebellar cortex

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While most of the neuroimaging research has been focused on the cerebral cortex, the cerebellum, home to over 70% of the brain's neurons, has been largely understudied. The intricately folded structure of the cerebellum and its deep position in the brain make it challenging to measure accurately with MEG. Recent advances have made high-resolution individual models of the cerebellum possible, facilitating the analysis and interpretation of the MEG data. Combining individual cerebellum models with high-resolution MEG using OPMs would potentially open new research avenues.

Motivated by this opportunity, this study compares the performance of SQUID-based MEG systems and OPM-based on-scalp systems for detecting cerebellar activity. Simulations were conducted to evaluate key metrics, including MEG sensitivity maps, total information capacity, and the conservation factor for different sensor types.

The results show that OPMs and triaxial OPMs (tOPMs) clearly outperform SQUIDs in terms of sensitivity. OPMs deliver at least twice the signal strength of SQUIDs, while tOPMs produce signals up to four times stronger. In terms of total information capacity, OPMs achieve a maximum of 3451 bits in the cortex and 631 bits in the cerebellum, surpassing the corresponding SQUID results of 693 bits and 261 bits. The conservation factor analysis reveals similar performance across all sensor types, with more signal cancellation observed in the cerebellum compared to the cortex.

P40 - OPM-MRI multi-modal integration for concurrent brain and spinal cord imaging

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Integration of spinal cord anatomy and electrophysiological recordings is complicated by the inherent flexibility of the spinal cord but crucial for accurate and precise localisation of the electrophysiological signal sources. This study aims to integrate anatomical magnetic resonance imaging (MRI) images with optically pumped magnetometer (OPM) signals in an automated fashion. A critical aspect of this work is to accurately determine the spatial relationship between the spinal cord and the sensor array used to make the OPM recordings.

A 3T Siemens Prismafit scanner was used to image the head and upper torso, encompassing the cervical spinal cord. Optical scans were obtained with participants in an OPM sensor array based on a 64 channel MRI neck-coil. Images from MRI and optical scans were surface matched using identifiable fiducial points then co-registered with the OPM sensor array using Head Position Indicator (HPI) coils.

A custom-built scanner cast is in development following early results from surface matching of the MRI and optical scans. This cast will be specifically engineered to ensure consistent head and neck positioning between scans obtained in the MRI and OPM magnetically shielded room (MSR) environments.

Preliminary results indicate that the co-registration of MRI and optical scans is feasible, paving the way towards more accurate forward models of the spinal cord and enhanced precision of concurrent brain and cord imaging.

P41 - OPM-specific cardiac field artefact correction

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The activity of the heart creates a strong electro-magnetic field that is superimposed on measured (MEG or EEG) brain activity. This cardiac field artefact is especially problematic in the context of imaging neural activity time-locked to the cardiac cycle. Common approaches for cardiac field artefact (CFA) correction include independent component analysis (ICA), principal component analysis (PCA), as well as simple subtraction methods (Park & Blanke, 2019). While generally effective, these methods may simultaneously remove parts of the brain signal under investigation.

We leverage the unique advantages of optically-pumped magnetometers (OPMs) to develop an OPM-specific CFA correction. Our method builds a template of the sensor-level projection of the magnetic field of the heart, dynamically accounting for the spatial relationship between the thorax and the scalp. This not only results in superior CFA correction, but simultaneously allows subjects to move freely during recording sessions.

We show, in simulation results and pilot data, that it is possible to create this CFA template with a small number of magnetic dipoles at the location of the heart. We base this approach on the fact that cardiac activity can be well-described in a three-dimensional vector space (Dirlich et al., 1997); and that the tissues close to the heart (intra-cardiac blood, lungs, and thorax) can be modelled with a relatively simple, homogenous volume conductor model (Mäntynen et al., 2014). It thus becomes mathematically tractable to predict how the magnetic field generated by the heart projects onto the OPM sensory array on the scalp, for any head rotation. The spatial relationship between the heart and the scalp is tracked via motion capture cameras combined with retro-reflective markers attached to the OPM scanner cast on the participant's scalp, as well as to the participants chest.

P42 - Decomposing preparatory from action signals in MEG dynamics

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Research in non-human primates has demonstrated that the same neural population in the premotor and motor areas is active during both phases, yet their neural trajectory is independent of each other (Lara et al. 2018). When neural activity is projected onto lower-dimensional spaces, the preparatory phase is orthogonal to the action phase (Churchland et al. 2015, Eriksson et al. 2021, Lindén et al. 2022). However, despite the clear distinction observed in invasive electrophysiological recordings in animal studies, the phase transition in humans is less well understood. While a switch in neural patterns has been confirmed in humans using fMRI (Yewbrey et al. 2023, Yewbrey and Kornysheva 2024), the exact dynamics and the role of regions beyond the motor areas remain unclear.

In this study, we employ pattern analysis and dimensionality reduction analysis to disentangle planning signals from action signals recorded using magnetoencephalography (MEG). The participants learned a delayed sequence production paradigm with go cue, isolating neural activity during the non-action-producing phase from that of the execution phase.

Our findings indicate that MEG signals during the preparatory phase are independent of those in the execution phase, with each exhibiting distinct neural activity patterns. Notably, preparatory signals diminish following the "go" cue, even before sequence initiation, as motor cortex activity dominates during execution. The weight matrix of linear discriminant analysis and PCA coefficients confirms distinct spatial patterns between the preparatory and action phases. These results provide new insights into the neural dynamics underlying human action planning and motor control.

P43 - Nicardipine induced changes on spectral power and dynamic functional brain networks

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L-type calcium channel (LTCC) antagonists have been used in bipolar disorder (BD), without clear results for their efficacy. Recent evidence has reignited interest in their therapeutic potential by the discovery that LTCC genes are part of the aetiology of BD and related phenotypes. We assessed the effects of LTCC antagonism upon neural activity measured using magnetoencephalography (MEG) during a working memory (WM) task.

Twenty-two participants (aged 18-35) completed MEG scans pre- and post-randomisation to nicardipine SR (30mg) (n=11) or matched placebo (n=11) for 14 days. The MEG task utilised retrospective cues to direct attention to one of four objects retained in WM, with participants recreating the objects orientation. Spectral power (1-45Hz) was computed and power maps were calculated within frequency bands (Delta, 1-4Hz; Theta, 4-8Hz; Alpha, 8-13Hz; Beta, 13-30Hz; Gamma, 30-45Hz). A time-delay embedded Hidden Markov Model (TDE-HMM) with 8 states was inferred on continuous, source-parcellated MEG data. This revealed networks with unique temporal, spectral, and spatial profiles. General Linear Models (GLMs) were used to assess changes pre-post-randomisation, in both spectral power and temporal characteristics of brain states, between nicardipine SR and placebo groups.

Nicardipine SR induced decreases in delta (2 parcels –superior frontal gyrus, occipital pole) and beta (2 parcels; occipital cortex, precuneous) power and increases in theta (1 parcel; postcentral gyrus) and alpha (4 parcels; occipital cortex, planum temporale, lateral occipital cortex) power compared to the placebo group (all parcels $p<.05$). Changes in neural dynamics, characterized by the TDE-HMM, showed reduced fractional occupancy (proportion of time spent in a brain state, $p=.01$) and interval times (time elapsed between brain state visits, $p=.03$) in a visual occipital brain state in the nicardipine SR group.

Changes in MEG signal after LTCC antagonism suggest functional LTCC occupancy. These findings are promising for further investigations into the use of LTCCs in psychiatry

P44 - Assessing the Reliability of OPM-MEG system for Language Lateralisation in Paediatric Epilepsy

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Optically pumped magnetometers (OPMs) alleviate the one-size-fits-all helmet limitation of cryogenic MEG, particularly benefiting research focused on children. Additionally, the OPM-MEG system is less restrictive, allowing children to be more comfortable during the scanning. Recent research has demonstrated that OPM-MEG system with 32 single axes sensors detects interictal epileptiform discharges in school-aged children with a higher signal-to-noise compared to conventional cryogenic MEG [1]. This work continues the clinical evaluation of OPM-MEG system. Here we validate the reliability of the OPM-MEG system (64dual axis QuSpin sensors) for language lateralisation using a picture naming paradigm.

7 patients with epilepsy aged 6 to 14 took part in the experiment. Participants were shown a series of pictures and had 1 second to name each one out loud. The experiment was divided into 90 trials, each lasting approximately 6 seconds. We show the most lateralizing component of the stimulus-locked response is the low-frequency M400 response. We demonstrate that even with participants not sitting still, resulting in substantial artefacts in the ≤10 Hz range, the significant M400 response can still be extracted using the temporal adaptive multipole models method [2]. This suggests that the OPM-MEG system can effectively be used to assess language lateralization using the M400 response to the picture naming paradigm.

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[2] Tierney, T. M., Seedat, Z., St Pier, K., Mellor, S., & Barnes, G. R. (2024). Adaptive multipole models of optically pumped magnetometer data. Human brain mapping, 45

P45 - Frontotemporal lobar degeneration changes neuronal beta-frequency dynamics during the mismatch negativity response

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The consequences of frontotemporal lobar degeneration include changes in prefrontal cortical neurophysiology, with abnormalities of neural dynamics reported in the beta frequency range (14-30 Hz) that correlate with functional severity. We examined beta dynamics in two clinical syndromes associated with frontotemporal lobar degeneration: the behavioral variant of frontotemporal dementia (bvFTD) and progressive supranuclear palsy (PSP). Whilst these two syndromes are partially convergent in cognitive effects, they differ in disease mechanisms such as molecular pathologies and prefrontal atrophy. Whether bvFTD and PSP also differ in neurophysiology remains to be fully investigated. We compared magnetoencephalography from 20 controls, 23 people with bvFTD and 21 people with PSP (Richardson's syndrome) during an auditory roving oddball paradigm. We measured changes in low and high total beta power responses (14-22 and 22-30Hz respectively) over frontotemporal cortex in the period of the mismatch negativity response (100-250ms post-stimulus). In controls, we found increased 14-22Hz beta power following unexpected sensory events (i.e. increased deviant versus standard response), from right prefrontal cortex. Relative to controls, PSP reversed the mismatch response in this time-frequency window, reflecting reduced responses to the deviant stimuli (relative to standard stimuli). Abnormal beta at baseline in PSP could account for the reduced task-modulation of beta. Across bvFTD and PSP groups, the beta response to deviant stimuli (relative to standard stimuli) correlated with clinical severity, but not with atrophy of the prefrontal source region. These findings confirm the proposed importance of higher-order cortical regions, and their beta-power generators, in sensory change detection and context-updating during oddball paradigms. The physiological effects are proposed to result from changes in synaptic density, cortical neurotransmitters and subcortical connections, rather than merely atrophy. Beta-power changes may assist clinical stratification and provide intermediate outcomes for experimental medicine studies of novel therapeutic strategies.

P46 - Alzheimer's disease, its severity and progression, reduce MEG responses to unexpected auditory stimuli

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Alzheimer's disease (AD) impairs cognition with synaptic and neuronal loss related to amyloid and tau pathology. Drug development needs sensitive and reliable biomarkers for early phase clinical trials. The effects of AD on brain function can be measured by magneto/electroencephalography (M/EEG). The New Therapeutics in Alzheimer's Disease study (NTAD) aims to test the sensitivity and reliability of M/EEG-based biomarkers to AD.

The entorhinal cortex and hippocampi are severely affected by AD, underlying deficits in associative learning. However, it is difficult to directly measure physiological responses from medial temporal lobe by MEG due to its depth and orientation. In contrast, lateral cortical responses to unexpected stimuli (e.g. mismatch negativity response) are readily detected by MEG. We therefore developed a hybrid task, based on associative learning, with novelty and associative deviants to rapidly presented standard trials: the visuo-auditory oddball task (VAB). We used concurrent M/EEG to measure neural responses to unexpected novel sounds and mismatches of associated image-sound pairings. Cognitively healthy older controls and patients with mild cognitive impairment (MCI) or early AD completed baseline assessment. A subset of patients was re-tested after an average 16 months.

Controls showed a stronger neural response (gradiometers, 100-200ms) to novel compared to mismatching sounds. In AD/MCI patients the response to mismatching sounds was increased compared to controls. After 16 months, the response to mismatched sounds was increased further while the response to novel sound was decreased, indicating a loss of differentiation between novel and learned sounds. Furthermore, the increase in neural response to mismatched sounds related to cognitive deficits (Addenbrooke's Cognitive Examination, ACE-R). Our results demonstrate that the MEG responses in the VAB task are sensitive to early stages of AD, and its progression. We propose that MEG is a suitable biomarker for experimental medicine studies of AD/MCI.

P47 - Memantine and Alzheimer's disease modulate NMDA-receptor blockade; insights from magnetoencephalography

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Background: To accelerate new treatments for Alzheimer's disease, there is the need for human pathophysiological biomarkers that are sensitive to treatment and disease mechanisms. Here, we assess new biophysical models of non-invasive human magnetoencephalography imaging to test the pharmacological and disease modulation of NMDA-receptor inhibition.

Methods: Magnetoencephalography was recorded during mismatch negativity paradigms from (1) neurologically-healthy people from a double-blind placebo-controlled crossover memantine study (n=19); (2) people with Alzheimer's disease from a longitudinal study (n=42, amyloid-biomarker positive). Optimised adynamic causal models inferred voltage-dependent NMDA-receptor blockade from the magnetoencephalography. Parametric empirical Bayes was used to test (1) whether memantine modulates NMDA-receptor blockade, and the direction of this pharmacological effect; and (2) the effect of Alzheimer's disease severity and progression on NMDA-receptor blockade.

Results: The mismatch negativity amplitude was attenuated when Alzheimer's disease was more severe (lower Mini-Mental State Examination scores, r=-0.04, p=.01) and after annual follow-up (follow-up versus baseline, t=2.92, p=-.003). Alzheimer's disease reduced NMDA-receptor inhibition in proportion to severity (Posterior mean, Ep=0.06; Posterior probability, Pp=0.99) and over time (Ep=-0.125, Pp=0.97). Although memantine's effect on the mean mismatch amplitude from 140-160ms was not significant, memantine did increase NMDA-receptor inhibition compared to placebo (Ep=0.41, Pp=1) to generate mismatch negativity responses from 0 to 300ms.

Discussion: In line with preclinical studies, we confirm in humans that memantine and Alzheimer's disease have opposing effects on NMDA-receptor inhibition (memantine increases while Alzheimer's disease decreases inhibition). Future clinical studies could similarly tailor biologically-informed models to measure their target-of-interest and so determine the potential of disease-modifying therapeutics.

P49 - Robust and replicable effect of ageing on neuronal oscillations

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Background: Brain network changes across the adult lifespan are observable in electrophysiological recordings of human brain activity. Here, we identify markers of ageing in neuronal oscillations across four large, open access MEG datasets and explore the extent to which whether they are robust to differences in physiology, demographics and acquisition.

Methods: We analyse sensor space power spectra using a temporal General Linear Model Spectrum (GLM-Spectrum) to estimate a power spectrum at the individual subject level. A group GLM then then describes how models between- subject factors such as head size, grey matter volume, sex and age affect the power spectrum. We explore four datasets with this approach: CamCAN, MEG-UK MEGIN VectorView data, MEG-UK CTF-275 data. The statistical significance of the spectrum of the age-effect was computed using maximum-statistic non-parametric permutation and effect sizes are computed using Cohen's F^2 statistic for multiple regression models.

Results: All four datasets show a characteristic effect of ageing that synthesises a variety of previously reported results into a single analysis. This includes older adults showing a decrease in low frequency power, an increase in beta power and a slowing of the alpha rhythm. The statistics were reproducible across all datasets though the effect sizes varied considerably. CamCAN showed the smallest effect sizes but the larger sample means that the experimental power of those effects was still much larger than the smaller MEG-UK datasets.

Discussion: The effect of ageing in neuronal power spectra across healthy ageing is robust to covariates and reproducible across datasets. Large dataset with hundreds of subjects are well powered to detect effects across the whole spectrum where as medium size datasets have sufficient power to detect larger age effects at low frequencies, alpha and beta bands.

P50 - Predicting the optimal contact for therapeutic deep brain stimulation based on simultaneous MEG - local field potential recordings

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Deep brain stimulation (DBS) is widely recognized as an effective treatment of movement disorders, particularly Parkinson's disease (PD). However, identifying the optimal DBS parameters remains a complex and time-demanding process. In this study, we aimed to predict the electrode contact that would yield the best clinical outcome during therapeutic stimulation, with the goal of automating contact selection for DBS programming. Additionally, we sought to uncover potential relationships between PD symptoms and electrophysiological markers.

To achieve this, we employed an Extreme Gradient-Boosted tree learning algorithm, applied to electrophysiological data obtained from simultaneous magnetoencephalography and local field potential recordings from the subthalamic nucleus (STN) in 45 PD patients during resting state. We extracted several features, including STN power and STN-cortex coherence across various frequency bands, to predict the therapeutic window for each electrode contact.

We found a significant positive correlation between actual and predicted therapeutic window values ($r=0.59$, $p < 0.001$). Our automated feature selection revealed a preference for the low-beta and high-beta frequency bands, with a focus on the frontal, parietal, and temporal regions contralateral to the STN. Furthermore, comparing the cumulative hit rate between predicted and randomly shuffled contact rankings indicated a potential time-saving advantage if applied to DBS programming in clinical settings ($p < 0.05$).

In conclusion, this study demonstrates the feasibility of predicting the optimal DBS contact based on electrophysiological features. When integrated into DBS systems equipped with real-time brain activity monitoring, our approach has the potential to greatly reduce the time required for neurologists to fine-tune DBS programming.

P51 - Individual cases of Parkinson's disease can be robustly classified by cortical oscillatory activity from magnetoencephalography

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Parkinson's disease (PD) is a progressive neurodegenerative disorder which causes debilitating symptoms in both the motor and cognitive domains. The neurophysiological markers of PD include 'oscillopathies' such as diffuse neural oscillatory slowing, dysregulated beta band activity, and changes in interhemispheric functional connectivity; however, the relative importance of these markers as determinants of disease status is not clear. In this case-control study, we used resting state magnetoencephalography data (n = 199 participants, 78 PD, 121 controls) from the open OMEGA repository to investigate changes in spectral power and functional networks in PD. Using a Contrast of Parameter Estimates (COPE) approach, we modelled the effects of PD while controlling for population-level confounds (age, sex, brain volume). Permutation testing revealed highly significant increases in theta ($p=0.0001$) and decreases in gamma band spectral power ($p=0.0001$). Building on the group contrast results, we investigated the ability of source-resolved MEG data to distinguish PD from healthy controls. Our approach uses a Partial Least Squares (PLS)-based classifier to find linear combinations of MEG features which independently predict PD. We found MEG-based predictions to be highly sensitive and specific, reaching an optimal AUC-ROC of 0.87 ± 0.04 using a model including spectral power features with 4 independent PLS components, compared to 0.68 ± 0.04 when using functional connectivity. Interpretation of the model weights suggests that oscillatory slowing can be separated into independent posterior theta and global diffuse delta components that can robustly identify individual cases of PD with a high degree of accuracy. This suggests MEG can reveal dissociable, complementary neural processes which contribute to PD.

P53 - MEG-derived measures of oscillatory network changes induced by Midazolam and Remifentanil

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The functional effects of sedative drugs in the human brain are not well understood. We used resting-state MEG to reveal the effects on oscillatory brain network activity of two sedative agents with different sites and mechanisms of action. Remifentanil is a potent ultra-short-acting sedative analgesic and mu-receptor agonist, used for anaesthesia and pain treatment. Midazolam is also a short acting sedative benzodiazepine acting as a positive allosteric modulator of the GABA-A receptor.

18 healthy male adults (18-43 years) were studied. Participants received either Remifentanil or Midazolam on separate days, with resting-state MEG (10 minutes' duration) before and after drug administration.

LCMV Beamformer source reconstructions in 8 frequency bands were mapped to the 90 regions of the AAL atlas. Both static connectivity and activity maps were constructed as well as estimates of dynamic connectivity. For each of the 8 frequency bands, t-tests were performed to investigate differences pre and post administration of each drug.

Both drugs modulated activity in the lower frequency bands (<30Hz) only. Remifentanil showed focal alpha and beta reductions in the frontal and parietal lobes, occipital theta reductions, increases in alpha and beta in the thalamus and extensive alpha and beta enhancement in the posterior cortices. In contrast, Midazolam showed widespread increases/decreases in all frequency bands from delta to beta, particularly in the medial and lateral frontal lobes, consistent with the wide distribution of GABA-A receptors. Importantly, Midazolam induced theta reductions in hippocampus/parahippocampal gyrus, which has been previously seen in animal models and proposed as a causal mechanism for the amnesia often induced by midazolam.

Knowing more about the oscillatory network changes induced by Midazolam and Remifentanil during the resting state, could offer important clinical insights, and a better understanding of their mechanisms of action in the brain.

P54 - Disconnected and hyperactive networks characterise people with Huntington's Disease before symptom onset

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Huntington's disease (HD) is a hereditary neurodegenerative disease causing a complex mixture of motor, cognitive and psychiatric symptoms with no effective treatment. Preventing disease in individuals with an HD gene expansion (HDGE) prior to clinical motor onset is the ultimate aim of therapeutics development. However, a significant barrier to this milestone is a lack of sensitive and specific functional biomarkers tracking disease progression. Magnetoencephalography (MEG), never before used in HDGE, may aid in this quest and shed light onto early pathophysiology.

36 HDGE and 36 healthy controls were recruited to the study. All participants underwent 8 minutes of resting-state eyes-open MEG with a CTF system. Data were pre-processed using the OSL pipeline and time-averaged metrics extracted including power, global connectivity (amplitude envelope correlation), oscillatory slowing and 1/f. The DyNeMo algorithm was trained on the dataset, extracting power and global connectivity for five functional dynamic networks, as well as summary statistics for dynamics. The effect of disease burden and HDGE on the metrics was evaluated using permutations-based general linear models with maximum t-statistic correction for multiple comparisons.

Greater disease burden resulted in increased delta and reduced alpha power, with reduced delta and alpha connectivity. There were no changes in 1/f or oscillatory slowing. Dynamic network analysis revealed marked increases in default mode network activity strength and reduced kurtosis (bursting). The background network showed reductions in activity strength and variability. Reduced dynamic network connectivity was noted in the visual network.

MEG identified marked differences in static and dynamic network activity in HDGE, which is characterised by disconnected networks and potentially compensatory increased frontal default mode network activity. Combined dynamic and static MEG analyses may prove useful as an adjunctive biomarker in treatment trials. Future work should focus on combining high-resolution structural MRI with MEG to provide detailed and hybridised functional-structural metrics.

P55 - Post-stroke changes in brain structure and function can both influence acute upper limb impairment and subsequent recovery

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Stroke is the leading cause of complex adult disability in the world. Improving outcomes is an urgent clinical and scientific goal, but success is slow to materialize. Advancing our understanding of post-stroke impairment and mechanisms involved in post-stroke recovery is crucial for predicting recovery, providing a basis for stratification in clinical trials as well as developing and optimising mechanistically informed therapies.

Therefore, we ask the following questions: does brain function and structure differ between (i) stroke patients with more and less initial impairment, and (ii) stroke patients with more compared to less subsequent motor recover? To answer these questions brain function (Magnetoencephalography) during tactile stimulation and brain structure (Magnetic Resonance Imaging) were acquired in the first week post-stroke and clinical measures (Nine-Hole Peg Test) were assessed in the first week and one-month post-stroke from 36 stroke patients (18 females, age: M = 66.56 years).

Our results show that higher initial motor impairment and less subsequent motor recovery (after accounting for initial impairment) are related to lower sensorimotor β power and greater lesion-induced disconnection of contralateral [ipsilesional] white-matter motor projection connections. Moreover, differences in intra-hemispheric connectivity (structural and functional) are unique to initial motor impairment, while differences in inter-hemispheric connectivity (structural and functional) are unique to subsequent motor recovery, when controlled for initial impairment.

Impairment-related and recovery-related differences in brain function and structure after stroke are related, yet not identical. Separating out the factors that contribute to initial motor impairment and those that are related to the subsequent motor recovery process itself is key to identifying potential therapeutic targets.

P56 - Relating attention deficits to the neural basis of attention during working memory tasks

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Alpha oscillations have been linked to attention in many attention-demanding tasks (e.g. Jensen & Mazaheri, 2010). However, most studies have been conducted in neurotypical adults. Alternatively, children with attention difficulties, including attention-deficit / hyperactivity disorder (ADHD), are often studied during the resting-state and/or with EEG with limited spatial resolution. This study aims to determine the reliability of the neural sources relating to control of attention in children (age 8-11), both with and without ADHD.

The current work analyses the neural sources during a working memory task, varying by load, and their correlation to the standard clinical assessments of ADHD. Test-retest reliability is assessed across two MEG sessions. The data for both adults and children show the expected decrease in posterior alpha during the encoding period; this alpha decrease has high test-retest reliability in both adults and children. Maintenance-period frontal theta shows a decrease instead of an expected increase. Maintenance theta and alpha are replicable over two sessions in adults, even when split between high and low loads; however, preliminary analyses in children's data shows greater variability in maintenance alpha and theta. Preliminary analyses indicate no significant relationship between the Conners Continuous Performance Test and MEG power during the working memory task in either adults or children.

By using MEG, this study aims to localise sources and connectivity in an attention-demanding working memory task, linking their reliability to measures used in clinical ADHD research. Future work will link functional connectivity (MEG) with structural connectivity (DTI) and assess test-retest reliability.

P57 - Localization accuracy of a 127-channel zero-field optically pumped magnetometer system

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Zero field optically pumped magnetometers (OPMs) are emerging as a potential alternative to cryogenics-based MEG systems (cryo-MEG). Unlike cryo-MEG which relies on superconducting quantum interference devices to achieve high sensitivity, zero field magnetometers measure optically the changes in the hyperfine structure of certain rare-earth metals enclosed in a vapour cell. This means the sensors operate at room temperatures rather than near absolute zero which simplifies the infrastructure needed. OPM sensor arrays with greater than 100 channels have become available and have been used in functional brain imaging studies. A key feature of MEG is its ability to localize the source of brain activity measured from external sensors that surround the scalp surface. How accurately the sources can be localized is dependent on several factors such as how well we know the sensor locations and orientation relative to the person's head at any instant in time, how well we know the sensor gains, the linearity of the signal over time and signal strength relative to background noise. Localization accuracy can be characterized using phantoms. Cryo-MEG phantom localization accuracy is typically quoted by the manufacturers to be < 3-6 mm but sub-millimeter accuracies been achieved in practice. We present phantom results from a 127-channel FieldLine HEDscan closed loop system. A 5-dipole wet BTI phantom was collected at 23 Hz, one dipole at a time. HPI's were placed at the standard fiducial locations and also localized to form a coordinate system relative to the phantom. The same phantom was collected with a cyro-MEG containing 248 gradiometers. The OPM dipoles localized between 1.7 mm to 2.7 mm to the calibrated phantom locations. The cryo-MEG localized to between 0.6 mm to 2.4 mm to the calibrated phantom locations. Results demonstrate the OPM systems are reaching similar localization accuracies to cryo-MEG.

P58 - Magnetoencephalography using OPMs in an unshielded office setting

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MEG has been traditionally recorded using cryogenically cooled superconducting quantum interference devices (SQUIDs). More recently, spin exchange relaxation free (SERF) magnetometers have proven capable of similar quality measurements, but they also require magnetic shielding to achieve sufficiently small magnetic field conditions for operation. Pulsed-pump magnetometers (PPM) are a new type of OPM sensor that dramatically improves the linearity and dynamic range of the magnetic field measurements.These total field or scalar magnetometers measure the Larmor precession frequency of the alkali metal atoms found in the vapor cell; this frequency is directly proportional to the magnetic field. Measuring frequency in this way entables dramatically superior dynamic range, linearity, and common mode noise rejection compared to all other types of magnetometers. The orientation of the sensor does not affect the field measured, which permits the system to subtract large amplitude common-mode noise imposed on the system.

We present MEG results from an array of 9 total field gradiometers and demonstrate the feasibility of obtaining MEG recordings in an unmodified office building for the first time. We present empty room performance, source localization accuracy using a dipole phantom, and system performance in recording evoked brain data from with source modelling results. Using this technique, a low-cost, portable point-of-care MEG device that can be used in earth's ambient magnetic field may be within reach.

P59 - An optically pumped magnetic gradiometer for the detection of human biomagnetism

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We realise an intrinsic optically pumped magnetic gradiometer based on non-linear magnetooptical rotation. We show that our sensor can reach a gradiometric sensitivity of 18 fT/cm/√Hz and can reject common mode homogeneous magnetic field noise with up to 30 dB attenuation. We demonstrate that our magnetic field gradiometer is sufficiently sensitive and resilient to be employed in biomagnetic applications. In particular, we are able to record the auditory evoked response of the human brain, and to perform real-time magnetocardiography in the presence of external magnetic field disturbances. Our gradiometer provides complementary capabilities in human biomagnetic sensing to optically pumped magnetometers, and opens new avenues in the detection of human biomagnetism.

P60 - Towards a 384-channel OPM-MEG system

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Optically-pumped magnetometers (OPMs) offer a step change in MEG instrumentation, with flexible, wearable arrays that reduce sensor-to-scalp distance, allow naturalistic paradigms and improve compliance. However, the technology remains in its infancy and extant systems have fewer measurement channels than the ~300 used in cryogenic instrumentation. This is despite theoretical studies (Boto et al., 2016, Iivanainen et al., 2017) suggesting they would benefit from more. If OPM-MEG is to realise its potential, then delivery of viable high channel density systems will be critical.

We aimed to resolve this by building a 384-channel OPM-MEG system. Our system comprised 128 triaxial OPMs (QuSpin Inc., Colorado, US) controlled by integrated miniaturised electronics. The 128 triaxial sensors provide 384 independent assessments of magnetic field. Sensors were housed in a high-density helmet. One participant (female, aged 24 years) was scanned using two paradigms: a visuo-motor task (known to elicit visual-gamma and motor-beta activity) and an emotional face paradigm (known to elicit evoked responses). Analyses included source localisation and reconstruction of time frequency induced effects in source space.

Gamma, beta and evoked effects were all successfully measured, with high SNR. Removal of channels from the analysis, to allow for comparison with lower channel counts on the same data, showed a linear reduction in SNR – confirming the value of the high channel count. In sum, this initial construction and successful demonstration of our system paves the way for future high-density OPM-MEG systems which can significantly outperform the current state of the art in cryogenic instrumentation.

P61 - An MNE-Python analysis pipeline for OPM data

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The rapid development of optically pumped magnetometers (OPMs) for magnetoencephalography (MEG) has created a pressing need for OPM data analysis pipelines. Many open-source packages for MEG data analysis exist. However, due to the rapidly evolving nature of OPM technology and variations between systems, well-established pipelines which are compatible with OPM systems are not readily available.

Here, we demonstrate an analysis pipeline using the widely used MNE-Python toolbox. The pipeline first converts data from arrays of QuSpin OPMs to. fif format; enabling the loading of data using conventional methods. Tools were also developed based on 3D optical scanning techniques to co-register OPM sensor locations/orientations to brain anatomy. Following this, the pipeline enables standard pre-processing steps such as bad channel/trial rejection, filtering, and visualisation of sensor-level data. The pipeline further allows source space analysis. Importantly, superconducting quantum interference device (SQUID) data can be processed using identical techniques, facilitating comparisons between scanner platforms.

We tested this pipeline via the analysis of a dataset which contained 32 OPM and 32 SQUID MEG recordings, in which the same 16 subjects were scanned twice using each system. We elucidate beta (13-30Hz) band responses to somatosensory stimulation and switching attention between hands. The pipeline was successful in reproducing known effects including sensor and source-level time-frequency descriptions and source images, which were highly comparable across systems. This pipeline paves the way for the standardised application of MNE-Python to OPM-MEG and more generally shows how the open-source package can now be used in the processing and interpretation of OPM-MEG data.

P62 - Validation of a 192-channel OPM-MEG system through comparison with a cryogenic MEG system using neural fingerprinting

Miss Zoe Tanner[1,2], Dr Lukas Rier[1,2], Miss Jessikah Fildes[1], Mr Gonzalo Reina Rivero[1], Miss Holly Schofield[1,2], Professor Matthew Brookes[1,2], Dr Elena Boto[1,2]
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Introduction: In recent years, optically pumped magnetometers (OPMs) have enabled development of wearable magnetoencephalography (MEG) devices, which have advantages over the current state-of-the-art. However, these systems are in their infancy and it is crucial that OPM-based instrumentation can reliably replicate the results from established cryogenic systems. Here, we used neural fingerprinting to probe equivalence between OPM and cryogenic MEG systems.

Methods: We collected data from 16 participants; each participant was scanned twice using both a 192 channel triaxial OPM-MEG system and a cryogenic MEG system (totalling 64 datasets). During the scans, participants performed a somatosensory spatial attention task, in which braille-like sensory patterns were presented to both index fingers and participants were asked to respond via button press to a predetermined target pattern. Data were analysed in source space, using an MNE-Python analysis pipeline, and we tested the hypothesis that within-subject correlation of beta band signatures would be greater than between-subject correlation, thus allowing the identification of individuals by matching data across multiple runs (neural fingerprinting). Fingerprinting was carried out on cryogenic and OPM data independently, as well as between systems (to evaluate both within- and between-system repeatability).

Results: Results show that neural fingerprinting was successfully achieved in both cryogenic- and OPM-based systems; after excluding one participant, 14 and 15 out of 15 participants were successfully identified within each modality respectively. When cross-validating between systems, 15 out of 15 participants were correctly identified.

Conclusion: Fingerprinting is a useful means to validate instrumentation, and our results suggest that OPM-MEG can capture the same information as conventional MEG systems.

P63 - EEGManyPipelines: A large-scale, grassroots multi-analyst study of EEG analysis practices

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Analysis of high-dimensional time-series data is highly complex. Analytic flexibility and subjectivity, both at the level of individual data analysis/teams, and at the level of analysis software, can lead to a 'garden of forking paths' that may limit the reproducibility and robustness of results. We have recently launched the EEGManyPipelines project as a means to assess the robustness of electroencephalography (EEG) research – one of the most widely used tools to study human cognition – in naturalistic conditions and experiment with an alternative model of conducting scientific research. 168 analyst teams, encompassing 397 individual researchers from 37 countries, independently analyzed the same unpublished, representative EEG dataset to test the same set of pre- defined hypotheses, provided their analysis pipelines and reported outcomes. I will report preliminary results from this project and highlight points of relevance for the MEG community.

P64 - MEGqc - an automated and standardized quality control workflow for MEG BIDS data

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Due to the high sensitivity of the sensors, magnetoencephalography (MEG) data are susceptible to noise, which can severely corrupt the data quality. Consequently, quality control (QC) of such data is an important step for valid and reproducible science (Niso, Botvinik-Nezer et al., 2022). However, the visual detection and annotation of artifacts in MEG data requires expertise, is a tedious and time extensive task and is hardly standardized. Since quality control is commonly done in an idiosyncratic fashion it might also be subject to individual biases. Despite the minimization of human biases, standardization of QC routines will additionally enable comparisons across datasets and acquisition sites. Hence, an automated and standardized approach to QC is desirable for the quality assessment of in-house and shared datasets. Therefore, we developed a software tool for automated and standardized quality control of MEG recordings: MEGqc. It is inspired by a software for quality control in the domain of fMRI, called mriqc (Esteban et al., 2017).

MEGqc strives to support researchers to standardize and speed up their quality control workflow and is designed to be easy and intuitive to use, e.g. only minimal user input (path to the dataset) is required. Therefore, the tool is tailored to the established BIDS standard (Gorgolewski et al., 2016; Niso et al., 2018). Among other metrics we detect noise frequencies in the Power Spectral Density and calculate their relative power, calculate several metrics to describe the 'noisiness' of channels and/or epochs, e.g. STD or peak-to-peak amplitudes, and quantify EOG and ECG related noise averaged over all channels and on a per-channel basis. MEGqc generates BIDS compliant html reports for interactive visualization of the data quality metrics and moreover provides machine interoperable JSON outputs, which allow for the integration into automated workflows. MEGqc is open source, can be found on Github, and its documentation is hosted on readthedocs.

Poster Presentations with Short Talk

PT65 - Modulation of 1/f spectral slope dynamics during an auditory oddball task

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Background: Multiple sclerosis (MS), a neurodegenerative disease characterized by the loss of inhibitory and excitatory synapses, often results in working memory and attention deficits. This disruption of synaptic balance can be reflected in the 1/f spectral slope, which represents the steepness of the 1/f component of the power spectrum and has emerged as a potential marker for excitation/inhibition balance. Building on our recent work, which demonstrated that a visuo-verbal working memory task modulates the 1/f spectral slope, this study explored 1/f slope changes during an auditory oddball task. We hypothesized that the 1/f slope will be steeper following non-standard stimuli (indicating higher inhibition) compared to standard tones, with a more pronounced effect in healthy controls (HCs) than in people with MS (pwMS), particularly during distractor trials.

Methods: Magnetoencephalography data were obtained from 117 participants during an auditory task: 21 pwMS treated with benzodiazepines (MS(BZD+)), 61 untreated (MS(BZD-)), and 44 HCs. The task included standard (1000 Hz), target (1500 Hz), and distractor (500 Hz) tones, with participants pressing a button in response to the target tone. Data were preprocessed using the OSL library, source-reconstructed with an LCMV beamformer, and divided into 42 parcels. The steepness of the 1/f aperiodic component was estimated using the FOOOF algorithm. Non-parametric statistics were applied for all comparisons.

Results: As expected, we observed a steeper 1/f slope following stimulus onset, with a larger modulation in response to non-standard stimuli, highlighting the link between the 1/f slope modulation and attentional demands. In line with our hypothesis, HCs showed significantly greater 1/f slope modulation (indicating higher inhibition) compared to both (MS(BZD-)) and (MS(BZD+)) groups during distractor trials.

Conclusion: These findings suggest that 1/f slope dynamics are sensitive not only to attentional demands but also to disease status, indicating a functionally relevant inhibitory deficit in MS.

PT66 - Spontaneous Fluctuations in Alpha Peak Frequency Along the Posterior-to-Anterior Cortical Plane

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Alpha oscillations (8-12 Hz) are a prominent feature of electro- and magneto- encephalography (E/MEG) recordings. Typically, the frequency of alpha oscillations is regarded as being stable. A wealth of recent evidence, however, indicates that alpha peak frequency (APF) shifts within short timespans in relation to task demands and even spontaneously. Further, brain stimulation studies often report shifts in APF both within- and between- sessions, directly contradicting the idea of a stable APF. To investigate the non-stationarities in spectral parameters, we estimated APFs from one-second epochs of resting-state MEG recordings. We enhanced signal-to-noise ratio, without compromising on temporal resolution, by averaging power spectra within parcelled regions. Our results showed that fluctuations in APF exacerbates along the posterior-to-anterior cortical axis i.e., from the occipital to the frontal cortex. The left lateral occipital cortex had the highest average APF of 10.57 Hz, with a SD of ± 1.37 Hz across epochs, whereas the left middle frontal gyrus had the lowest APF of 7.5 ± 1.64 Hz [mean ± SD]. Further, we found that the gradient was not just an anomaly related to measurement noise. In general, we established that depending on the timescale of the investigations, APF appear highly volatile, and exhibit spontaneous fluctuations in frequency. Our study highlights the necessity to consider temporal variability and overall signal-to-noise ratio in the study of alpha oscillations. In line with recent studies, we posit that the dynamics of the alpha oscillations are tied to the spatial arrangement of its cortical generators.

PT67 - Simultaneous EEG-MEG Sleep Recording and Source Localization Reveal Precise Spatiotemporal Distribution of Spindle Activity During Sleep

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Introduction: Sleep spindles (12-16 Hz) are key EEG oscillations during NREM sleep, thought to originate in the thalamus and propagate through thalamocortical pathways. While invasive studies have provided direct insights into spindle activity, the whole-brain spatiotemporal profile remains unclear due to limited coverage. MEG offers higher spatial resolution than EEG, making it ideal for studying spindle activity across the whole brain in healthy individuals. This study uses simultaneous MEG-EEG recordings to investigate spindle dynamics.

Methods: Eleven healthy adults underwent sleep recording in an MEG scanner for up to 2.5 hours, with simultaneous EEG monitoring. Spindles were identified using the EEG Cz channel, and these events were used to analyze the spatiotemporal properties of the MEG signal. Surrogate spindles from NREM windows without spindle events were used as a baseline. MEG preprocessing was done using the FLUX Toolkit, and source localization via beamforming was performed using FieldTrip in MATLAB. Cluster-based permutation tests were applied for whole-brain comparisons.

Results: Source localization revealed that spindles originate in the precuneus, parietal cortex, and thalamus, spreading to the temporal, orbitofrontal, and anterior cingulate cortices. Spindle activity was broadly distributed across the brain, with less distinct posterior separation than commonly seen in EEG. Region-of-interest analysis showed significantly greater spindle band activity in the thalamus compared to the hippocampus. Although we observed hints of ripple-band activity in anterior hippocampal voxels time-locked to scalp EEG-detected spindles, the results did not survive correction for multiple comparisons.

Conclusion: This study demonstrates the feasibility of using source localization with simultaneous MEG-EEG sleep recordings to explore the spatial and temporal dynamics of spindle activity and the potentials to characterise hippocampal ripples in healthy participants. Future analysis will focus on detecting and characterising local spindles and ripples from the source.

PT68 - Predictive suppression relies on late attentional mechanisms

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Visual attention is modulated by statistical regularities in the environment, with spatially predictable salient distractors being proactively suppressed. Thus far, the neural characteristics of this proactive suppression remain poorly understood. Here, we used magnetoencephalography and multivariate decoding analysis to investigate how predicted distractors are represented in a visual search task involving statistical learning of distractor location. Participants were required to identify a target stimulus and report its identity while ignoring a colour-singleton distractor. The distractor was presented more frequently on one side of the visual field, but the participants were not informed of this and did not become aware of it in the course of the experiment. We found that the location of the predictable distractor was represented even before the stimulus appeared, supporting the hypothesis that proactive suppression mechanisms guide visual attention away from predictable distractor locations. Importantly, the pattern of activity indexing this proactive distractor suppression generalized to stimulus-evoked activity in late “attentional” stages (~200 ms), suggesting a common mechanism implemented by temporo-parietal cortex. However, this generalization of pre-stimulus suppression to post-stimulus signal was not observed in early “sensory” stages (~100 ms). This indicates that the reactive suppression we observe is not a simple reflection of proactive suppression that sustains into the post-stimulus interval. Rather, a similar suppressive mechanism is activated at two discrete timepoints. These findings establish a mechanistic link between proactive and reactive suppression, highlighting their shared and distinctive underlying attentional processes.

PT69 - Neuronal evidence for category parafoveal previewing during the 200 ms intersaccadic interval

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Research on visual cognition has typically required participants to keep their eyes centrally fixated, though humans naturally make saccades approximately every 250 ms. Since a saccade takes about 50 ms, around 200 ms remains to plan and execute the next one while processing a fixated object. Our study investigates the neuronal dynamics of parafoveal processing during this brief intersaccadic interval and during foveal processing and saccade preparation.

Participants completed a visual exploration task while their eye movements and brain activity were recorded using eye-tracking and magnetoencephalography (MEG). They were shown arrays of natural images belonging to different categories (animal, food, object) in greyscale or colour. After viewing the array twice, they identified which image had changed. Using multivariate pattern analysis, we tracked when information about visual features (greyscale vs. colour) and object categories (e.g., animal vs. food) emerged for both foveal and parafoveal images.

Our classifier detected the visual features of foveal and upcoming parafoveal images at around 100 ms and 110 ms, respectively, and the category of these images at 145 ms and 160 ms. There was a notable 45 ms delay in the peak decoding of colour between foveal and parafoveal images, while category information of past parafoveal images persisted in brain activity up to 230 ms after saccade onset. Crucially, decoding was dependent on whether the images were saccade targets.

Our findings provide electrophysiological evidence that parafoveal objects' features and categories are extracted within ~200 ms, fast enough to guide saccades during free exploration. The results support the idea of a pipelining mechanism, where foveal and parafoveal objects are processed simultaneously but at different stages within the visual hierarchy and rule out strict serial or parallel processing models.

PT70 - Human hippocampal theta oscillations code distance to goal during spatial navigation

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The rodent hippocampal local field potential is dominated by 6-12 Hz theta band oscillations during active exploration, and this rhythmic activity has been strongly implicated in spatial coding and memory function across species. Invasive electrophysiology in both rodents and humans have shown increases in hippocampal theta power immediately before the onset of translational movement that persist throughout subsequent motion. Intriguingly, it has also been shown that the magnitude of theta power increases before movement onset correlate with the distance subsequently travelled. Using non-invasive magnetoencephalography (MEG) and an abstract navigation task, we sought to further characterize the neural correlates of spatial planning and the oscillatory signatures of translational movement in healthy participants. In line with previous rodent and human electrophysiology studies, we observed increased theta power during both planning and navigation. Importantly, the magnitude of this theta power increase in the right hippocampus covaried with subsequent path distance during planning, and only when participants were aware of the distance to their goal. Similarly, during navigation, the magnitude of hippocampal theta power decreased dynamically as participants approached the goal, and only when they were aware of how far they still needed to travel. These effects were observed both for familiar paths, and for those that had never been traversed before. In sum, these findings are consistent with the proposed role of hippocampal theta-band activity in flexible planning and goal-directed spatial navigation across mammalian species.

PT71 - Investigating Neural and Cognitive Mechanisms of Free Viewing Tasks Using Concurrent MEG/OPM-MEG and Eye Tracking

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Eye movements are fundamental to everyday activities, from reading to driving. While much is known about eye movement patterns and behaviour in real-world tasks, the neural mechanisms underlying these processes remain poorly understood. One key challenge is that eye movements generate artifacts in electrophysiological recordings, often larger than the brain signals themselves. Here, we introduce a novel method for analysing concurrent MEG and eye-tracking data. We first demonstrate how to reliably identify and characterise saccadic spike artifacts in both the time and frequency domains. By applying source modelling to saccade- and fixation-aligned data, we observed a robust lambda response occurring approximately 100ms after fixation onset, localised in the primary visual cortex, along with task-specific oscillations, most notably in the alpha, beta, and gamma bands. We validated our approach across tasks of varying complexity: a visual and memory search task using a CTF 275-channel MEG system with 22 participants, a driving hazard perception task in a CTF MEG system where 25 participants watched videos containing hazards, and a hazard detection task in a driving simulator using an OPM system, where 10 participants drove through various scenarios. Across all tasks, integrating eye movements with MEG recordings enables us to explore neural processing in naturalistic conditions.

PT72 - Probing Spatiotemporal Neural Dynamics of Working Memory Reactivation

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Working memory (WM) is posited to rely on short-term synaptic plasticity (STP) and neural reactivation. Our previous research developed a novel "dynamic perturbation" approach to manipulate the recency effect in sequence WM based on STP principles. Yet, two critical questions remain: the unidentified brain regions involved in WM reactivation during the maintenance phase and the lack of direct neural evidence supporting this perturbation approach. To address these gaps, we utilized an impulse-response approach combined with magnetoencephalography (MEG) recordings. In experiment 1, participants need to retain a sequence of two gratings in WM and later recall their orientations. Importantly, a neutral impulse (PING stimulus) was used during WM maintenance to assess neural reactivation patterns. In experiment 2, we applied "dynamic perturbation" by presenting flickering probes with different temporal associations with luminance sequences during maintenance. We employed representational similarity analysis (RSA) to examine the spatiotemporal patterns of WM reactivation at both sensor and source levels. Source localization analyses in both experiments revealed distinct brain regions responsible for WM encoding and reactivation. The frontoparietal region was associated with encoding, while the medial temporal lobe (MTL) was crucial for memory reactivation during retention. Furthermore, "dynamic perturbation" altered the multi-item neural reactivation profiles triggered by the PING stimulus, providing direct neural evidence for memory manipulation. Our findings provide new neural evidence for the efficacy of STP-based "dynamic perturbation" in modifying WM. Crucially, WM encoding and reactivation involve distinct neural networks. Information in WM is primarily held in the frontoparietal regions, with reactivation facilitated through the hippocampus-related medial temporal lobe, implying an intertwined link between WM and episodic long-term memory.

PT73 - Using OPM-MEG to Study the Infant Brain: Auditory Oddball Responses to Speech and Pure Tones in 2-Month-Olds

Dr Ana Luisa Pesquita[1], Dr Andrew Quinn[1], Dr Giulia Orioli[1], Dr Anna Kowalczyk[1], Dr Barbara Pomiechowska[1]
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Understanding early human brain development is crucial for advancing both fundamental neuroscience and clinical applications. Optically pumped magnetometers for magnetoencephalography (OPM-MEG) have emerged as a promising technology for infant studies, offering high spatiotemporal resolution in a more infant-friendly design compared to traditional MEG systems. However, adapting this technology for infant use presents unique challenges, necessitating rigorous methodological validation. This study reports findings from a validation experiment conducted at the University of Birmingham's OPM-MEG laboratories. Using an array of 50 OPM sensors (FieldLine Inc.), we successfully recorded auditory evoked field responses to tones and syllables from five infants under two months of age. Our findings demonstrate the feasibility of using OPM-MEG to investigate brain function during early postnatal development. In doing so, this work marks a significant step towards more detailed and extensive studies of infant brain dynamics, with implications for both basic research and clinical applications.

PT74 - Measuring signals in utero using OPM MEG

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During gestation, the foetus develops within the mother's body and has an independent heartbeat from around 5 weeks. Gestation causes physical and neural changes in the mother as well as the foetus. These include hormonally driven changes to maternal blood vessels and a 50% increase in blood volume, resulting in a stronger and faster maternal heartbeat. An awareness of internal bodily sensation (interoception) has been linked to psychological well-being and the detection of our heartbeats may be particularly important for well-being due to a strong association with anxiety. However, during pregnancy, there are two heartbeats in the maternal body: those of the mother and the foetus. Maternal physiology can influence foetal heartbeats - for example maternal stress can increase foetal heart rate and foetal heartbeats phase synchronise with maternal heartbeats.

However, the mechanisms underlying these connections as well as the influence of foetal physiology on maternal systems is unknown. EEG and conventional MEG can capture neural responses that are time-locked to a person's heartbeats (Heartbeat evoked responses, HERs). However, identifying maternal neural responses to foetal heartbeats is challenging - as is looking for HERs in foetal brain activity.

We are using our OPM MEG's detachable sensors to capture heartbeat and neural activity from both the foetus and mother simultaneously. We developed a custom 3D printed sensor mount for the abdomen that houses three OPM sensors. This allows sensors to sit on the mother's abdomen secured by a Velcro strap and record signals directly from the foetus while most of the remaining sensors record neural data from the mother's head. We will present preliminary data of signals detected in utero using these methods and discuss potential implications for future research.

PT75 - Seeing Speech in a New Light: Augmenting Speech Performance using Rapid Invisible Frequency Tagging (RIFT) and MEG

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In challenging listening environments, lip movements can enhance speech comprehension. Studies have demonstrated that the visual cortex, similar to the auditory cortex, synchronizes with speech in cocktail party-like settings. This suggests that external modulation of visual rhythms could be harnessed to improve speech understanding. However, the direct causal relationship between visual rhythm modulation and enhanced comprehension is yet to be established. Here we offer a novel paradigm to probe this link. We directly tested whether manipulating visual speech signals – using non-invasive rhythmic stimulation – influenced the integration of visual and auditory information in the brain, resulting in an effective boost in speech comprehension. Using MEG and audiovisual RIFT, we employed a naturalistic audiovisual speech paradigm whereby participants attended to one of two speakers. Following each condition, participants completed a speech comprehension task based on information in the to-be-attended speech. To examine the impact of rhythmic modulation on speech comprehension performance, the visual flicker was modulated by either the to-be-attended or ignored speech amplitude. The results showed significant effects of auditory and visual tagging in their respective sensory cortices across all experimental conditions. Moreover, higher-order brain regions exhibited representations of intermodulation frequencies in the right temporo-parietal junction and superior/middle temporal gyrus, specifically in the condition where the visual tagging (luminance of lip area) was amplitude-modulated by the to-be-attended speech. These findings highlight the potential of non-invasive sensory stimulation through RIFT as a promising tool for enhancing speech intelligibility, particularly in environments where multiple speakers are present.

PT76 - The neural correlates of selective visual attention in natural scenes

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Visual environments are highly cluttered, requiring humans to deploy attention selectively in order to prioritize relevant information and suppress distracting stimuli. The mechanisms through which selective visual attention facilitates both the temporal and spatial accumulation of information and modulates encoded category representation require further exploration. In this study, we leveraged the temporal precision of magnetoencephalography (MEG) to identify and correlate independent neural measures of attentional selection and object category representation. Participants searched for visual targets in real-world images containing various object categories (e.g., cars, people, plants), while undergoing MEG recording. Attentional selection was indexed by the amplitude of the magnetic N2pc (mN2pc) component, a well-established marker of selective visual attention. Category representation was quantified using linear discriminant analysis (LDA) applied to neuroimaging data and model classification accuracy was calculated. We observed a temporal correlation between variance in attentional selection and object representation. Follow-up analyses will focus on both the spatial correlates of this relationship and how attentional selection affects the neural representation of distractors, providing a more comprehensive understanding on how targets and distractors are differentially represented in the brain. These findings have the potential to fill the current gap in knowledge on how attention guides the activation and construction of conceptual information during visual search.

PT77 - Volume conductor models for magnetospinography

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Recent developments in both SQUID-based and optically-pumped biomagnetic sensing offer us the opportunity to go beyond imaging the fields produced by the brain and heart and onto the entire central nervous system. The latter technology, optically pumped magnetometers, allows us a flexible system where we can image activity from (for example) an entire ascending pathway – from muscle, to spinal cord to brain – and how it operates in both health and disease.

However little work has been done on how to best estimate the sources of signals that originate from the spinal cord. Here, we investigated which forward models might be appropriate for magnetospinography. We compared multiple approaches using open-source tools used in the brain and heart literature to identify what gains can be made by increasing the complexity of the volume conductor model. These models include infinite medium, spherically symmetric, and realistically shaped models (boundary and finite element models). We directly compared field patterns between models to measure relative model performance.

Our key findings were that along the rostral-caudal axis of the spinal cord most models provided similar field patterns. However, models which incorporate the conductivity of the vertebrae demonstrated an orientation-specific gain profile, with sources oriented along the rostral-caudal axis several times larger in magnitude than off-axis sources. Finally, field patterns representing the sources in the left and right parts of the spinal cord were more distinct from each other if vertebrae conductivity were included in the model. With these findings we believe the modelling of the bone in the spinal column to be a critical step in designing a volume conductor model for magnetospinography source analysis.

PT78 - Efficient and reproducible batch processing of M/EEG data using osl in Python

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The analysis of M/EEG data involves complicated analysis steps which are deployed heterogeneously to suit both the dataset and the scientific question. To this aim, the field relies on a large tradition of open-source software toolboxes developed by individual research groups or community efforts, but most of these rely on licensed, third-party software like MATLAB. Here, we present the osl toolbox, a free and open-source Python package built on the backbone of MNE-Python.

The osl toolbox is designed to augment the widely adopted MNE-Python toolbox. For example, there is increasing use of publicly available and large datasets that require efficient and reproducible processing of data, whilst retaining analysis flexibility. The osl toolbox implements efficient (parallelisable) batch processing using a concise and easily shareable configuration API. In addition, detailed logbook keeping, and the generation of processing reports facilitate reproducibility and quality assurance.

osl is a modular analysis toolbox that integrates well with other Python and MATLAB based toolboxes, currently containing modules for MaxFilter-ing, preprocessing, source reconstruction, parcellations, statistical analysis and visualisation. Notably it includes functionality for doing source reconstruction and parcellation in volumetric space, without the need for FieldTrip.

More will be added in the future, and the efficient osl pipelines can always be supplied with additional, user defined functions and third-party toolboxes. We present the toolbox by a set of examples outlining a typical MEG analysis pipeline, using the publicly available multimodal faces dataset (Wakeman & Henson, 2015).

PT79 - Breathing modulates cortical activity in newborns

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Brainstem structures activate the breathing muscles in a cyclic manner which allows for inspiration and expiration. Whilst breathing is accomplished seemingly effortless via these sub-cortical structures, breathing can be adapted via top-down control from the cortex. In fact, multiple cortical regions alter breathing, for example, during swallowing and singing. It was recently found that these cortico-respiratory interactions can be captured using phase-amplitude coupling (PAC) where the breathing phase modulates the amplitude of oscillatory brain activity. We aimed to investigate if such PAC already exists in newborns. If true, this could provide mechanistic insights into early existence of respiratory-brain networks as well as clinical relevance for disorders such as apnoea of prematurity.

We studied 103 (mostly preterm) infants (post-menstrual age: 34.8±3.3 weeks) who were aged 3.1±2.4 weeks during 167 recordings. These infants were inpatients in the neonatal unit (Oxford University Hospitals, Oxford). We recorded resting state electroencephalography (EEG) at 8 channels and vital signs including impedance pneumography (IP). Cross-frequency coupling was determined using a coherence-based PAC measure between the IP and EEG signals, quantifying how the breathing phase at low frequencies is coupled to the EEG amplitude at high frequencies. Statistical significance for each EEG channel was determined using a surrogate method comprising epoch shuffling after which true and surrogate PAC spectra were compared using cluster-based permutation testing.

The respiratory phase at the mean breathing frequency (~1 Hz) is significantly coupled to EEG power at delta- and theta-frequencies between 1-8 Hz. Such coupling was evident in central areas (channels Fz, Cz, C3, C4, and CPz) and to a lesser extent in the occipital area (Oz). This underlines that breathing rhythms already modulate oscillatory cortical activity in the first few weeks of life. Future studies should shed light on how this coupling is affected by breathing disorders such as apnoea of prematurity.

PT80 - Mapping eloquent cortex using OPM-MEG in children with epilepsy

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Magnetoencephalography (MEG) has been a valuable tool for mapping epileptiform activity and eloquent cortices in the presurgical evaluation for epilepsy surgery for decades. Specifically, precise eloquent cortex mapping can improve post-surgical outcomes, preserving vital functions for patients. However, despite its clear benefits in spatial localisation, routine clinical adoption of the technique remains relatively low, particularly in the UK. This is likely due to several barriers, including high operating costs and sourcing of cryogenic materials. Optically pumped magnetometer-MEG (OPM-MEG) presents a promising alternative, offering comparable spatial and temporal resolution, without cryogenics. Additionally, OPM-MEG features a simple helmet design that better accommodates the head shape and size of children.

We propose that OPM-MEG can enhance presurgical mapping by precisely localising eloquent cortices. In this study, we utilised an array of 64 QuSpin Gen 3 dual-axis sensors (128 channels) within a light MuRoom coupled with active shielding (Cerca Magnetics Ltd, Nottingham, England, UK) to map the motor cortex of children with focal epilepsy who are on an epilepsy surgical pathway. During the experiment, participants (N = 5, ages 7-15) were instructed to perform a rapid right index finger abduction upon visual cue, completing 50 trials over 4.5 minutes.

We beamformed motor related beta activity, mapping to the contralateral motor cortex for each participant. In patient with clear interictal activity, epileptogenic zones were mapped, showing consistent localisation relative to clinical investigations. The increased accessibility of OPM-MEG, particularly its robustness to movement and adaptability to a wide range of head shapes and sizes, makes it a promising tool for future clinical implementation. Furthermore, the technique has been shown to be better tolerated by children with sensory sensitivities, enhancing its potential for broader clinical use.

PT81 - A National Facility for OPM-MEG

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The past 10 years have seen the rapid proliferation of OPM-MEG technology, from conception and simulation of neural fields, through to production of fully integrated OPM-MEG systems worldwide. OPM-MEG was conceived with the ultimate aim of becoming a useful clinical tool, therefore the scientific work so far has been focused on validation of OPM-MEG in comparison to the 'gold standard' fixed-array SQUID systems, while further exploiting the novel advantages OPM-MEG has to offer as a flexible and motion robust sensor array. Published literature has already shown OPM-MEG can provide reliable data during naturalistic movement-related activities and across the lifespan. Consequently OPM-MEG is emerging as a promising platform upon which to build a more clinical or neuroscience-based programme of work.

The OPM-MEG National Facility was established with the aim of assisting the progression of the academic field by providing a cost-free opportunity for research and clinical collaborations within the UK and worldwide. The Facility, based at the University of Nottingham and funded by an MRC mid-range equipment grant, comprises one large and one small magnetically shielded room, each containing a 192-channel OPM-MEG system. There is scope to perform naturalistic paradigms as well as peripheral equipment available, including an eight camera optitrack motion capture system, different sizes and styles of helmets suitable for scanning children as well as ROI-based high density clustering of sensors to access deeper neural sources. Our hope is that we can work with researchers and clinicians across the UK to provide assistance with piloting studies, work towards grants, and successfully build the evidence-base needed to drive OPM-MEG towards the clinical field.

PT82 - Magnetoencephalography versus blood-based biomarkers of Alzheimer's Disease

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Alzheimer's Disease is characterised by accumulation of amyloid (Aβ) and τ proteins, which are in turn associated with synaptic dysfunction and cognitive impairments. A challenge for drug development is the development of biomarkers to identify disease and predict disease progression. Here we examine between-subject relationships between two different type of biomarkers: 1) neural activity, as measured by magnetoencephalography (MEG), which is dependent on synaptic function, and 2) levels of synaptic proteins measured in blood as a proxy of synaptic health. We analysed data from healthy controls and amyloid-positive patients with Alzheimer's disease or mild cognitive impairment. MEG was recorded during a 10-minute auditory mismatch negativity task of short term plasticity (MMN), in which participant passively listened to a tone every 500 ms. The tones varied in frequency every 3-11 trials – meaning that each new tone represents a 'deviant' and each following tone represents a 'repetition'. We calculated the difference in evoked MMN amplitude (140-160ms post-stimulus) between the deviant and repetitions 1-5. These amplitudes were averaged across tones and across trials – resulting in a subject-specific average MMN amplitude. Eight different blood-based biomarkers were analysed for each participant (phosphorylated τ-181, phosphorylated τ-217, Aβ1-42/ Aβ1-40, brain-derived τ, glial fibrillary acidic protein, triggering receptor expressed on myeloid cells 2, neurogranin, and neurofilament light). Between-subject Bayesian correlation showed that none of the blood-markers correlated with the MMN amplitude (BF10 ranging from .38 to .20). A Bayesian linear regression analysis with MMN as dependent variable and the blood-biomarkers as predictors showed a similar lack of relationship – favouring the null model. In summary, we find no relationship between the these specific blood- and MEG-markers.

PT83 - The impact of subthalamic nucleus deep brain stimulation in the beta range on cortical beta oscillations and motor performance

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Recordings from Parkinson's disease (PD) patients typically show pathologically enhanced oscillations in the beta-band (13-35 Hz), which can be modulated by means of deep brain stimulation (DBS). While high-frequency DBS (>100 Hz) ameliorates motor symptoms and reduces beta activity in basal ganglia and motor cortex, the effects of low-frequency DBS (<30 Hz) are less clear. Here, we investigated how subthalamic nucleus (STN) beta-band DBS affects cortical beta oscillations and motor performance. We recorded the magnetoencephalogram of 14 PD patients implanted with an STN DBS system while they were on their usual medication. Following a baseline recording (DBS off), bipolar DBS was applied at beta frequencies (10, 16, 20, 26, and 30 Hz) using the left electrode in a cyclic fashion (5s on, 3s off). The pulse amplitude was set to 3 mA. For each stimulation frequency, cyclic stimulation was applied at rest and during right-hand finger tapping. At rest, beta-band DBS increased cortical beta power during stimulation, and this effect persisted for approximately 400 ms after cyclic stimulation ceased. This after-effect was most prominent in frontal and sensorimotor regions of the left hemisphere, ipsilateral to stimulation, and differed spectrally and topographically from the DBS artifact, indicating a physiological origin. In the baseline recording (DBS off), we observed a negative correlation between the strength of hemispheric beta power lateralization and the tap rate, suggesting that a relatively high level of beta power in the hemisphere contralateral to movement slows down movement. Notably, beta-band DBS accentuated the lateralization and reduced the tap rate proportionally. Our study demonstrates that cortical beta oscillations can be manipulated by STN beta-band DBS, suggesting that DBS might be suited to probe the causal role of cortical beta oscillations in motor control.

PT84 - Word-category-selective EEG/MEG responses in English language with Fast Periodic Visual Stimulation (FPVS)

Dr Olaf Hauk

Fast periodic visual stimulation (FPVS) allows the recording of objective brain responses of human word categorization (i.e., reproducible word-category-selective responses) with high signal-to-noise ratio. This approach has been successfully employed over the last decade in a number of scalp electroencephalography (EEG) studies. Yet, robust measures of written word-selective responses with this approach have not been reported in the most spoken and read language in the world, English. Moreover, word-selective responses have only been reported in EEG, but not with MEG and without source localization. Here, we presented common English words periodically (2 Hz) among different types of letter strings (10Hz; consonant strings, non-words, pseudowords, similar to Lochy et al., Neuropsychologia 2015 and Cortex 2024) whilst recording simultaneous EEG and MEG in 25 participants who performed a simple non-linguistic color detection task. Data were analyzed in sensor and in source space (L2-minimum-norm estimation, MNE). With only 4 minutes of stimulation we observed a robust grand-mean word discrimination response in each condition. Importantly, a reliable discrimination response was present for words embedded in word-like pseudowords. This response was larger in nonwords and largest in consonant strings. We observed left-lateralized responses in all conditions in the majority of our participants. Cluster-based permutation tests revealed that these responses were significant in sensor as well as in source space, with peaks in left posterior regions. Our results demonstrate that the FPVS paradigm can elicit robust English word-discrimination responses in EEG and MEG within only a few minutes of recording time. Together with source estimation, this can provide novel insights into the neural basis of visual word recognition in healthy and clinical populations.

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