MEG United Kingdom and Ireland Conference 2023

#MEGUKI2023 Conference

Trinity College Dublin

October 27-28, 2023

GETTING TO THE VENUE

Edmund Burke Theatre, Trinity College Dublin Arts Block

Situated in the centre of Dublin City, Trinity College is a short walk from Pearse Street Train Station, College Green Luas stop (tram), numerous bus stops, and also has ample bicycle parking.

Trinity College is a walled campus. The closest campus access point to the venue is the Nassau Street Entrance. This entrance brings you directly inside the Arts Building, where the Edmund Burke Theatre is located. The Arts Building can also be accessed from within the campus (alternative campus entrance points indicated by arrows on the above map).

All talks will take place in the Edmund Burke Theatre. There are three entrances to the Arts Building, one from Nassau Street and two from the campus itself. The Edmund Burke Theatre is close to these entrances and will be well sign-posted.

By Taxi
Taxis from Dublin Airport to Trinity College Dublin will cost approximately €30 each way. Taxis from Dublin Ferry Port will cost approximately €15 each way.

By Bus
Dublin Express (Route 782) travels from the Airport to Trinity College Dublin. If choosing the bus option, purchasing return tickets (€14) online in advance is advised.

By Air
Dublin Airport is situated 12km from Trinity College. There are regular scheduled flights from Edinburgh, Glasgow, Belfast, Dublin, Cork and several European destinations.

By Ferry
Dublin ferry port is situated 6km from Trinity College. There are regular scheduled ferries from Holyhead and Liverpool.

THINGS TO NOTE

- The registration desk will be well sign-posted. Here, you will collect your name tag and ticket for the gala dinner at the Guinness Storehouse. **Note:** Only registrants who have indicated that they wish to attend the Gala Dinner on their registration form will receive a ticket.

- Poster boards and industry display stands will be located on the main concourse directly outside the Edmund Burke Theatre lecture hall.

- Posters should be formatted in AO portrait (84.1cm wide X 118.9cm high). Velcro hooks will be provided on site for affixing the posters to the poster boards.

- For attendees travelling with babies, please note there is a breastfeeding room located right beside the Edmund Burke theatre.

Sustainability at TCD

- Trinity is a green campus, so **please bring your own water bottle** and fill it up at the venue.

- **Please bring a reusable cup** for teas and coffees. A limited number of reusable cups will be available for rent at the venue. No crockery or disposable cups will be provided.

- Kindly deposit your name tag lanyard in our collection box on the last day of the conference for future use.

- The Plant-Based Universities campaign is an initiative seeking to transition to 100% just and sustainable plant-based catering in order to tackle the climate and nature crises. To support this initiative, the **lunch sandwich platters will be solely plant-based (i.e. vegan).**

To connect to the 'TCDconferenceWIFI' guest Wi-Fi network:

1. Ensure Wi-Fi is turned on on your device.
2. Open the Wi-Fi configuration screen of your device.
3. Select the **'TCDconferenceWIFI'** SSID.
4. If a login page doesn't open automatically, try opening an external webpage on your web browser.
5. On the TCDconferenceWIFI landing page, if you do not have a username and password, select the link to self- register. Otherwise, enter your username and password.
6. On the 'Self-Registration' page, enter the following details:
   - Conference ID **TCDCONF3D**
   - Mobile phone number: this will be used to send you a password and will also become the username.
7. On the 'Self-Registration Receipt' page, select 'Sign-In' and enter the credentials you received via SMS.

Additional Wi-Fi info:

1. To get back to the login page at any stage, go to your device's Wi-Fi configuration screen and re-select the 'TCDconferenceWIFI' SSID
2. A number of devices can be registered using the same mobile phone number, however, you can only log onto the self-service guest Wi-Fi using the device from which you sent the request.

GALA DINNER

- The Gala dinner will take place on Friday evening, October 27th (doors open at 6.30 pm, pre-dinner drinks served from 7pm, and dinner served at 7.30 pm) at the **Guinness Storehouse Arrol Suite**. Please note that you can only attend the Gala dinner if you have registered for it (tickets printed on name tags to be collected from the registration desk the morning of the conference).

- The dress code is smart casual, allowing attendees to wear their conference clothes for comfort.

- Complementary wine, beer and soft drinks will be available until 10.00pm. Other drinks (e.g. spirits) will also be available from the bar at your own cost. After 10.00pm drinks will be at your own cost and the bar will remain open until 12.30am.

Getting to the Guinness Storehouse

- **On foot:** The Guinness Storehouse is a ~30-minute walk from the conference venue. We'll lead a group on foot from the Trinity College Arts Block, departing at 6pm.
  We'll begin our walk from College Green by heading west down Dame Street, following the road until passing Christ Church Cathedral on our right. We'll continue down Thomas Street, turning left onto Crane Street. At the end of Crane Street, we'll turn right onto Bellevue. Finally, we'll continue onto Market Street where we'll find The Guinness Storehouse on our right.

- **By bicycle:** The Guinness Storehouse is a 10-minute cycle from College Green, and rental bicycles are available from Dublin Bikes.
  Start your cycle from College Green by heading west down Dame Street. Follow the road until you pass Christ Church Cathedral on your right. Continue down Thomas Street until you reach the Guinness brewery entrance at St. James's Gate. Turn left up Crane Street where you can get a photo in front of the famous Guinness gates!
  You can leave your bike in the secure bike area, situated in the free car park on Crane Street. If you hired from Dublin Bikes, there is a station at Market Street South, near the front entrance.

- **By bus:** Take the Number 123 from Dame Street Stop 1935 (direction Walkinstown; every 12 minutes) and get off the bus on James's Street Stop 1941. You can ask the bus driver and he'll give you a shout when it's your stop.
  Once you get off the bus, walk to your left and take your immediate right onto Echlin Street. At the end of Echlin street, turn left onto Grand Canal Place, and a final left onto Market St where the Guinness Storehouse will be on your left.

- **By taxi:** Guests can hail a taxi from Dame street to the Guinness Storehouse. Alternatively, taxi apps Freenow, Bolt, and Uber all operate in Dublin city centre.

Questions?

You can contact the conference organisation team at **meguki2023@gmail.com**

PROGRAMME AT A GLANCE

FRIDAY, OCTOBER 27TH

8.00 – 9.00 **Registration, breakfast and coffee**

9.00 – 9.15 **Welcome address**

9.15 – 9.55 **Keynote 1: Satu Palva**

9.55 – 12.15 **Seminar Session 1 (includes 30 min coffee break)**
Sensory, Memory and Motor Processes (see pg 10 for abstracts)

12.15 - 12.45 **Lunch**

12.45 - 14.15 **Poster Session 1** *(see pg24 for abstracts)*

14.15 – 14.55 **Keynote 2: Klauss Kessler**

14.55 – 17.15 **Seminar Session 2 (includes 30 min break)**
Higher Cognition (see pg 12 for abstracts)

18.30 - late **Gala Dinner at the Guinness Storehouse (Sponsored by CERCA)**

SATURDAY, OCTOBER 28TH

8.30 – 9.30 **Registration, breakfast and coffee**

9.30 – 10.10 **Keynote 3: James Bonaiuto**

10.10 – 12.30 **Seminar Session 3 (includes 30 min coffee break)**
New Developments in MEG Methods (see pg 14 for abstracts)

12.30 - 13.00 **Lunch**

13.00 - 14.30 **Poster Session 2** *(see pg51 for abstracts)*

14.30 – 15.10 **Keynote 4: Margot Taylor**

15.10 – 17.30 **Seminar Session 4 (includes 30 min break)**
Neurodevelopment and Brain Disorders (see pg 16 for abstracts)

SEMINAR SCHEDULE DAY 1

9.15 - 12.05, Friday, October 27th

Session 1: Sensory Memory & Motor Processes

9.15 - 9.55	**Keynote: Satu Palva (University of Glasgow)** Controlling brain synchronization dynamics
9.55 – 10.15	**Rik Henson (University of Cambridge)** The effect of adult age on sensorimotor evoked responses: dynamics and physiological modelling of the large CamCAN MEG dataset
10.15 - 10.35	**Peter Murphy (Maynooth University)** Decision-making in changing environments: linking normative computation and neural implementation
10.35 - 11.05	**Coffee Break**
11.05 – 11.25	**Aidan Horner (University of York)** Theta and alpha oscillations in the hippocampus and medial parietal cortex support the formation of location-based representations
11.25 - 11.45	**Surjo Soekadar (Universitätsmedizin Berlin)** Neuromagnetic brain/neural-machine interfaces for restoration of motor function and beyond
11.45 - 12.05	**Poster Prize Winner: Mats Van Es (University of Oxford)** Cyclical evolution of functional brain networks in rest

SEMINAR SCHEDULE DAY 1 CONTD.

14.00 - 17.00, Friday, October 27th

Session 2: Higher Cognition

14.00 - 14.40	**Keynote: Klaus Kessler (University College Dublin)** Oscillatory coupling networks of social cognition
14.40 – 15.00	**Alex Wade (University of York)** Piloting the international brain laboratory perceptual decision task using MEG
15.00 - 15.20	**Anne Keitel (University of Dundee)** Rhythms in brain and behaviour
15.20 - 15.50	**Break**
15.50 – 16.10	**Lilian Weber (University of Oxford)** Decision-making in dynamic, continuously evolving environments: neural signatures of flexible choice strategies
16.10 - 16.30	**Yali Pan (University of Birmingham)** Linking attention to reading using rapid invisible frequency tagging
16.30 - 16.50	**Poster Prize Winner: Oscar Ferrante (University of Birmingham)** An adversarial collaboration to critically evaluate theories of consciousness: activation and synchronisation in MEG

SEMINAR SCHEDULE DAY 2

09.30 - 12.30, Saturday, October 27th

Session 3: New developments in MEG Methods

9.30 - 10.10	**Keynote: James Bonaiuto (CNRS Institut des Sciences Cognitives, Lyon)** Non-invasive investigation of cortical laminar dynamics with MEG
10.10 – 10.30	**Svenja Knappe (University of Colorado)** HEDscan: A whole-head high-density OPM-MEG system
10.30 - 10.50	**Tim Tierney (University College London)** Harmonic models of OP-MEG data: Implications for system design and data quality
10.50 - 11.20	**Coffee Break**
11.20 – 11.40	**Olaf Hauk (University of Cambridge)** “Transforming” neuroimaging data: Estimating pattern-to-pattern transformations of brain activity
11.40 - 12.00	**Matt Brookes (University of Nottingham)** Development and application of a 192 channel OPM-MEG system
12.00 - 12.20	**Etienne Labyt (Université Grenoble Alpes)** From 5 Sensors to the Whole Head 4He OPM-MEG

SEMINAR SCHEDULE DAY 2 CONTD.

14.30 - 17.30, Saturday, October 27th

Session 4: Neurodevelopment and Brain Disorders

14.30 - 15.10	**Keynote: Margot Taylor (Sick Kids, Toronto)** Going younger: OPM-MEG in under 5-year olds
15.10 – 15.30	**Laura Hughes (University of Cambridge)** MEG as a platform for early phase clinical trials
15.30 - 15.50	**Peter Uhlhaas (University of Glasgow)** Gamma-band oscillations in schizophrenia: mechanisms, biomarkers and the search for novel treatments
15.50 - 16.20	**Break**
16.20 – 16.40	**Esther Florin (Universität Düsseldorf)** Modulation of dynamic cortico-subcortical interactions by DBS and medication in Parkinson's disease
16.40 - 17.00	**Elaine Foley (Technological University Dublin)** MEG network alterations in paediatric brain disorders
17.00 - 17.20	**Poster Prize Winner: Timothy West (University of Oxford)** Reaching to understand the neural correlates of tremor variability during naturalistic movement: A high-density neuroimaging study in essential tremor patients

Seminar Abstracts

Session 1: Sensory Memory & Motor Processes

9.15 - 12.15, Friday, October 27th

Keynote: Satu Palva, University of Glasgow
9.15 – 9.55. Emergent variability of brain dynamics
Neuronal oscillations and their interareal synchronization are fundamental for human behaviour, but show large inter-individual and anatomical variability. The neuronal basis of this variability has remained poorly understood. In my talk, I will show how individual variability in oscillation dynamics could emerge due to critical brain dynamics (Fusca et al., 2023). I will then discuss its relevance in understanding aberrant connectivity in brain diseases.

Rik Henson (University of Cambridge)
9.55 – 10.15. The effect of adult age on sensorimotor evoked responses: dynamics and physiological modelling of the large CamCAN MEG dataset
Healthy ageing is known to alter sensorimotor processing. Using the relatively large, open-access, multimodal "CamCAN" dataset (www.cam-can.org), we previously showed that age has differential effects on the latency of MEG evoked responses in visual versus auditory cortex (Price et al, 2017). Using a first-order expansion of amplitude and post-stimulus time, we showed that age increased the onset delay but not dispersion of visual responses, and increased the dispersion but not onset delay of auditory responses. Furthermore, the visual onset delay was mediated by white-matter integrity of the optic radiations, whereas the auditory dispersion was mediated by grey-matter volume in Heschl's gyrus. In new work, we fit a conductance-based neural mass model, using the dynamic causal modelling framework, to better understand these age-related latency effects. We found evidence that age affects AMPA and NMDA decay rates differentially across sensory regions, as well as affecting afferent input in auditory cortex.

Peter Murphy (Maynooth University)
10.15 – 10.35. Decision-making in changing environments: linking normative computation and neural implementation
A sensible, neurophysiologically plausible strategy for making decisions under uncertainty is to accumulate information over time. In natural environments, this accumulation process is complicated by the existence of hidden changes in the state of the world and should be adapted to suit the environmental statistics. I will build on work showing that humans can approximate normative decision-making in such changing environments, and suggest how this might be realized in neural circuits. I will show that M/EEG signatures of the underlying computations are evident in the dynamics of a network of brain regions encompassing sensory, parietal and (pre)motor cortex; and that these dynamics can be explained by a recurrent cortical circuit that generates competitive 'attractor' states and is shaped, on the fly, by pupil-linked arousal signals. Moreover, I will highlight the sensitivity of this paradigm to individual differences in a phenotype associated with inflexible decision-making: proneness to psychosis.

10.35 – 11.05. COFFEE BREAK

Aidan Horner (University of York)
11.05 – 11.25. Theta and alpha oscillations in human hippocampus and medial parietal cortex support the formation of location-based representations.
Our ability to navigate in a new environment depends on learning new locations. fMRI research has shown that location-based representations emerge in the retrosplenial cortex and parahippocampal gyrus. However, little is known about the oscillatory dynamics that support the formation of location-based representations. We used MEG to investigate region-specific oscillatory activity related to forming location-based representations. Participants viewed videos

showing that two perceptually distinct scenes (180° apart) belonged to the same location. This "overlap" video allowed participants to bind the two distinct scenes together into a more coherent location-based representation (relative to a "non-overlap" control video). Theta and alpha/beta power was greater during video presentation of the overlap relative to non-overlap videos, specifically at time-points when scene integration should occur. These oscillations localised to the medial parietal cortex and medial temporal lobe, including the hippocampus. Therefore, we find that theta and alpha/beta oscillations in the hippocampus and medial parietal cortex are involved in the formation of location-based representations.

Surjo Soekadar (Universitätsmedizin Berlin)
11.25 – 11.45. Neuromagnetic brain/neural-machine interfaces for restoration of motor function and beyond

Early Career Researcher Poster Prize Winner – Mats Van Es (University of Oxford)
11.45 – 12.05. Cyclical evolution of functional brain networks in rest

Aim: Brain activity contains recurrent oscillatory activity in large scale cortical networks, but their temporal evolution is unclear. Our study introduces a new method for analyzing the long-term dynamics of these states and demonstrate that there is a tendency for the brain to cycle through the states in a particular order.
Methods: We used hidden Markov modelling to identify 12 network states from three large MEG datasets (MEGUK, CamCAN, HCP), and studied their temporal dynamics via a new method called Temporal Interval Network Density Analysis (TINDA). TINDA computes a measure for each pair of states indicating how much a state occurs in the first, versus the second, half of the time between subsequent visits to another state. This indicates if there is a tendency for a state to follow, or precede, another state over long time-scales. We then globally organize the states into a circle such that we minimize violations of the pairwise ordering learnt by TINDA.
Results: Applying TINDA to the MEGUK resting MEG data, we found unique pairwise state orderings for each network state. Globally ordering the states revealed an unmistakable cyclical pattern with the brain moving through network states in a consistent direction. The strength of the cycling was stronger than expected by chance, especially for longer intervals. We replicated these results in the CamCAN and HCP datasets and showed that cycle strength and cycle rate are related to age/sex, and cycle rate is heritable. Moreover, the cycle's phase incorporated the resting states' spatio-spectral features, progressing from high power/synchrony states to low frequency cognitive states, low power/synchrony states, and finally high frequency perceptual/attentional states.
Conclusion: We have developed a new method to study temporal dynamics in brain networks and revealed an intrinsically cyclical organization of network activity, which was replicated in three datasets and is predictive of personal traits.

Session 2: Higher Cognition

14.00 - 17.00, Friday, October 27th

Keynote: Klaus Kessler (University College Dublin)
14.00 – 14.40. Oscillatory coupling networks of social cognition
What makes us human? Our ability to solve complex problems is often emphasised as the major capacity that set us apart from other species during evolution. However, human social abilities have also been argued to be more sophisticated than those of other species, providing the basis for our unique cultural evolution. While basic automatic processes are shared with other species and are often summarised as "mirroring" or "resonance", high-level functions, commonly referred to as "mentalizing" or "theory of mind" seem to be uniquely human. The talk will explore how Magnetoencephalography (MEG) has contributed towards furthering our understanding of the brain networks and oscillatory mechanisms underpinning social processing and how the recent development of non-cryogenic MEG systems may provide more flexibility for investigating embodied processing and genuinely interactive paradigms in the future.

Alex Wade (University of York)
14.40 – 15.00. Piloting the international brain laboratory perceptual decision task using MEG
The IBL is a large-scale collaborative project to obtain dense multiunit measurements from the mouse brain during a simple 2AFC perceptual decision task. The goal is to characterise the flow of information across the brain from sensory input areas through to motor outputs, and the way that this information flow can be modulated by priors. Our lab is translating the IBL task to humans using a combination of psychophysics and neuroimaging. Here we describe the results from a pilot MEG study showing that many of the fundamental components of the task (sensory stages, decisions and motor outputs) can be decoded at different time points and from different brain regions. We also describe failures of the pilot protocol - for example, the inability to decode high level priors and consider possible remedies for future, full-scale experiments using both MEG and fMRI.

Anne Keitel (University of Dundee)
15.00 – 15.20. Rhythms in brain and behaviour
Each brain area has characteristic patterns of intrinsic neural rhythms that generalise across individuals. However, despite this generalisability, individual variability in brain rhythms exist, and these likely account for differences in the perception of auditory stimuli. It has also been suggested that individuals have preferred perceptual and motor rhythms, which could arise from underlying neural rhythms. We here tested whether individual intrinsic brain frequencies predict the preference for musical rhythms. Our results showed that individuals' theta frequency peak in auditory electrodes predicted their preferred tempo: The faster the theta rhythm, the faster the musical rhythms that individuals liked to hear. In addition, we find limited evidence for the idea that preferred auditory and motor rhythms are connected, in a series of behavioural studies with music and speech. If preferred neural and perceptual/motor rhythms exist, this suggest that tailoring auditory stimuli to the individual might help in training and intervention contexts.

15.20 – 15.50. COFFEE BREAK

Lilian Weber (University of Oxford)
15.50 – 16.10. Decision-making in dynamic, continuously evolving environments: neural signatures of flexible choice strategies
In contrast to most experiments, the choices that we make in daily life rarely occur in discrete trials. Instead, we navigate volatile environments, where changes in decision-relevant variables need to be detected among noise fluctuations. In this talk, I will present data from novel continuous decision paradigms that probe decision-making in dynamic and temporally extended choice settings. In two studies, we find that participants adapt their decision strategies to the levels of volatility and noise in their environment, and that this adaptation is reflected in M/EEG signatures of decision formation. Notably, using a deconvolutional GLM analysis of the continuous M/EEG data, we are able to measure neurophysiological signatures of decision

formation with high reliability in relatively short amounts of time. Abandoning the rigid trial structure of conventional choice paradigms thus allows us to study more naturalistic choice behaviour, while also making more efficient use of experiment time and data.

Yali Pan (University of Birmingham)
16.10 – 16.30. Linking attention to reading using rapid invisible frequency tagging
Visual attention plays a critical role in natural reading, yet a fundamental question remains: is attention deployed in a serial or parallel manner across words? We propose that this longstanding debate can be effectively addressed by applying rapid invisible frequency tagging (RIFT) in a natural reading paradigm with co-registration of MEG and eye tracking. The target word in a sentence was manipulated either on the lexical level in Experiment 1 (low/high, e.g., waltz/music) or the semantic level in Experiment 2 (congruent/incongruent, e.g., blue jacket/blue brother). Subliminal tagging of the target word at 60 Hz allowed us to measure the dynamics of attention that was allocated to the target word. We found that attention was modulated by both the lexical and semantic information of the target word, even before it was fixated. These results provide compelling neural evidence supporting the notion that attention flexibly spans across more than one word simultaneously.

Early Career Researcher Poster Prize Winner – Oscar Ferrante (University of Birmingham)
16.30 – 16.50. An adversarial collaboration to critically evaluate theories of consciousness: activation and synchronisation in MEG
Understanding the neuronal mechanisms supporting consciousness is a fundamental question in neuroscience. Several competing theories have been proposed. To accelerate research, the predictions of these theories should be tested together under a common framework. This is the aim of COGITATE, an adversarial collaboration testing predictions from Global Neuronal Workspace (GNW) and Integrated Information Theory (IIT).
Here we tested two predictions made by the two theories regarding activation and inter-areal communication using MEG. Participants were presented with visual stimuli that were undoubtedly consciously perceived. GNW predicted a phasic activation in prefrontal cortex at both stimulus onset and offset, while IIT predicted content-specific sustained activation in posterior cortex during stimulus presentation. Additionally, GNW predicted stronger synchronization between prefrontal and category-selective areas in the “ignition” time window, whereas IIT predicted sustained synchronization between early visual cortex and category-selective areas.
The results indicated the presence of the predicted sustained alpha activity in posterior cortex. Furthermore, we observed the predicted late phasic ignition in prefrontal cortex at stimulus offset in the alpha band. However, this result was not supported by control analyses. Concerning phase-synchronization, neither the frequency band nor the temporal patterns of connectivity were consistent with the predictions of either theory.
By integrating our MEG results with other neuroscientific techniques (fMRI, intracranial EEG) and testing additional theoretical predictions (e.g., decoding of conscious content), we will get more conclusive evidence supporting or refuting the two theories and to clarify how consciousness arises in the human brain.

Session 3: New Developments in MEG Methods

9.30 - 12.30, Saturday, October 28th

Keynote: James Bonaiuto (CNRS Institut des Sciences Cognitives, Lyon)
9.30 – 10.10. Non-invasive investigation of cortical laminar dynamics with MEG
Recent years have seen a transformative shift in the study of human cortical circuit dynamics, propelled by advancements in magnetoencephalography (MEG) techniques. In particular, high precision, head-cast MEG offers the tantalizing prospect of measuring neural activity in different cortical laminae. I will review methods for making lamina-specific inferences with MEG, and how this approach can be combined with computational modeling and neuroanatomy for fine-grained temporal analysis of laminar dynamics underlying beta bursts as well as motor and visual event-related fields. Finally, I will present a new source reconstruction approach with a depth electrode-like source space, revealing dynamic current sources and sinks that align with cortical layer boundaries, and a laminar distribution of relative alpha/beta and gamma power that matches the spectrolaminar motif identified from intracranial recordings. The non-invasive and global nature of high precision MEG offers promising avenues for bridging the gap between understanding neural circuits and large-scale brain networks.

Svenja Knappe (University of Colorado)
10.10 – 10.30. HEDscan: A whole-head high-density OPM-MEG system
Magnetoencephalography (MEG) with on-scalp sensors has been promising high spatial resolution on the order of 1 mm, motivated by several simulation studies. Nevertheless, this has not been accomplished experimentally. Two of the main inhibitors have been the availability of large sensor arrays and the ability to determine the positions and orientations of all sensors well enough. A full-head, high-density HEDscan system consisting of 128 OPM sensors is used to assess the ability to localize a series of dipoles in a wet MEG phantom. Latest developments in the OPM sensors will be discussed and how this improves the performance, ease of use, and integration of OPM-MEG.

Tim Tierney (University College London)
10.30 – 10.50. Harmonic models of OP-MEG data
Harmonic models have been used extensively for mitigating environmental interference and modelling brain signal. However, their application to Optically Pumped Magnetometer (OPM) data is challenging due to the wide variety of existing OPM sensor and array designs. We therefore explore how such models can be adapted to provide stable models of brain signal and interference across OPM systems. We demonstrate how prolate spheroidal harmonics can provide a compact representation of brain signal when sampling on the scalp surface with as few as 100 channels. We then introduce a type of orthogonal projection incorporating this basis set. This combined basis set and projection maximizes interference rejection across systems (in theory and in silico), even in the presence of spatially structured nonlinearity errors. We conclude with an empirical demonstration of improved signal to noise ratio for the neuronal response to a flickering checkerboard in a 128-channel OPM system at sensor and source level.

10.50 – 11.20. COFFEE BREAK

Olaf Hauk (University of Cambridge)
11.20 – 11.40. "Transforming" neuroimaging data: Estimating pattern-to-pattern transformations of brain activity
In order to characterize brain connectivity most accurately, connectivity methods should make use of the full multivariate and multidimensional information available from neuroimaging data. This should include a characterization of transformations between patterns of activation across brain regions, and their dependence on stimulus features, task and context. Here, we describe novel methods developments to estimate the multidimensional relationships between patterns of brain activity from different brain regions. In particular, we will highlight their potential to estimate the voxel-to-voxel transformations between these patterns. We will focus on methods

that are suitable for event-related experimental designs and illustrate their application with examples from EEG/MEG and fMRI research on language processing.

Matt Brookes (University of Nottingham)
11.40 -12.00. Towards high-density OPM-MEG: development and applications
OPM-MEG ostensibly offers non-invasive assessment of brain function with unprecedented spatial resolution and sensitivity – potentially even close to that of invasive EEG. However, OPMs remain nascent technology, their noise floor (7-15 fT/sqrt(Hz)) is higher than cryogenic sensors (limiting sensitivity), and we have yet to see devices with high channel count (limiting resolution). In this talk, I will describe our work towards developing of high-density OPM-MEG. I will show theoretical and experimental data in which the sensitivity of OPM-MEG is optimised by sensor and array design, allowing for significantly better sensitivity compared to conventional MEG. I will show how this system is "portable" – and can be easily transported between MEG labs. I will show how it offers a means to gather MEG data as a person walks around a room. Finally, I will show how we are using this system to characterise neurodevelopmental trajectory of oscillations and connectivity in children.

Etienne Labyt (Université Grenoble Alpes)
12.00 – 12.20. From 5 Sensors to the Whole Head 4He OPM-MEG
In 2020, our first prototype MEG system with only 5 sensors based on our He OPM technology launched. Several studies have been performed in 3 hospitals, overcoming our expectations that were to validate the technology and its operability in various real environments. Beyond that, it has been possible to collect lots of data in healthy subjects and several epileptic patients. Based on standard neurophysiological responses, the equivalence to SQUID recordings could be shown. Furthermore, we have demonstrated that we were able to record interictal epileptic discharges, validated by simultaneous intracerebral EEG recordings. Now, MAG4health proposes a whole head Helium OPM MEG system, working without heating nor cooling and going beyond alkali OPM dynamic range and bandwidth. Validation based on somesthetic evoked brain response has been achieved. SNR of our system has been assessed by simulation for various numbers of sensors and head sizes compared to SQUID systems.

Session 4: Neurodevelopment and Brain Disorders

14.30 - 17.30, Saturday, October 28th

Keynote: Margot Taylor (Sick Kids, Toronto)
14.30 – 15.10. Going younger: OPM-MEG in under 5-year olds
One of the most appealing aspects of the new OPM technology is being able to scan young children who have difficulties staying still during scanning. Following system set-up and an extended period of piloting, cross-site and cryogenic-OPM comparisons, we began data collection in young children (1–5-year-olds) and have collected OPM data in over 100 children to date. I will first present results comparing our OPM and cryogenic MEG systems in adults, demonstrating the replicability of recordings across the two systems, from a face processing task and task-free recordings. I will discuss lessons learned and how we optimised testing in little ones to obtain good quality data, including in young children with autism. I will then present data from the children, also in task and task-free recordings. We are at an enormously exciting time for MEG research and our knowledge gained will help extend the possibilities of OPMs.

Laura Hughes (University of Cambridge)
15.10 – 15.30. MEG as a platform for early phase clinical trials
Background: Magnetoencephalography (MEG) is a promising platform for clinical trials, with the potential to provide reliable and mechanistically informative neurophysiological biomarkers of disease. In a series of studies we link MEG markers of dementias with clinical symptoms and aim to restore deficits in neurotransmission with pharmacological manipulation.
Methods: Resting state and task-based M/EEG was enhanced by targeted pharmaco-magnetoencephalography in a series of studies using: Tiagabine and Zolpidem (GABA), Memantine (NMDA glutamate), and Citalopram (serotonergic reuptake inhibition). Test-retest assessments and longitudinal M/EEG are supplemented by structural MRI, Spectroscopy, and cognitive and clinical assessments.
Results: MEG is sensitive to pharmacological manipulation in health and neurodegenerative diseases. Localised effects on evoked responses and spectral power are highly reliable and correlate with clinical and behavioural assessments sufficient to stratify into trials. Reliable and sensitive models of cortical microcircuit connectivity reveal the mechanisms underlying the differential responses to drug.
Discussion: This body of work provides evidence for pharmacological MEG protocols that can identify specific pharmacological targets for restoration that are directly relevant to the neurophysiology and symptomology of disease. These results open the way for future research to determine drug efficacy, and to develop a range of symptomatic treatments to benefit people with dementia.

Peter Uhlhaas (University of Glasgow)
15.30 – 15.50. Gamma-band oscillations in schizophrenia: mechanisms, biomarkers and the search for novel treatments
There is converging evidence that 40-Hz Auditory Steady-State Responses (ASSRs) are robustly impaired in schizophrenia and could constitute a potential biomarker for characterizing circuit dysfunctions as well as enable early detection and diagnosis. Here, I will summarize findings from electro- and magnetoencephalographic studies in participants at clinical high risk for psychosis, patients with first-episode psychosis as well as patients with 22q11.2 deletion syndrome to identify the pattern of deficits across illness stages, the relationship with clinical variables, and the prognostic potential. Finally, data on genetics and developmental modifications will be reviewed, highlighting the importance of late modifications of 40-Hz ASSRs during adolescence, which are closely related to the underlying changes in GABA (gamma-aminobutyric acid) interneurons. Together, our review suggests that 40-Hz ASSRs may constitute an informative electrophysiological approach to characterize circuit dysfunctions in psychosis that could be relevant for the development of mechanistic biomarkers.

15.50 – 16.20. COFFEE BREAK

Esther Florin (Universität Düsseldorf)
16.20 – 16.40. Modulation of dynamic cortico-subcortical interactions by DBS and medication in Parkinson's disease
Current treatment strategies for Parkinson's disease (PD) include medication and deep brain stimulation within the subthalamic nucleus (STN). While these treatment options are, in most cases effective, their exact mechanisms of action remain elusive. To gain a further understanding of medication and DBS effects, we recorded MEG in combination with simultaneous local field potential recordings as well as deep brain stimulation in the STN of patients with PD. Using both classical evoked responses as well as data-driven dynamic network approaches, we gained valuable insights into PD and its treatment: On the one hand, we could identify a network related to the adverse effects of medication, and on the other hand, we identified cortical responses related to optimal treatment with DBS. These findings might in the future help clinicians to better identify optimal stimulation settings.

Elaine Foley (Technological University Dublin)
16.40 – 17.00. MEG network alterations in paediatric brain disorders
Functional brain network topology in children with auto-immune encephalitis (AE) and epilepsy was investigated using magnetoencephalography (MEG). Resting-state MEG data were acquired from a group of twelve children with AE, eighteen patients with refractory epilepsy and twelve typically-developing children (age 11.8±3.6y, 22M:20F). Functional connectivity analysis in delta (1-4 Hz) and theta (4-8 Hz) bands was compared across groups. In theta, patients with epilepsy showed significantly higher clustering coefficient and lower characteristic path length compared to patients with AE and controls. No significant network differences were found between patients with AE and controls in the theta band. However, the AE group showed significantly lower clustering coefficient in delta compared to controls and epilepsy patients. These findings demonstrate distinct patterns of network topology in paediatric patients with AE and epilepsy, where epilepsy networks were characterized by a more efficient global and local transmission in theta compared to controls. While AE differed in delta connectivity, with lower levels of connection clusters, translating to limited local transmissions.

Early Career Researcher Poster Prize Winner – Timothy West (University of Oxford)
17.00 – 17.20. Reaching to understand the neural correlates of tremor variability during naturalistic movement: A high-density neuroimaging study in essential tremor patients
Background: Essential tremor (ET) manifests in pathological tremors that vary with factors such as stress and motor demands. This study investigates the brain circuits governing these variations in a cohort of patients and healthy controls, to identify oscillatory biomarkers associated with endogenous tremor suppression that have the potential to be leveraged by brain stimulation therapies.
Methods: The first cohort included 12 ET patients and 12 age-matched controls (using 128 channel EEG) and a second cohort including 4 controls/3 ET patients (using OPM/MEG). Brain signals, electromyography (EMG), and kinematics were recorded during a cued, whole limb reaching task using high-density neuroimaging, employing a 2×2 design (high vs low uncertainty cues; small vs large targets). Dynamic Imaging of Coherent Sources (DICS) was used to localize sources modulated by motor demands as well as sources in the brain that were synchronized to tremor activity.
Results: In controls and patients, both response times and reach duration were modulated by cue uncertainty and target size (ANOVA (21) $P < 0.001$). Tremor amplitude was suppressed by ~10% when reaching for small targets (T-test (12), $P < 0.05$). Beta band (14-30 Hz) movement related synchronization was localized to the supplementary motor cortex (SMA). For small targets, beta resynchronization was significantly slowed. Increased motor precision elicited increases in gamma power that was most clear in OPM recordings (permutation test (5), $P< 0.01$) and localized to the posterior parietal cortex.
Discussion/Conclusions/Implications: Recordings of brain activity with OPMs during large scale, whole limb movement reflects a novel achievement and are well validated against EEG data recorded using the same task. This work shows that activity across physiological beta/gamma bands are responsive to changes in motor demands during whole limb reaching and begins to untie how they co-modulate with tremor in pathologies such as ET.

Poster Session 1

1.01 – The influence of prestimulus phase on temporal integration
Michelle Johannknecht; Joachim Lange
Heinrich Heine University of Düsseldorf, Germany.

1.02 – Modulating Somatosensory Alpha Oscillations Using Short-period Transcranial Alternating Current Stimulation
Vaishali Balaji, Joachim Lange, Heinrich Heine University of Düsseldorf, Germany.

1.03 – How do focal brain lesions affect information coding during spatial and feature-selective attention? A case series
Nadene Dermody; Elizabeth Michael; Olaf Hauk; Polly Peers; Romy Lorenz, University of Cambridge, United Kingdom.

1.04 – Computational modelling of age-related delays in audiovisual sensory information processing using MEG
Pranay S. Yadav; Rik Henson, University of Cambridge, United Kingdom.

1.05 - Combining video telemetry and wearable MEG for naturalistic imaging
George O'Neill; Robert Seymour; Stephanie Mellor; Nicholas Alexander; Tim Tierney; Meaghan Spedden; Ryan Timms; Sven Bestmann; Gareth Barnes
University College London, United Kingdom.

1.06 - Studying responses to reward and loss in the human Ventral Tegmental Area with simultaneous MEG and intracranial recordings
Arjun Ramaswamy, Douglas Steele, Harith Akram, Manjit Matharu, Ludvic Zrinzo, Vladimir Litvak
University College London, United Kingdom.

1.07 – Investigating the neural tracking of dialogue
Emily Y.J Ip, Benjamin R. Cowan, and Giovanni M. Di Liberto, Trinity College Dublin, Ireland.

1.08 – Whole-head simultaneous EEG and OPM-MEG
Zelekha A Seedat, Kelly St. Pier, Niall Holmes, Molly Rea, Elena Boto, Layla Al-Hilaly, Matthew J Brookes, J Helen Cross, University of Nottingham, United Kingdom

1.09 – Identifying a shared source of age-related decline in working memory and decision-making
Jade S. Duffy, Hannah McDermott, Robert Whelan, Redmond G. O'Connell, Peter R. Murphy, Trinity College Dublin, Ireland.

1.10 – Structural disintegration and hypoexcitation in neurodegeneration via generative EEG whole-brain modeling
Carlos Coronel-Oliveros; Raul Gonzalez-Gomez; Kamalini Ranasinghe; Agustin Sainz-Ballesteros; Agustina Legaz; Sol Fittipaldi; Josephine Cruzat; Rubén Herzog; Gorsev Yener; Mario Parra; David Aguillon; Francisco Lopera; Hernando Santamaria-Garcia; Sebastián Moguilner; Vicente Medel; Patricio Orio; Robert Whelan; Enzo Tagliazucchi; Pavel Prado; Agustín Ibañez, Trinity College Dublin, Ireland.

1.11 – Alpha-beta decoupling associated with inhibition deficits leads to suicide attempt in major depressive disorder
Zhongpeng Dai; Wei Zhang; Li Xue; University of Birmingham, United Kingdom.

1.12 – The Effect of Task on Exemplar- and Category-level MEG Classifier Fidelity
Adam J. Curtis; Akul Satish; Maria Wimber; Aidan J. Horner, University of York, United Kingdom.

1.13 – Healthy ageing of static and dynamic networks in MEG
Chetan Gohil; Andrew Quinn; Jemma Pitt; Mark Woolrich, University of Oxford, United Kingdom.

1.14 – Enabling ambulatory movement in OPM-MEG with matrix coil active shielding
Niall Holmes; Gonzalo Reina Rivero; Molly Rea; Ben Styles; Stephen Pink; James Chalmers; Peter J Hobson; James Leggett; Lucy J. Edwards; Ryan M. Hill; Elena Boto; Vishal Shah; David Woolger; T. Mark Fromhold; Matthew J. Brookes; Richard Bowtell, University of Nottingham, United Kingdom.

1.15 – Sensorimotor network dynamics in a paediatric cohort using OPM-MEG
Lukas Rier; Natalie Rhodes; Daisie Pakenham; Ryan Hill; Elena Boto; Niall Holmes; Vishal Shah; Gonzalo Reina Rivero; Margot Taylor; Richard Bowtell; Matthew Brookes, University of Nottingham, United Kingdom.

1.16 - Internal States and Internal Models Dissociate Components of Motor Beta Oscillations
Tom R. Marshall, Mengxi Wang, Emma L. Lawrance, Nils Kolling, Jill X.O'Reilly, University of Birmingham, United Kingdom.

1.17 – Investigating the neurophysiology of speech perception: a novel assessment metric for linguistic expectations
Amirhossein Chalehchaleh; Martin Winchester; Giovanni M. Di Liberto, Trinity College Dublin, Ireland

1.18 – Modelling subject variability in MEG data with deep learning
Rukuang Huang; Chetan Gohil; Mark Woolrich, University of Oxford, United Kingdom

1.19 - The effect of age on neuronal power spectra
Andrew J Quinn; Jemma Pitt; Chetan Gohill; Anna Christina Nobre; Mark Woolrich, University of Birmingham, United Kingdom.

***1.20 – Cyclical evolution of functional brain networks in rest**
Mats WJ van Es; Cameron Higgins; Chetan Gohil; Diego Vidaurre; Andrew J Quinn; Mark W Woolrich, University of Oxford, United Kingdom.

1.21 - Hemispheric asymmetry during attentional control: Is the right hemisphere dominant?
Gabriela Cruz; Maria Melcon, Satu Palva, Gregor Thut, University of Glasgow, United Kingdom.

1.22 - Inferring EOG signal from Video
Peter Redmond, Mohammad Ahsan Awais, and Tomás Ward, Dublin City University, Ireland.

***Poster Prize winner, see pg24 for poster abstracts**

Poster Session 1

1.23– Covariate shift analysis and single-trial classification of MEG motor imagery data
Haider Raza, Sanjeev Nara, Minerva Sarma, Charles Bond, University of Essex, United Kingdom.

1.24 – Retrieval of virtual naturalistic experiences during OPM-based MEG.
Robert A. Seymour, Nicholas Alexander, Yan Wu, Eleanor A. Maguire, University College London, United Kingdom.

1.25 – Cortico-Pallidal Interactions in Dystonia: A Combined EEG-LFP Study.
Mansoureh Fahimi Hnazaee, Eoin Mulroy, Olga Sinani, Harith Akram, Ludvic Zrinzo, Tom Foltynie, Patricia Limousin, Vladimir Litvak, University College London, United Kingdom.

1.26 – Encoding of virtual naturalistic experiences during OPM-based MEG.
Nicholas Alexander, Robert A. Seymour, Yan Wu, Eleanor A. Maguire, University College London, United Kingdom.

1.27 – High-frequency alpha activity involved in the top-down control of information maintained in short-term memory.
Mate Gyurkovics, Gabriela Cruz, Matias Palva, Gregor Thut, Satu Palva, University of Glasgow, United Kingdom.

1.28 – Combining OPM and lesion mapping data for epilepsy surgery planning: a simulation study.
Stephanie Mellor, Ryan Timms, George C O'Neill, Tim M Tierney, Meaghan E Spedden, Matthew J Brookes, Konrad Wagstyl, Gareth R Barnes, University College London, United Kingdom.

1.29 – Optimising the Sensitivity of Electrophysiological Imaging using Optically-Pumped Magnetometers.
Ryan M Hill, Holly Schofield, Elena Boto, Lukas Rier, James Osborne, Cody Doyle, Frank Worcester, Tyler Hayward, Niall Holmes, Richard Bowtell, Vishal Shah, Matthew J Brookes, University of Nottingham, United Kingdom.

1.30 – Next Generation Acquisition and Control for OPM-MEG.
Holly Schofield, Ryan M Hill, Elena Boto, Matthew J Brookes, James Osborne, Cody Doyle, Vishal Shah, University of Nottingham, United Kingdom.

1.31 – Imperceptible gamma-band sensory stimulation enhances episodic memory retrieval.
Benjamin J. Griffiths, Daniel Weinert, Ole Jensen, Tobias Staudigl, University of Birmingham, United Kingdom.

1.33 – The mTBI-predict candidate biomarker variability study: the challenges and practical considerations of a multi-site and multi-vendor study.
Alice E Waitt, Tara Ghafari, Iman Idrees, Sebastian C Coleman, Ruwan Wanni Arachchige, Yidian Gao, Waheeda Hawa, Aliza Finch, Sian F Worthen, Shaheen Lateef, Davinia Fernandez-Espejo, Karen J Mullinger, Jan Novak, Matthew J Brookes, Hyojin Park, Caroline Witton, Ole Jensen, Alexandra J. Sinclair, Aston University, University of Nottingham, University of Birmingham.

1.34 – Altered information gathering in obsessive-compulsive subjects linked to evidence integration.
Magda del Rio, Nadescha Trudel, Laurence Hunt, Michael Moutoussis, Ray Dolan, Tobias U. Hauser, University College London, United Kingdom.

1.36 – Spatial factorization of moving-window kurtosis for optimal detection and characterization of spiking networks in pre-surgical epilepsy.
Ryan Beckerleg, Megan Godfrey, Kevin Murphy, Krish Singh, Khalid Hamandi, Cardiff University, United Kingdom.

1.37 – Using OPMs to study interactions between the brain, spinal cord, and muscle.
Meaghan E. Spedden, George C. O'Neill, Tim M. Tierney, Ryan Timms, Timothy O. West, Stephanie Mellor, Nicholas Alexander, Robert Seymour, Simon F. Farmer, Sven Bestmann, Gareth R. Barnes University College London, United Kingdom.

1.38 – Alterations of PAC-based resting state networks in Parkinson's disease are partially alleviated by levodopa medication.
Sean Patrick Mertiens, Matthias Sure, Alfons Schnitzler, Esther Florin, Heinrich Heine University, Germany.

1.39 – The neural dynamics of visual shape predictions.
Dorottya Hetenyi, Oscar Ferrante, Peter Kok, University College London, United Kingdom.

1.40 – MEG/EEG microstates of functional connectivity in dementia with Lewy bodies.
Ludmila Kucikova, Yi Zhang, Li Su, Sheffield University, United Kingdom.

1.41 – Using Magnetoencephalography to accelerate CNS drug discovery.
Rasha Hyder, Natalie Jones, Jennifer Swettenham, Neil Harrison and Krishna Singh, Cardiff University, United Kingdom.

See pg36 for poster abstracts

Poster Session 1

1.42 – Behavioural and neurophysiological underpinnings of complex bimanual motor learning.
Catharina Zich, Marleen J Schoenfeld, Carl Lindersson, Charlotte J Stagg, University College London, United Kingdom.

1.43 – Cholinergic Modulation of Spontaneous Cortical Oscillatory Activity and Domain-specific Behavior: A Pharmaco-MEG Study.
Rachel K. Spooner, Hannah Kurtenbach, Monja Froböse, Eduard Ort, Markus Butz, Gerhard Jocham, Esther Florin, Heinrich Heine University, United Kingdom.

1.44 – Altered neural tracking of continuous speech in cochlear-implanted children.
Alessandra Federici, Marta Fantoni, Evgenia Bednaya, Francesco Pavani, Alice Martinelli, Martina Berto, Giacomo Handjaras, Emiliano Ricciardi, Elena Nava, Eva Orzan, Benedetta Bianchi, Davide Bottari, IMT School for Advanced Studies Lucca, Italy.

1.45 – Vision through cortico-ocular coupling.
Tzvetan Popov, Jan-Mathijs Schoffelen, University of Zurich, Switzerland.

See pg48 for poster abstracts

Poster Session 2

Day 2 poster presenters are required to remove their posters immediately after the session ends as the poster boards will be taken down from 3pm onwards.

2.01 – A stimulus-computable model of beta oscillatory responses to speech
Christoph Daube, Joachim Gross, Robin A. A. Ince, University of Glasgow, United Kingdom.

2.02 – Mapping Neural Activity During Naturalistic Visual and Memory Search
Matias Ison, Joaquin Gonzalez, Anthony Ries, Juan Kamienkowski, University of Nottingham, U.S. Army Research Laboratory, University of Buenos Aires.

2.03 – Behavioural and neurophysiological underpinnings of complex bimanual motor learning
Catharina Zich, Marleen J Schoenfeld, Carl Lindersson, Charlotte J Stagg, University College London, United Kingdom.

2.04 – Neural representation strength of predicted category features biases decision behavior
Yuening Yan, Jiayu Zhan, Oliver Garrod, Xuan Cui, Robin A.A. Ince, Philippe G. Schyns, University of Glasgow, United Kingdom.

2.05 – Living in a World of "Close Enough": Apathy and the Bayesian Brain
Rebecca S Williams, Michelle Naessens, Amir Jafarian, Frank Hezemans, Laura Hughes, James B Rowe, University of Cambridge, United Kingdom.

2.06 – There's life in that old MEG yet: Depth electrode-like laminar source reconstruction with high precision MEG.
Maciej J Szul, Suvadeep Maiti, Ishita Agarval, Siqi Zhang, Gareth R Barnes, Sven Bestmann, James J Bonaiuto, Institut des Sciences Cognitives, CNRS, France.

2.07 – Multi-scale parameterization of periodic neural activity with lagged Hilbert coherence
Siqi Zhang, Maciej J Szul, Sotirios Papadopoulos, James J Bonaiuto, Université Claude Bernard Lyon, Université de Lyon, CNRS, France.

2.08 – "What" and "when" predictions jointly modulate speech processing
Ryszard Auksztulewicz, Ozan Ödül, Saskia Helbling, Ana Böke, Drew Cappotto, Luo Dan, Jan Schnupp, David Poeppel, Lucia Melloni, Freie Universität Berlin, Germany.

2.09 – Corticomuscular connectivity in amyotrophic lateral sclerosis
Katie Yoganathan, Michael Trubshaw, Irene Echeverria-Altuna, Oliver Kohl, Thanuja Dharmadasa, Nahid Zokaei, Andreas Themistocleous, Charlotte Stagg, Mark Woolrich, Anna C Nobre, Kevin Talbot, Alexander G. Thompson, Martin R. Turner, University of Oxford, United Kingdom.

2.10 – Effects of remifentanil and midazolam on processing auditory stimuli
Elena Stylianopoulou, Sharmila Khot, Gavin Perry, Rasha Hyder, Neeraj Saxena, Krish D. Singh, Cardiff University, United Kingdom.

2.11 – Relating attention deficits to the neural basis of attention during tasks
Ashley C. Goneso, Jan Novak, Caroline Witton, Johanna M. Zumer, Aston University, United Kingdom.

2.12 – Co-varying eye movements and power modulations of alpha oscillations during working memory: a pilot study
Arne D Hansen, Dawid Strzelczyk, Lea Z M Bächlin, Nicolas Langer, Tzvetan Popov, University of Zurich, Switzerland.

2.13 – The resting-state cortical signature of amyotrophic lateral sclerosis
Michael Trubshaw, Chetan Gohil, Katie Yoganathan, Oliver Kohl, Evan Edmond, Malcolm Proudfoot, Alexander G Thompson, Kevin Talbot, Charlotte Stagg, Anna C Nobre, Mark Woolrich, Martin R Turner, University of Oxford, United Kingdom.

2.14 – Investigating Foveal and Parafoveal Object-Categorization in Visual Exploration
Camille Fakche, Ole Jensen, University of Birmingham, United Kingdom.

2.15 – Network-level properties that underlie neural synchronisation in the acute psychedelic state
Kenneth Shinozuka, Joana Cabral, Francesca Castaldo, Robin Carhart-Harris, Morten Kringelbach, University of Oxford, United Kingdom.

2.16 – Investigating Gamma Oscillations in Children with Autism Spectrum Disorders during Visuomotor Processing
Kyung-min An, University of Birmingham, United Kingdom.

2.17 – Burst Characteristics of Oscillatory Rebounds following Working Memory and Movement
Sebastian C. Coleman, Zelekha A. Seedat, Daisie O. Pakenham, Andrew J. Quinn, Matthew J. Brookes, Mark W. Woolrich, Karen J. Mullinger, University of Nottingham, United Kingdom.

2.18 – Comparison of resting-state EEG and MEG in detecting the effects of healthy aging
SungJun Cho, Mats van Es, Chetan Gohil, Mark W Woolrich, University of Oxford, United Kingdom.

2.19 – Task-induced changes in 1/f slope of aperiodic activity
Fahimeh Akbarian, Chiara Rossi, Miguel D'haeseleer, Marie B D'hooghe, Guy Nagels, Jeroen Van Schependom, Vrije Universiteit Brussel, Belgium.

2.20 – Beta desynchronisation and movement pre-ordering during sequence planning in individuals with dyspraxia/DCD
Helena Wright, Katja Kornysheva, University of Birmingham, United Kingdom.

See pg51 for poster abstracts

Poster Session 2

2.21 – MEGqc – an automated and standardized quality control workflow for MEG BIDS data
Aaron Reer, Evgeniia Gapontseva, Jochem W. Rieger, University of Oldenburg, Germany.

2.22 – Critical-like bistable dynamics characterize Alzheimer's disease progression
Ehtasham Javed, Sheng H Wang, Isabel Suárez-Méndez, Gianluca Susi, Matias Palva, Fernando Maestú, Satu Palva, University of Helsinki, Finland.

2.23 – MEG resting-state coupling co-varies with neurotransmitter receptor and transporter density
Felix Siebenhühner, J. Matias Palva, Satu Palva, University of Helsinki, Finland.

2.24 – Practice-induced reductions in Gamma power in Response to Proper Name Anomia Therapy in people with dementia: An MEG Study
Aygun Badalova, Tae Twomey, George O'Neill, Alex Leff, University College London, United Kingdom.

2.25 – Oscillatory dynamics of spoken language production
Haya Akkad, Daniel Bush, Tae Twomey, Robert Seymour, Susanne Pelke, Sasha Ondoobaka, Sven Bestmann, Jenny Crinion, University College London, United Kingdom.

2.26 – Predicting individual traits from models of brain dynamics using the Fisher kernel
Christine Ahrends, Mark Woolrich, Diego Vidaurre, Aarhus University, Denmark.

2.27 – Stacking models of brain dynamics improves prediction of subject traits
Ben Griffin, Christine Ahrends, Mark Woolrich, Stephen Smith, Diego Vidaurre, University of Oxford, United Kingdom.

2.28 – Stability of dynamic FC estimates in neuroimaging and electrophysiology
Sonsoles Alonso, Diego Vidaurre, Aarhus University, Denmark.

2.29 – What drives a hidden Markov model decomposition of brain data?
Laura Masaracchia, Diego Vidaurre, Aarhus University, Denmark.

***2.30 – An adversarial collaboration to critically evaluate theories of consciousness: activation and synchronisation in MEG**
Oscar Ferrante, Ole Jensen, Ling Liu, Huan Luo, COGITATE Consortium, University of Birmingham, United Kingdom.

2.31 – Variability in visual processing owes to cognitive context but is largely stable across time
Laura B Paulsen, Christine Ahrends, Laura Masaracchia, Francesca Fardo, Diego Vidaurre, Aarhus University, Denmark.

2.32 – Altered Cortical Microstates in 22q11 Deletion Syndrome
Luke Tait, Joanne Doherty, Marianne van den Bree, David Linden, Michael Owen, Krish D Singh, Cardiff University, United Kingdom.

2.33 – Predicting subject traits from M/EEG spectrograms using kernel mean embedding
Cecilia Jarne, Ben Griffin, Diego Vidaurre, Aarhus University, Denmark.

2.34 – "Transforming" the neuroscience of language: Estimating pattern-to-pattern transformations of brain activity
Olaf Hauk, Rebecca L Jackson, Setareh Rahimi, University of Cambridge, United Kingdom.

2.35 – Modulation of Subthalamic Deep Brain Stimulation-Induced Cortical Responses and Motor Function Based on the Directionality and Magnitude of Current Administration
Rachel K. Spooner, Baccara Hizli, Bahne H. Bahners, Alfons Schnitzler, Esther Florin, Heinrich-Heine University Düsseldorf, Germany.

2.36 – Cross-site comparison of visual gamma oscillations using OPM-MEG
Natalie Rhodes, Julie Sato, Marlee Vandewouw, Lukas Rier, Elena Boto, Ryan Hill, Kristina Safar, Margot J. Taylor, Matthew J. Brookes, University of Nottingham, United Kingdom.

2.37 – Investigating the neural encoding of melodic expectations in polyphonic music
Martin M. Winchester, Charbel Nebo, Kevin Reynolds, Giovanni M. Di Liberto, Trinity College Dublin, Ireland.

2.38 – Attentional modulation of beta band power in the motor cortex
Gonzalo Reina, Elena Boto, Ryan M. Hill, Niall Holmes, Lucrezia Liuzzi, Natalie Rhodes, Molly Rea, Richard Bowtell, Matthew J Brookes, University of Nottingham, United Kingdom.

2.39 – Two distinct neural representations of confidence in categorization of a natural image
Xuan Cui, Yaocong Duan, Yuening Yan, Christopher Benwell, Robin Ince, Philippe Schyns, University of Glasgow, United Kingdom.

2.40 – The MEG & MOG study: Understanding the effect of autoantibodies to myelin oligodendrocyte glycoprotein (MOG) in pediatric acquired demyelinating disease using Magnetoencephalography (MEG)
Daniel Griffiths-King, Charly Billaud, Amanda G. Wood, Evangeline Wassmer, Sukhvir Wright, Elaine Foley, Aston University, United Kingdom.

2.41 – Detection of fetal biomagnetic signals using optically pumped magnetometers
Isabel Gale, Lauren Gascoyne, Ryan Hill, Elena Boto, Niall Holmes, Nia Jones, Vishal Shah, Penny Gowland, Matthew Brookes, University of Nottingham, United Kingdom.

***Poster Prize winner, see pg62 for poster abstracts**

Poster Session 2

2.42 – The effect of Alzheimer's disease on pyramidal cells
Juliette H Lanskey, Amirhossein Jafarian, Melek Karadag, Ece Kocagoncu, Andrew J Quinn, Jemma Pitt, Ana Klimovich-Gray, Vanessa Raymont, Krish D Singh, Mark Woolrich Anna C Nobre, Richard N Henson, James B Rowe, University of Cambrigde, United Kingdom.

***2.43 – Reaching to Understand the Neural Correlates of Tremor Variability During Naturalistic Movement: A High-Density Neuroimaging Study in Essential Tremor Patients**
Timothy O. West, Kenan Steidel, Tjalda Flessner, Marielle J. Stam, Deniz Kucukahmetler, Meaghan Spedden, Ryan Timms, Tabish Saifee, Simon Farmer, Gareth Barnes, David Pedrosa, Hayriye Cagnan, University of Oxford, United Kingdom.

2.44 – Using the Hurst exponent to reveal changes in brain activity following mild traumatic brain injury
Alice E Waitt, Iman Idree, Waheeda Hawa, Kirandeep Kaur, Gerard Gooding-Williams, Sergey Sergeyev, Paul L. Furlon, Caroline Witton, Aston University.

2.45 – On the similarities of representations in artificial and brain neural networks for speech recognition
Li Su, University of Cambridge, University of Sheffield.

2.46 – Solving large-scale MEG/EEG source localisation and functional connectivity problems simultaneously using state-space models
Jose Sanchez-Bornot, Roberto C. Sotero, J. A. Scott Kelso, Özgür Şimşek, Damien Coyle, Ulster University.

***Poster Prize winner, see pg74 for poster abstracts**

Poster Abstracts

* indicates poster prize winner.

Session 1, Friday October 27th

1.01 – The influence of prestimulus phase on temporal integration.
Michelle Johannknecht, Joachim Lange, Heinrich Heine University of Düsseldorf, Germany.

While we perceive our world as continuous, the human perceptual system is limited in processing incoming information. We will see discrete picture as continuous, if the presentation time between pictures is short enough. The neural mechanisms of temporal perception, however, are not well understood. A candidate mechanism are alpha oscillations. Alpha oscillations have been shown to correlate with visual perception. Using near threshold stimuli, results suggest an influence of prestimulus alpha phase and our detection ability.

In this study, we investigated how prestimulus alpha oscillations influence visual temporal perception. Specifically, we were interested whether prestimulus alpha phase influences behavioural accuracy and shapes integration windows and/or modulates perceptual processes. In an MEG study, participants had to integrate two visual stimuli, separated by a stimulus onset asynchrony, and report the position of a missing element. Source reconstruction was used to evaluate the location of phase effects by calculating the quantitative difference between phase angles values of correctly and incorrectly integrated trials.

We found a cluster between -0.8 and -0.5 s (relative to stimulus presentation) and between 8-20 Hz in parieto-occipital regions in which phases differed between correct and incorrect perceptions. Additionally, behavioural performance decreased when deviating from the participants' individually preferred phase. We also found a correlation between early event related components (N100) and phase. Again, the amplitude of the N100 decreased when deviating from the subject specific preferred phase. In contrast, we found no evidence that prestimulus phase modulates temporal integration windows. We conclude that, that stimulus processes is optimal at a certain phase and therefore results in increased behavioural performance.

1.02 – Modulating Somatosensory Alpha Oscillations Using Short-period Transcranial Alternating Current Stimulation.
Vaishali Balaji, Joachim Lange, Heinrich Heine University of Düsseldorf, Germany.

Transcranial Alternating Current Stimulation (tACS) is a non-invasive brain stimulation technique in which alternating sinusoidal currents are applied to the scalp. In turn, the electric field generated by the stimulation is presumed to entrain endogenous brain oscillations in a frequency-specific manner. Some studies report that applying tACS at alpha frequencies induce changes that persist beyond the stimulation period. However, there is no consensus on the ideal stimulation protocol to elicit long-lasting aftereffects. Stimulation parameters such as frequency, intensity and duration of applied current, and electrode montage differ widely between studies, thereby leading to several contradictory results. The origin of the aftereffects of stimulation also remains a matter of contention as tACS effects may be mediated by transcutaneous stimulation of peripheral nerves. In this study, we aimed to elucidate paradoxical reports by modulating alpha power in the right somatosensory cortex while controlling for peripheral nerve stimulation. We were interested in testing whether comparably short periods of tACS are able to entrain neuronal oscillations. To this end, during simultaneous acquisition of MEG, we administered tACS at individual alpha frequency in an intermittent on/off pattern. tACS was applied in 10 or 30 second trains in two separate blocks. Changes in alpha power in the post-stimulation intervals were

compared to resting-state baseline as well as sham. The results show focal enhancements of alpha power at stimulation frequency relative to baseline, and this power modulation was more substantial than sham. These findings provide evidence for direct transcranial modulation of alpha power in the somatosensory cortex and point to the importance of combining tACS with electrophysiological recordings to probe the causal role of alpha oscillations.

1.03 – How do focal brain lesions affect information coding during spatial and feature-selective attention? A case series.
Nadene Dermody, Elizabeth Michael, Olaf Hauk, Polly Peers, Romy Lorenz, University of Cambridge, United Kingdom.

Background: Our previous fMRI work showed that a frontoparietal network posited to play a critical role in attentional control (the multiple-demand, MD, network) selectively codes information at the intersection of spatial and feature attention. Further, our MEG work showed this tuning arises first in higher-order brain regions, which in turn Granger-causally influence coding in visual cortex. We thus propose that the highly selective task- relevant representations of MD regions act as a source of bias, directing task-related representations to be similarly precise in domain-specific regions. Using an exploratory case series approach, we ask how and when this selective prioritisation changes after damage to the MD system.

Methods: We recruited six patients with unilateral, primarily parietal, chronic lesions of mixed aetiology (three male, three female; three left, three right hemisphere; age range: 55 to 75), and ten age-, sex- and education- matched controls (six male, four female; age range: 53 to 76). Participants covertly attended to one of two objects, presented left and right of a fixation cross (spatial attention), and reported the attended object's colour ("red" or "green") or shape ("X-shaped" or "flat") (feature attention) via button press while MEG data were recorded. Attention was also assessed behaviourally using standard neuropsychological tests. In ongoing analyses, we are using multivariate pattern analysis in sensor and volumetric source space to quantify the dynamic representation of attended and unattended stimulus information.

Objectives: We aim to examine whether chronic parietal lesions, typically associated with subtle spatial attention deficits, affect the specificity and/or timecourse of task-related representations. Moreover, we will explore whether task-related coding in patients relates to performance on behavioural measures of attentional bias. Through this work, we aim to elucidate how attentional prioritisation is achieved after brain damage.

1.04 – Computational modelling of age-related delays in audiovisual sensory information processing using MEG.
Pranay S. Yadav, Rik Henson, University of Cambridge, United Kingdom.

Cognitive ageing in humans is marked by declines in vision and hearing, and manifest as delays in sensory-evoked potentials, likely reflecting a general slowing of information processing with age. There has been evidence that different mechanisms may drive age-related delays in distinct ways—for instance, visual-evoked responses are marked by a constant delay—suggesting reduction in transmission mediated by white matter tracts; while auditory-evoked responses are marked by a delay that accumulates over time—likely mediated by deficits in local processing in grey matter [1].

In the proposed study, we investigate the causal role of these mechanisms underlying age-related delays in visual and auditory evoked responses using dynamic causal modelling (DCM) of magnetoencephalography (MEG) data from a large (N=630) healthy population-derived sample from the Cambridge Centre for Ageing & Neuroscience (Cam-CAN) [2]. Data was acquired during an audiovisual task in which participants passively experienced 120 trials with either a visual stimulus consisting of two circular checkerboards, or binaural auditory tone.

We apply DCM to model evoked responses for the visual and audio trial from MEG data [3]. We model the extrastriate and primary auditory cortices as generators of visual and auditory evoked responses respectively. We hypothesize that age-related delays in transmission will result in reduced strength of inputs to the generators, while age-related deficits in local processing will result in reduced strength of intrinsic connections in the generators. We test these predictions using Bayesian model comparison within the Parametric Empirical Bayes (PEB) framework. Our findings will help elucidate the different neural mechanisms that could result in distinct age-related delays in different sensory systems.

Ref: 1. D. Price et al, Nat Commun. 8, 15671 (2017)
2. J. R. Taylor et al, NeuroImage. 144, 262–269 (2017)
3. O. David et al, NeuroImage. 30, 1255–1272 (2006)

1.05 – Combining video telemetry and wearable MEG for naturalistic imaging.

George O'Neill, Robert Seymour, Stephanie Mellor, Nicholas Alexander, Tim Tierney, Meaghan Spedden, Ryan Timms, Sven Bestmann, Gareth Barnes, University College London, United Kingdom.

Background: MEG studies typically rely on simple or abstract experiments to carefully probe cognition. Whilst powerful, these paradigms do not resemble how we use these faculties in everyday life, and so we need experiments which closer reflect the real world, rather than the laboratory. With the advent of MEG systems which are both wearable and allow the subject to around move freely, MEG is in a unique position generate high-quality data from complex paradigms.

Aim: To derive the organization of the motor cortex from spontaneous human movement.

Methods: 4 participants underwent 2 experiments; the first a simple block design experiment where a participant was visually cued to move one of their 4 limbs, and a second where they danced to an audio recording the "Hokey Cokey". All participants wore custom-fitting helmets containing an array of multi-axis optically pumped magnetometers (OPMs) and underwent simultaneous recordings of MEG and video of them performing the experiments. The video was processed with a deep-learning framework to extract key points (wrist, elbow, etc.) from the body and key point velocities were partitioned with a hidden Markov model to detect states of movement.

Results: Hidden Markov Model states corresponding to the 4 limbs were recovered from the video in both experiments. In the block design motor experiment, the video states closely matched stimulus timings (AUC: 0.912). Source reconstruction of beta-band activity based on either the block design timings and video-derived timings showed similar spatial organisation, with the video-derived timings generating higher magnitude statistical images. States derived from the dancing paradigm and their associated cortical maps also closely resemble the cortical homunculus.

Conclusion: We can partition and analyse MEG data to recover motor function based on video-derived subject behaviour, opening the possibility of more complex naturalistic studies in the future.

1.06 – Oscillatory dynamics of spoken language production

Haya Akkad, Daniel Bush, Tae Twomey, Robert Seymour, Susanne Pelke, Sasha Ondoobaka, Sven Bestmann, Jenny Crinion, University College London, United Kingdom.

Background
Theta-gamma phase-amplitude coupling (PAC) is thought to be an important brain mechanism

that allows coordination of neural activity within and between distinct cortical regions to control behaviour. Here, we investigated oscillatory dynamics in the spoken language network, with a focus on theta-gamma PAC.

Aim
How do principle neurophysiological mechanisms support language functioning. Methods 27 healthy older adults (≥50 years) completed an overt picture naming task during an MEG scan. Stimuli consisted of black and white line drawings of objects randomised to a clear (naming) or scrambled (control) condition. Stimuli were presented on the screen for 2s, preceded by a 2.5s fixation period. Participants were instructed to name clear stimuli and respond 'no' when scrambled stimuli appeared. The scrambled condition controlled for low-level visual input and overt speech output but did not involve lexical retrieval processes. MEG analyses were conducted using SPM12 on response-locked epochs. Sources of oscillatory activity were reconstructed using an LCMV beamformer and contrasted between naming and control conditions at a statistical threshold of FWE-c $p< 0.05$ at voxel level. Theta-gamma PAC was estimated using KL divergence (Tort et al., 2010). Cluster-based-permutation testing was used to assess PAC differences between conditions.

Results
Picture naming, relative to control, induced theta (4-6Hz) synchronisation followed by an alpha-beta (8–20Hz) desynchronization during word retrieval. Theta activity localised to left superior and inferior frontal gyri and left superior and medial temporal gyri. These same regions also showed significant theta-gamma PAC that was only present during naming.

Discussion
Theta-gamma PAC appears to facilitate functional integration between frontal and temporal regions of the language network during spoken naming. Future work will explore whether theta-gamma PAC is altered in aphasia and if it can be modulated to improve anomia.

1.07 – Investigating the neural tracking of dialogue.
Emily Y.J Ip, Benjamin R. Cowan, and Giovanni M. Di Liberto, Trinity College Dublin, Ireland.

Speech communication is a fundamental aspect of human experience, enabling us to express thoughts and emotions. This study investigates the possibility of measuring the neural processes underlying social speech perception with electroencephalography (EEG). Past research has contributed significantly to our understanding of how speech is transformed into meaning by our brain. While previous work typically relied on simplified speech listening tasks, such as listening to sequences of isolated syllables, recent developments have shifted towards employing more naturalistic paradigms in ecologically-valid settings: the perception of continuous speech. In particular, EEG and magnetoencephalography demonstrated a robust relationship between speech inputs and the corresponding neural signal. This enabled researchers to probe the neural encoding of speech and language properties at various levels of abstraction. However, that work focused on how the human brain processes speech monologues, either in quiet or in noise, while ignoring one of the foundational roles of speech: social communication. Here we present an EEG experiment where we take the first step in that direction. Participants were presented with a dialogue between two interlocutors from conversations in a podcast-style setting. The multivariate Temporal Response Function (mTRF) methodology was used to measure the EEG encoding of the sound envelope and lexical predictions. We will present results supporting the hypothesis that the analytical mTRF framework for studying monologue listening also applies to third- person perception of dialogues. This social scenario presents challenges that have yet to be addressed in the literature, such as the adaptation of speech and language for their use in social contexts. We will discuss how the outcomes of this study could render a novel avenue for speech neurophysiology, enabling the investigation of social communication in more realistic scenarios involving natural speech listening.

1.08 – Whole-head simultaneous EEG and OPM-MEG.

Zelekha A Seedat, Kelly St. Pier, Niall Holmes, Molly Rea, Elena Boto, Layla Al-Hilaly, Matthew J Brookes, J Helen Cross, University of Nottingham, Young Epilepsy, Cerca Magnetics Limited, University College London, United Kingdom.

Background
Optically-pumped magnetometers (OPMs) promise to make MEG technology more clinically accessible, particularly for epilepsy evaluation. However, it is critical that this new technology is validated against the current clinical standard – EEG. Here, we use a 128-channel OPM-MEG system (Cerca Magnetics Ltd) and a whole-head 64-channel EEG (Brain Vision LLC, NC, USA), to test the feasibility of simultaneous OPM-MEG and EEG measurements.

Methods
12 healthy adults (mean age 41 ± 13yrs, 8 female), undertook a right index finger abduction task (50 trials) and an eyes open/eyes closed task (5 trials). Tasks were completed 3 times: with simultaneous EEG/MEG, EEG only, and MEG only, allowing comparison of MEG signal quality in the presence of EEG and vice versa. Before each scanning session, the remnant magnetic field was nulled by combining optical tracking (OptiTrack, NaturalPoint Inc., USA) with magnetometer data from sensors in the helmet (Rea et al., 2021).

Results
For MEG and EEG at the sensor level, there is a clear increase in alpha with eyes closed in comparison with eyes open. For the finger abduction task, trials were time locked to the point of movement offset and averaged over trials for each participant, revealing a task-modulated beta response in EEG and MEG. The sensor with the highest SNR was selected separately for each participant and the SNR was calculated for EEG alone, MEG alone, and each in the presence of the other. There was no significant difference in the SNR of MEG signals with and without EEG ($p=0.4$) or EEG with and without MEG ($p=0.5$). The presence of EEG also did not affect the quality of residual field nulling.

Conclusion
It is possible to measure whole-head EEG and OPM-MEG together with good quality data. This paves the way for future clinical assessment of patients with epilepsy using the two modalities combined.

1.09 – Identifying a shared source of age-related decline in working memory and decision-making.

Jade S. Duffy, Hannah McDermott, Robert Whelan, Redmond G. O'Connell, Peter R. Murphy, Trinity College Dublin, Ireland.

Background: As population ageing continues to surge globally, a major imperative exists to identify mechanisms of cognitive decline associated with aging. Working memory (WM) and decision-making (DM) are fundamental building blocks of cognition that deteriorate with age. While these processes are typically studied in isolation, recent computational and empirical studies indicate that a common neural circuit configuration is capable of maintaining (for WM) and integrating (for DM) information over time through shared attractor dynamics, and that this circuit is subject to shared sources of noise and bias that shape both WM and DM behaviour.

Methods: The present study leveraged this emerging, consolidative framework for understanding WM and DM to interrogate sources of age-related decline in both functions. Young and older adults (N=33 in each group) completed psychophysical tasks designed to parse sources of shared and unique variance in WM and DM behaviour while high-density scalp EEG was recorded.

Results: Results from both modalities, informed by analyses of noise and bias in WM and DM

reports and decoding of task variables from EEG signals, converged to suggest a leading locus of age-related dysfunction – degraded sensory encoding – that gives rise to a specific pattern of decline across both domains.

Conclusions: These findings provide fundamental insights into the neural basis of these functions and their susceptibility to the deleterious effects of aging. More generally, we hope that the integrative approach to understanding WM and DM developed here will be of merit for pinpointing loci of dysfunction in mental disorders characterised by deficits in both functions.

1.10 – Structural disintegration and hypoexcitation in neurodegeneration via generative EEG whole-brain modeling.
Carlos Coronel-Oliveros, Raul Gonzalez-Gomez, Kamalini Ranasinghe, Agustin Sainz-Ballesteros, Agustina Legaz, Sol Fittipaldi, Josephine Cruzat, Rubén Herzog, Gorsev Yener, Mario Parra, David Aguillon, Francsisco Lopera, Hernando Santamaria-Garcia, Sebastián Moguilner, Vicente Medel, Patricio Orio, Robert Whelan, Enzo Tagliazucchi, Pavel Prado, Agustín Ibañez, Trinity College Dublin, Ireland.

Background: Alzheimer's disease (AD) and behavioral variant frontotemporal dementia (bvFTD) lack well-understood characterization in diverse, non-stereotypical, and underrepresented populations. Electroencephalography (EEG) is a high-resolution, cost-effective technique for studying dementia globally, but lacks mechanistic models and produce non-replicable results.

Methods: We developed a generative whole-brain model that combines EEG source-level metaconnectivity, anatomical priors, and a perturbational approach. This model was applied to Global South participants (AD, bvFTD, and healthy controls).

Results: Metaconnectivity outperformed pairwise connectivity and revealed more viscous dynamics in patients, with altered metaconnectivity patterns associated with multimodal disease progression. The biophysical model showed that connectome disintegration and hypoexcitability triggered the altered metaconnectivity dynamics, and identified critical regions for brain stimulation. We replicated main results in a second subset of participants for validation with unharmonized, heterogeneous recording settings.

Implications: The results provide a novel agenda for developing diagnostic methods and model-inspired therapies in clinical, translational, and computational neuroscience.

1.11 – Alpha-beta decoupling associated with inhibition deficits leads to suicide attempt in major depressive disorder.
Zhongpeng Dai, Wei Zhang, Li Xue, University of Birmingham, United Kingdom.

Background: Major depressive disorder (MDD) carries a significant risk of suicide, particularly among individuals with a history of suicide attempts (SA), which may be associated with deficits in inhibitory control. This study aimed to investigate the role of abnormal neuronal oscillations in the inhibitory function deficits observed in SA patients.

Methods: A total of 111 participants, including 74 MDD patients with SA and 37 controls, underwent magnetoencephalography recordings while performing a GO/NOGO task. Time-frequency representations and phase-amplitude coupling were analyzed for the brain circuits involved in inhibitory function. Phase-slope indexes were calculated to determine power flow direction between regions.

Results: The SA group exhibited significantly increased reaction time and decreased judgment accuracy compared to other groups. During the perception stage of the GO task (around 125 ms),

the SA group showed elevated alpha power in the ventral prefrontal cortex (VPFC) and reduced beta power in the dorsal anterior cingulate (dACC) compared to the other groups ($p < 0.01$). In the processing stage of the NOGO task (around 300 ms), the SA group displayed decreased beta power in the VPFC and increased alpha power in the dACC ($p < 0.01$). Alpha-beta decoupling was observed in the SA group during both tasks. Moreover, the decoupling from VPFC to dACC during the NOGO task significantly correlated with suicide risk level.

Conclusion: Our findings suggest that dysregulated oscillatory activities in the dACC and VPFC are associated with deficits in execution and inhibition functions, contributing to an increased risk of suicide in SA patients. The alpha-beta decoupling from the VPFC to the dACC holds promise as a neuro-electrophysiological biomarker for identifying individuals at potential suicide risk.

1.12 – The Effect of Task on Exemplar- and Category-level MEG Classifier Fidelity.
Adam J. Curtis, Akul Satish, Maria Wimber, Aidan J. Horner, University of York, United Kingdom.

Multivariate pattern classification (MVPC) plays an important role in many areas of cognitive research including visual perception and memory. Many studies begin with a classifier training task to acquire data that a classifier can be trained on before subsequently being applied to the main experimental data. Classification can occur at multiple levels of analysis, for example, at the category or the exemplar level. Here we ask whether the task used during classifier training and the level of analysis at which it requires participants to process visual stimuli can influence subsequent classifier fidelity. Participants performed three tasks during MEG: a category discrimination task, in which participants needed to focus on category level information, an exemplar discrimination task, in which the participants needed to focus on exemplar level information, and an oddball task, which acted as a baseline in which neither category nor exemplar level information were required. In each task participants were presented with exemplars from eight categories: faces, plants, dogs, insects, buildings, cars, tools, and furniture. We applied MVPC to the data to determine whether the level of processing required in each task could influence classifier fidelity when classifying the stimuli at either the category or the exemplar level. The results from this experiment will help to inform the field on how to best structure pre-experimental classifier training tasks so as to optimise MEG classification accuracy.

1.13 – Healthy ageing of static and dynamic networks in MEG.
Chetan Gohil, Andrew Quinn, Jemma Pitt, Mark Woolrich, University of Oxford, United Kingdom.

With an increasing proportion of elderly people, there is a pressing need to disambiguate between healthy and pathological ageing of the brain. Here, we examine the impact of healthy ageing on networks of oscillatory activity using resting-state MEG recordings from 612 participants (18-88 years old). We source reconstruct this data to 52 regions of interest and estimate static and dynamic networks (power spectra, spatial power maps and coherence networks). Dynamic (transient) networks are identified using a Time-Delay Embedded Hidden Markov Model (TDE-HMM). We observe clear trajectories for changes in oscillatory properties as a function of age. For static networks we see a slowing of occipital alpha (8-13 Hz) activity into the theta band (4-7 Hz), increase in temporal alpha activity, decrease in whole-brain delta (1-4 Hz) activity and increase in frontal and sensorimotor beta (13-22 Hz) activity. We see that the coherence of each frequency band can sometimes change in the opposite direction to power; e.g., there is an increase in whole-brain delta coherence with age. Underlying insights into the causes of these static changes can be found by looking at the dynamics of networks identified using the TDE-HMM. We find that significant differences between young and old participants can be seen in metrics that summarise the “activity” time courses of each dynamic network (e.g., lifetime, interval, fractional occupancy). In particular, the strongest effect is an increase in the lifetime of a temporal alpha state which explains the increase in static temporal alpha power. Additionally, we see a lower fractional occupancy of an occipital alpha state, which explains the

decrease in static occipital alpha with age. Understanding age-related changes to oscillatory activity is invaluable as a normative model. In this work, we characterise the expected functional networks at rest using a large population. These networks can be used as a basis set for smaller boutique studies.

1.14 – Enabling ambulatory movement in OPM-MEG with matrix coil active shielding.
Niall Holmes, Gonzalo Reina Rivero, Molly Rea, Ben Styles, Stephen Pink, James Chalmers, Peter J Hobson, James Leggett, Lucy J. Edwards, Ryan M. Hill, Elena Boto, Vishal Shah, David Woolger, T. Mark Fromhold, Matthew J. Brookes, Richard Bowtell, University of Nottingham, United Kingdom.

Background: Magnetoencephalography (MEG) systems based on optically pumped magnetometers (OPMs) typically employ large, external, electromagnetic coils for active magnetic shielding [1] as well as sensor benchmarking and calibration [2]. Whilst coil systems formed from distributed windings can be designed to produce accurate magnetic field patterns [3], they are difficult to manufacture, occupy space inside the magnetically shielded room (MSR) and only operate over fixed regions [4]. By contrast, matrix coil systems (formed from a series of small simple unit coils, each with an individually controlled current) can effectively 're-design' themselves to generate desired magnetic field patterns over multiple volumes [5].

Methods: Here we outline the construction, calibration and operation of a matrix coil system and its associated low-noise (<25 nV/√Hz@5Hz) coil drive system. Through the integration of the matrix coil with optical tracking with OPM data acquisition, field changes induced by participant movement are cancelled with low latency (25 ms).

Results: Beta-band modulation relating to a button pressing task was clearly observed in sensorimotor areas despite the presence of large (65 cm translations and 270° rotations) ambulatory participant movements during the recording.

Discussion: This work shows the capabilities of OPM-MEG to provide a platform for previously unrealisable studies of movement disorders, including Parkinson's disease and gait ataxia, and exciting neuroscientific studies of spatial navigation and social interaction.

References:
[1] Boto, E.; et al. Nature 2018, doi:10.1038/nature26147. [2] Iivanainen, J.; et al. Sensors 2022, doi:10.3390/s22083059. [3] Zetter, R.; et al. J. Appl. Phys. 2020, doi:10.1063/5.0016087. [4] Holmes, N.; et al. Neuroimage 2018, doi:10.1016/j.neuroimage.2018.07.028. [5] Holmes, N.; et al. Neuroimage 2023, doi:10.1016/j.neuroimage.2023.120157.

1.15 – Sensorimotor network dynamics in a paediatric cohort using OPM-MEG.
Lukas Rier, Natalie Rhodes, Daisie Pakenham, Ryan Hill, Elena Boto, Niall Holmes, Vishal Shah, Gonzalo Reina Rivero, Margot Taylor, Richard Bowtell, Matthew Brookes, University of Nottingham, United Kingdom.

Background: The adoption of MEG for clinical applications is partially hindered by its reliance on cryogenic sensors housed in non-life-span compliant, one-size-fits-all systems. Recently developed wearable systems using lightweight optically pumped magnetometers (OPMs) have shown promise, but the optimal design of paediatric OPM-MEG systems has not been established and normative paediatric OPM-MEG data is not widely available. We test the capability of a novel 186-channel OPM-MEG system to map the sensorimotor cortex, construct whole-brain functional connectomes in a paediatric cohort and compare results with data collected in adults.

Methods: MEG data were recorded in 26 children aged 2-13 years and 26 adults while they

watched television and received tactile stimulation from braille stimulators. In each trial, 0.5s of tactile stimulation to the tips of the index or little finger was followed by 3s rest. Participants wore a size-matched, rigid helmet populated with 63 triaxial OPM sensors to give whole-head coverage. The OPM-MEG system was housed in a magnetically shielded room with active magnetic field compensation. Pseudo-T statistical maps of activation for index- and little-finger trials were generated and time-courses of activity in 78 cortical regions were estimated using beamforming. Source modelling was achieved using template MRIs, warped to fit individual head shapes estimated using 3D structured light scans.

Results: We observed the expected changes in oscillatory power from finger-tip stimulation and sensorimotor and visual networks in both groups. Children exhibited lower task-induced modulation in the beta band and connectomes revealed age-related changes.

Conclusion: OPM-MEG is an exciting new platform to study neurodevelopmental trajectories in both health and disease with the capability to detect network dynamics in children.

1.16 – Internal States and Internal Models Dissociate Components of Motor Beta Oscillations.
Tom R., Marshall, Mengxi Wang, Emma L. Lawrance, Nils Kolling, Jill X.O'Reilly, Wellcome Centre for Integrative Neuroimaging, University of Oxford, University of Birmingham, Imperial College London, Université Lyon.

Background/Aims:
Agents can optimise behaviour by attributing undesired outcomes to different underlying causes, which require different actions: For example, a misjudgement (internal error), requires the alteration of an internal state to improve performance, e.g. slowing down to improve accuracy. Alternatively, a change in the world (external error), may require an agent to adjust their world model, e.g. learning new stimulus- response mappings. A candidate neural mechanism for integrating these distinct sources of error is sensorimotor beta oscillations, which consist of two components: A pre-movement desynchronisation, and a post-movement rebound.

Methods:
We combined EEG with a novel orientation judgement task where volunteers had to determine the direction of rotation of two gratings, one of which was associated with a reward. The absence of reward could be due to either a perceptual error (incorrect rotation direction) or a side error (volunteer reported the rotation of the unrewarded stimulus).

Results:
We show a cognitive double dissociation between beta desynchronization and rebound. Beta desynchronisation was associated specifically with residual reaction time; the degree to which a participants' response was faster or slower than predicted by the difficulty of the rotation task, i.e., an index of internal state regarding vigilance, attention etc. In contrast, beta rebound was specifically associated with proximity to a decision to switch sides, indicating that it may relate to a participants' internal model of the world and belief that that model needs updating.

Discussion/conclusions/implications:
The novel conclusion of this study is that beta desynchronisation and rebound are not merely 'two sides of the same coin'. Rather, they index two distinct cognitive processes by which an agent may integrate two distinct causes of an undesirable outcome, respectively, updating internal state or adjusting an internal model.

1.17 – Investigating the neurophysiology of speech perception: a novel assessment metric for linguistic expectations.

Amirhossein Chalehchaleh, Martin Winchester, Giovanni M. Di Liberto, Trinity College Dublin, Ireland.

Speech perception is an active process where our brains build expectations that are compared with the actual speech input. This phenomenon has been extensively studied with controlled experiments involving simplified listening tasks (e.g., single words, single sentences), indicating distinctive neural changes due to violations of linguistic expectations, such as lexical violations when hearing a word that is out of context. Recent work has demonstrated that the neural signature of that process can also be measured in response to continuous natural speech. Methodologies such as the multivariate temporal response function (TRF) enables the isolation of such prediction processes. Specifically, it was shown that neural signals co-vary with information such as semantic dissimilarity and lexical surprisal. This work is also relevant to the recent breakthroughs in large language models, as those precise and cohesive models of language (e.g., GPT) can be used for estimating expectations at multiple linguistic levels at once, which are then related with the neural signals. While previous TRF results showed significant relationships between neurophysiology recordings and such word-level information, the literature shows effects that are typically weak, leaving considerable uncertainty on whether the neural activity tracks that information only coarsely or at a fine-grained level, hampering the applicability of those metrics in basic and applied research. For example, given two possible models of lexical processing, could these measurements be used to determine which model is most physiologically plausible? In this study, we identified an improved TRF metric that is more sensitive to the effect of word-level information on neurophysiology signals. First, we present the new metric by showing its effectiveness on synthesised EEG data. Second, we will discuss how the new assessment metric performs on EEG and MEG responses to natural speech monologues.

1.18 – Modelling subject variability in MEG data with deep learning.

Rukuang Huang, Chetan Gohil, Mark Woolrich, University of Oxford, United Kingdom.

Background:
Accurate modelling of functional brain networks is essential in the quest for understanding how the brain produces cognition. With recent studies, data driven models like the Hidden Markov Model (HMM, Baker et al), Dynamic Network Modes (DyNeMo, Gohil et al) are getting more attention due to their ability to infer fast temporal dynamics in dynamic functional networks in an unsupervised manner. However, these dynamic network models are limited by only giving a group level description, e.g., of the brain regions and spectral content in each brain network. While it is possible to post-hoc estimate subject-specific estimates of these networks, using so-called dual-estimation, this does not allow for the model to discover and benefit from subject-wise structure in the population, e.g. sub-groupings of subjects.

Methods:
We propose an extension to the current approaches (HMM, DyNeMo) that incorporates subject embedding (analogous to word embedding in Natural Language processing) into the group model. This effectively infers a “fingerprint”for each subject, which can group together subjects with similar spectra/networks.

Results:
Using simulated data, we show that the approach can reliably recover the underlying population structure and infer subject-specific estimates more accurately than post-hoc dual-estimation. Results on real data show that the model can distinguish data from different datasets and subjects with different demographics.

Conclusion:
We propose an approach that models subject variability in a principled way and have shown its advantages over traditional post-hoc dual-estimation on simulated data. On real data, we show its

utility in uncovering underlying population structure. The more accurate subject-specific estimates can also benefit downstream prediction tasks.

1.19 – The effect of age on neuronal power spectra.
Andrew J Quinn, Jemma Pitt, Chetan Gohill, Anna Christina Nobre, Mark Woolrich, University of Birmingham, United Kingdom.

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/EEG datasets and explore the extent to which they are robust to differences in physiology, acquisition and recording modality.

Methods:
We analyse sensor space power spectra using a temporal General Linear Model (GLM) to estimate a power spectrum at the individual subject level, by using the output from a sliding window Fourier Transform at each frequency separately as the dependent variable while controlling for covariates such as blinking and scan duration at the individual subject level. A group GLM then then models between- subject factors such as head-size, sex, acquisition site and age affect the power spectrum.

Results:
A consistent set of age-effects are found. Ageing is associated with decreased low frequency power , increased low alpha power, decreased high alpha power and increased beta power. These effects are robust across different datasets, sensor types, MEG systems, and source reconstruction. The two alpha effects constitute a slowing of alpha peak frequency which is accompanied by a spatial shift from a strong peak in occipital pole in young adults to a more diffuse occipital/parietal/temporal distribution in older adults.

Discussion:
The effect of ageing in neuronal power spectra across healthy ageing is robust and reproducible at the group level.

***1.20 – Cyclical evolution of functional brain networks in rest.**
Mats WJ van Es, Cameron Higgins, Chetan Gohil, Diego Vidaurre, Andrew J Quinn, Mark W Woolrich, University of Oxford, United Kingdom.

Aim
Brain activity contains recurrent oscillatory activity in large scale cortical networks, but their temporal evolution is unclear. Our study introduces a new method for analyzing the long-term dynamics of these states and demonstrate that there is a tendency for the brain to cycle through the states in a particular order.

Methods
We used hidden Markov modelling to identify 12 network states from three large MEG datasets (MEGUK, CamCAN, HCP), and studied their temporal dynamics via a new method called Temporal Interval Network Density Analysis (TINDA). TINDA computes a measure for each pair of states indicating how much a state occurs in the first, versus the second, half of the time between subsequent visits to another state. This indicates if there is a tendency for a state to follow, or precede, another state over long time-scales. We then globally organize the states into a circle such that we minimize violations of the pairwise ordering learnt by TINDA.

Results

Applying TINDA to the MEGUK resting MEG data, we found unique pairwise state orderings for each network state. Globally ordering the states revealed an unmistakable cyclical pattern with the brain moving through network states in a consistent direction. The strength of the cycling was stronger than expected by chance, especially for longer intervals. We replicated these results in the CamCAN and HCP datasets and showed that cycle strength and cycle rate are related to age/sex, and cycle rate is heritable. Moreover, the cycle's phase incorporated the resting states' spatio-spectral features, progressing from high power/synchrony states to low frequency cognitive states, low power/synchrony states, and finally high frequency perceptual/attentional states.

Conclusion
We have developed a new method to study temporal dynamics in brain networks and revealed an intrinsically cyclical organization of network activity, which was replicated in three datasets and is predictive of personal traits.

1.21 – Hemispheric asymmetry during attentional control: Is the right hemisphere dominant? Hemispheric asymmetry during attentional control: Is the right hemisphere dominant?.
Gabriela Cruz, Maria Melcon, Satu Palva, Gregor Thut, University of Glasgow, United Kingdom.

Background/Aims:
The striking right-hemisphere dominance of neglect, plus observations of pseudo-neglect in healthy population (leftward attention in line bisection), support the widely accepted view that the right hemisphere of the brain is dominant for spatial attention. However, regions in the right hemisphere that cause neglect overlap with the ventral attention system – which activates for involuntary/ exogenous attention, and brain damage to regions that are part of the dorsal attention network– involved in the voluntary control of attention – do not produce neglect. Furthermore, brain stimulation to left parieto-occipital areas (not only right brain areas) have shown to modulate attention shifts. Even though the general dominance of the right hemisphere in attentional processes cannot be dismissed, evidence for its dominance in the voluntary control of spatial attention is scarce. Therefore, the question still stands: Is the right hemisphere dominant for spatial attention also when voluntarily controlled?

Methods: 32 participants undertook an attention-shift task with concurrent Magneto- and Electro-encephalogram recordings. Our experimental conditions control for general attentional processes, isolating the spatial component. We analyse individual hemispheric contribution to control of spatial attention at sensor and source-level.

Results:
We hypothesise that attentional control for spatial orienting arises from symmetric interhemispheric interaction.
Discussion:
This study will present results at sensor and source level, using complementary EEG and MEG data, relying on changes in alpha-amplitude as a reliable measure of hemispheric engagement during spatial attention deployment. We look to discuss our results in light of past literature on alpha-modulation that has used diverse experimental designs, to provide an answer to the question if the right hemisphere is dominant during voluntarily controlled spatial attention.

1.22 – Inferring EOG signal from Video.
Peter Redmond, Mohammad Ahsan Awais, and Tomás Ward, Dublin, City University, Ireland.

Background/Aims:
Electrooculography (EOG) and Electroencephalography (EEG) are integral to neurophysiological research and diagnostics. However, the presence of EOG artefacts in EEG data can complicate

data interpretation. This research aimed to develop a computer vision-based system, using OpenCV, for non-invasive EOG data inference from video, and to explore its potential in enhancing EEG data interpretation.

Methods:
OpenCV was leveraged to track eye movements from video data and to infer corresponding EOG signals. This system was then extensively tested for accuracy and reliability against traditional EOG data. Further, the inferred EOG signals were integrated with EEG data for improved interpretation. The procedure involved identifying EEG artefacts related to eye movements, annotating these periods in the EEG data, and exploring the enriched understanding of brain activity patterns.

Results:
The developed system demonstrated strong agreement with traditional EOG data despite minor limitations related to resolution and precision. The application of inferred EOG signals to EEG data resulted in the enhanced understanding of brain activity, improved artifact identification, and EEG data annotation.

Discussion/Conclusions/Implications:
This research presents a promising approach for non-invasive, comfortable EOG data acquisition, and potential improvement in EEG data interpretation. It has significant implications for neuroscience, biomedical signal processing, and human-computer interaction. Future research can further optimize this system, extend its application to other types of artifacts, and explore automatic artifact tagging and removal.

1.23 – Covariate shift analysis and single-trial classification of MEG motor imagery data.
Haider Raza, Sanjeev Nara, Minerva Sarma, Charles Bond, University of Essex, United Kingdom.

Background:
Magnetoencephalography (MEG) is a non-invasive neuroimaging technique that measures the magnetic fields generated by neuronal electrical activity in the brain. MEG provides high temporal resolution and has become a valuable tool in neuroscience and clinical research. One of the challenges in analyzing MEG data is the non-stationarity of brain signals. The brain's activity fluctuates over time, making it difficult to assume that the statistical properties of the data remain constant throughout the recording. Non-stationarity can arise from various factors, including changes in attention, arousal, or task demands. Dealing with non-stationarity is crucial for the accurate interpretation of MEG data. Researchers employ various strategies such as segmenting the MEG data into smaller time intervals, applying adaptive filtering, and time-frequency analysis for feature extraction.

Method:
In this work, we have analysed non-stationarity (i.e. covariate shift) on the publically available MEG data acquired from 17 healthy subjects and developed MEGNet for single-trial classification to decode or classify brain states or cognitive processes from individual trials of MEG data. MEGNet network is inspired by EEGNet (a deep learning-based architecture), which helps to avoid doing manual feature extraction and lets the network learn the hidden pattern in the data for pair-wise binary classification. Robust single-trial classification can be useful in various applications, including brain-computer interfaces (BCI), cognitive load estimation, and clinical diagnosis.

Result:
We got 69% accuracy H-W (i.e. hand vs word) class pair.

Discussion:
MEG is a powerful neuroimaging technique that enables the study of brain activity with high

temporal resolution. However, the non-stationarity of brain signals poses challenges in data analysis. By employing appropriate methods to address non-stationarity and using deep learning we can adapt to these non-stationary changes.

1.24 – Retrieval of virtual naturalistic experiences during OPM-based MEG.
Robert A. Seymour, Nicholas Alexander, Yan Wu, Eleanor A. Maguire, University College London, United Kingdom.

Recalling our past experiences, autobiographical memories, is a reconstructive process that involves many cognitive skills. Previous research has implicated a set of brain regions in autobiographical memory retrieval, including the hippocampus and medial prefrontal cortex (mPFC). Here we investigated whether a similar network of brain areas was involved in the retrieval of memories that were formed in a naturalistic virtual reality (VR) environment. Specifically, we created a VR town through which participants (N=12; 6 female; aged 23-34) virtually navigated using a walk-in-place method, within the confines of a magnetically shielded room. This involved a range of different naturalistic experiences – see the Alexander et al. poster on encoding. One day later they returned to recall autobiographical memories of the virtual experiences which involved a period of silent retrieval of each memory, followed by recollection of each memory out loud. Neuromagnetic fields were recorded throughout encoding and retrieval using a whole-head OPM-MEG system (120-142 channels). First, we will show that participants recalled the virtual experiences similarly to real-world autobiographical memories, with good accuracy and vividness. Next, we will present preliminary analyses of whole brain oscillatory power changes in the theta (4-8 Hz) and alpha (8-12 Hz) bands during silent memory retrieval versus a control task. In addition, we will show time-frequency spectrograms from regions of interest including the hippocampus and mPFC. Finally, we will share preliminary data from the out loud recall period to assess whether memory-related neuromagnetic fields can be identified despite the artefacts from speech production. Overall this retrieval study represents an important step forwards in showing that VR is a proxy for actual lived experiences which, when combined with OPM-MEG, opens up a host of opportunities for future naturalistic studies across a range of neurocognitive domains.

1.25 – Cortico-Pallidal Interactions in Dystonia: A Combined EEG-LFP Study.
Mansoureh Fahimi Hnazaee, Eoin Mulroy, Olga Sinani, Harith Akram, Ludvic Zrinzo, Tom Foltynie, Patricia Limousin, Vladimir Litvak, University College London, United Kingdom.

Introduction:
The basal ganglia and their interactions with the cortex play an important role in movement, as shown by animal- and non-invasive human neuroimaging studies. In humans, one can investigate cortico- basal ganglia interactions when patients undergo deep brain stimulation (DBS) surgery, as researchers can directly record local field potentials (LFP) from the DBS target in the basal ganglia. Combining LFP recordings with MEG or EEG affords the characterization of large-scale brain networks associated with movement. Previous studies mostly focused on MEG due to the presence of externalised DBS wires which hinder the placement of an EEG cap. However, MEG limits the amount of movement and is heavily affected by DBS artefacts. The new generation of DBS technology, the Percept PC from Medtronic, offers wireless LFP recording in patients with chronically implanted stimulators, opening new possibilities for movement neuroscience.

Methods:
We measured simultaneous EEG and internal Globus Pallidus LFPs in 8 patients with dystonia on and off DBS, during several tasks. Our movement tests were passive and active movement, walking, writing, pouring, hand posing and speaking. We also included non-movement tasks such as resting- state, sensory stimulation and sensory tricks, a classic hallmark of dystonia. Simultaneously, we acquired movement tracking data.

Results:
We developed a pipeline for data synchronisation and analysis and identified and solved several of the challenges involved in recording from the new Medtronic device. Our analysis of the resting state shows a significant EEG-pallidal coherence in the theta and alpha band which is significantly suppressed by DBS in the posterior parietal area. During movement, significant EEG-pallidal coherence is observed which is suppressed by DBS in the beta band, and increased in the low gamma band.

Conclusion:
Our results are broadly consistent with the previously reported suppression of pallidal low-frequency activity by DBS in dystonia. Our study has several limitations, among which are the small population and heterogeneity of the patient group, and the short withdrawal time between the DBS on and off conditions. Nevertheless, we believe our results offer important and novel insights into the cortico- basal ganglia interactions in dystonia.

1.26 – Encoding of virtual naturalistic experiences during OPM-based MEG.
Nicholas Alexander, Robert A. Seymour, Yan Wu, Eleanor A. Maguire, University College London, United Kingdom.

Our life experiences are encoded in autobiographical memories. To date, neuroimaging research has mostly focussed on the retrieval of autobiographical memories, because examining their formation is precluded in traditional head-immobilising brain scanners such as MRI and SQUID MEG. Moreover, in the absence of information from the time of encoding, the accuracy of retrieval could not be reliably assessed in most extant studies. Here we created a virtual reality environment through which participants (N=12; 6 female; aged 23-34) moved using a walk-in-place method while in a magnetically shielded room. During their tour of this virtual town, they had a range of different naturalistic experiences, such as visiting a museum or observing street musicians, that varied in duration and content. Throughout the town tour we collected neural data using a ~130 channel OPM-based MEG system. The next day, and also during OPM-MEG, participants were asked to recall and describe their memories of experiences from the town tour – see the Seymour et al. poster for further details on retrieval. We first applied our recently-established pre-processing pipeline for ambulatory OPM-MEG which allowed us to reliably identify brain signals during large movements (~50 cm) caused by walking-in-place and looking around the virtual town. We then undertook, and will present, a preliminary characterisation of the neural signatures associated with forming naturalistic memories, including those that go on to be remembered or degraded (where now the ground truth is known). Based on the extant literature, we also examined the boundaries, particularly those at the end, of experiences. Our main focus was on theta activity (4-7 Hz) in the hippocampus and medial prefrontal cortex. Overall our study shows that it is possible to leverage the combination of virtual reality and OPM-MEG to examine how the brain functions in something more akin to everyday life which, until now, has eluded detailed scrutiny.

1.27 – High-frequency alpha activity involved in the top-down control of information maintained in short-term memory.
Mate Gyurkovics, Gabriela Cruz, Matias Palva, Gregor Thut, Satu Palva, University of Glasgow, United Kingdom.

Background:
Short-term memory (STM) sustains information temporarily, while working memory (WM) is defined as goal-directed manipulation of this maintained information. The neural background of memory-related processes has been widely studied but many previous studies of visual WM maintenance have operationalized it in a way that is more consistent with STM, i.e., maintenance

of information over a short delay, with no additional processing demands. These studies found both local and interareal oscillatory changes in several frequency ranges during the maintenance period.

Objectives:
Our objective was to identify oscillatory mechanisms dissociating WM and STM, utilizing a task where participants had to either mentally manipulate the maintained information (WM) or not (STM). We hypothesized that increased top-down modulation in the WM condition would be associated with increased theta (4-8 Hz) and alpha (8-14 Hz) activity.

Methods:
We recorded brain activity with simultaneous MEG-EEG during a retro-cued delayed- match-to-sample memory task from 30 healthy young adults (ongoing, target n = 40). Participants were retro-cued to maintain either all probe stimuli (shapes and gratings) during a delay period (STM condition) or only stimuli belonging to one category (shapes or gratings), while ignoring non-cued stimuli (WM condition).

Results:
Source localized oscillatory power in the high-frequency alpha (10-14 Hz) band in parieto-occipital regions was increased during the maintenance (post-retrocue) period for WM compared to STM trials, while prefrontal theta power was decreased. Preliminary analyses of interareal synchrony revealed hubs differentiating WM and STM trials in similar regions and frequency ranges.

Discussion:
Our results suggest that high-alpha band oscillations reflect top-down selective attention acting on internal mental representations during maintenance, while frontal theta might be linked to increased resource allocation in conditions with higher load.

1.28 – Combining OPM and lesion mapping data for epilepsy surgery planning: a simulation study.

Stephanie Mellor, Ryan Timms, George C O'Neill, Tim M Tierney, Meaghan E Spedden, Matthew J Brookes, Konrad Wagstyl, Gareth R Barnes, University College London, United Kingdom.

Background and Aims:
When planning for epilepsy surgery, multiple potential sites for resection may be identified through anatomical imaging. The likely seizure onset zone is frequently confirmed using intracranial EEG. Non-invasive magnetoencephalography using optically pumped sensors (OP-MEG) could potentially refine or replace this invasive recording. Here, we test the utility of a-priori information from anatomically identified potential lesion sites in simulation.

Methods:
We simulated OP-MEG recordings for 1309 potential lesion sites identified from anatomical images in the Multi-centre Epilepsy Lesion Detection (MELD) project. To localise the simulated data, we used the empirical Bayesian beamformer (EBB), as well as a restricted version of Multiple Sparse Priors (MSP) with only the patient's potential lesion locations as priors. We added errors to both the sensors (e.g. gain and co-registration) and the source model (e.g. lesion extent).

Results:
Knowledge of the candidate lesion zones made the inversion extremely robust to random errors in sensor gain, orientation and even location. For sensor position, orientation and gain errors of 5 mm, 10^0 and 5%, 98% of the correct sites were identified. By contrast, imprecise source models undermined the utility of the a-priori information. When the edge of the lesion was simulated as the epileptogenic source but the model prior assumed that only the centre of the lesion was active, accuracy dropped to 60% (chance level 18%).

Discussion and Conclusions:
Anatomical lesion mapping data could be used in conjunction with flexible OP-MEG helmets to overcome limitations due to imprecise array geometry. However, consideration should be given to the source modelling assumptions, which can have a considerable impact on reconstruction accuracy.

1.29 – Optimising the Sensitivity of Electrophysiological Imaging using Optically-Pumped Magnetometers.
Ryan M Hill, Holly Schofield, Elena Boto, Lukas Rier, James Osborne, Cody Doyle, Frank Worcester, Tyler Hayward, Niall Holmes, Richard Bowtell, Vishal Shah, Matthew J Brookes, University of Nottingham, United Kingdom.

The measurement of electrophysiology is of critical importance to our understanding of brain function. However, current non-invasive measurements, including electroencephalography (EEG) and magnetoencephalography (MEG) have limited sensitivity, particularly compared to invasive recordings. Optically-pumped magnetometers (OPMs) are a new type of magnetic field sensor which ostensibly promise MEG systems with higher sensitivity; however, the noise floor of current sensors remains high compared to cryogenic instrumentation and this has proven limiting. Here, we question how sensor array design affects sensitivity, and whether judicious sensor placement could compensate for the higher noise floor. Through theoretical analyses, simulations, and experiments we show that increasing the total signal measured by an OPM array – either by increasing the number of sensors and channels, or by changing the placement of those sensors – affords a linearly proportional increase in signal-to-noise ratio (SNR). Our experimental measurements confirm this finding, showing that by changing sensor locations in a 90-channel array, we could increase the SNR of visual gamma oscillations from 4.8 to 10.5. Using a 180-channel OPM-array, we capture broadband gamma oscillations induced by a naturalistic visual paradigm, with an SNR of 3; a value that compares favourably to similar measures made using conventional MEG. Our findings add to the growing argument that OPMs are the sensor of choice for MEG system construction. They are also important for the design of future OPM based instrumentation, and most importantly, they show how non-invasive imaging technologies can be optimised to provide non-invasive measurements of human brain electrophysiology with the highest possible sensitivity.

1.30 – Next Generation Acquisition and Control for OPM-MEG.
Holly Schofield, Ryan M Hill, Elena Boto, Matthew J Brookes, James Osborne, Cody Doyle, Vishal Shah, University of Nottingham, United Kingdom.

Background/aims:
Optically pumped magnetometers (OPMs) have revolutionised neuroimaging, enabling a new generation of MEG system which allows movement during scanning. However, most existing OPM-arrays require complex cabling to control each OPM, making ambulatory motion challenging. Here we trial a new OPM array design with miniaturised control and data acquisition electronics integrated into a wearable “backpack”. We compare system performance to an established OPM-MEG system and determine its viability for MEG measurements.

Methods:
The system comprised 64 triaxial OPMs (QuSpin) (192 independent MEG channels) mounted in a 3D printed helmet. The OPMs are connected to a miniaturised digital control electronics and data acquisition system (QuSpin) housed inside a backpack. The electronics can be positioned a maximum of 80 cm from the OPMs. Firstly, noise recordings were taken in an empty magnetically shielded room. We contrasted this with an established system comprising 57 triaxial OPMs each controlled by its own electronics. Then, we measured MEG signals from an individual performing

a button press task. Data were processed by a beamformer to generate functional images depicting the spatial signature of beta modulation.

Results:
For both systems, the noise floors were 15 fT/√(Hz) or lower. The presence of the system electronics in close proximity to the sensors had little effect on system noise. Beta modulation induced by a button press was seen, with primary effects in sensorimotor cortex and the expected oscillatory signature (movement induced beta desynchronisation followed by a post movement rebound) clearly delineated.

Discussion:
Our results show clearly that the new system is capable of collecting high quality MEG data. Minimised cabling means new opportunities for ambulatory experimentation and the removal of long cabling to electronics outside the MSR means the system is less vulnerable to electronic interference.

1.31 – Imperceptible gamma-band sensory stimulation enhances episodic memory retrieval.
Benjamin J. Griffiths, Daniel Weinert, Ole Jensen, Tobias Staudigl, University of Birmingham, United Kingdom.

Background/Aims:
Enhanced gamma activity (30-100Hz) coincides with successful episodic memory retrieval, but it remains unknown whether this oscillatory activity is a cause or a consequence of the retrieval process. We aim to address this question of causality.

Methods: 70 human participants completed a paired associates memory task whilst undergoing sensory stimulation (at 65Hz, 43.3Hz and 32.5Hz) during memory retrieval. To understand the neural effects of stimulation, we built pyramidal-interneuronal network gamma (PING) models and stimulated them using the same protocol as the behavioural task. Two ongoing MEG and EEG studies will aim to identify the neural locus of these behavioural and computational effects.

Results:
Both 65Hz and 32.5Hz sensory stimulation enhanced memory recall above a baseline condition where no sensory stimulation was applied. Only a small proportion of participants (~10%) could perceive the 65Hz visual flicker, suggesting 65Hz sensory stimulation is imperceptible. The behavioural results could be reproduced by stimulating a PING model with an endogenous ~32Hz oscillation, but not in a PING model with an endogenous ~65Hz oscillation, suggesting 65Hz sensory stimulation enhances recall by harmonically entraining an endogenous ~32Hz oscillation. We anticipate that the M/EEG results with verify this “harmonic entrainment”, with 65Hz and 32.5Hz sensory stimulation both enhancing visual cortical “slow” gamma (~32.5Hz) activity.

Discussion:
These results suggest imperceptible sensory stimulation enhances recall, providing a novel and entirely unintrusive means of tackling mnemonic issues. Furthermore, these results show that harmonic entrainment can impact behaviour, highlighting the non-linear interactions between exogenous stimulation and endogenous neural activity. Lastly, if the M/EEG results complement these findings, we would propose that “slow” gamma oscillations play a causal role in episodic memory retrieval.

1.33 – The mTBI-predict candidate biomarker variability study: the challenges and practical considerations of a multi-site and multi-vendor study.

Alice E Waitt, Tara Ghafari, Iman Idrees, Sebastian C Coleman, Ruwan Wanni Arachchige, Yidian Gao, Waheeda Hawa, Aliza Finch, Sian F Worthen, Shaheen Lateef, Davinia Fernandez-Espejo, Karen J Mullinger, Jan Novak, Matthew J Brookes, Hyojin Park, Caroline Witton, Ole Jensen, Alexandra J. Sinclair, Aston University, University of Nottingham, University of Birmingham.

Background/Aims:
"mTBI-predict" is a large, multi-site, multi-vendor, longitudinal prospective cohort study on patients with mild traumatic brain injury (mTBI) which aims to evaluate the accuracy and precision of prognostic biomarkers. As a precursor, we will undertake a baseline variability study to assess the reproducibility of our data collection and analysis methods.

Methods:
The study involves 3 sites. 20 controls will complete 6 scanning days (4 at one site, 1 at each of the other sites) and 20 mTBI patients complete 4 scanning days (1 site only). Half of the subjects are civilians and half military. On each day, participants complete MEG and MRI scans. The MEG session involves two 5-minute resting-state scans and 3 tasks: choice reaction task (CRT), spatial attention task (covert attention) and implicit face viewing task (happy, neutral, or angry faces).

Analysis:
Control data will be used to characterise how much pre-defined primary outcomes, outlined here, vary across sites and sessions. Spatial attention data will be used to assess hemispheric lateralisation (cue-target alpha power and target gamma power) as a diagnostic marker of mTBI-related attention problems. Greater induced gamma (60-90Hz) power associated with angry face stimuli has been found in PTSD, so this measure will be used to identify patients with PTSD symptoms. Resting-state delta (2-8Hz) power and functional connectivity will be examined as a diagnostic marker of mTBI. CRT data will be used to compare measures from different modalities (e.g., fMRI).

Implications:
This study will enable quantitative assessment of candidate biomarker variability across scanning sessions and sites. Achieving high reproducibility and repeatability in brain metrics across centres will determine whether these measures can be used for the main project. This large, cross-site MEG study will provide valuable lessons about optimising high-intensity cross-site working to achieve high statistical power in MEG research.

1.34 – Altered information gathering in obsessive-compulsive subjects linked to evidence integration.

Magda del Rio, Nadescha Trudel, Laurence Hunt, Michael Moutoussis, Ray Dolan, Tobias U. Hauser, University College London, United Kingdom.

Background/Aims:
Doubt is typically considered a hallmark of obsessive-compulsive disorder (OCD), yet its mechanistic account remains unclear. Here we aimed to investigate individual differences in the components of information gathering and their neural correlates.

Methods:
We collected MEG data from a sample including OCD patients and high compulsive non-patients (N = 113) using a newly developed information gathering task, where participants indicated which of two possible stimuli was more plentiful. Subjects had the choice to either continue sampling additional information or stop and make a binary choice between the two stimuli. We experimentally varied the amount of current and past information, the maximum sampling time before making a decision and the evidence strength to assess their impact on information gathering and the relationship with OCD traits. We used MEG decoding to analyse the time

course of these experimental factors and investigated how the underlying activation patterns (Haufe et al., 2014) related to OC traits. Behavioural analyses will be verified in a large-scale online sample completed the Obsessive-Compulsive Inventory-Revised (N = 4375).

Results:
In our behavioural analysis, we found that individuals with higher OC traits were less sensitive to the difference in evidence for the two stimuli when making a decision. When analysing the MEG data, we find a timely separation of all experimental factors, suggesting a cascade in information processing. We also find altered decodability in people with high OCD traits, driven by altered late activation patterns in centroparietal areas.

Discussion/conclusions/implications:
Together, this suggests that indecisiveness across the OC spectrum stems from differences in evidence sensitivity and thus belief updating during information search. Our new task provides a deeper understanding of the underlying mechanisms, which could enable more targeted interventions in future.

1.36 – Spatial factorization of moving-window kurtosis for optimal detection and characterization of spiking networks in pre-surgical epilepsy.
Ryan Beckerleg, Megan Godfrey, Kevin Murphy, Krish Singh, Khalid Hamandi, Cardiff University, United Kingdom.

Kurtosis beamforming of MEG data can be used to spatially locate the epileptogenic zone (Hall et al., 2018) in patients with epilepsy. Here, we present and evaluate a method for enhanced semi-automatic detection and characterization of these zones, based on moving-window kurtosis and spatial clustering in atlas space, based on this kurtosis timeseries, using non-negative matrix factorization (NNMF). Here we demonstrate the approach on pre-surgical MEG data collected from 4 patients scheduled for inter-cranial EEG and subsequent re-section. LCMV beamformer of 10-minutes of resting-state data was performed at 20-70 Hz, the standard range for kurtosis spike estimation (Ishii et al., 2008; Kirsch et al., 2006), on a 2x2x2 mm grid throughout the brain. Excess kurtosis was calculated for each of these grid locations, which is commonly used to visualise candidate epileptogenic regions. In our proposed method, for computational tractability, brain regions-of-interest (ROIs) were first defined using a variant of the standard AAL90 atlas, in which the larger atlas regions have been sub- divided, resulting in 174 ROIs. Within each ROI, the voxel containing the maximum kurtosis was determined and the beamformer virtual-sensor timecourse estimated for this grid location. The next stage involved spike detection and characterization. It was expected that true interictal epileptic activity would be represented as brief, high-kurtosis events in this timeseries. For each of the 174 AAL regions, a moving window kurtosis timeseries was calculated using a 1s window and used to identify brief events in the timeseries. This allowed us to identify those ROIs with the most spikes and confirm their likely epileptiform status via visualization of the event timecourses. In the final stage, we used NNMF to group the 174 ROIs into spatial clusters based on their moving- window kurtosis timeseries. The resulting output was a spatial connectivity map of each cluster and accompanying representative timeseries, revealing the presence of different sub-networks with independent spiking profiles. The new method therefore allows both easier segregation of true, versus artefactual, epileptiform spiking networks, and the possible identification of multiple, and clinically relevant, epileptiform networks in some patients.

References
Hall, M. B. H., Nissen, I. A., van Straaten, E. C. W., Furlong, P. L., Witton, C., Foley, E., Seri, S., & Hillebrand, A. (2018). An evaluation of kurtosis beamforming in magnetoencephalography to localize the epileptogenic zone in drug resistant epilepsy patients. Clinical Neurophysiology, 129(6), 1221–1229. https://doi.org/10.1016/j.clinph.2017.12.040
Ishii, R., Canuet, L., Ochi, A., Xiang, J., Imai, K., Chan, D., Iwase, M., Takeda, M., Snead, O. C., & Otsubo, H. (2008). Spatially filtered magnetoencephalography compared with electrocorticography to identify intrinsically epileptogenic focal cortical dysplasia. Epilepsy Research, 81(2), 228–232. https://doi.org/10.1016/j.eplepsyres.2008.06.006
Kirsch, H. E., Robinson, S. E., Mantle, M., & Nagarajan, S. (2006). Automated localization of magnetoencephalographic interictal spikes by adaptive spatial filtering. Clinical Neurophysiology, 117(10), 2264–2271. https://doi.org/10.1016/j.clinph.2006.06.708

1.37 – Using OPMs to study interactions between the brain, spinal cord, and muscle.
Meaghan E. Spedden, George C. O'Neill, Tim M. Tierney, Ryan Timms, Timothy O. West, Stephanie Mellor, Nicholas Alexander, Robert Seymour, Simon F. Farmer, Sven Bestmann, Gareth R. Barnes University College London, United Kingdom.

Background:
Traditionally, the brain and spinal cord have been studied as separate systems due to the challenges of simultaneously imaging their activity. However, optically pumped magnetometer (OPM)-based imaging is uniquely versatile, allowing flexible sensor placement on different parts of the body. Using OPMs, we have developed a novel system for concurrent imaging of brain and spinal cord activity. Our focus in this work is to explore the endogenous interactions between the

brain, spinal cord, and muscles involved in sensorimotor control.

Methods:
Healthy participants performed simple voluntary movements with their right and left hands. We recorded brain and spinal cord activity using OPMs placed on the head and neck, while also recording electromyography (EMG) data from the thumb abductor muscle. The data were then reconstructed in source space, and canonical variate analysis was applied to identify maximally correlated components of brain-spinal cord and spinal cord-EMG activity.

Results:
Our results provide evidence for both linear and nonlinear oscillatory interactions between the brain, spinal cord, and muscles during voluntary movement. These functional connectivity patterns were similar for movements of the right and left hands and were consistent with known features of sensorimotor pathways.

Implications:
This research demonstrates the utility of OPMs in studying endogenous spinal cord activity. Our OPM-based system, allowing concurrent imaging of the brain and spinal cord, opens new possibilities for advancing our understanding of how communication is coordinated in the central nervous system, both in health and disease.

1.38 – Alterations of PAC-based resting state networks in Parkinson's disease are partially alleviated by levodopa medication.
Sean Patrick Mertiens, Matthias Sure, Alfons Schnitzler, Esther Florin, Heinrich Heine University, Germany.

Background:
Parkinson's Disease (PD) is a neurodegenerative disorder affecting the whole brain, leading to several motor and non-motor symptoms. In the past, it has been shown that PD alters resting state networks (RSN) in the brain. These networks are usually derived from fMRI BOLD signals. This study investigated RSN changes in PD patients based on maximum phase amplitude-coupling (PAC) throughout the cortex. We also tested the hypothesis that levodopa medication shifts network activity back toward a healthy state.

Methods:
We recorded 23 PD patients and 24 healthy age-matched participants for 30 minutes at rest with magnetoencephalography (MEG). PD patients were measured once in the dopaminergic medication ON and once in the medication OFF state. A T1-MRI brain scan was acquired from each participant for source reconstruction. After correcting the data for artifacts and performing source reconstruction using a linearly constrained minimum variance beamformer, we extracted visual, sensorimotor (SMN), and frontal RSNs based on PAC (Florin and Baillet 2015).

Results:
We found significant changes in all networks between healthy participants and PD patients in the medication OFF state. Levodopa had a significant effect on the SMN but not on the other networks. There was no significant change in the optimal PAC coupling frequencies between healthy participants and PD patients.

Discussion/Summary: Our results suggest that RSNs, based on PAC in different parts of the cortex, are altered in PD patients. Furthermore, levodopa significantly affects the SMN, reflecting the clinical alleviation of motor symptoms and leading to a network normalization compared to healthy controls.

1.39 – The neural dynamics of visual shape predictions.
Dorottya Hetenyi, Oscar Ferrante, Peter Kok, University College London, United Kingdom.

Aims:
Our prior knowledge greatly influences how we perceive the world and helps us to create better predictions of future events. Previous studies have shown that the power and phase of alpha oscillations (8-12Hz) modulate perception. Here, we seek to identify whether sensory predictions in visual cortex oscillate and are coupled to specific phases of low frequency oscillations. Establishing a link between perceptual predictions and endogenous oscillations would shed light on the mechanisms by which the brain generates predictions.

Methods:
Healthy volunteers (n=32) performed a shape discrimination task while neuromagnetic activity was measured using MEG. Auditory cues predicted the identity of an upcoming abstract shape with 75/25% trial validity and were orthogonal to the discrimination task.

Results:
Using a time-resolved decoding analysis at the sensor level, we identified the neural representations of the presented abstract shapes. To test whether sensory predictions have an oscillatory nature, we performed a time-frequency analysis on the decoded data in the pre-stimulus period. The decoded prediction templates fluctuated at low frequencies, predominantly in the alpha band (8–12Hz). We further hypothesise that the magnitude of the same decoded prediction templates is modulated by the phase of the alpha oscillations. Phase modulation of the alpha oscillations will be calculated and related to the strength of the decoded predictions in visual cortex. To obtain individual neural representations of the predicted abstract shapes and spatial origin of the alpha oscillations, MEG data will be further analysed with generalised eigendecomposition at sensor and source level. Discussion: Our results indicate that top-down prediction signals are dominated by oscillatory activity in the alpha-band. These findings are potentially in line with alpha oscillations acting as carriers of the neural representations of predicted shapes from downstream regions to visual cortex.

1.40 – MEG/EEG microstates of functional connectivity in dementia with Lewy bodies.
Ludmila Kucikova, Yi Zhang, Li Su, Sheffield University, United Kingdom.

Background:
Previous evidence suggests there are functional connectivity changes across multiple large-scale networks in Dementia with Lewy Bodies (DLB), Parkinson's Disease Dementia (PDD), and Alzheimer's Disease (AD) observed in fMRI and EEG. Although MEG offers many advantages over other imaging modalities, very little is known about large-scale networks in dementia, specifically in DLB, derived from MEG data.

Aims:
Hence, we are conducting the multimodal imaging in Lewy body disorders (MILOS) study. The main objective of this study is to investigate combined MEG/EEG "microstates" of functional connectivity in large-scale networks in DLB. We will explore network organisation, characterisation of temporal dynamic patterns, and fast oscillatory activities in both space and time. Furthermore, this study will also study correlations between connectivity alterations and clinical symptoms commonly found in DLB.

Methods:
Patients with Lewy body disorder and healthy controls undergo T1 structural MRI in addition to resting state MEG/EEG for source localisation. The source localised MEG data is first separated into 10-sec-long intervals to allow for computing a dynamic evolution of large-scale networks' topography. The data is then separated into Delta, Theta, Alpha, Beta, and low and high Gamma frequencies to examine different patterns of functional connectivity that can help identify

frequency-specific biomarkers. Then, Independent Component Analysis is used, and the resulting components are then matched with the templates of large-scale networks for each 10 second time window.

Results/Discussion:
Here, we will report preliminary findings by showing MEG/EEG microstates with large-scale networks and expand our understanding of temporal characteristics of functional connectivity in DLB. This study will therefore provide the results of using a different form of methodology to obtain MEG/EEG microstates of functional connectivity than what is currently available.

1.41 – Using Magnetoencephalography to accelerate CNS drug discovery.
Rasha Hyder, Natalie Jones, Jennifer Swettenham, Neil Harrison and Krishna Singh, Cardiff University, United Kingdom.

Background/Aims:
Traditionally, Phase I (first in human) clinical trials have focused on assessing safety and pharmacokinetics (effects of the body on the drug). However, the repeated, hugely expensive late (i.e. phase III) failure of many Central Nervous System (CNS)-targeted drugs has highlighted the need for a radical redesign of Phase I trials. Influential initiatives such as the NIMH Fast-Fail program show the critical need to include in-vivo measures of target engagement to accelerate CNS drug discovery. To address this, we are using pharmaco- MEG and fMRI as indices of target engagement in a Phase I clinical trial of a novel positive allosteric modulator (PAM) of the AMPA receptor developed at Cardiff University. AMPA PAMs increase the conductance of AMPA and co-localised NMDA receptors, and are proposed to improve cognition via an increase in synaptic plasticity, particularly in conditions such as schizophrenia where NMDA receptor function is impaired. Schizophrenia affects ~1 % of the global population and though positive symptoms (e.g., hallucinations) can be relatively well managed, there are currently no treatments for the cognitive impairments that severely impair quality of life. Studies targeting different receptors, including AMPARs, show that MEG can provide sensitive and time-resolved markers of pharmacological action.

Methods:
Here, MEG will be recorded from healthy participants for the following paradigms: 1) resting-state 2) visual-motor gamma 3) auditory oddball 4) 40 Hz-steady-state auditory. Both evoked and induced responses will be analysed. Resting-state MEG will be analysed using frequency specific measures of both oscillatory amplitude and connectivity. In addition to MEG, we will collect resting state fMRI, structural MRI and a battery of cognitive tests. The study is placebo-controlled and double blinded. MEG/MRI study design exploits the 14-day dosing part of the trial (a key test of safety) and an additional 3-way crossover study will explore neural effects from a single dose (placebo, lower- and higher-dose).

Discussion/conclusions/implications:
To our knowledge, this is the first time MEG has been used at this stage of drug development. Data collection is ongoing, but the research demonstrates the possibilities for MEG to be integrated into the intensive and highly regulated Phase 1 clinical trial environment.

1.42 – Behavioural and neurophysiological underpinnings of complex bimanual motor learning.
Catharina Zich, Marleen J Schoenfeld, Carl Lindersson, Charlotte J Stagg, University College London, United Kingdom.

Background/Aims:
Many tasks require the skilled interaction of both hands, such as eating with a knife and fork or keyboard typing. However, our understanding of the behavioural and neurophysiological

mechanisms underpinning bimanual motor learning is still sparse. Here, we aimed to address this by characterising learning-related changes of different levels of bimanual interaction.

Methods:
To explore early bimanual motor learning, we designed a bimanual motor learning task. In the task, a force grip device held in each hand (controlling x- and y-axis separately) was used to move a cursor along a path of streets at different angles (0°, 22.5°, 45°, 67.5°, and 90°). Each street corresponded to specific force ratios between hands, which resulted in different levels of hand interaction, i.e., unimanual (Uni, i.e., 0°, 90°), bimanual with equal force (Bieq, 45°), and bimanual with unequal force (Biuneq 22.5°, 67.5°). 42 healthy participants performed the task for 100 trials, whereby each trial comprises six streets.

Results:
On the behavioural level, the three conditions differed in their movement time and error. Further, we found that the novel task-induced improvements in movement time and error, with no trade-off between movement time and error, and with distinct patterns for the three levels of bimanual interaction. On the neural level, beta event-related desynchronisation and synchronisation show different spatial topographies for the unimanual conditions. Moreover, we found that learning-related changes are manifold and are explored in detail using the amplitude-envelope variant of the Hidden Markov Model.

Discussion/conclusions/implications:
Overall, this complex bimanual motor task allows us to characterise bimanual motor learning with different levels of bimanual interaction. This should pave the way for future neuroimaging studies to further investigate the underlying mechanism of bimanual motor learning.

1.43 – Cholinergic Modulation of Spontaneous Cortical Oscillatory Activity and Domain-specific Behavior: A Pharmaco-MEG Study.
Rachel K. Spooner, Hannah Kurtenbach, Monja Froböse, Eduard Ort, Markus Butz, Gerhard Jocham, Esther Florin, Heinrich Heine University, United Kingdom.

Recent studies suggest that spontaneous cortical activity underlies numerous processes (e.g., disease, demographics, cognition), albeit the neurochemical bases of spectral changes at rest are not well characterized. For example, the widespread action of acetylcholine (ACh) on pyramidal cell function implicates its role in a myriad of behavioral states, including visual-motor processing and attention. Such behavioral modulation is associated with increases in task-relevant low and high frequency oscillations in model systems. However, the role of ACh in modulating resting neural dynamics and behavior is unknown.
In this study, 43 healthy men completed 5 minutes of eyes open rest during MEG following administration of an ACh muscarinic receptor antagonist, biperiden, or placebo. MEG data were imaged in the time-frequency domain using a beamformer to examine drug-dependent effects of ACh on large-scale resting networks across the canonical frequency bands. Peak vertex time series were extracted from drug-dependent statistical maps and related to behavior assessed outside the scanner.
Our results revealed spectrally and spatially-resolved changes in cortical oscillations following biperiden administration. Specifically, we observed elevations in low (~2-7 Hz) and high-frequency (>30 Hz) cortical activity in key hubs of visual, motor, and dorsal attention networks following biperiden administration, while the opposite trajectory was observed for resting alpha power. Moreover, we observed a drug-dependent modulation of better behavioral performance during basic motor, learning and decision making tasks by resting state networks resonating at lower (<4 Hz) and higher (>30 Hz) frequencies.
En masse, these data suggest that the disruption of cholinergic transmission leads to widespread changes in spontaneous cortical rhythms, which may relate to compensatory changes in domain-specific cognitive function observed under deviant neurochemical conditions in humans.

1.44 – Altered neural tracking of continuous speech in cochlear-implanted children.
Alessandra Federici, Marta Fantoni, Evgenia Bednaya, Francesco Pavani, Alice Martinelli, Martina Berto, Giacomo Handjaras, Emiliano Ricciardi, Elena Nava, Eva Orzan, Benedetta Bianchi, Davide Bottari, IMT School for Advanced Studies Lucca, Italy.

Since early development, the brain synchronizes to external rhythms, such as speech. To date, little is known about the role of acoustic experience in the development of neural tracking of speech. Cochlear-implanted (CI) children, having experienced a period of auditory deprivation, provide the opportunity to fill this gap.
By applying an encoding model on electrophysiological data, we measured the neural tracking of speech envelope and spectrogram in 3-18 years old hearing controls (HC; N=37) and bilateral profound deaf children who received CIs (N=32). CI group was equally divided into children with congenital deafness (CD) and delayed deafness (DD) onsets to estimate the specific role of auditory deprivation in the first phase of life.
Results revealed a defined auditory response function and a developmental trajectory in HC and CI children. However, neural tracking of speech envelope measured in CI significantly differed from HC. The earliest auditory response was delayed in CI, and the subsequent neural tracking was reduced. While no difference emerged between CD and DD, we found that the latency of the earliest auditory response in CI was associated with the age of cochlear implantation. Behavioural data showed a significant speech comprehension deficit in CI children. Importantly, CI's neural tracking dynamic was significantly reduced at the latency [150-250ms] correlated with comprehension scores in HC children. Finally, multivariate encoding of the speech spectrogram unveiled the role of the low-frequency range in CI's neural tracking alterations.
These findings revealed that neural tracking of speech emerges regardless of the absence of acoustic experience in the first phases of life. However, it is delayed and hampered in CI children. Although early implantation mitigates the delayed auditory response, alterations at higher stages of speech processing remain and might account for CI's comprehension deficits.

1.45 – Vision through cortico-ocular coupling.
Tzvetan Popov, Jan-Mathijs Schoffelen, University of Zurich, Switzerland.

Background:
Steady fixation is considered a necessary requirement in cognitive experiments that involve visual stimuli. It is the absence of macroscopic oculomotor events that is thought to ensure the validity of the interpretation of the acquired data in relation to the cognitive construct studied. That is, a putative relationship between eye movement control and the brain's response to visual stimulation is not considered per definition. The present report explores the extent to which visual signals may be related to eye movements through an analysis of cortico-ocular coherence, akin to established observations in the motor system.

Methods:
We re-examined simultaneously acquired magnetoencephalographic and eye tracking data in the context of an inward moving grating experiment. During visual stimulation, gaze was directed towards central fixation – as instructed. We processed the horizontal eye gaze position data in order to be able to use it as a proxy for the EMG of the extraocular muscles. We first subtracted a median filtered version of the eye tracker signal, to remove saccades. This was followed by high pass filtering (cutoff frequency at 40 Hz, windowed sync FIR filter), and rectification.

Results:
Sensor level coherence analysis revealed two spectral peaks in the delta/theta frequency range (2-7 Hz), and alpha/beta frequency range (10-16 Hz). Source localization identified involvement of bilateral early visual cortical areas, bilateral cerebellum and possibly the superior colliculus.

Conclusion:
The results are discussed in light of the conjecture that coherence between subsaccadic

movements and cortical rhythms is a manifestation of an efferent oculomotor process supporting active vision.

Session 2, Saturday October 28th

2.01 – A stimulus-computable model of beta oscillatory responses to speech
Christoph Daube, Joachim Gross, Robin A. A. Ince, University of Glasgow, United Kingdom.

Background/Aims:
A growing body of research is concerned with modelling magneto- or electroencephalography (MEEG) responses to speech. This usually focuses on predicting the low-frequency time-domain portion of the signal in the delta (1 – 4 Hz) and theta (4 – 8 Hz) ranges from different stimulus features. Here, we instead focus on oscillatory power and aim to predict it with a stimulus-computable computational model.

Methods:
We re-analyse an MEG dataset of passive story listening. We obtain spatio-spectral response filters from a canonical correlation analysis (CCA) that maps MEG sensor power time courses onto the time-lagged envelope of the speech stimulus. We then predict the projections of the MEG responses through the spatio-spectral filters with features of a recurrent network that predicts the future of the speech envelope at multiple forecast horizons by parameterising it as two-component Gaussian mixture distributions.

Results:
The CCA weights suggest generators in the beta frequency range (13 – 30 Hz) in bilateral auditory cortices, which we confirm with source localisation. We then find that network outputs related to the variance but also the mean of the upcoming sound energy predict the MEG response component better than acoustic baseline models.

Discussion/conclusions/implications
Our model is only a suggestion of a computational process that could be underlying the generation of the biological beta power signal, and more work is needed to disambiguate the contributions from mean and variance outputs of our network. Based on its success in outperforming acoustic baseline models, we however conclude that our approach of ignoring textual linguistic annotations and instead considering a deceptively simplistic optimisation objective is promising in order to arrive at a stimulus-computable model of the listening brain.

2.02 – Mapping Neural Activity During Naturalistic Visual and Memory Search
Matias Ison, Joaquin Gonzalez, Anthony Ries, Juan Kamienkowski, University of Nottingham, U.S. Army Research Laboratory, University of Buenos Aires.

Background/Aims:
In real-life scenarios, individuals frequently engage in tasks that involve searching for one of various items stored in memory. This intertwined cognitive operation, referred to as hybrid search, is essential for activities like driving following reference landmarks. While behavioural aspects of hybrid search have received extensive attention, in this study our focus is on delving into the underlying neural mechanisms.

Methods:
We recorded concurrent magnetoencephalography (MEG) and eye tracking recordings while participants engaged in a visual and memory search task involving items embedded within naturalistic photographs.

Results:
By applying a deconvolution analysis approach to disentangle brain activity from eye movements artifacts, we found a robust marker that could differentiate between targets and distractors. We also found strong decrease in frequency power in the alpha and beta bands, which was associated with increased memory load.

Discussion/conclusions/implications:
This study casts a spotlight on the pivotal role of alpha oscillations in both memory retention and visual search processes. Beyond this foundational insight, our approach offers a gateway to investigating neural processes in contexts mirroring real-world situations, such as the cognitive demands associated with driving.

2.03 – Behavioural and neurophysiological underpinnings of complex bimanual motor learning
Catharina Zich, Marleen J Schoenfeld, Carl Lindersson, Charlotte J Stagg, University College London, United Kingdom.

Background/Aims:
Many tasks require the skilled interaction of both hands, such as eating with a knife and fork or keyboard typing. However, our understanding of the behavioural and neurophysiological mechanisms underpinning bimanual motor learning is still sparse. Here, we aimed to address this by characterising learning-related changes of different levels of bimanual interaction.

Methods:
To explore early bimanual motor learning, we designed a bimanual motor learning task. In the task, a force grip device held in each hand (controlling x- and y-axis separately) was used to move a cursor along a path of streets at different angles (0°, 22.5°, 45°, 67.5°, and 90°). Each street corresponded to specific force ratios between hands, which resulted in different levels of hand interaction, i.e., unimanual (Uni, i.e., 0°, 90°), bimanual with equal force (Bieq, 45°), and bimanual with unequal force (Biuneq 22.5°, 67.5°). 42 healthy participants performed the task for 100 trials, whereby each trial comprises six streets.

Results:
On the behavioural level, the three conditions differed in their movement time and error. Further, we found that the novel task-induced improvements in movement time and error, with no trade-off between movement time and error, and with distinct patterns for the three levels of bimanual interaction. On the neural level, beta event-related desynchronisation and synchronisation show different spatial topographies for the unimanual conditions. Moreover, we found that learning-related changes are manifold and are explored in detail using the amplitude-envelope variant of the Hidden Markov Model.

Discussion/conclusions/implications:
Overall, this complex bimanual motor task allows us to characterise bimanual motor learning with different levels of bimanual interaction. This should pave the way for future neuroimaging studies to further investigate the underlying mechanism of bimanual motor learning.

2.04 – Neural representation strength of predicted category features biases decision behavior
Yuening Yan, Jiayu Zhan, Oliver Garrod, Xuan Cui, Robin A.A. Ince, Philippe G. Schyns, University of Glasgow, United Kingdom.

Aims:
To understand prediction-for-perception, studies should address where, when, and how the brain predicts the stimulus features that change behavior. Typical multivariate classifiers are trained to contrast the bottom-up patterns of neural activity between two stimulus categories. These classifiers then quantify predictions as reactivations of the category contrast but cannot capture the features reactivated for each category. We addressed these predicted features.

Method:

In a prediction experiment, we used Dali's ambiguous painting–Slave Market with the Disappearing Bust of Voltaire which contains two possible perceptions (Nuns vs. the bust of Voltaire). In each of 3150 trials, 10 participants were cued to each perception, followed by deciding whether the stimulus was "Volaire" or "Nuns." Stimuli comprised random samples (Gabor) of the features leading to each perception. Using each participant's reconstructed MEG on 8196 sources, we (1) decoded the category-contrast prediction (Voltaire vs. Nuns) using classifiers trained to discriminate Nuns vs. Voltaire images in a localizer run prior to the experiment; (2) decoded the category-feature predictions (separately for Voltaire and Nuns predicted features) with classifiers trained to discriminate High (> 70%) from Low (< 30%) proportions of Voltaire and Nuns features in uncued trials; (3) studied how trial-by-trial reactivation of category-feature representations in the brain changes subsequent behavior.

Result:
We show that top-down reactivations of the category-features (vs. category-contrast) are more precisely localized (i.e. lateralize to left occipital cortex for LSF Voltaire and right LOC for HSF Nuns), with per-trial reactivation strength that more strongly biases participant's perceptual behavior across a wider range of stimulus evidence.

Discussion:
Our novel approach can therefore track the reactivation of category-specific visual contents to better relate mechanisms of prediction to behavior.

2.05 – Living in a World of "Close Enough": Apathy and the Bayesian Brain
Rebecca S Williams, Michelle Naessens, Amir Jafarian, Frank Hezemans, Laura *Hughes, James B Rowe, University of Cambridge, United Kingdom.*

Background/Aims:
Apathy is a pervasive symptom across a spectrum of neurological conditions. There are currently no approved treatments, despite negative links with caregiver burden, quality of life and survival. In this ongoing project, we propose and test a new model of apathy focused on a reduction in prior precision of action outcomes. We explore this new framework using psychophysical analysis of performance and expectations in a goal directed task, in combination with MEG and Bayesian modelling, to identify the neural mechanisms underpinning apathy.

Methods:
N=20 participants with no history of psychological or neurodegenerative condition completed a goal directed task in the MEG scanner. Our primary task involves participants landing a virtual ball on a target. In a subset of trials, the ball disappears, and participants estimate the end position. From performance and estimation errors, we can infer the priors on outcomes. Participants with more precise prior beliefs are systematically biased towards the target in their estimates, and their prior precision is inversely proportional to trait apathy (Hezemans et al, 2020) as measured by the Apathy Motivation Index.

Hypotheses:
Our primary (confirmatory) hypothesis is that there is a negative correlation between trait apathy and prior precision. Our co-primary (exploratory) hypothesis is that including prior precision as an empirical prior for physiological response can explain activity in the prefrontal and motor cortex as measured by MEG. We will test this formally using dynamic causal modelling, employing Parametric Empirical Bayes to compare models with and without prior precision. Additional exploratory hypotheses will be specified in an online preregistration.

Conclusion:
In summary, the aim of this ongoing project is to test the neural underpinnings of apathy in healthy adults, with the goal of laying groundwork for new experimental medicine studies in people with neurological disorders.

2.06 – There's life in that old MEG yet: Depth electrode-like laminar source reconstruction with high precision MEG.

Maciej J Szul, Suvadeep Maiti, Ishita Agarval, Siqi Zhang, Gareth R Barnes, Sven Bestmann, James J Bonaiuto, Institut des Sciences Cognitives, CNRS, France.

Background:
Simulations have shown that MEG is capable of localising brain signals with laminar precision, given high enough levels of data quality, and these levels are achievable with high precision, head-cast MEG. Previous laminar source reconstruction efforts used two surfaces, representing deep and superficial layers. One of these approaches used a sliding time window model comparison for temporally resolved laminar inference, limiting its applicability across experimental conditions, and limiting inference to whether activity is strongest in deep or superficial layers. Here we aimed to provide a more complete picture of neural dynamics across cortical layers.

Methods:
A depth electrode-like source space was created by generating 11 equidistant layers between the white matter and pial surfaces, with vertices matched across layers. We then applied the Empirical Bayesian Beamformer to visual and motor ERFs from high precision, head-cast MEG data. This yielded, for each pial surface vertex, 11 source time series at different laminar depths. We then applied two analyses to these series: a current source density (CSD) transform, revealing temporally dynamic current sources and sinks, and a relative power analysis, thought to be a marker of the boundary between deep and superficial layers.

Results:
The boundaries of current source and sink patterns tightly corresponded to the estimated thickness of each cortical layer as estimated from the BigBrain histological atlas. Moreover, alpha/beta power was strongest in deep layers and gamma in superficial layers, and the crossover point of relative alpha/beta and gamma power was correlated with the estimated depth of layer IV from the BigBrain atlas.

Discussion:
Multilaminar source localisation with high precision MEG is possible and extremely promising. Contrary to sparse sampling of intracranial electrodes, laminar MEG has the potential to non-invasively and globally test hypotheses about cortical layer dynamics.

2.07 – Multi-scale parameterization of periodic neural activity with lagged Hilbert coherence

Siqi Zhang, Maciej J Szul, Sotirios Papadopoulos, James J Bonaiuto, Université Claude Bernard Lyon, Université de Lyon, CNRS, France.

Background:
Analysis of neural activity in various frequency bands is ubiquitous in systems and cognitive neuroscience. Recent analytical breakthroughs and theoretical developments rely on phase maintenance of oscillatory signals or a clean separation in power between aperiodic and periodic activity, without considering whether or not such assumptions are met. Lagged coherence, the coherence between a signal and itself at increasing temporal delays, has been proposed as a way to quantify the rhythmicity, or periodicity, of a signal. However, current lagged coherence algorithms suffer from poor spectral accuracy and resolution, aliasing effects that become more pronounced at higher frequencies, and conflation with amplitude covariation, especially in frequency ranges in which the signal power is low.

Methods:
We introduce a continuous lagged coherence metric, lagged Hilbert coherence, that addresses these shortcomings by using multiplication in the frequency domain for precise bandpass

filtering, instantaneous analytic signals via the Hilbert transform, and thresholding using the amplitude covariation of surrogate data generated by an autoregressive model.

Results:
We show that this version of lagged coherence yields vastly higher spectral accuracy and resolution that previous versions, and demonstrate how it can be used to 1) examine the relationship between mean frequency-specific rhythmicity and response time, 2) improve parameterization of the aperiodic and periodic components of power spectral densities, and 3) detect the occurrence of transient oscillatory bursts.

Implications:
Lagged Hilbert coherence thus offers a significant toolset advancement for complex neurophysiological spectral analysis.

2.08 – "What" and "when" predictions jointly modulate speech processing
Ryszard Auksztulewicz, Ozan Ödül, Saskia Helbling, Ana Böke, Drew Cappotto, Luo Dan, Jan Schnupp, David Poeppel, Lucia Melloni, Freie Universität Berlin, Germany.

Background:
Forming predictions based on statistical stimulus regularities is essential for adaptive behaviour. Such regularities pertain not only to stimulus contents ("what") but also their timing ("when"), and both can interactively modulate sensory processing. In speech streams, predictions can be formed at multiple hierarchical levels, both in terms of contents (e.g. single syllables vs. words) and timing (e.g., faster vs. slower time scales). It is unknown if the brain integrates these predictions in a hierarchically specific way (e.g., faster "when" predictions selectively modulating "what" predictions of single syllables), and if prediction integration at different hierarchical levels relies on dissociable neural correlates.

Methods:
We manipulated "what" and "when" predictions at two levels – single syllables and disyllabic artificial words – while neural activity was recorded using magnetoencephalography (MEG) in healthy volunteers (N=22). We analysed event-related fields evoked by syllable and/or word deviants, focusing on their modulation by "when" predictability. We used source reconstruction and dynamic causal modelling to explain the observed effects in terms of the underlying effective connectivity.

Results:
"When" predictions modulated "what" mismatch responses in a hierarchically specific way. However, these modulations were shared across hierarchical levels in terms of the spatiotemporal distribution of MEG signals. Effective connectivity analysis showed that the integration of "what" and "when" predictions selectively increased connectivity at relatively late processing stages, between the superior temporal gyrus and the fronto-parietal network.

Discussion:
These results suggest that the brain integrates different predictions with a high degree of mutual congruence, but in a shared and distributed cortical network. This contrasts with recent studies indicating separable networks for different levels of hierarchical speech processing.

2.09 – Corticomuscular connectivity in amyotrophic lateral sclerosis
Katie Yoganathan, Michael Trubshaw, Irene Echeverria-Altuna, Oliver Kohl, Thanuja Dharmadasa, Nahid Zokaei, Andreas Themistocleous, Charlotte Stagg, Mark Woolrich, Anna C Nobre, Kevin Talbot, Alexander G. Thompson, Martin R. Turner, University of Oxford, United Kingdom.

Background:
Amyotrophic lateral sclerosis (ALS) is a fatal neurodegenerative disorder of the motor neuronal system spanning cortex to muscle. Biomarkers are needed to serve as outcome measures in therapeutic trials. We examined corticomuscular coherence (CMC) via MEG, as a more holistic motor system biomarker of disrupted neural dynamics in ALS.

Methods:
In an ongoing study, data from 25 ALS patients and 30 healthy age-matched controls (HC) were analysed. Participants completed 120 bilateral and 60 unilateral trials of a gripper task during MEG. CMC was calculated for each trial type, and group comparison via cluster-based permutation testing.

Results:
During bilateral contraction, ALS patients showed significantly reduced beta-band CMC in the motor cortex. A reduction of CMC between cortex and contralateral muscle was also evident when considering its topographical distribution. In both groups, coherence was localised to the same contralateral motor channels, but was considerably weaker in ALS. No significant differences were found in grip strength, ipsilateral CMC, mean beta power, interhemispheric coherence, or right-hand task CMC. However, the ALS left-hand task showed a significantly reduced contralateral beta-band CMC, with localised weaker coherence in the motor channels. This was independent of handedness, site and side of symptom onset or grip strength.

Discussion:
Independently of grip strength, a localised CMC reduction is associated with ALS, potentially with unexpected pathological lateralisation. Beta-band CMC was easily acquired in physically disabled individuals and is an attractive potential biomarker for the assessment of therapeutic potential in drug screening studies.

2.10 – Effects of remifentanil and midazolam on processing auditory stimuli
Elena Stylianopoulou, Sharmila Khot, Gavin Perry, Rasha Hyder, Neeraj Saxena, Krish D. Singh, Cardiff University, United Kingdom.

Background/Aims:
Remifentanil and midazolam are well-known sedative drugs used in anaesthesia. The former is a short-acting opioid analgesic drug, whereas the latter is part of the family of benzodiazepines. Auditory mismatch negativity (MMN) is the component of the event-related potential (ERP) induced by deviant auditory stimuli occurring in a sequence of regular stimuli. The principal theory suggests that MMN reflects auditory sensory memory and is an index of pre-attentive information processing. Here, for the first time, we measured the MMN using magnetoencephalography (MEG) while remifentanil or midazolam was administered to participants to reveal drug specific effects on network connectivity within the brain.

Methods:
Participants were 18 fit and healthy male adults between 18-43 years old. A passive auditory oddball task was used to elicit MMN during two MEG sessions. In each session, participants were presented with standard and deviant tones, before and after mild sedation using one of the two sedative drugs. Sensor and source level connectivity analysis will be conducted, to investigate differences in functional connectivity during the MMN task in contrast to the two drugs, as well as before and after sedation. Given the different mechanisms of action of the two drugs, we anticipate they will have differential modulatory profiles on the task-relevant networks involved in the MMN. Benzodiazepines have been shown to reduce the MMN oddball response, whilst evidence for remifentanil is mixed, with some evidence for an increased response.

Discussion/implications:
Knowing more about how the two sedative drugs can influence processing of auditory stimuli

during the MMN task could offer important clinical insights and a better understanding of whether MMN can be used as a marker for sedation level, under different sedative agents, via their modulation of task-based functional connectivity.

2.11 – Relating attention deficits to the neural basis of attention during tasks
Ashley C. Goneso, Jan Novak, Caroline Witton, Johanna M. Zumer, Aston University, United Kingdom.

Alpha oscillations have been demonstrated to link to attention in many attention-demanding tasks (e.g. Jensen & Mazaheri, 2010). However, the majority of 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. The overall goal of this study is to uncover the neural sources relating to control of attention in children (age 8-11), those both with and without ADHD. By using MEG, this study aims to localise sources relevant in an attention-demanding working memory task (e.g. Lenartowicz et al., 2014) as well as neural connectivity during the same task, and link this to 'standard' measures used in clinical ADHD research, such as resting-state connectivity, theta-beta ratio, performance on a clinically valid Continuous Performance Task (CPT) and questionnaire scales. This poster will present preliminary data. Future work within this project will aim to link functional connectivity (from MEG) to structural connectivity (DTI) and assess test-retest reliability.

2.12 – Co-varying eye movements and power modulations of alpha oscillations during working memory: a pilot study
Arne D Hansen, Dawid Strzelczyk, Lea Z M Bächlin, Nicolas Langer, Tzvetan Popov, University of Zurich, Switzerland.

A common assumption in Cognitive Neuroscience is that brain rhythms vary with task-specific cognitive demands and reflect the neural support of the cognitive operation performed. Power modulations of alpha oscillations are consistently related to working memory (WM). However, there is an inconsistency in the literature regarding the direction of this association between alpha power and WM load: some findings suggest an increase while others suggest a decrease. To shed light on this topic, a pilot study (N=10) was conducted using the Sternberg and N-back task. The study aimed to explore whether different gaze patterns during these tasks could predict variations in alpha power. The preliminary findings revealed that the relationship between alpha power and WM load varied depending on the variability of participants' oculomotor actions. Specifically, when participants exhibited higher variability in their eye movements, there was a stronger decrease in alpha power with increasing WM load and lower variability was associated with a weaker decrease. These preliminary results suggest that variations in alpha power with WM load, and power modulations more generally, may primarily serve to support oculomotor control, rather than solely reflecting the cognitive demands of the task.
Furthermore, the study identified several other noteworthy preliminary conclusions. There was a close relationship between gaze patterns and alpha power modulation during WM, indicating that eye movements and alpha oscillations are intricately linked. Higher WM load was associat-ed with a stronger reduction in alpha power and increased gaze variability. The modulation of posterior alpha power with WM load displayed significant inter-individual variability.
These findings will be used as the basis for a larger study (N=90) which will provide valuable insights into the role of oculomotor actions in the dynamics of alpha power during working memory tasks.

2.13 – The resting-state cortical signature of amyotrophic lateral sclerosis
Michael Trubshaw, Chetan Gohil, Katie Yoganathan, Oliver Kohl, Evan Edmond, Malcolm Proudfoot, Alexander G Thompson, Kevin Talbot, Charlotte Stagg, Anna C Nobre, Mark Woolrich, Martin R Turner, University of Oxford, United Kingdom.

Background:
Amyotrophic lateral sclerosis (ALS) is a fatal adult-onset neurodegenerative disorder of the motor system characterised by progressive muscle weakness. It involves widespread cerebral extra-motor as well as motor pathology, including cortical hyperexcitability with paired-pulse transcranial magnetic stimulation. Biomarkers are needed to provide trial outcome measures that are more sensitive than disability or survival, against which to screen potentially therapeutic drugs.

Methods:
Ten minutes of resting state MEG were recorded in ALS (n=36) and healthy controls (n=51), followed by a structural MRI scan for co-registration. Extracted metrics from 52 regions and 6 frequency bands (δ, θ, α, β, γ, high-γ) included static power, amplitude envelope correlation (connectivity), 1/f exponent and Higuchi fractal dimension (complexity), which were entered into a permutations-based general linear model with correction for multiple comparisons.

Results:
The ALS group showed lower cortical sensorimotor β and higher high-γ power. Greater disability was associated with increased δ, θ and high-γ global connectivity, increased fractal dimension and a lower 1/f exponent. Increases in temporal connectivity were driven by intra-hemispheric hyperconnectivity, whereas frontal and occipital connectivity increases were driven by global hyperconnectivity.

Discussion:
Resting state MEG identified key elements of a cortical neurophysiological signature for ALS. The combined findings of reduced β power, increased γ power and increased complexity metrics are compatible with the existing hypothesis that the loss of inhibitory GABAergic interneurons is a key feature of pathogenesis. Increased connectivity may represent compensatory responses to a failing motor system. MEG has potential to provide early sub-clinical biomarkers of therapeutic benefit in ALS.

2.14 – Investigating Foveal and Parafoveal Object-Categorization in Visual Exploration
Camille Fakche, Ole Jensen, University of Birmingham, United Kingdom.

Background:
Investigating natural vision in settings where participants can saccades is becoming increasingly important. Here, we investigate the categorization of visual objects during natural viewing, characterized by frequent eye movements. Human saccades occur every ~250 ms, leaving only ~150 ms for foveal processing and planning the next saccade. The extent to which a parafoveal object is processed before we saccade to it remains unknown. Serial processing models posit that parafoveal processing occurs only when the foveated object has been processed, while parallel processing proposes that foveal and parafoveal objects are processed simultaneously. These two mechanisms predict varying degrees of processing of parafoveal previewing before saccade onset. Using Multivariate Pattern Analysis (MVPA), we investigate in which detail a parafoveal object is processed.

Methods:
We used a free-viewing paradigm with naturalistic equidistant images, from different categories (animal, food, object) there were displayed in greyscale or in colors. After a mask, the images were presented once more, except one that has been replaced and had to be identified. 36 participants performed the task while eye movements and brain activity were acquired

respectively with an eye tracker and magnetoencephalography (MEG). MVPA was conducted to classify feature (greyscale vs color) and semantic (category) characteristics of objects in the fovea and parafovea.

Results:
Preliminary results suggest that feature and semantic information can be extracted at the fovea during natural vision. We are currently exploring the decoding of parafoveal information. The time courses and the source-level analysis of the classification results will allow the reconstruction of the processing of foveal and parafoveal objects along the visual hierarchy.

Conclusion:
In sum, our study will provide a stronger neuroscientific understanding of human's ability to explore visual scenes efficiently in daily life.

2.15 – Network-level properties that underlie neural synchronisation in the acute psychedelic state
Kenneth Shinozuka, Joana Cabral, Francesca Castaldo, Robin Carhart-Harris, Morten Kringelbach, University of Oxford, United Kingdom.

Background/Aims:
Psychedelic drugs have shown great promise for treating a number of psychiatric conditions, such as depression and anxiety, but the underlying brain mechanisms that subserve their therapeutic potential are still unknown. In this study, we apply a biophysical Hopf bifurcation model of MEG oscillations (Cabral et al., 2022) to shed light on the network properties that drive previously-observed changes in neural synchronization on psychedelics (Muthukumaraswamy et al., 2013; Carhart-Harris et al., 2016).

Methods:
We analysed an existing MEG dataset in which the psychedelic LSD was administered to 17 healthy participants (Carhart-Harris et al., 2016). In particular, we determined the values of the free parameters (global coupling strength and mean conduction delay) that optimised the fit between the Hopf bifurcation model and the data, for both the placebo and LSD conditions. We also computed the metastable oscillatory modes (MOMs) – clusters of strongly synchronised regions – at this optimal point in parameter space and measured the differences in summary metrics, such as duration, size, and fractional occupancy, between the placebo and LSD conditions.

Results:
We detected significant differences in MOM properties between conditions. That is, LSD strongly reduced the duration, size, and fractional occupancy of MOMs in all the measured frequency bands (theta, alpha, beta, gamma). These changes could be explained by changes in global model parameters, namely an increase in the mean conduction delay and coupling strength.

Discussion:
The results not only align with but also explain previous findings of broadband desynchronisation in the acute psychedelic state, as observed in MEG. They suggest that psychedelics may exert their characteristic effects on human brain activity by slowing down connectivity and diminishing the influence of local synchronisation.

2.16 – Investigating Gamma Oscillations in Children with Autism Spectrum Disorders during Visuomotor Processing
Kyung-min An, University of Birmingham, United Kingdom.

Background:
Autism spectrum disorders (ASD) are neurodevelopmental conditions characterized by difficulties in social communication and interaction, restricted interests, and repetitive behaviours. Sensory and motor difficulties are also common in the majority of children with ASD, affecting more than 80% of individuals. However, our understanding of the neural mechanisms associated with sensorimotor processing in children with ASD is limited.

Methods:
We recruited 18 children diagnosed with ASD (mean age = 6.00 years, SD = 0.59, 5 females, 13 males) and 19 typically developing (TD) children matched based on age and IQ (mean age = 5.71 years, SD = 0.46, 4 females, 15 males). We designed a child-friendly video game-like motor task, where participants had to press a button in response to a visual target while we recorded their brain activity using a child-customized MEG system.

Results:
We observed significant gamma power increases at 70 to 90 Hz and 0 to 100 ms period following the button response onset in the primary motor cortex (M1) and gamma power increases at 50 to 60 Hz and 150 to 450 ms period following the visual target onset in the bilateral cuneus in both TD and ASD groups. We identified statistically significant differences in motor-related gamma power in the right M1 ($t = 2.412$, $p = 0.021$), but not in the left M1, but not in visual gamma power within the bilateral cuneus between the two groups. Furthermore, we conducted correlation analyses to investigate the relationship between visual and motor gamma power increases. Within the TD group, we discovered significant negative correlations between visual and motor gamma power specifically within the left hemisphere ($\rho = -0.553$, $p = 0.014$). However, such correlations were not observed within the ASD group.

Discussion:
These findings might provide compelling evidence for distinct neural mechanisms underlying varied patterns of visuomotor processing in individuals with ASD.

2.17 – Burst Characteristics of Oscillatory Rebounds following Working Memory and Movement

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The post-movement beta rebound, as measured with MEG, has neuroscientific and clinical importance. This is the most widely studied example of a “post-task response” (PTR), i.e., a response that occurs in between periods of task and rest. We recently reported PTRs in MEG following cessation of working memory processes, using an n-back task. These responses occurred across the cortex in theta, alpha and beta bands, scaled with working memory load, and left lateral visual alpha PTR correlated with reaction times.
This study aims to determine whether PTRs following higher cognitive processes are driven by the same underlying phenomenon as the post-movement beta rebound. This was addressed by performing a burst analysis using a hidden Markov model (HMM), a technique shown to be effective in characterising bursts. Using a univariate HMM, we compare PTRs in the n-back dataset with a visuomotor dataset. Using k-means clustering of states across 78 AAL regions, we identify a PTR state in both tasks from the average HMM state probability timecourse. Binary HMM timecourses were visually compared to single-trial time-frequency responses to verify that PTRs are driven by transient bursts. Bursts were characterised in terms of burst duration and spectral content, comparing region-wise variation of the PTR state across tasks. Results show that both burst duration and spectral content in the PTR state show remarkable similarity across tasks, with alpha and beta content of bursts across brain regions correlating strongly between tasks ($R^2 = 0.89$, $R^2 = 0.53$, for alpha and beta, respectively), as well as burst durations ($R^2 = 0.56$). Burst durations had a mean of 310 ms and 320 ms for n-back and visuomotor tasks. These results suggest that PTRs induced by different cognitive processes may be driven by the

same underlying neural phenomenon, which, based on previous evidence, may serve a self-stabilising inhibitory function to bring active networks back to rest following task cessation.

2.18 – Comparison of resting-state EEG and MEG in detecting the effects of healthy aging
SungJun Cho, Mats van Es, Chetan Gohil, Mark W Woolrich, University of Oxford, United Kingdom.

Background:
Aging is a significant risk factor for many neuropsychiatric disorders. To properly assess the impact of these conditions against controls, a comprehensive understanding of healthy aging is necessary. While the effects of healthy aging have been widely investigated in the resting-state networks (RSNs) of EEG and MEG, a formal comparison of these modalities in capturing such effects remains lacking.

Methods:
In this study, we qualitatively compared M/EEG-driven static and dynamic brain network features to characterise how each modality represents age-related neural differences. We used openly available EEG LEMON and MEG CamCAN datasets to compute power spectra, power spatial maps, and functional connectivity (FC) of the whole-brain RSNs from 86 young (20-35 years) and 29 old (55-80 years) participants.

Results:
Our findings indicate that MEG outperforms EEG in revealing static and dynamic differences between age groups. While our analysis of static power spectra unveiled comparable frequency ranges with age effects in MEG and EEG, only MEG demonstrated spatially localised age effects in source space. Furthermore, when examining dynamic network features in source space, MEG exhibited a greater number of network states with between-group power and FC differences compared to EEG. Nonetheless, our results do not suggest dismissing EEG, as it identified spectral and spatial age effects that do not overlap with those of MEG, implying the potential presence of distinct but complementary information within each modality.

Conclusion:
Our study, therefore, proposes that the distinction between EEG and MEG should be carefully considered when interpreting the results of aging studies while recognising the complementary potentials of these modalities. Future studies combining the two will be instrumental in identifying how aging influences changes in healthy and diseased brains, leading to a more concrete picture of neuropsychiatric disorders associated with aging.

2.19 – Task-induced changes in 1/f slope of aperiodic activity
Fahimeh Akbarian, Chiara Rossi, Miguel D'haeseleer, Marie B D'hooghe, Guy Nagels, Jeroen Van Schependom, Vrije Universiteit Brussel, Belgium.

Background:
Multiple sclerosis (MS), a neurodegenerative disease characterized by inhibitory and excitatory synaptic loss, imposes working memory (WM) impairment. The 1/f slope has recently been hypothesized to provide an accessible marker of E/I ratio. In this study, besides the well-known oscillatory alpha suppression during WM tasks, we explored the task-induced variations in non-oscillatory component particularly the 1/f slope (indicating the steepness of the 1/f power-law component). We also hypothesized that healthy subjects (HC) have a higher level of inhibition (steeper 1/f slope) after distractor stimuli compared to MS patients.

Methods:
MEG data were recorded from 38 HC and 60 MS patients during a visual-verbal n-Back task which includes 0, 1 and 2-back conditions. Data were preprocessed using the OSL library and

source reconstructed using an LCMV beamformer and then parceled into 42 parcels. We used the FOOOF algorithm to estimate the 1/f exponent and correct the power spectra by subtracting the non-oscillatory component. We used non-parametric statistics to compare the 1/f slope and periodic alpha power over the whole brain and then re-done at the parcel level before analysing the spatial structure.

Results:
Besides the alpha suppression, as expected we observed a steeper 1/f slope after both target and distractor stimuli onset. In line with our hypothesis, the 1/f slope was steeper after the distractor stimuli in HC as compared to MS patients, suggesting a higher level of inhibition of distractor stimuli in HC subjects which is important for optimal WM performance in all three conditions (p(0-back)=0.043, p(1-back)=0.02, p(2-back)=0.043). We also observed a significant correlation between 1/f slope changes and visuospatial working memory performance measured by the Brief Visuospatial Memory Test.

Conclusion:
Our results suggest that the 1/f slope variations may serve as a potential biomarker to monitor the WM performance during visuospatial WM task.

2.20 – Beta desynchronisation and movement pre-ordering during sequence planning in individuals with dyspraxia/DCD
Helena Wright, Katja Kornysheva, University of Birmingham, United Kingdom.

Dyspraxia/Developmental coordination disorder (DCD) is characterised by an impairment in the acquisition and performance of motor skills. End-state comfort research suggests the motor deficit is related to planning of movement sequences; but it is unclear what component of planning is affected. Neurophysiology and behavioural findings in controls show that movements in a sequence are pre-ordered in parallel, and the strength of pre-ordering, known as competitive queuing (CQ), predicts the accuracy of performance. This is accompanied by movement-related beta desynchronisation (MRBD) during planning and execution. This study aimed to build on our behavioural results, which found a reduced CQ of movements during planning, to examine the neural mechanisms of sequence planning in adults with DCD. Participants who took part in the preceding behavioural learning study were reinvited to perform finger sequences from memory in the Magnetoencephalography (MEG) scanner after a refresher of the delayed sequence production task. We used multivariate linear discriminant analysis of whole-head MEG activity patterns associated with the execution of each finger press to quantify the relative pattern probability of each press position during planning. Based on the behavioural data it is expected that the DCD group will show a weaker neural CQ gradient, i.e. reduced pre-ordering of press-related patterns during planning. Additionally, we hypothesise that the DCD group will have a higher beta power during baseline and a less pronounced MRBD compared to controls, particularly during planning, based on results in motor-impaired stroke and Parkinson's disease patients. Critically, the study aims to tease apart effects related to performance from group, by looking at performance-matched trial analysis. This will promote understanding of the neural basis of disorderly motor planning in DCD and prepare interventions that target the neural organisation of memory-guided sequential movements.

2.21 – MEGqc – an automated and standardized quality control workflow for MEG BIDS data
Aaron Reer, Evgeniia Gapontseva, Jochem W. Rieger, University of Oldenburg, Germany.

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 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.

2.22 – Critical-like bistable dynamics characterize Alzheimer's disease progression

Ehtasham Javed, Sheng H Wang, Isabel Suárez-Méndez, Gianluca Susi, Matias Palva, Fernando Maestú, Satu Palva, University of Helsinki, Finland.

Background/Aim:
Recent studies support the central role of synaptic loss leading to excitation/inhibition (E/I) imbalance, which prompts subclinical epileptiform activity as the primary initiator of Alzheimer's disease (AD), and consequently neural network dysfunction. The classic brain criticality hypothesis posits that neuronal systems operate in the vicinity of continuous phase transition, regulated by E/I balance. This provides brain with optimal dynamic range, which is essential to healthy cognition and behaviour. However, due to positive feedback —a slow parameter in addition to E/I— neurons show bistable activity, demonstrating discontinuous phase transition. It is suggested that moderate and elevated degree of bistability in ongoing neuronal oscillations were predictive of cognitive performance in healthy adults and neuropathology in epilepsy and geriatric subjects, respectively. Taken that since there is growing evidence of presence of subclinical epileptiform activity in patients of AD that can hasten cognitive decline, we aim to characterize such events with bistability analysis and provide mechanistic understanding of disease progression.

Methods:
We analysed resting-state MEG data recorded from 85 preclinical (SCD: Subjective Cognitive Decline), 142 prodromal (MCI: Mild Cognitive Impairment), 14 AD patients, and 116 healthy controls (HC). MNE estimated sources were collapsed into 400 parcels with a fidelity-optimized operator. Parcel broadband data were then filtered with 32 wavelets within a range of 2–90 Hz and bistability (BiS) indices were estimated.

Results:
We found aberrant BiS for SCD, MCI and AD compared to HC over the spectrum of 7–40 Hz. Importantly, BiS differentiated early disease stages and had frequency specific between-cohort differences.

Conclusion:
The results suggest BiS already alters at the early stages of AD and progressively alters with disease progression, and potentially be utilized as a biomarker for AD diagnosis and prognosis.

2.23 – MEG resting-state coupling co-varies with neurotransmitter receptor and transporter density

Felix Siebenhühner, J. Matias Palva, Satu Palva, University of Helsinki, Finland.

Background & Aims
Inter-areal coupling of neuronal oscillations is essential for regulation of neuronal processing and communication. Oscillatory activity in the brain is affected by neuromodulatory systems which exhibit regional specificity in afferent connections, receptor distributions, and neurotransmitter reuptake regulation. Here, we set out to investigate how frequency-specific coupling of neuronal oscillations covaries with the spatial distributions of NT receptors and transporters in the human cortex.

Methods
We computed phase-and amplitude-coupling in source-reconstructed human magnetoencephalography (MEG) data from 67 healthy subjects in frequencies from 1 to 96 Hz and estimated the covariance of local coupling strength with the density of 19 NT receptors and transporters across 200 cortical parcels. We further used principal component analysis (PCA) to identify common structures shared between these receptor and transporter density maps.

Results
Local strengths of large-scale phase and amplitude coupling strongly covaried with receptor and transporter densities across brain areas in a frequency-specific manner. Specifically, we found that dopaminergic, GABA, NMDA, muscarinic, and most serotonergic densities were positively correlated with local strength of both phase- and amplitude coupling in delta and gamma bands, and negatively in high-alpha and beta bands. In contrast, in theta and low-alpha bands, phase and amplitude node strengths showed more distinct coviance with receptor densities. PCA revealed several distinct anatomical patterns underlying the distribution of receptor and transporter densities, which also covaried with coupling strength.

Implications
Our findings indicate that oscillatory activity and coupling between neuronal oscillations are likely influenced by fundamental neuroarchitectionical principles underlying the distribution of NT receptors and transporters.

2.24 – Practice-induced reductions in Gamma power in Response to Proper Name Anomia Therapy in people with dementia: An MEG Study

Aygun Badalova, Tae Twomey, George O'Neill, Alex Leff, University College London, United Kingdom.

Objective
Proper name anomia is a common language deficit observed in people with dementia (PWD), impacting their ability to recall and retrieve the names of familiar people. We investigated the neural changes associated with a 6-week, app-based, proper-name anomia therapy in PWD using MEG.

Methods
14 PWD with proper name anomia were recruited. Following baseline assessment, patients underwent a structured 6-week proper-name anomia therapy program using a novel app called Gotcha! Participants were trained to name 6-10 familiar faces (usually their relatives and close friends), using confrontation naming and audio cueing methods. MEG recordings were obtained at two time points: pre- and post-therapy while PWD were presented with pictures of the familiar or untrained famous faces, which they named aloud. MEG data were analysed in SPM. We measured source localised gamma-band (30-80 Hz) power 0-1000 ms after the onset of a face. We ran a 2×2 factorial analysis (familiar/famous; pre-/post-therapy) on our source images using a repeated-measures ANOVA to look for changes in power across conditions. The behavioural data

was analysed using a repeated-measures ANOVA with named faces during free-naming as the dependent variable.

Results
Behavioural data analysis revealed that a significant effect of training (post>pre), F(1,14)=8.79, p=0.01. For the MEG analysis, we identified a large cluster situated in the left ventral temporal lobe (MNI: -50 -28 -26, F=9.19, p=0.004, k=813) where gamma reduction was associated with training (pre>post) of familiar faces, but not (untrained) famous faces.

Discussion
This is the first study to demonstrate that the left ventral temporal lobe supports re-learning for familiar face-name associations in PWD. App-based proper name anomia retraining appears to be an effective therapy for PWD. Initial MEG findings suggest that therapy effects are manifest in areas associated with face-naming.

2.25 – Studying responses to reward and loss in the human Ventral Tegmental Area with simultaneous MEG and intracranial recordings.
Arjun Ramaswamy, Douglas Steele, Harith Akram, Manjit Matharu, Ludvic Zrinzo, Vladimir Litvak, University College London, University of Dundee, United Kingdom.

Abstract: Chronic cluster headaches (CCH) are debilitating conditions often accompanied by mood disorders such as depression. Deep Brain Stimulation (DBS) of the Ventral Tegmental Area (VTA) is an experimental treatment for this group of disorders and provides a unique opportunity to study VTA activity and connectivity using simultaneous MEG and intracranial recordings. In the present study we used a reinforcement learning task to explore VTA responses to reward and loss and their possible correlation with depressive symptoms.

Methods: Fourteen patients with VTA-DBS electrodes for CCH treatment were scanned using MEG. A paradigm was designed, incorporating three outcome types (win, loss, neutral) associated with unique fractal images. Hierarchical behavioural modelling code was developed to capture the dynamics of decision-making, prediction error, and learning. We examined VTA evoked responses to the presentation of trial outcome.

Results: A clear response to the outcome event was detected peaking around 200ms. The early part of this response was correlated with reward prediction error derived from behavioural modelling.

Conclusions and future work: The investigation of reward prediction errors in the VTA is critical, as it could reveal potential therapeutic DBS targets for depression and mood disorders comorbid with CCH. Understanding the underlying neural mechanisms is vital in advancing treatments for both cluster headaches and general mood disorders like depression. We will next look for correlation between the magnitude or VTA response to reward and depression severity. We would expect the correlation to be negative in line with the suggestion that depression is associated with decreased reward sensitivity. We will also look for MEG sources that could be upstream or downstream relative to VTA in the reward processing sequence.

2.26 – Predicting individual traits from models of brain dynamics using the Fisher kernel
Christine Ahrends, Mark Woolrich, Diego Vidaurre, Aarhus University, Denmark.

Predicting an individual's cognitive traits or clinical condition using brain signals is a central goal in modern neuroscience. This is commonly done using either structural aspects, or aggregated measures of brain activity that average over time. But these approaches are missing the unique ways in which brain activity unfolds over time. The reason why these dynamic patterns are not usually taken into account is that they have to be described by complex, high-dimensional

models; and it is unclear how best to use information from these models for a prediction. We here propose an approach that describes dynamic frequency-specific power- and phase-coupling patterns using a Hidden Markov model (HMM) and combines it with the Fisher kernel, which can be used to predict individual traits. The Fisher kernel is constructed from the HMM in a mathematically principled manner, thereby preserving the structure of the underlying HMM. In this way, the unique, individual signatures of brain dynamics can be explicitly leveraged for prediction. The model is generally applicable to neuromaging and non-invasive electrophysiological data, including MEG. In summary, our approach makes it possible to leverage information about an individual's brain dynamics for prediction in cognitive neuroscience and personalised medicine.

2.27 – Stacking models of brain dynamics improves prediction of subject traits
Ben Griffin, Christine Ahrends, Mark Woolrich, Stephen Smith, Diego Vidaurre, University of Oxford, United Kingdom.

Background/Aims:
Beyond structural and static connectivity brain measures, the way brain activity dynamically unfolds can add important information when investigating individual cognitive traits. One approach to leverage this information is to infer on generative models of brain network dynamics and, from the model fits, extract features that can predict individual traits. However, there can be two potential sources of variation in these predictions. First, in certain cases, the run-to-run variability (e.g., due to different initialisations); and second, the variability induced by the choice of the model hyperparameters that determine the complexity of the model.

Methods:
To improve prediction accuracy, we propose an approach that leverages the useful aspects of this variability —in the sense of carrying complementary information rather than being the mere result of statistical noise— by combining predictions from different models and runs. Specifically, we use stacking to combine predictions from multiple models of brain dynamics to generate predictions that are accurate and robust across multiple cognitive traits.

Results:
We demonstrate the approach by describing dynamic frequency-specific power- and phase-coupling patterns using the Hidden Markov Model, and show that the use of stacking can significantly improve the accuracy and robustness of subject-specific phenotype predictions.

Discussion/conclusions/implications:
Looking forward, stacking predictions opens up avenues for integrating a wider variety of data or models that may improve predictions further, for example combining predictions generated using data from different brain imaging modalities, as well as static functional connectivity and structural information. Our model is broadly applicable to neuroimaging and non-invasive electrophysiological data, including MEG. In summary, our approach leverages multiple perspectives of brain dynamics to improve prediction in cognitive neuroscience.

2.28 – Stability of dynamic FC estimates in neuroimaging and electrophysiology
Sonsoles Alonso, Diego Vidaurre, Aarhus University, Denmark.

Introduction:
Understanding human cognition requires mapping brain activity's spatio-temporal structure. Time-varying functional connectivity (FC) methods are popular for describing statistical coupling changes in the brain. However, some existing methods suffer from unstable estimations across data runs. To address this, we propose two robust approaches based on Hidden Markov Models (HMMs): Best-Ranked HMM (BR-HMM) and Hierarchical Cluster HMM (HC-HMM).

Methods:
We applied the BR-HMM and HC-HMM to fMRI (100 subjects; 4800 timepoints per subject) and MEG (10 subjects; ≈72500 timepoints per subject) datasets. The HMM characterized concatenated timeseries as state activations, with each state representing a pattern of FC. For the MEG dataset, HMM was applied to power (band-limited to 8-12 Hz). BR-HMM involved running the model multiple times and selecting the best-ranked run based on free energy values. HC-HMM applied hierarchical clustering on state timeseries from multiple runs.

Results:
Both BR-HMM and HC-HMM showed significantly higher similarity scores (≈[0.85-0.95]) for fMRI and MEG datasets compared to individual runs (≈0.6), indicating improved stability. The BR-HMM approach required more runs for fMRI, while HC-HMM achieved high stability with fewer runs. For MEG, both approaches were comparable. However, when the lowest free-energy runs exhibited variations within the same HMM decomposition, the simpler BR-HMM approach was effective in capturing the dynamics, while the added complexity of HC-HMM may affect its performance.

Conclusions:
Despite HMM's stochastic nature, our proposed approaches reliably captured momentary changes in FC for fMRI and MEG. BR-HMM offers higher stability scores but can be computationally costly. HC-HMM provides a more affordable solution. These methods yield stable and reliable estimates of time-varying FC, facilitating our understanding of neural processes and cognitive functions.

2.29 – What drives a hidden Markov model decomposition of brain data?
Laura Masaracchia, Diego Vidaurre, Aarhus University, Denmark.

Unsupervised, data-driven methods are commonly used in neuroscience to automatically decompose data into interpretable patterns. These patterns differ from one another depending on the assumptions of the models. How these assumptions affect specific data decompositions in practice, however, is often unclear, which hinders model applicability and interpretability. For instance, the hidden Markov model (HMM) automatically detects characteristic, recurring activity patterns (so-called states) from time series data. States are defined by a certain probability distribution, whose state-specific parameters are estimated from the data. But what specific features, from all of those that the data contain, do the states capture? That depends on the choice of probability distribution and on other model hyperparameters. Using both synthetic and real MEG data, we aim to better characterize the behavior of two HMM types that can be applied to electrophysiological data. Specifically, we study which differences in data features (such as frequency, amplitude, or signal-to-noise ratio) are more salient to the models and therefore more likely to drive the state decomposition. Overall, we aim at providing guidance for the appropriate use of this type of analysis on electrophysiological data and an informed interpretation of its results given the characteristics of the data and the purpose of the analysis.

***2.30 – An adversarial collaboration to critically evaluate theories of consciousness: activation and synchronisation in MEG**
Oscar Ferrante, Ole Jensen, Ling Liu, Huan Luo, COGITATE Consortium, University of Birmingham, United Kingdom.

Understanding the neuronal mechanisms supporting consciousness is a fundamental question in neuroscience. Several competing theories have been proposed. To accelerate research, the predictions of these theories should be tested together under a common framework. This is the aim of COGITATE, an adversarial collaboration testing predictions from Global Neuronal Workspace (GNW) and Integrated Information Theory (IIT).

Here we tested two predictions made by the two theories regarding activation and inter-areal communication using MEG. Participants were presented with visual stimuli that were undoubtedly consciously perceived. GNW predicted a phasic activation in prefrontal cortex at both stimulus onset and offset, while IIT predicted content-specific sustained activation in posterior cortex during stimulus presentation. Additionally, GNW predicted stronger synchronization between prefrontal and category-selective areas in the "ignition" time window, whereas IIT predicted sustained synchronization between early visual cortex and category-selective areas.
The results indicated the presence of the predicted sustained alpha activity in posterior cortex. Furthermore, we observed the predicted late phasic ignition in prefrontal cortex at stimulus offset in the alpha band. However, this result was not supported by control analyses. Concerning phase-synchronization, neither the frequency band nor the temporal patterns of connectivity were consistent with the predictions of either theory.
By integrating our MEG results with other neuroscientific techniques (fMRI, intracranial EEG) and testing additional theoretical predictions (e.g., decoding of conscious content), we will get more conclusive evidence supporting or refuting the two theories and to clarify how consciousness arises in the human brain.

2.31 – Variability in visual processing owes to cognitive context but is largely stable across time

Laura B Paulsen, Christine Ahrends, Laura Masaracchia, Francesca Fardo, Diego Vidaurre, Aarhus University, Denmark.

Understanding visual perception involves gaining knowledge of its temporal dynamics, stability and dependency on the participant's cognitive state and context. However, in many cognitive electrophysiological studies participants are typically measured during a single experimental session, which restricts the investigation of processing variations over time scales longer than a few hours. We acquired and analysed a unique MEG dataset containing recordings from one adult subject. The dataset comprises data from 11 scanning days over the course of over 5 months in which the subject was instructed to mentally perform (with no behavioural output, and with exactly equal stimulus input) either a memory or visual task, thus enabling investigation of the influence of both cognitive context and temporal variations on visual processing. Temporal generalisation matrices were obtained using linear decoders. Context-related processing differences were explored through the training of a decoder to discriminate between memory and visual tasks. Additionally, decoders were trained for each session to discriminate between animate and inanimate trials. Their performance was evaluated by testing them on the other sessions, enabling investigation into how decoders trained on one task perform on the other. To investigate how processing of visual stimuli varies over time we compared decoding generalisation across sessions as a function of how far away in time are such sessions. Evidence of context-dependent differences in processing visual stimuli was found, but decoding was shown to be very robust across days or even months. In conclusion, our findings highlight the main differences in visual stimulus processing, with cognitive state (task) playing a significant role, while time appears to have little to no influence. However, validation across multiple participants is necessary to corroborate these results.

2.32 – Altered Cortical Microstates in 22q11 Deletion Syndrome

Luke Tait, Joanne Doherty, Marianne van den Bree, David Linden, Michael Owen, Krish D Singh, Cardiff University, United Kingdom.

Background/Aims:
22q11 deletion syndrome (22q11ds) is a genetic condition caused by a deletion along chromosome 22. Common cognitive and psychiatric symptoms include learning disabilities, attention deficit hyperactivity disorder (ADHD), autism, and adulthood schizophrenia. MEG

studies of children with 22q11ds have demonstrated altered static power and functional connectivity patterns which reflect those seen in adults with schizophrenia and correlate with cognitive scores. The dynamic sub-second activation of discrete functional networks (microstates) have also widely been shown to be altered in people with schizophrenia and are known to correlate with different domains of cognition, yet cortical microstates have not been studied in 22q11ds. Here we apply a recently published approach to source-space MEG cortical microstate analysis to uncover how dynamic cortical networks are altered in 22q11ds.

Methods:
Resting-state MEG and cognitive test scores were collected from 10-18 year-old participants with 22q11ds (N=35) and sibling controls (N=25). MEG cortical microstate analysis was performed and microstate statistics calculated using the +microstate toolbox.

Results:
Microstates were identified reflecting resting-state networks and previously published MEG cortical microstates in normative controls. A range of statistics including activation patterns, frequency content, and transitioning statistics differed between participants with 22q11ds and controls, and correlated with cognitive test scores.

Discussion:
Our results suggest that the activation and transitioning of dynamic cortical networks are altered in children with 22q11ds and are correlated with their cognitive and psychiatric symptoms. Microstate analysis uncovered altered brain dynamics in 22q11ds that were complementary to static connectivity and power analysis, suggesting the use of MEG cortical microstates may give novel insight into psychiatric and neurological disorders.

2.33 – Predicting subject traits from M/EEG spectrograms using kernel mean embedding
Cecilia Jarne, Ben Griffin, Diego Vidaurre, Aarhus University, Denmark.

Predicting subject traits from data is crucial for understanding cognitive processes, brain disorders, diseases and normal ageing. In this work, we propose a mathematically principled method to predict subject traits from M/EEG spectrograms. The idea is to interpret a spectrogram as a probability distribution and apply the Kernel Mean Embedding of distributions, a powerful kernel-based approach that takes probability distributions as inputs. Focusing on both accuracy and robustness, we demonstrate its use and improvement for age estimation over a baseline method like ridge regression by leveraging the HarMNqEEG dataset—a multinational compilation of EEG recordings—, which we assessed using leave-one-country-out cross-validation. Our method shows key insights, such as identifying brain regions with larger effects on ageing and intriguing gender-related patterns. We observed that for both genders, the frontotemporal region presents a slightly higher ageing impact than the other regions. In general, men exhibit a more pronounced effect than women. These results are consistent with previous studies based on MRI, indicating that the more pronounced ageing effects are observed in the healthy brain for men than for women. Remarkably, our approach can be used for broader cross-modal applications, including MEG data. This study advances M/EEG-based age prediction and underscores the versatility and efficacy of our proposed method.

2.34 – "Transforming" the neuroscience of language: Estimating pattern-to-pattern transformations of brain activity
Olaf Hauk, Rebecca L Jackson, Setareh Rahimi, University of Cambridge, United Kingdom.

An important aspect of the brain processes underlying language and cognition is the integration and transformation of information across multiple brain systems. Thus, a detailed characterisation of brain connectivity is key. In order to characterize brain connectivity most

accurately, connectivity methods should make use of the full multivariate and multidimensional information available from neuroimaging data. This should include a characterization of transformations between patterns of activation across brain regions, and their dependence on stimulus features, task and context.
Here, we describe novel methods developments to estimate the multidimensional relationships between patterns of brain activity from different brain regions. In particular, we will highlight their potential to estimate the voxel-to-voxel transformations between these patterns. This opens up opportunities to characterise these transformation with metrics such as sparsity, divergence, convergence, etc. We will specifically focus on methods that are suitable for event-related experimental designs. A few recent studies employed ridge regression to estimate linear transformation matrices. In fMRI data from an object recognition experiment this revealed that transformations between early visual cortex and inferior temporal areas are relatively sparse. In dynamic EEG/MEG data, this approach supported a central role for bilateral ATLs with a wider semantic brain network. The latter results have been confirmed using a nonlinear extension of this method, indicating that linear methods provide an efficient approximation of multidimensional brain connectivity. A multivariate as well as multidimensional extension of this method has also recently been proposed.
We propose methods for analysing pattern transformations in language research in more detail. We illustrate this on simplified examples from the neuroscience of word recognition.

2.35 – Modulation of Subthalamic Deep Brain Stimulation-Induced Cortical Responses and Motor Function Based on the Directionality and Magnitude of Current Administration
Rachel K. Spooner, Baccara Hizli, Bahne H. Bahners, Alfons Schnitzler, Esther Florin, Heinrich-Heine University Düsseldorf, Germany.

Subthalamic deep brain stimulation (STN-DBS) is an effective therapy for alleviating motor symptoms in people with Parkinson's disease (PwP), although some may not receive optimal clinical benefits. One potential mechanism of STN-DBS involves antidromic activation of the hyperdirect pathway (HDP), thus suppressing cortical beta synchrony to improve motor function, albeit the precise mechanisms underlying optimal DBS parameters are not well understood.
To address this, 20 PwP with STN-DBS completed a 2 Hz monopolar stimulation of the left STN during MEG. MEG data were imaged in the time-frequency domain using MNE. Peak vertex time series data were extracted to interrogate the directional specificity and magnitude of DBS current on evoked and induced cortical responses and accelerometer metrics of finger tapping using linear mixed-effects models and mediation analyses.
We observed increases in evoked responses (HDP ~3-10ms) and synchronization of beta oscillatory power (14-30Hz, 10-100ms) following DBS pulse onset in the primary sensorimotor cortex (SM1), supplementary motor area (SMA) and middle frontal gyrus (MFG) ipsilateral to the site of stimulation. DBS parameters significantly modulated neural and behavioral outcomes, with clinically-effective contacts eliciting significant increases in HDP responses, reductions in induced SM1 beta power and better movement profiles compared to suboptimal contacts, often regardless of the magnitude of current applied. Finally, HDP-related improvements in motor function were mediated by the degree of SM1 beta suppression in a setting-dependent manner. Together, these data suggest that DBS-evoked brain-behavior dynamics are influenced by the level of beta power in key hubs of the basal ganglia-cortical loop, and this effect is exacerbated by the clinical efficacy of DBS parameters. Such data may be useful for characterizing DBS programming strategies to optimize motor symptom improvement in the future.

2.36 – Cross-site comparison of visual gamma oscillations using OPM-MEG
Natalie Rhodes, Julie Sato, Marlee Vandewouw, Lukas Rier, Elena Boto, Ryan Hill, Kristina Safar, Margot J. Taylor, Matthew J. Brookes, University of Nottingham, United Kingdom.

OPM-MEG offers sensitive measurement of brain activity in a wearable system, enabling naturalistic movement, lifespan compliance and comfortable scanning environments. Systems have recently been set up in research centres globally, facilitating the opportunity for large collaborative datasets. However, variability between OPM-MEG systems in different laboratories must first be characterised to achieve data harmonization. The present study compares gamma oscillations, a crucial aspect of neural communication and cognition, across OPM-MEG systems in Nottingham, UK (Notts) and SickKids hospital, Canada (SK). 52 healthy adults (24 male, average age 27) were recruited, 26 from each site. Participants passively viewed a visual stimulus (a circularly oscillating grating). Participants wore size-matched rigid 3D printed helmets with 58 triaxial OPM sensors (Notts) or 40 dual-axis sensors (SK). 3D structure scans were taken; one of the head-shape to warp age-matched template MRIs, and one wearing the helmet to coregister sensors to template anatomy. Data were epoched and filtered to the gamma band. Beamformer analysis was conducted on both datasets, generating pseudo-t statistical maps by contrasting task and rest periods. Results revealed increased stimulus induced gamma power, returning to baseline at rest. Average peak frequencies of gamma modulation were measured at 54 Hz in Notts and 56 Hz in SK. The relative change in signal amplitude in the 50 – 60 Hz band was 35% in Notts and 24% in SK. When equivalent channel count was implemented, Notts had peak frequency at 55 Hz and 28% change. This cross-site investigation of human visual gamma oscillations with OPM-MEG provides valuable insights into the reliability of measurement across systems, enabling future collaborative data collection across OPM-MEG sites.

2.37 – Investigating the neural encoding of melodic expectations in polyphonic music
Martin M. Winchester, Charbel Nebo, Kevin Reynolds, Giovanni M. Di Liberto, Trinity College Dublin, Ireland.

The perception of polyphonic music is an effortless and enjoyable task that is made possible by complex neural mechanisms processing multiple musical streams. Previous studies demonstrated that the human brain learns the statistical regularity of a melody and actively attempts to anticipate upcoming notes. The perception and enjoyment of music has been suggested to arise from the combination of the input melody and our expectations, in line with the predictive processing framework. However, there remains considerable uncertainty on how polyphonic music is processed. Here, we tested the hypothesis that our brains can build predictions for multiple melodic streams simultaneously, rather than for just the most salient stream. To this end, we carried out a novel electroencephalography (EEG) experiment involving the natural listening of diaphonic classical music i.e., involving two simultaneous melodic streams. Temporal response functions (TRF) were used to estimate the neural encoding of melodic expectations for the diaphonic streams. Behavioural measures and a control condition were included to determine the most salient stream, allowing us to measure the impact of salience on melodic processing. Further analyses were carried out to discern the acoustic and melodic features driving salience in music.

2.38 – Attentional modulation of beta band power in the motor cortex
Gonzalo Reina, Elena Boto, Ryan M. Hill, Niall Holmes, Lucrezia Liuzzi, Natalie Rhodes, Molly Rea, Richard Bowtell, Matthew J Brookes, University of Nottingham, United Kingdom.

Recent research indicates a correlation between beta band (13-30Hz) modulation and top-down influence, where heightened beta power suggests heightened inhibition. We investigated the effects of attention on beta amplitude using Optically Pumped Magnetometer (OPM) based Magnetoencephalography (MEG). MEG data were collected from 17 healthy participants undertaking a spatially selective tactile attention paradigm (Bauer et al., 2006). Tactile stimulation of the index fingers was achieved using 'braille' stimulators. Participants focused on one hand following a visual cue and identified target patterns presented in subsequent pattern sequences via button presses. 80 trials were conducted, interspersed with rest intervals. Data

acquisition was conducted using a 192-channel OPM-MEG system. For each participant, sensor space time-frequency spectra were calculated, and source space analysis was performed using a linearly constrained minimum variance beamformer to project data onto 78 cortical regions. Task-induced SNR was calculated for each region, and beta envelope analysis compared attended and unattended stimuli (collapsed across hands and participants, excluding response trials). Sensor level results show the expected beta band modulation across stimuli segments. Beamformer analysis identified the postcentral gyrus as having the highest SNR during stimulation, other regions included the inferior and superior parietal lobes, integral for multimodal sensory processing. Further investigation of the beta envelope revealed significantly higher beta band amplitude for non-attended vs. attended stimuli (p=4.01e-5 and 6.97e-5 for left and right motor cortex; Wilcoxon sign rank test), implying beta band modulation is linked to inhibitory mechanisms preventing further action on non-attended stimuli. Our findings support the proposition that beta oscillations serve as markers of top-down inhibition in primary sensory cortices and are susceptible to attentional modulation.

2.39 – Two distinct neural representations of confidence in categorization of a natural image
Xuan Cui, Yaocong Duan, Yuening Yan, Christopher Benwell, Robin Ince, Philippe Schyns, University of Glasgow, United Kingdom.

Metacognition represents evaluation of our own knowledge and behaviours. Deficits or alterations in metacognition have been implicated in a range of cognitive functions and mental health issues, but the neural mechanisms of metacognition in naturalistic tasks remain poorly understood. Metacognitions are typically studied in 2 alternative forced choice (2-AFC) tasks, with simple artificial stimuli varying on a few discrete levels of a one-dimensional feature. To explore metacognition with more ecological validity and reveal the specific visual contents used by individuals, we consider rich sampling of a naturalistic ambiguous image that affords different perceptions in a 3-AFC task.
We apply Bubbles sampling to a naturalistic ambiguous image that affords two perceptions in a 3-AFC task—i.e. perceiving the nuns, the bust of Voltaire, or neither. Bubbles selectively reveal parts of the image randomly on each trial, resulting in a high-dimensional stimulus evidence space while we concurrently recorded MEG. Each participant also rated their confidence in each response. To explore the neural mechanisms of metacognition, we use mutual information (MI) to quantify the trial-by-trial dependence between confidence ratings and MEG responses.
We reveal the critical information for category judgment and confidence and find two distinct neural responses related to confidence: a slow response, visible in the evoked response after 500ms, and an alpha/beta desynchronisation effect between 800-1500ms. Source localisation results show these responses originate from different locations: slow response starts from parietal and then move to occipital sources, alpha desynchronisation mainly in occipital.
Our design enables us to explore metacognition with more ecological validity. Analysis results show that rather than reflecting the same evidence processing, these two neural representations of confidence may reflect different stages of metacognitive evaluation.

2.40 – The MEG & MOG study: Understanding the effect of autoantibodies to myelin oligodendrocyte glycoprotein (MOG) in pediatric acquired demyelinating disease using Magnetoencephalography (MEG)
Daniel Griffiths-King, Charly Billaud, Amanda G. Wood, Evangeline Wassmer, Sukhvir Wright, Elaine Foley, Aston University, United Kingdom.

Background:
Acquired demyelinating syndromes (ADS) disrupt brain connectivity, especially in paediatrics. Autoantibodies to myelin oligodendrocyte glycoprotein (MOG-ab) have been newly identified in proportion of children with ADS with a significantly altered phenotype. We demonstrated MOG-ab +ve ADS to have more favourable cognitive outcomes, compared to seronegative

counterparts.

Aim:
To establish whether the less severe phenotype in MOG-ab +ve ADS can be explained through differences in neurophysiological responses which have been identified as 'atypical' in ADS.

Methods:
To date, n=17 children with ADS have been recruited (n=7 tested positive for MOG-ab) and n=12 healthy controls (HCs). Post-movement beta (14–30 Hz) rebound (PMBR), a motor response following movement cessation, was assessed with a child-adapted visuomotor task. We performed source localisation of greatest difference in beta-band oscillations during the active contrasted against baseline and extracted virtual electrode time-series. Time-frequency spectrograms of beta-band oscillatory power were then used to estimate PMBR neurophysiology (e.g. peak power, latency of peak power). Participants completed structural MRI and cognitive assessment.
Results:
Preliminary analyses (n=7 MOG –ve ADS, n=3 MOG +ve ADS) showed no differences between participants with and without MOG-ab, in behaviour or neurophysiology. We hypothesise, in the larger sample, increased latency in both patient groups compared to controls, which will be lesser in the MOG-ab +ve children, in line with more favourable cognitive outcomes. Exploratory analyses will investigate white matter integrity of corticospinal motor tracts as a potential structural correlate.

Implication:
This research will tease apart the neurophysiological basis of spared cognitive functioning seen in MOG-ab +ve patients, compared to seronegative counterparts. This may therefore identify therapeutic targets to help protect cognition in seronegative ADS.

2.41 – Detection of fetal biomagnetic signals using optically pumped magnetometers
Isabel Gale, Lauren Gascoyne, Ryan Hill, Elena Boto, Niall Holmes, Nia Jones, Vishal Shah, Penny Gowland, Matthew Brookes, University of Nottingham, United Kingdom.

Fetal magnetocardiography (fMCG) has emerged as a non-invasive method of electrophysiological imaging of the fetal heart. Currently, cryogenic systems are one-size-fits-all, and use unnatural scanning positions, making them generally inappropriate for fetal imaging. Optically pumped magnetometers (OPMs) allow for room temperature, on-skin measurements of the fetal heart in a flexible array of sensors that can conform to the individual mother's abdominal geometry. The aims of this work are to show the ability of OPMs to detect fMCG, and extract clinically useful information: signal morphology, fetal heart rate variation (FHRV) and movement detection. Fetal biomagnetic activity data were collected by QuSpin OPMs (16-35 sensors). Six subjects were scanned, between 32-35 weeks gestational age (GA), with one subject additionally scanned at 19 and 28 GA, providing 22 datasets. Sensors were secured to subjects via plaster of Paris 'bump casts'. 10 minute recordings were taken from subjects sitting down. Movement felt by the mother was recorded. Independent component analysis was used to separate the fetal and maternal cardiac signals and an R-peaks extraction algorithm applied. The quality of the recordings were quantified by peak amplitudes and signal-to-noise ratio (SNR). R-peaks were used to perform FHRV analysis. OPMs were able to successfully detect the fMCG in all cases with GA > 32 weeks. The quality of the fMCG signals are sufficient for clinical applications. Movement was felt by mother in 14/22 datasets, and correlations between perceived movement and changes in FHRV observed. In the early GA scans, the fetal fMCG is undetectable at 19 weeks GA, and detectable at 28 weeks GA, showing the emergence of a sufficiently strong fetal heart signal between 19 and 28 weeks GA. OPMs can successfully detect the magnetic field signals originating from the fetal heart, and hold significant potential for clinical applications whilst being adaptable to fit a range of subjects.

2.42 – The effect of Alzheimer's disease on pyramidal cells
Juliette H Lanskey, Amirhossein Jafarian, Melek Karadag, Ece Kocagoncu, Andrew J Quinn, Jemma Pitt, Ana Klimovich-Gray, Vanessa Raymont, Krish D Singh, Mark Woolrich Anna C Nobre, Richard N Henson, James B Rowe, University of Cambrigde, United Kingdom.

Alzheimer's disease affects neurophysiology by loss of neurones, synapses and neurotransmitters. A mechanistic understanding of the human disease will facilitate new treatments. Recent developments in biophysically-informed dynamic causal models enable inferences around laminar and cell-specific disease effects from human non-invasive imaging. Based on pre-clinical models and effects of cholinesterase inhibitors, we hypothesised that Alzheimer's disease would affect superficial pyramidal cell gain and extrinsic connectivity in hierarchical cognitive networks.
Magnetoencephalography was recorded during a mismatch negativity (MMN) task from healthy adults (n=15) and people with symptomatic Alzheimer's disease or mild cognitive impairment (n=47, amyloid-biomarker positive) at baseline and 16 months. Fifteen people from the patient group had repeat magnetoencephalography at two weeks. We inverted MMN responses to dynamic causal models. Second-level parametric empirical Bayes of the dynamic causal models examined the effect of group and progression (baseline vs follow-up) on pyramidal cell self-inhibition and extrinsic connectivity.
Sensor data confirmed the effect of disease and progression (patients vs controls, T=-1.80, p=0.04; patient baseline vs follow-up, T=-1.82, p=0.03) and reliability of the mismatch negativity amplitude (ICC=0.94, p<.001). Parametric empirical Bayes revealed that there is strong evidence (posterior probability>95%) in Alzheimer's disease of reduced connectivity between pyramidal cells and reduced superficial pyramidal cell gain which changed further during follow up.
Dynamic causal models confirmed that reduced pyramidal cell gain and connectivity can explain the observed physiological effect of Alzheimer's disease. This approach to non-invasive magnetoencephalography data may be used for experimental medicine studies of candidate treatments and bridge clinical to preclinical models of drug efficacy.

***2.43 – Reaching to Understand the Neural Correlates of Tremor Variability During Naturalistic Movement: A High-Density Neuroimaging Study in Essential Tremor Patients**
Timothy O. West, Kenan Steidel, Tjalda Flessner, Marielle J. Stam, Deniz Kucukahmetler, Meaghan Spedden, Ryan Timms, Tabish Saifee, Simon Farmer, Gareth Barnes, David Pedrosa, Hayriye Cagnan, University of Oxford, United Kingdom.

Background:
Essential tremor (ET) manifests in pathological tremors that vary with factors such as stress and motor demands. This study investigates the brain circuits governing these variations in a cohort of patients and healthy controls, to identify oscillatory biomarkers associated with endogenous tremor suppression that have the potential to be leveraged by brain stimulation therapies.

Methods:
The first cohort included 12 ET patients and 12 age-matched controls (using 128 channel EEG) and a second cohort including 4 controls/3 ET patients (using OPM/MEG). Brain signals, electromyography (EMG), and kinematics were recorded during a cued, whole limb reaching task using high-density neuroimaging, employing a 2×2 design (high vs low uncertainty cues; small vs large targets). Dynamic Imaging of Coherent Sources (DICS) was used to localize sources modulated by motor demands as well as sources in the brain that were synchronized to tremor activity.

Results:
In controls and patients, both response times and reach duration were modulated by cue uncertainty and target size (ANOVA (21) $P < 0.001$). Tremor amplitude was suppressed by ~10%

when reaching for small targets (T-test (12), P < 0.05). Beta band (14-30 Hz) movement related synchronization was localized to the supplementary motor cortex (SMA). For small targets, beta resynchronization was significantly slowed. Increased motor precision elicited increases in gamma power that was most clear in OPM recordings (permutation test (5), P< 0.01) and localized to the posterior parietal cortex.

Discussion/Conclusions/Implications:
Recordings of brain activity with OPMs during large scale, whole limb movement reflects a novel achievement and are well validated against EEG data recorded using the same task. This work shows that activity across physiological beta/gamma bands are responsive to changes in motor demands during whole limb reaching and begins to untie how they co-modulate with tremor in pathologies such as ET.

2.44 – Using the Hurst exponent to reveal changes in brain activity following mild traumatic brain injury

Alice E Waitt, Iman Idree, Waheeda Hawa, Kirandeep Kaur, Gerard Gooding-Williams, Sergey Sergeyev, Paul L. Furlon, Caroline Witton, Aston University.

Background/Aims:
The Hurst exponent is a simple autocorrelation measure describing self-similarity or long-range dependence in timeseries data. In other words, it evaluates whether the observed deviations as part of a dynamical system are substantially outside the normal state of balanced criticality. It is increasingly being applied in neuroscience, in the context of scale-free brain networks, and has shown promise as a method for localising epileptogenic zones in patients awaiting neurosurgery.
Changes in brain architecture resulting from brain damage, as well as brain diseases, are known to interfere with the dynamics of neuronal activity; this is often seen in the form of abnormal slow waves or other deviations from expected patterns of oscillatory activity.
In this study, we aim to explore the potential of the Hurst exponent to quantify deviations from healthy brain activity in MEG data from patients who have suffered a mild traumatic brain injury (mTBI) and characterise its natural variability in adult controls.

Methods:
Resting state MEG data from the current study were used to produce a broad-band beamformer source model, reconstructing the timeseries for every voxel in the brain. The Hurst exponent was computed for each voxel to produce a volumetric map, which enables the quantification of regional and localised deviations in neurological dynamics for both control and patient groups.

Results:
We present group comparisons to determine whether the Hurst exponent can dissociate healthy brain activity in controls from the disturbed activity and abnormal neurological features seen in data from mTBI patients.

Implications:
Since these alterations in brain dynamics are typically associated with significant behavioural and quality-of-life changes, finding methods to quantify them and distinguish from other diagnoses with overlapping symptoms (e.g. depression) has clinical value. Using algorithms like the Hurst exponent could thus be incorporated in future diagnostic tools.

2.45 – On the similarities of representations in artificial and brain neural networks for speech recognition

Li Su, University of Cambridge, University of Sheffield.

Background:
In recent years, machines powered by deep learning have achieved near-human levels of performance in speech recognition. The fields of artificial intelligence and cognitive neuroscience have finally reached a similar level of performance, despite their huge differences in implementation, and so deep learning models can, in principle, serve as candidates for mechanistic models of the human auditory system.

Methods:
Utilizing high-performance automatic speech recognition systems, and advanced non-invasive human neuroimaging technology such as magnetoencephalography and multivariate pattern-information analysis, the current study aimed to relate machine-learned representations of speech to recorded human brain representations of the same speech.

Results:
In one direction, we found a quasi-hierarchical functional organization in human auditory cortex qualitatively matched with the hidden layers of deep artificial neural networks (DNN) trained as part of an automatic speech recognizer. In the reverse direction, we modified the hidden layer organization of the artificial neural network based on neural activation patterns in human brains. The result was a substantial improvement in word recognition accuracy and learned speech representations.

Discussion:
We have demonstrated that artificial and brain neural networks can be mutually informative in the domain of speech recognition. The neurocomputational function of superior temporal gyrus regions is akin to later layers of the DNN, computing complex auditory features such as articulation and phonemic information. On the other hand, “reverse-engineering” human learning systems implemented in brain tissue in such a bidirectional fashion provides a complementary approach in developing and refining DNN learning algorithms.

2.46 – Solving large-scale MEG/EEG source localisation and functional connectivity problems simultaneously using state-space models

Jose Sanchez-Bornot, Roberto C. Sotero, J. A. Scott Kelso, Özgür Şimşek, Damien Coyle, Ulster University.

State-space models are widely employed across various research disciplines to study unobserved dynamics. Conventional estimation techniques, such as Kalman filtering and expectation maximisation, offer valuable insights but incur high computational costs in large-scale analyses. Sparse inverse covariance estimators can mitigate these costs, but at the expense of a trade-off between enforced sparsity and increased estimation bias, necessitating careful assessment in low signal-to-noise ratio (SNR) situations. To address these challenges, we propose a three-fold solution: 1) Introducing multiple penalised state-space (MPSS) models that leverage data-driven regularisation; 2) Developing novel algorithms derived from backpropagation, state-space gradient descent, and alternating least squares to solve MPSS models; 3) Presenting a K-fold cross-validation extension for evaluating regularisation parameters. We validate this MPSS regularisation framework through lower and more complex simulations under varying SNR conditions, including a large-scale synthetic MEG data analysis. In addition, we apply MPSS models to concurrently solve brain source localisation and functional connectivity problems for real event-related MEG/EEG data, encompassing thousands of sources on the cortical surface. The proposed methodology overcomes the limitations of existing

approaches, such as constraints to small-scale and region-of-interest analyses. Thus, it may enable a more accurate and detailed exploration of cognitive brain functions.

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