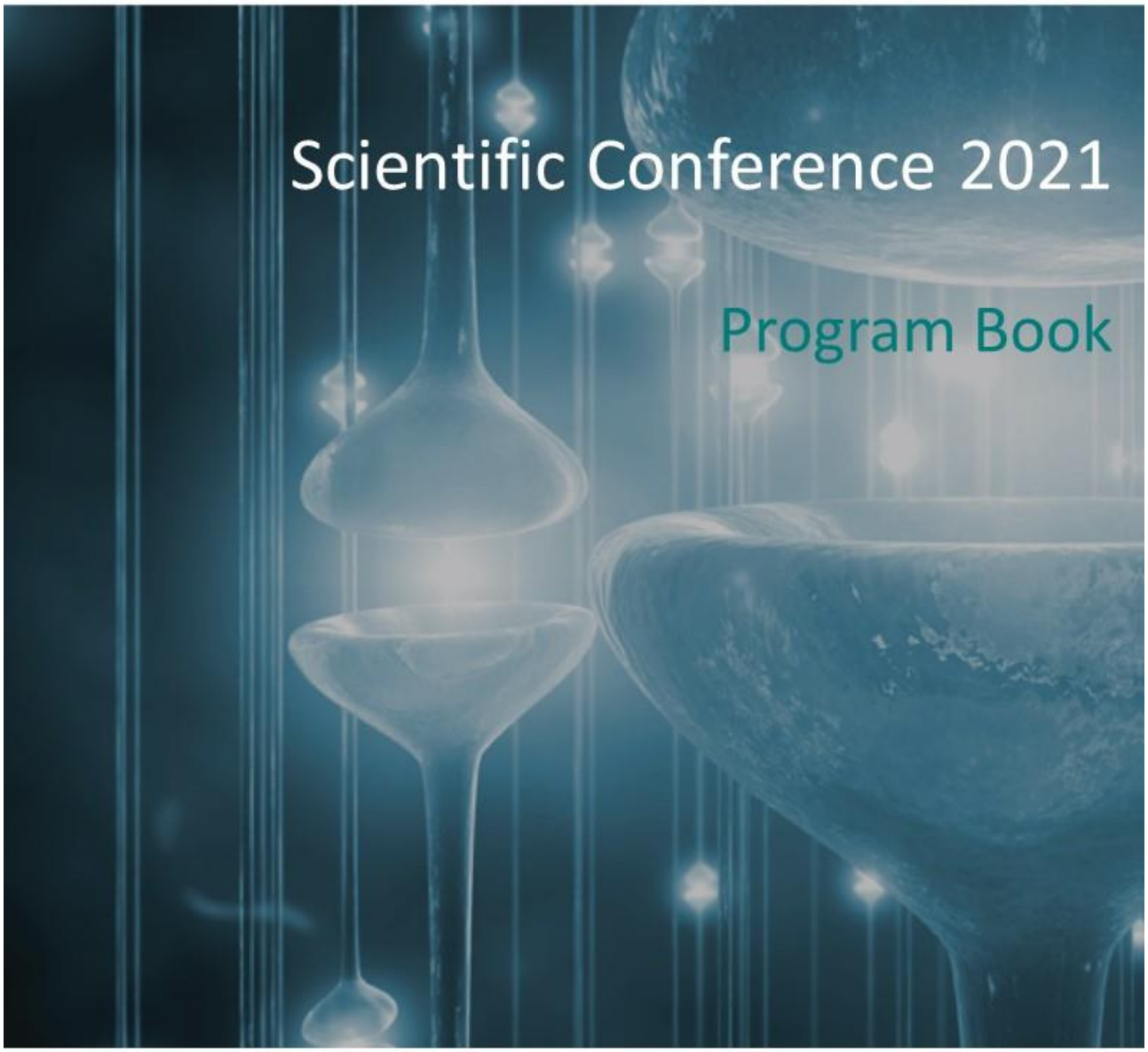
abss | Australasian Brain Stimulation Society



ABSS2021
12 – 15 JULY 2021 - ONLINE

Contents

Welcome
to ABSS2021 Online

On behalf of the organising committee and the Australasian Brain Stimulation Society executive, it is my pleasure to e-welcome you to ABSS2021Online.

Following two highly successful Australasian Brain Stimulation Meetings in 2013 and 2016, the Australasian Brain Stimulation Society (ABSS) officially launched in late 2018. The society was established with several key aims, including promoting brain stimulation, fostering collaboration, supporting students and EMCRs, and providing professional development. In the last two and half years ABSS has worked hard to achieve these aims despite the extraordinary circumstances. During 2020, to help our community stay connected and support each other we launched a series of initiatives, namely the ABSS Collaborative Networks, Student and ECR Network, and Mentoring Program. We also ran several webinars throughout 2020, which were well attended and received positive feedback from the membership. The ABSS Executive Committee, ABSS officers and the membership have worked hard and engaged across all these activities, and I am very grateful that collectively we have been able to keep our community connected throughout this time. And, of course, 2020 meant that we needed to pivot our two-day in person conference to ABSS2021Online.

I want to thank the organising committee for their tireless work in organising what I'm sure will be a fantastic meeting. I'd also like to thank our conference sponsors for their support and flexibility, which greatly facilitated the transition to the online conference format. The Program sets out a stellar series of presentations and events over the next four half days. We are thrilled to welcome four outstanding keynote speakers, two international and two national, ABSS award winners, selected presenters, panellists, and all attendees to ABSS2021Online.

We very much look forward to your participation throughout the conference, and hope you find it enjoyable, informative, and inspiring.

Professor Kate Hoy
President, Australian Brain Stimulation Society

ABSS Committee 2021

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President

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Co-Chair

Dr Ann-Maree Vallence
Co-Chair

Genevieve Kieseker

Nick Bland

Yohan Wards

Brittany Rurak

Dr Manreena Kaur

We would like to thank Dr Li-Ann Leow and Dr Claire Bradley for their contribution to the ABSS meeting planned for Brisbane, July 2020.

General Information

Australasian Brain Stimulation Society

The Australasian Brain Stimulation Society (ABSS) was founded in 2018. The ABSS is made up of a diverse group of researchers, scientists, and clinicians from across Australasia. Our goal is to promote excellence in scientific research and clinical practice using brain stimulation, in order to advance our understanding of the brain and improve wellbeing for people with psychiatric or neurological illness.

The purposes of ABSS are to:

- Promote the understanding and use of brain stimulation in scientific research and clinical practice.
- Foster communication and collaboration between research groups and clinical groups across Australasia who use brain stimulation.
- Support students, early/mid-career researchers, and clinicians who use brain stimulation.
- Provide opportunities for high quality education and training of members.
- Convene regular meetings of members and facilitate workshops on the use of brain stimulation.

ABSS is committed to ensuring equitable participation that is representative of the diversity of our field across all its activities.

Event Code of Conduct

ABSS is committed to providing a safe and enjoyable event experience for all participants, and a welcoming environment for free discussion of ideas. We do not tolerate harassment of event participants in any form. If you are being harassed, notice that someone else is being harassed, or have any related concerns, please immediately contact anyone on the ABSS Committee.

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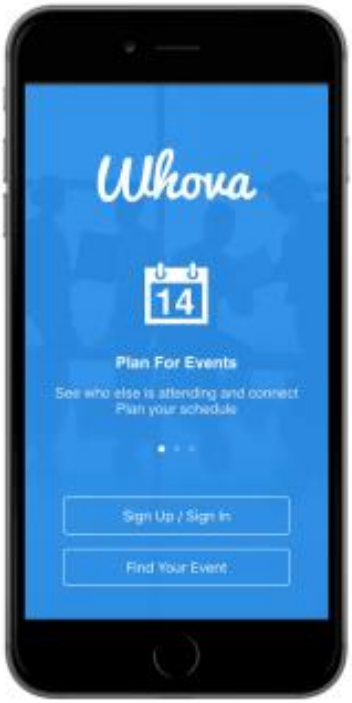

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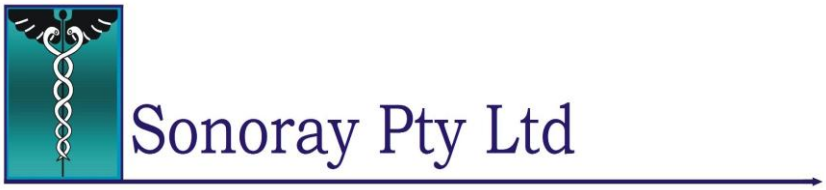
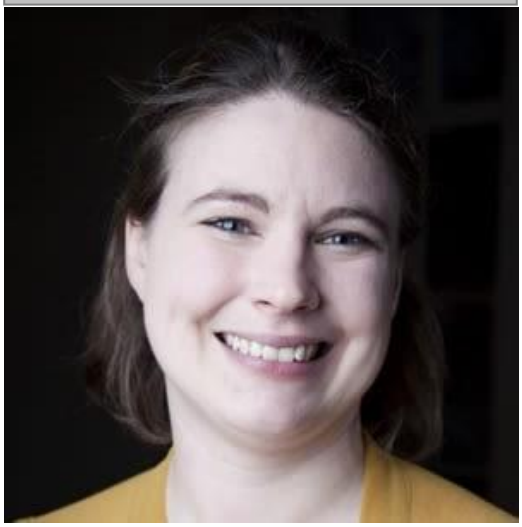


International Keynote Speaker

Prof Charlotte Stagg

University of Oxford



Biography

Charlotte Stagg is Professor of human neurophysiology at the Nuffield Department of Clinical Neurosciences at the university of Oxford. She leads the Physiological Neuroimaging Group and is interested in understanding how the brain adapts to new challenges, focusing in particular in the physiological processes underlying the learning of new motor skills and in the recovery of motor function after stroke.

Her lab takes a multimodal approach to answer these questions, using advanced magnetic resonance approaches, magnetoencephalography, non-invasive brain stimulation and pharmacological agents. Their multidisciplinary team works on a wide variety of projects, with the ultimate aim of developing novel therapies to improve function in a range of neurological disorders.

Medilink International Keynote

12 July 2021: 3:30 pm – 4:15 pm (AEST)

International Keynote Speaker

A/Prof Flavio Frohlich

University of North Carolina

Biography

Flavio Frohlich is currently a tenured Associate Professor in the Departments of Psychiatry and Cell Biology and Physiology at University of North Carolina. In addition, he is a member of the UNC Neuroscience Center and holds adjunct appointments in Biomedical Engineering and Neurology. He is also adjunct associate professor of electrical and computer engineering at North Carolina State University and Adjunct Professor of neurology at the University of Bern in Switzerland.

Flavio's goal is to revolutionize how we treat psychiatric illnesses. His vision is that understanding brain network activity will enable the development of novel diagnosis and treatment paradigms. Flavio is convinced that such rational design of neurotherapeutics will open the door for individualized, highly effective brain stimulation in psychiatry. Flavio is passionate about combining different methodological approaches to scientific problems and is a pioneer in the field of network neuroscience. His research integrates neurobiology, engineering, and medicine.

The Frohlich Lab performs computer modeling, combines electrophysiology, imaging, brain stimulation, and behavioral assays in animal models, records and modulates human brain activity, and studies new treatments in randomized controlled clinical trials. Flavio is the director of the Carolina Center for Neurostimulation, which integrates brain stimulation research and clinical care.

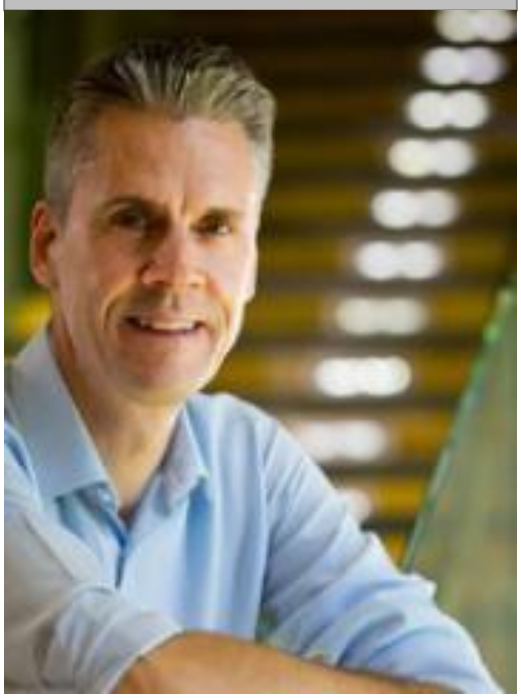
International Keynote

15 July 2021: 9:00 am – 9:45 am (AEST)

National Keynote Speaker

Prof Jason Mattingley

University of Queensland



Biography

Professor Mattingley's research investigates how the brain gives rise to perception, cognition and motor behaviour, in health and disease. He has examined this issue across a range of domains, from the initial filtering and prioritisation of sensory information to object recognition processes, multisensory interactions, executive control and action planning.

Studies conducted in his laboratory also focus on implicit and explicit learning, cognitive training, and the role of attention and neural oscillations in brain plasticity. He seeks converging evidence from multiple empirical techniques, including behavioural measures in healthy participants and neurological patient groups, brain imaging and brain stimulation techniques.

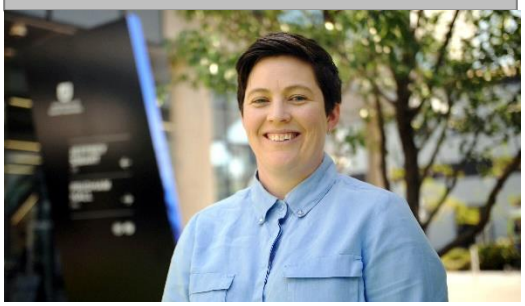
Symbiotic Devices National Keynote

13 July 2021: 11:30 am – 12:15 pm (AEST)

National Keynote Speaker

Dr Ashleigh Smith

University of South Australia



Biography

Dr Ashleigh Smith is an emerging research leader whose research is positioned at the nexus of neuroscience, exercise physiology and cognitive ageing. She has held consecutive research fellowships since 2013 and is leading a national interdisciplinary team, which has recently been awarded a Boosting Dementia Research Grant worth $1,2 million.

She has set up an exercise focussed neurophysiology laboratory equipped with state of the art equipment, such as single and repetitive pulse transcranial magnetic stimulation (TMS), electroencephalography (EEG), exercise equipment and virtual and augmented reality technologies. Her research has been supported by the ARC, NHMRC and Alzheimer's Australia, totalling more than $3 million.

Dr Ashleigh Smith is a member of the Alliance for Research in Exercise Nutrition and Activity (ARENA), whose research vision is to develop targeted and sustainable physical interventions, to improve health, across the lifespan.

In 2017, her research excellence and outstanding community engagement in science was recognised with a South Australian Young Tall Poppy Award.

Sonoray National Keynote

14 July 2021: 1:00 pm – 1:45 pm (AEST)

2021 ABSS Early Career Researcher Award

Dr Brenton Hordacre

University of South Australia

Biography

Dr Hordacre is a clinician and academic with expertise in neurorehabilitation technologies to enhance quality of life. He has a PhD in Neurorehabilitation and was employed as a post-doctoral researcher in Stroke Neurophysiology at the University of Adelaide from 2015-2017. In 2017, Dr Hordacre was awarded an NHMRC Early Career Fellowship (2017-20) at the University of South Australia. Since 2021, Dr Hordacre has been employed as a Senior Lecturer in Physiotherapy.

His research program involves: 1) Understanding neural mechanism by which new therapeutic technologies can improve human behaviour, 2) Testing new solutions to enhance neurorehabilitation in clinical trials, and 3) Implementing therapeutic technologies into clinical practise through his Technology Clinic at UniSA.

Dr Hordacre has expertise in neuroimaging and neurophysiological techniques to investigate the human brain. He has tested, or currently evaluating, the therapeutic potential of novel interventions such as brain stimulation for neuromodulation, rehabilitation robotics, virtual/augmented reality, gamified rehabilitation and brain computer interfaces. As evidence of his capacity to translate research to clinical practise, his Technology Clinic at UniSA now offers therapeutic treatments with brain stimulation for people in the community living with post-stroke depression.

ECR Award Presentation

14 July 2021: 3:15 – 3:45 pm (AEST)

2021 ABSS Best PhD Thesis Award

Dr Mana Biabani

Monash University

Mana completed her PhD in 2019 at Brain and Mental Health Research Hub at Monash University, under the supervision of Dr. Nigel Rogasch and Prof. Alex Fornito. Her PhD focused on advancing methodological approaches in non-invasive brain stimulation research with the aim of maximising the potential of transcranial magnetic stimulation (TMS) to study neural mechanisms including excitation and inhibition. Mana's PhD work mainly focused on the dynamics of motor circuits following TMS. After her PhD, she received Monash Bridging Fellowship to employ the methods that she developed to characterise the cortical responses to TMS over non-motor regions and provide an advanced picture of neurophysiological mechanisms underlying brain responses to TMS by combining it with neuroimaging techniques, cognition and genetic assessments. In 2021, she joined Prof. Mark Bellgrove's lab at Turner Institute for Brain and Mental Health to extend her work to clinical contexts and use brain stimulation and neuroimaging techniques to establish the causal influence of attention on perceptual decision making in patients with Attention Deficit Hyperactivity Disorder (ADHD).

Best PhD Thesis Award Presentation

14 July 2021: 3:45 – 4:15 pm (AEST)

Program and abstracts

12 July 2021 – program

1:00 pm - 1:15 pm	Welcome A/Prof Martin Sale and Dr Ann-Maree Vallence
1:15 pm - 2:15 pm	Sympoisum: Personalised brain stimulation in psychiatry - recent developments Chairs: A/Prof Andrew Zalesky and Dr Robin Cash
	A/Prof Andrew Zalesky: University of Melbourne
	Dr Robin Cash: University of Melbourne
	Bhedita Seewoo: University of Western Australia
	A/Prof Luca Cocchi: QIMR Berghofer Medical Research Institute
2:15 pm - 3:05 pm	Neurophysiology of learning and cognitive function Chair: Dr Hakuei Fujiyama
	Jessica Michael (10 min) Transdiagnostic EEG correlates of Attentional Control in Anxiety: A systematic review and implications for treatment development.
	Dr Tribikram Thapa (10 min) No evidence for changes in GABA concentration, functional connectivity, or working memory following continuous theta burst stimulation over dorsolateral prefrontal cortex.
	Dr Joshua Hendrikse (10 min) The effects of multi-day rTMS on functional connectivity and associative memory performance.
	Genevieve Kieseker (10 min) Transcranial Direct Current Stimulation to the Bilateral Dorsolateral Prefrontal Cortex Does Not Facilitate Hazard Perception Skill Acquisition.
	Dr Donel Martin (10 min) Targeting the Left Dorsolateral Prefrontal Cortex for Transcranial Magnetic Stimulation using a Cognitive Task.
3:05 pm - 3:30 pm	BREAK and MEET THE SPONSORS - meet the sponsors at the Community hub on Whova
3:30 pm - 4:15 pm	**Medilink International Keynote: Prof Charlotte Stagg** *Oscillations and inhibition: towards an understanding of the neurophysiology of motor learning* . Chair: Prof Janet Taylor

12 July 2021 – abstracts

1:15 pm - 2:15 pm	Sympoisum: Personalised brain stimulation in psychiatry - recent developments Chairs: A/Prof Andrew Zalesky and Dr Robin Cash

Symposium Overview. Repetitive transcranial magnetic stimulation (rTMS) has gained increasing interest for its capacity to directly target and modulate aberrant neurocircuitry in treatment resistant psychiatric disorders, especially depression. Brain stimulation targets have been informed and guided by neuroimaging since its clinical inception. It has become increasingly clear that the prefrontal cortex is particularly heterogenous across individuals and that response rates depend on precisely where rTMS is administered. Concurrently, rTMS has become increasingly conceptualized as a network therapy – although stimulation is typically applied to a single brain region, its effects are mediated via distributed networks. Advances in mapping brain networks now allow us to identify the connections underpinning treatment effects and establish an optimal TMS target. We illustrate evidence, derived from rodent and human studies, for lasting effects of TMS on brain networks and how these are understood to mediate treatment response. We discuss new opportunities to personalize TMS interventions using neuroimaging and computational modeling, and by applying an improved basic understanding of mechanisms, aiming to optimize treatment to suit particular individuals and clinical subgroups. We demonstrate that it is now possible to robustly and precisely pinpoint personalised connectivity-based cortical stimulation targets and that clinical response is significantly better when patients are treated closer to their personalized connectivity-based cortical target. Our speakers will present different approaches in neuroimaging and discuss the relative merits to facilitate the development of targeted interventions for psychiatric disorders. Attendees will also be provided with practical advice for translation of these methods into basic research and clinical practice.

Abstract: A/Prof Andrew Zalesky
School of Medicine and Engineering, The University of Melbourne.
Overview of personalized brain stimulation therapies for psychiatric disorders.

Mounting evidence suggests that personalization of neural stimulation therapies such as transcranial magnetic stimulation (TMS) and Deep Brain Stimulation (DBS) can improve efficacy and treatment outcomes. I will introduce some of the key neuroimaging modalities that enable treatment personalization. Neuroimaging can be used to identify individualized circuit-based targets that account for inter-individual variation in brain morphology, connectivity and network architecture. I will specifically focus on personalization based on structural and functional connectivity derived from functional and diffusion-weighted MRI, respectively, and briefly consider alternative neuroimaging modalities that can be used to optimize and personalize neural stimulation therapies. I will show how whole-brain circuit maps can be derived from these modalities and how these maps can be utilized to identify optimal stimulation targets as well as optimize other parameters of a stimulation protocol. This talk will provide the necessary background for the subsequent talks that will focus on specific clinical studies on personalization of neural stimulation therapies in psychiatry.

Abstract: Dr Robin Cash
School of Medicine and Engineering, The University of Melbourne.
Toward state-of-the-art personalised brain stimulation: precision, feasibility and relation to clinical outcome.

Mounting evidence suggests that antidepressant response to TMS depends on functional connectivity with the subgenual cingulate cortex (SGC) at the precise stimulation site. Critically, SGC functional connectivity shows considerable interindividual variation across the spatial extent of the dorsolateral prefrontal cortex, providing a strong

rationale for connectivity-based target site personalisation. However, recent research indicated that determination of person-specific connectivity-based TMS targets was not feasible (Ning et al., 2018). To bridge this translational gap, we developed novel methodology that enables personalised connectivity-based cortical stimulation targets to be pinpointed with high (millimetre) accuracy. We validated this methodology in MRI scans acquired across 1000 healthy adults. We further showed that personalised targets were heritable, suggesting that connectivity-guided rTMS personalisation is stable over time and under genetic control. We then demonstrated, via retrospective analysis of a clinical sample, that TMS antidepressant outcomes were better when individuals were serendipitously treated closer in proximity to personalised targets. Our findings have since been independently replicated. Various lines of evidence now suggest that personalised rTMS has the potential to be clinically transformative in the treatment of psychiatric disorders.

Abstract: Bhedita Seewoo

School of Biological Sciences, The University of Western Australia.

Combined rTMS/MRI studies in animal models to study lasting effects of rTMS.

There is increasing concern surrounding the interindividual variability in response to rTMS. I will discuss the importance of investigating the underlying mechanisms of rTMS in preclinical animal studies to understand these sources of variability and how they may be overcome to develop tailored treatments for specific individuals and neuropsychiatric disorders. A key challenge is to align the different experimental approaches used in human (non-invasive: MRI, PET, TMS and behavioural) and preclinical studies (invasive: cellular and molecular outcomes). Our research uses low-intensity (LI) rTMS to preserve focality of stimulation in the small rodent brain and applies multimodal MRI methods to link our understanding of cellular and molecular mechanisms to brain changes that are clinically relevant. We have recently shown that a single session of LI-rTMS in healthy rats has frequency-specific effects on functional connectivity that are similar to those described in humans following rTMS. When delivered daily for 2 weeks, 1 Hz LI-rTMS had subtler but opposite and longer-lasting effects on functional connectivity and neurometabolite levels than 10 Hz stimulation. We have also validated the chronic restraint stress (CRS) model of depression in rats using MRI measures. We observed increased depression- and anxiety-like behaviours, dysfunctional connectivity in several RSNs, neurometabolite imbalance, hippocampal atrophy, microstructural disruption in the white matter and demyelination of the corpus callosum after CRS in rats. Importantly, these abnormalities reflect the pathological changes reported in human depression. Several of these changes were restored by repeated delivery of an accelerated protocol of 10 Hz LI-rTMS. These correlational measures may suggest how to improve personalised rTMS treatment protocols and outcomes.

Abstract: A/Prof Luca Cocchi

QIMR Berghofer Medical Research Institute, Brisbane, AUS

Focal neural perturbations reshape the brain activity flow supporting cognition.

Brain functions are supported by the neural activity of specialised brain regions as well as macroscopic brain networks. The neural mechanisms that link changes in neural activity in specialised regions, with the emergence of large-scale brain network dynamics remain largely unknown. This knowledge is essential to understand how information flows across brain regions, as well as guide new brain stimulation interventions aiming to restore brain networks dysfunctions supporting psychiatric illnesses. In this talk, I will present the results of a new multimodal study assessing the context-specific effects of a targeted perturbation in neural activity to whole-brain network dynamics underpinning behaviour. In closing, I will briefly discuss the implications of these findings to targeted and personalised brain stimulation.

12 July 2021 – abstracts (cont'd)

2:15 pm - 3:05 pm | Neurophysiology of learning and cognitive function
Chair: Dr Hakuei Fujiyama

Transdiagnostic EEG correlates of Attentional Control in Anxiety: A systematic review and implications for treatment development.

Jessica A. Michael[a], Michael Wang[a], Manreena Kaur[a,b,c], Paul B. Fitzgerald[a], Bernadette M. Fitzgibbon[a1], Kate E. Hoy[a1]

a Epworth Centre for Innovation in Mental Health, Epworth Healthcare and Department of Psychiatry, Monash University, 888 Toorak Rd, Camberwell, Victoria, Australia
b Neuroscience Research Australia, Sydney, New South Wales, Australia
c School of Psychiatry, University of New South Wales, Sydney, New South Wales, Australia
[1] Joint Senior Author

Background: Anxiety disorders are highly prevalent and cause substantial burden, however current treatment approaches are largely ineffective. Altered attentional control appears to be a robust transdiagnostic symptom across anxiety disorders, which brain stimulation techniques may have some potential to improve. However, it is important to first identify objective outcome measures to allow evaluation of brain stimulation approaches. Therefore, we conducted a systematic review to assess the changes in the EEG markers of error-related negativity (ERN) and correct-response negativity (CRN), both of which are believed to reflect attentional control related changes in clinical anxiety symptomology.
Methods: A comprehensive literature search was conducted for studies published prior to October 22nd, 2020. Protocol details for this systematic review were registered on PROSPERO (CRD42019144885).
Results: 66 studies had their data extracted, with 85% finding significantly increased ERN amplitudes associated with clinical anxiety. 44 studies analysed CRN with only ~20% finding significant changes in CRN amplitude associated with individuals with clinical anxiety.
Conclusions: Therefore, we found the ERN to have potential as a robust transdiagnostic marker of attentional control in anxiety. Incorporation of the ERN will be a valuable outcome measure of intervention studies in brain stimulation.
Planned future research: We are now conducting a study investigating whether theta-tACS (as theta oscillations have convergent links to both attentional control and anxiety) to improve attentional control across the anxiety spectrum, measuring both behavioural and EEG outcomes (including the ERN).

No evidence for changes in GABA concentration, functional connectivity, or working memory following continuous theta burst stimulation over dorsolateral prefrontal cortex

Tribikram Thapa*, Joshua Hendrikse*, Sarah Thompson , Chao Suo, Mana Biabani, James Morrow, Kate E Hoy, Paul B Fitzgerald, Alex Fornito, Nigel C Rogasch

* These authors contributed equally to the study.

Background: Continuous theta burst stimulation (cTBS) is thought to reduce cortical excitability and modulate functional connectivity, possibly by altering cortical inhibition at the site of stimulation. However, most evidence comes from the motor cortex and it remains unclear whether similar effects occur following stimulation over other brain regions.
Methods: We assessed whether cTBS over left dorsolateral prefrontal cortex altered gamma aminobutyric acid (GABA) concentration, functional connectivity and brain dynamics at rest, and brain activation and memory performance during a working memory task. 17 healthy individuals participated in a randomised, sham-controlled, cross-over experiment. Before and after either real or sham cTBS, magnetic resonance spectroscopy was obtained at rest to measure GABA concentrations, whereas functional magnetic resonance imaging (fMRI) was recorded at rest and during an n-back working memory task to measure functional connectivity, brain dynamics (low-frequency fluctuations), and task-related patterns of brain activity.
Results: We could not find evidence for changes in GABA concentration (P=0.66, Bayes factor [BF_{10}]=0.07), resting-state functional connectivity ($P_{(FWE)}$>0.05), resting-state low-frequency fluctuations (P=0.88, BF_{10}=0.04), blood-oxygen level dependent activity during the n-back task ($P_{(FWE)}$ >0.05), or working memory performance (P=0.13, BF_{10}=0.05) following real or sham cTBS. Conclusions: Our findings add to a growing body of literature suggesting the effects of cTBS are highly variable between individuals and question the notion that cTBS is a universal 'inhibitory' paradigm.

The effects of multi-day rTMS on functional connectivity and associative memory performance

Joshua Hendrikse, James P. Coxon, Sarah Thompson, Chao Suo, Alex Fornito, Murat Yucel, and Nigel C. Rogasch

Background: Transcranial magnetic stimulation (TMS) is a non-invasive brain stimulation technique with the capacity to modulate brain network connectivity and cognitive function. Recent studies have demonstrated long-lasting improvements in associative memory and resting- state connectivity following multi-day repetitive TMS (rTMS) to individualised parietal-hippocampal networks. We aimed to assess the reproducibility and network- and cognitive-specificity of these effects following multi-day rTMS.
Methods: Participants received four days of 20 Hz rTMS to a subject-specific region of left lateral parietal cortex exhibiting peak functional connectivity to the left hippocampus. In a separate week, the same stimulation protocol was applied to a subject-specific region of pre- supplementary motor area (pre-SMA) exhibiting peak functional connectivity to the left putamen. We assessed changes to associative memory before and after each week of stimulation (N = 39), and changes to resting-state functional connectivity before and after stimulation in week one (N = 36).
Results: We found no evidence of long-lasting enhancement of associative memory or increased parieto-hippocampal connectivity following multi-day rTMS to the parietal cortex, nor increased pre-SMA-putamen connectivity following multi-day rTMS to pre-SMA. Instead, we observed some evidence of site-specific modulations of functional connectivity lasting ~24 h, with reduced connectivity within targeted networks and increased connectivity across distinct non-targeted networks.
Conclusions: Our findings suggest a complex interplay between multi-day rTMS and network connectivity. Further work is required to develop reliable rTMS paradigms for driving changes in functional connectivity between cortical and subcortical regions.

Anodal Transcranial Direct Current Stimulation to the Bilateral Dorsolateral Prefrontal Cortex Does Not Facilitate Hazard Perception Skill Acquisition

Kieseker, G. A. [1], Horswill, M. S. [2], Sale, M. V. [1, 3]

1. School of Health and Rehabilitation Sciences, The University of Queensland;
2. School of Psychology, The University of Queensland; 3. Queensland Brain Institute, The University of Queensland

Background: Young, novice drivers (aged 16 – 25 years) have poorer hazard perception skills compared to older, more experienced drivers. Fortunately, this skill can be improved with training. Additionally, transcranial direct current stimulation (tDCS) has demonstrated facilitative effects in the neuroenhancement of learning, attention, and memory processes. Thus, we seek to enhance the rate of hazard perception learning in young drivers by applying excitatory (i.e., anodal) tDCS to the bilateral dorsolateral prefrontal cortices (DLPFC). The bilateral DLPFC were chosen as research has implicated these regions in executive functions recruited in hazard perception while driving (i.e., top-down attentional processing, learning, and working memory).
Methods: Forty participants were randomly assigned to sham or active stimulation. They took a hazard perception test before and after completing a 3-session hazard perception training intervention with concurrent tDCS at 2milliamperes. Participant's reaction time and accuracy in responding to a potential traffic conflict on the test was recorded via mouse-click. We hypothesized that participants would be quicker and more accurate in identifying hazards post-intervention, and that those who had undergone active stimulation during training would experience greater facilitation compared to sham stimulation.
Results: Whilst all participants were significantly faster and more accurate at identifying traffic hazards post-intervention, results indicated no facilitative effects of active stimulation.
Conclusions: Possible explanations for the null effect include potential dosage effects, limitations in the spatial specificity of tDCS in general, or that hazard perception is a skill that takes years to acquire, therefore neural substrates require more time to consolidate the information learned.

Targeting the Left Dorsolateral Prefrontal Cortex for Transcranial Magnetic Stimulation using a Cognitive Task

Donel M Martin [1,2], Ashley Wang [1], Stevan Nikolin [1,2], Adriano H Moffa [1], Colleen K Loo [1,2,3]

[1]School of Psychiatry, University of New South Wales, Sydney, NSW Australia

[2]Black Dog Institute, Sydney, NSW Australia

[3]St George Hospital, Sydney, NSW Australia

Background: Repetitive transcranial magnetic stimulation (rTMS) has potential to be developed as a novel treatment for cognitive dysfunction. However, current methods of targeting rTMS for cognition fail to consider interindividual functional variability. This study explored the use of a cognitive task to individualise the target site for rTMS administered to the left dorsolateral prefrontal cortex (L-DLPFC).
Method: Twenty-five healthy participants were enrolled in a sham-controlled, crossover study. Participants performed a random letter generation task under the following conditions: no stimulation, sham and active 'online' rTMS applied to F3 (International 10-20 System) and four standardised surrounding sites.
Results: Across all sites combined, active 'online' rTMS was associated with significantly reduced performance compared to sham rTMS for unique trigrams (p = .001), but not for unique digrams (p >.05). Using a novel localisation methodology based on performance outcomes from both measures, a single optimal individualised site was identified for 92% [n = 23] of participants. At the individualised site, performance was significantly poorer compared to a common standard site (F3) and both control conditions (ps <.001).
Conclusions: The current results suggest that this localisation methodology using a cognitive task could be used to individualise rTMS target site at the L-DLPFC for modulating and potentially enhancing cognitive functioning.

12 July 2021 – abstracts (cont'd)

3:30 pm - 4:15 pm	**Medilink International Keynote: Prof Charlotte Stagg** *Oscillations and inhibition: towards an understanding of the neurophysiology of motor learning .* Chair: Prof Janet Taylor

Oscillations and inhibition: towards an understanding of the neurophysiology of motor learning.

Professor Charlotte Stagg

Professor of Human Neurophysiology
University of Oxford

How we learn new motor skills, such as learning to play the piano or play tennis, is a question of fundamental importance to everyday life. It also has direct relevance to how we might re-learn to move our hands after a brain injury such as a stroke. However, motor plasticity occurs across multiple spatial and temporal scales; from the synapse to the network and from effects lasting seconds to those lasting months or even years.

Here, I will discuss recent studies from my group studying the physiological basis of motor plasticity *in vivo*, in particular how changes across a wide range of spatial scales may interact to support functional improvements. To this end we combine advanced neuroimaging, including MR Imaging, MR Spectroscopy and Magnetoencephalography, with non-invasive brain stimulation.

Taken together, these studies provide convergent evidence that changes in local and network-level inhibitory processing is a key component of motor learning. I will also highlight how inter-individual differences may prove important for predicting response to potential interventions post-stroke.

13 July 2021 – program

9:00 am - 10:00 am	Mechanistic insights into the effects of non-invasive brain stimulation Chair: Prof Karen Barlow
	Barbora Fulopoval (10 min) Low-intensity repetitive magnetic stimulation restores synaptic plasticity in APP/PS1 mouse model of Alzheimer's disease.
	Dr Jamie Beros (10 min) Static magnetic stimulation induces dose-dependent axonal plasticity in cortical neurons.
	Emily King (10 min) Driving axon initial segment plasticity with subthreshold intermittent theta burst stimulation in vitro.
	Rawan Abuyosef (10 min) A Coil Array using Cone-shaped Structure for Safe Deep Transcranial Magnetic Stimulation.
	Dr Jodie Naim-Feil (10 min) Anomalies in global network features during early recovery from alcohol dependence: A network TMS-EEG study.
	Dr Alex Tang (10 min) Subthreshold repetitive transcranial magnetic stimulation drives structural synaptic plasticity in the young and aged motor cortex.
10:00 am - 11:00 am	Meet the Editors: A Q&A session with editorial board members from journals publishing NiBS research. Chair: Dr Nigel Rogasch
	Prof Kate Hoy: Editor, Cortex Prof Paul Fitzgerald: Editor, Brain Stimulation Prof Winston Byblow: Editor-in-Chief, Experimental Brain Research
11:00 am - 11:30 am	BREAK and MEET THE SPONSORS - meet the sponsors at the Community hub on Whova
11:30 am - 12:15 pm	**Symbiotic Devices National Keynote: Prof Jason Mattingley** State-dependent effects of neural stimulation on brain function and behaviour. Chair: A/Prof John Semmler
12:15 pm - 12:30 pm	Data Blitz Presentations Chair: A/Prof John Semmler
	Julia Wood (5 min) Modulation of motor skill consolidation by slow, oscillatory tES: a research protocol.
	Conor Robinson (5 min) Theta burst stimulation on the motor cortex induces frequency–resolved changes in cortical network activity.
	Emily Brotherton (5 min) Motor cortical output is suboptimal in people with Multiple Sclerosis during sustained low-intensity contractions.
12:30 pm - 2:30 pm	Student & EMCR Networking Event. Chairs: Dr Manreena Kaur and Brittany Rurak

13 July 2021 – abstracts

9:00 am - 10:00 am	Mehcanistic insights into the effects of non-invasive brain stimulation Chair: Prof Karen Barlow

Low-intensity repetitive magnetic stimulation restores synaptic plasticity in APP/PS1 mouse model of Alzheimer's disease.

Barbora Fulopova, William Bennett, Alison Canty

Wicking Dementia Research and Education Centre, University of Tasmania

Background: There is a growing interest in potential clinical benefits of transcranial magnetic stimulation to alter brain activity in neurodegenerative conditions such as Alzheimer's disease (AD). The underlying neural mechanisms of the stimulation effects are not well understood. Neuroplastic synaptic changes are thought to be involved, however, the exact mechanisms remain unknown.
Methods: Combining low-intensity intermittent theta burst stimulation (LI-iTBS), cranial window implantation and two-photon microscopy, we tracked real-time changes on presynaptic axonal boutons in the motor cortex. We imaged adult (10-13 months) Thy1-GFP- M (GFP) mice that express green-fluorescent-protein in a subset of excitatory cortical neurons, and GFP mice crossed with the APP/PS1 model of AD (APP-GFP). Imaging occurred in 48- hour intervals over 9 sessions, and LI-iTBS was delivered in the middle of the timeline. We measured the density, and synaptic turnover (proportion of gains and losses) of axonal boutons.
Results: We observed no changes in the density of synaptic boutons between the GFP and APP-GFP groups, nor following the stimulation. The synaptic turnover was significantly lower in the APP-GFP pre-stimulation ($p=0.003$). Post-stimulation, there was a significant and maintained increase in turnover of boutons in both the GFP and APP-GFP groups ($p<0.01$). The lower pre-stimulation turnover in APP-GFP was elevated to the baseline of healthy GFP animals post-stimulation.
Conclusion: Imaged excitatory axons maintained the overall number of presynaptic outputs post-stimulation, however, the targets of these outputs were more dynamic following LI-iTBS. The post-stimulation increase of low baseline plasticity in APP-GFP group points to possible clinical applications of LI-iTBS in AD.

Static magnetic stimulation induces dose-dependent axonal plasticity in cortical neurons [1,2] [1,2] [1,2]

Beros J , King E , Rodger J , Tang A

[1] *University of Western Australia, School of Biological Sciences*

[2] *Perron Institute for Neurological and Translational Science*

Background: The axon initial segment (AIS) is a specialised region of the neuronal membrane responsible for action potential initiation. This structure is highly plastic and remodels its length and distance from the cell body as a homeostatic response to changes in neural activity. We aimed to investigate if altering neural activity with static magnetic stimulation (sMS), a neuromodulatory intervention typically seen to inhibit neural activity, can drive AIS plasticity in cortical neurons.
Methods: Primary cortical neurons were cultured from P1 mouse pups for 7 days. In addition to unstimulated controls, neurons were stimulated with a rare earth neodymium magnet (0.5 Tesla strength) placed under the culture plate for 6 or 48 hours. After stimulation, neurons were fixed and immunofluorescent confocal microscopy was used to quantify AIS length and the distance of AIS starting position from the cell body.
Results: When compared to unstimulated controls, sMS caused a distal relocation in the AIS (41% more distal, $p < 0.01$) of cortical neurons after 48hrs, but not 6hrs of stimulation. No changes in AIS length were observed at any assessed times.
Conclusion: These results provide a proof of concept that sMS can drive AIS plasticity in cortical neurons and that the dosage may be important to induce any changes. Ongoing experiments are underway elucidating the mechanisms responsible, with preliminary findings suggesting that this is dependent on voltage-gated calcium channels. These initial findings suggest that sMS may be a relevant intervention to target the AIS and potentially treat disorders with AIS dysfunction.

Driving axon initial segment plasticity with subthreshold intermittent theta burst stimulation *in vitro*

Emily King[1,2], Jamie Beros[1,2'], Darren Clarke[1,2], Jennifer Rodger[1,2], Alexander Tang[1,2]

1 Experimental and Regenerative Neurosciences, School of Biological Sciences, University of Western Australia, Crawley, Western Australia.

2 Perron Institute for Neurological and Translation Sciences, Nedlands, Western Australia.

For the last 30 years, repetitive transcranial magnetic stimulation (rTMS) has been used to modulate synaptic-like plasticity due to its ability to alter the activity of neural circuits (i.e. activity-dependent plasticity). However, its ability to drive activity-dependent plasticity at other neuronal elements, such as the axon, is not well understood. In particular, one axonal region that has yet to be investigated is the axon initial segment (AIS), an excitable domain responsible for the generation of action potentials. The AIS is known to undergo structural plasticity (including alterations in length and location) in an activity- dependent manner, with such structural changes regulating neuronal excitability. However, whether rTMS can drive activity-dependent plasticity at the AIS is unknown. Here, we investigate whether subthreshold intermittent theta burst stimulation (iTBS) modulates AIS plasticity *in vitro*. Primary cortical neurons were isolated from post-natal day one mouse pups and cultured for seven days before subthreshold iTBS was delivered in a single 6-hour block. Changes to AIS length and location were then assessed at two different timepoints to examine both acute and delayed effects of stimulation. Our results show that 6-hours of iTBS induced a significant acute distal shift in AIS position from the soma (+18%, $p=0.04$) and delayed decrease in AIS length (-19%, $p<0.0001$), with both forms of structural refinement likely lowering neuronal excitability. Together, these findings provide the first evidence that subthreshold iTBS can trigger AIS plasticity in cortical neurons, suggesting a novel use for rTMS in driving axonal plasticity and modulating neuronal excitability through axonal mechanisms.

A Coil Array using Cone-shaped Structure for Safe Deep Transcranial Magnetic Stimulation

Rawan Abu Yosef, *Student Member, IEEE*, Ahmed Toaha Mobashsher, *Member, IEEE,* Amin Abbosh, Senior *Member, IEEE,* and Firuz Zare, Senior *Member, IEEE*

Non-invasive deep brain stimulation using transcranial magnetic stimulation (TMS) is a promising technique to treat many neurological disorders, such as Alzheimer's disease. However, current TMS coils have poor stimulation performance in deep regions, like the hippocampus of the brain. In this

study, a novel coil array is designed by utilizing a combination of two coil designing techniques namely, the magnetic resonance coupling (MRC) coil and the cone-shaped coil (CSC) methods. The effects of modifying the two coil design methods by adding a magnetic core and shielding, different aspects of the field strength, focality, decay rate, and safety are investigated. A parametric study is also performed on the coils to investigate the effects of coil size on the electric field performance at deep brain areas. The induced electric field in a realistic human head phantom called MIDA is calculated using the finite element method (FEM) electromagnetic tool, Sim4life. Simulation results show that the use of the magnetic core and shielding increases the electric field intensity and enhances the focality, albiet without improving the field decay rate. The decay rate can be reduced by increasing the coil size at the expense of focality. However, in this case, the ratio between the maximum value of the field at cortical and deep regions (safety ratio) exceeds safety limits. By adopting the optimum coil design and size, the proposed coil array effectively reduces the electric field attenuation rate and keeps the safety ratio within the standard, making it a viable candidate for non-invasive deep TMS applications.

Anomalies in global network features during early recovery from alcohol dependence: A network TMS-EEG study

Jodie Naim-Feil [a,b,c], Paul B. Fitzgerald [d], Mica Rubinson [a], Dan I. Lubman [e], Dianne Sheppard [f,] John L. Bradshaw [c], Nava Levit-Binnun [b], Elisha Moses [a]

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[b] Sagol Center for Brain and Mind, Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC), Herzliya, Israel

[c] Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash, University, Melbourne, Victoria, Australia

[d] Epworth Centre for Innovation in Mental Health, Epworth Healthcare and Monash University Department of Psychiatry, Camberwell, Victoria, Australia

[e] Turning Point, Eastern Health and Monash Addiction Research Centre, Eastern Health Clinical School, Monash University, Victoria, Australia

[f] Monash University Accident Research Centre, Monash University, Clayton Campus, Victoria, Australia

Background: Although models of addiction have implicated local cortical structures within the mesocorticolimbic reward circuitry, there is limited research into global features of this circuitry. Network Analysis (via Graph Theory) allows researchers to extract topological features of brain connectivity. Combined Transcranial Magnetic Stimulation (TMS) and electroencephalography (EEG) can non-invasively perturb the mesocorticolimbic 'addiction' circuitry network while EEG rapidly measures network response. The current study is the first to apply a TMS inhibitory paradigm to the frontal cortex while applying network science to analyse the EEG data and quantify network anomalies associated with ALD during early recovery.
Methods: Eleven individuals with alcohol-dependence (ALD) in early recovery and 16 healthy controls (HC) were administered 75 single pulses and 75 paired-pulses (inhibitory paradigm) bilaterally to the dorsolateral prefrontal cortex (DLPFC). Pearson cross-correlation was applied to the EEG traces and correlation matrices constructed. Global network measures (mean degree, global efficiency and global clustering) were extracted.
Results: Following application of paired-pulse (inhibitory) TMS to the left DLPFC, the ALD group presented with reduced mean degree, global efficiency and global clustering compared to HC. Decreases in global efficiency increased prediction of ALD group membership and reduced mean degree and global clustering was associated with increased severity of past alcohol use.
Conclusion: These results provide preliminary evidence of altered network features in ALD patients during early recovery. Moreover, these network anomalies predicted high alcohol use and were associated with clinical aspects of ALD. Further research into these altered networks may assist in identifying useful network biomarkers of alcohol dependence and recovery.

Subthreshold repetitive transcranial magnetic stimulation drives structural synaptic plasticity in the young and aged motor cortex

Alexander D Tang [a,b], William Bennett [c,] Aidan D Bindoff [c], Jessica Collins [c,]Michael I Garry [d], Jeffery J Summers [d,e], Mark R Hinder [d,] Jennifer Rodger [a,b], Alison J Canty [c]

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[e] Research Institute for Sport and Exercise Sciences, Liverpool John Moores University.

Background: Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive tool commonly used to drive neural plasticity in the young adult and aged brain. Recent data from mouse models have shown that even at subthreshold intensities (0.12 Tesla), rTMS can drive neuronal and glial plasticity in the motor cortex. However, the physiological mechanisms underlying subthreshold rTMS induced plasticity and whether these are altered with normal ageing are unclear.
Objective: To assess the effect of subthreshold rTMS, using the intermittent theta burst stimulation (iTBS) protocol, on structural synaptic plasticity in the mouse motor cortex of young and aged mice.
Methods: Longitudinal *in vivo* 2-photon microscopy was used to measure changes to the structural plasticity of pyramidal neuron dendritic spines in the motor cortex following a single train of subthreshold rTMS (in young adult and aged animals) or the same rTMS train administered on 4 consecutive days (in young adult animals only). Data were analysed with Bayesian hierarchical generalized linear regression models and interpreted with the aid of Bayes Factors (BF).

Results: We found strong evidence (BF>10) that subthreshold rTMS altered the rate of dendritic spine losses and gains, dependent on the number of stimulation sessions and that a single session of subthreshold rTMS was effective in driving structural synaptic plasticity in both young adult and aged mice.
Conclusion: To our knowledge, these results provide the first *in vivo* evidence that rTMS drives synaptic plasticity in the brain and uncovers structural synaptic plasticity as a key mechanism of subthreshold rTMS induced plasticity.

10:00 am - 11:00 am	Meet the Editors: A Q&A session with editorial board members from journals publishing NiBS research. Chair: Dr Nigel Rogasch

Professor Kate Hoy has been an Action Editor for Cortex since 2018, where she handles submissions in the area of brain stimulation and cognitive neuroscience. Prof Hoy is also a regular reviewer for a large number of journals in the field of neuroscience, psychiatry and neurology. In 2019 she as named in the top ten reviewers (from 463) for Brain Stimulation.

Professor Paul Fitzgerald is Professor of Psychiatry at Monash University and Director of the Epworth Centre for Innovation in Mental Health based at Epworth Camberwell. His main editorial responsibilities have been as deputy editor responsible for psychiatry for the journal *Brain Stimulation* since the journal was launched in 2008 on average editing about 140-150 submissions per year.

Professor Winston Byblow is a Professor of Neuroscience and Director of the Movement Neuroscience Laboratory at the University of Auckland where he leads research in the areas of motor neurophysiology, neurorehabilitation and brain stimulation. He has served as a reviewer for almost three decades, is a member of several editorial boards, and is Editor-in-Chief of *Experimental Brain Research*, Springer-Nature's longest-running neuroscience serial.

13 July 2021 – abstracts (cont'd)

11:30 am - 12:15 pm	**Symbiotic Devices National Keynote: Prof Jason Mattingley** State-dependent effects of neural stimulation on brain function and behaviour. Chair: A/Prof John Semmler

State-dependent effects of neural stimulation on brain function and behaviour

Professor Jason Mattingley

University of Queensland

Brain stimulation methods are widely used in neuroscience to establish causal relationships between distinct brain regions and the sensory, cognitive and motor functions they subserve. When combined with concurrent brain imaging, such stimulation methods can reveal patterns of activity responsible for regulating simple and complex behaviours at the level of local brain regions and across widespread networks. Despite the growing popularity of these multimodal approaches, we still do not understand how fluctuations in physiological state or task demands impact the effects of brain stimulation on neural activity and behaviour. In this talk I will consider the concept of such "state-dependent" changes in brain activity in response to neural stimulation. I will illustrate the concept with examples from our own work on sleep and drowsiness, and on the role of selective attention and cognitive control in regulating network integration and neural plasticity. Given the widespread use of brain stimulation as a treatment for a variety of psychiatric disorders, consideration of the influence of physiological and cognitive state is likely to be important for the efficacy of these interventions.

13 July 2021 – abstracts (cont'd)

12:15 pm - 12:30 pm Data Blitz Presentations
Chair: A/Prof John Semmler

Modulation of motor skill consolidation by slow, oscillatory tES: a research protocol

Julia Wood [1], Nicholas Bland [1, 3], Sonia Brownsett [1, 4], Martin Sale [1,2]

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[2] Queensland Brain Institute, University of Queensland, St Lucia, Queensland, Australia

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[4] NHMRC Centre of Research Excellence in Aphasia Recovery and Rehabilitation (NHMRC CRE administered by La Trobe University)

Slow wave sleep (SWS) plays a vital role in the consolidation of new memories. Slow oscillations (0.5–4Hz) prevalent during SWS may promote memory consolidation by enhancing the relative strength of learning-related synapses, through a selective weakening of noisy, unwanted synaptic connections (1). Slow, oscillatory transcranial electrical stimulation (so-tES) applied during *wake* can increase slow oscillations in the *awake* brain (2), so it may be able to facilitate consolidation during wake. This may occur via selective synaptic weakening mechanisms, so changes in net synaptic strength may be observed over the targeted cortical region. In the motor system, changes in net synaptic strength can be probed by measuring changes in corticospinal excitability via motor-evoked potentials (MEPs). Motor learning depends on long-term potentiation induction in the primary motor cortex (M1), and the subsequent consolidation of this learning is promoted by sleep. Therefore, so-tES may promote the consolidation of new motor learning, when applied over M1, during wake, and after learning. This stimulation protocol may also induce consolidation-related changes in net synaptic strength in M1, observed as changes in the size and inter-trial variability of MEPs. Therefore, I will investigate these potential effects of so-tES in the first of three studies I have planned for my PhD at the University of Queensland. I will present my plan for this study, including objectives and methods.

Theta burst stimulation on the motor cortex induces frequency–resolved changes in cortical network activity

Conor Robinson[1,2], Luca Cocchi[1,2], Anton Tokariev[1,3], Caitlin Hall[1,2], Michael Breakspear [1,4] Leonardo L. Gollo[1,5]

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[5] *The Turner Institute for Brain and Mental Health, School of Psychological Sciences, and Monash Biomedical Imaging, Monash University, Victoria, Australia.*

Introduction. Transcranial magnetic stimulation (TMS) is a neurostimulation technique that modifies local neural activity. Recent computational-modelling work suggest the periphery-to-core hierarchy of the brain can determine the effect of local stimulation on whole-brain dynamics. To empirically test this relationship, we combined repetitive TMS with electroencephalography (EEG) to modulate neural activity of a peripheral brain region and study variations in canonical brain rhythms. TMS was applied to the primary motor cortex to determine if intermittent (iTBS, excitatory) and continuous (cTBS, inhibitory) stimulation paradigms induced opposing effects on cortical activity.
Methods. Twenty-one healthy volunteers participated (10 female, aged 18-35yrs). EEG was recorded with a 64-channel, TMS-compatible device. Subsequent changes in resting state EEG cortical activity were recorded 10 minutes before and after excitatory (iTBS) and inhibitory (cTBS) paradigms. Stimulation was delivered at 70% of resting motor threshold for 600 pulses using a figure-of-eight coil. Frequency-resolved functional connectivity changes were measured by extracting the amplitude-envelope correlation between the primary motor cortex and disparate brain areas.
Results. Consistent with previous findings, we observed an increase (iTBS) and decrease (cTBS) in corticospinal excitability. Frequency-resolved oscillations reflected spatially and spectrally distinct changes in cortico-cortical brain

networks. Excitatory stimulation suppressed amplitude fluctuations in the beta band, while inhibitory stimulation enhanced amplitude fluctuations in the alpha band.
Conclusion. These findings demonstrate a novel insight into the complex effects of brain stimulation paradigms and their ability to modulate local brain activity. Here we demonstrate that specific patterns of TMS can induce opposing oscillatory activity in the brain.

Motor cortical output is suboptimal in people with Multiple Sclerosis during sustained low-intensity contractions

Brotherton, E.J., Sabapathy, S., Mckeown, D.J., Morris, N.R. and Kavanagh, J.J.
Menzies Health Institute Queensland, Griffith University, Gold Coast, Queensland.

Background. Up to 80% of people with Multiple Sclerosis (MS) report excessive levels of exercise-induced fatigue. Single-pulse TMS has been regularly used to assess the neural basis of fatigue, however few studies have employed this technique to examine MS fatigue.
Methods. Nine MS (39 ± 6 yr, 6 F) and ten controls (39 ± 6 yr, 6 F) performed an elbow flexion at 15% maximal voluntary contraction (MVC) for 26 min. MVCs were performed every 2 min to establish if maximal force was compromised by the low-intensity contraction. Single-pulse TMS (Magstim 200^2) was delivered to the primary motor cortex with a circular coil during each MVC. Superimposed twitches were the increase in flexion force in response to the TMS pulse. Ratings of perceived exertion (RPE) were obtained before each MVC.
Results. A main effect of contraction time was identified for the amplitude of MVCs ($p < 0.001$), superimposed twitches ($p < 0.001$), and RPE ($p < 0.001$), where MVC progressively declined, superimposed twitches progressively increased, and RPE progressively increased throughout the protocol. A main effect of group was identified for the amplitude of MVCs ($p = 0.025$) and superimposed twitches ($p = 0.004$), where MVC was lower and superimposed twitches were greater in MS compared to controls.
Conclusions. The MS group fatigued more compared to healthy individuals, which reflected suboptimal output from the motor cortex during the exercise task. As RPE was similar between groups, it appears that perception of fatigue may not be exacerbated in MS during low-intensity contractions.

12:30 pm - 2:30 pm Student & EMCR Networking Event.

Chairs: Dr Manreena Kaur and Brittany Rurak

A Student-ECR Networking Event in a “speed-networking” format, where attendees will be assigned to small groups and rotated through 4 breakout rooms; each breakout room will have an academic with experience with a particular topic, such as ECR work/life balance, publications, grant writing, pathways in our field. This gives students and ECRs an unique opportunity to speak with academics experienced in these topics in an informal format.

14 July 2021 – program

12:00 pm - 12:45 pm	**Sonoray National Keynote: Dr Ashleigh Smith** Neural control of movement with aging and effects of activity. Chair: Dr Bernadette Fitzgibbon
12:45 pm - 1:45 pm	ABSS Annual General Meeting 2021 Chair: Prof Kate Hoy
1:45 pm - 2:00 pm	BREAK and MEET THE SPONSORS - meet the sponsors at the Community hub on Whova
2:00 pm - 3:00 pm	Grant Review Panel: NHRMC and ARC grant schemes Chair: Dr Ann-Maree Vallence
	Prof Paul Dux, University of Queensland A/Prof Siobhan Schabrun, NeuRA Prof Colleen Loo, University of New South Wales
3:00 pm - 3:15 pm	BREAK and MEET THE SPONSORS - meet the sponsors at the Community hub on Whova
3:15 pm - 4:15 pm	**ABSS Award Winner Presentations** Chair: Prof Peter Enticott Early Career Researcher Award: Dr Brenton Hordacre (30 min) Evidence For A Window of Enhanced Plasticity in the Human Motor Cortex Following Ischemic Stroke. Best PhD Thesis Award: Dr Mana Biabani (30 min) Uncovering brain dynamics following transcranial magnetic stimulation.
4:15 pm - 4:45 pm	Non-invasive brain stimulation to understand action Chair: Prof Timothy Carroll
	Rechu Divakar (10 min) Initial corticospinal excitability responses to visual target presentation during reaching reflect the target direction rather than the reach direction.
	Aaron McInnes (10 min) Premovement inhibition protects motor actions from interference.
	Brodie Hand (10 min) TMS-induced corticomotor plasticity is greater in endurance-trained cyclists following acute exercise.

14 July 2021 – abstracts

12:00 pm - 12:45 pm	**Sonoray National Keynote: Dr Ashleigh Smith** Neural control of movement with aging and effects of activity. Chair: Dr Bernadette Fitzgibbon

Neural control of movement with aging and effects of activity.

Dr Ashleigh E. Smith

Alliance for Research in Exercise Nutrition and Activity (ARENA), University of South Australia

Aging is associated with reduced neuromuscular function, which may be due to central nervous system changes in corticospinal excitability and a reduced capacity of the human brain to re-organize the strength of its connections (neuroplasticity). This keynote presentation will highlight a range of complementary studies exploring the influence of aging and physical activity (PA) on motor cortical excitability and neuroplasticity, elicited with Transcranial Magnetic Stimulation (TMS). I will discuss studies exploring both acute aerobic exercise and recent work by my team exploring the effect of physical activity on the neural control of movement with ageing. Together, these studies provide evidence that PA in both young and old adults is associated with alterations in corticospinal excitability in the lower limb and an enhanced capacity of the motor cortex to re-organize the strength of its connections. Together these results suggest regular PA may protect against age-related movement decline through preservation of the inhibitory and excitatory networks within the primary motor cortex, resulting in maintenance of an optimal environment for neuroplasticity. Consideration of the current activity level of your study population is important for all researchers probing function and behaviour using non-invasive brain stimulation techniques.

Supported by NHMRC-ARC Dementia Research development fellowship awarded to Dr Ashleigh Smith (GNT 1097397), NHMRC PR5 grant (GNT 1171313) awarded to Dr Ashleigh Smith and NIH Grant R01 awarded to Dr Sandra K. Hunter.

12:45 pm - 1:45 pm	ABSS Annual General Meeting 2021 Chair: Prof Kate Hoy

2:00 pm - 3:00 pm	Grant Review Panel: NHRMC and ARC grant schemes Chair: Dr Ann-Maree Vallence

Professor Paul Dux has received continuous funding, predominantly form the ARC, since 2009. This includes 7 discovery grants, 2 NHMRC project grants, 2 ARC fellowships, and Dept of Defence funding. He has regularly reviewed for both the ARC and NHMRC and people he has directly mentored have also received ARC DP and Fellowship funding.

Doctor Siobhan Schabrun has received an NHMRC Early Career Fellowship, an NHMRC Career Development Fellowship and 2 NHMRC project grants. She has reviewed for the NHMRC fellowships scheme and the new NHMRC Investigator grant scheme at emerging leader level (2020, 2021, 2022).

Professor Colleen Loo has received continuous NHMRC funding since 2008, including 11 NHMRC CI grants (8 as CIA). Career total research funding for investigator led research is $23M, $16.5M as CI (13.2 M as CIA, mostly NHMRC). She has served on several NHMRC GRPs for project grant and clinical trial schemes.

14 July 2021 – abstracts (cont'd)

3:15 pm - 4:15 pm	**ABSS Award Winner Presentations** Chair: Prof Peter Enticott

ABSS Early Career Researcher Award: Dr Brenton Hordacre

Evidence For A Window of Enhanced Plasticity in the Human Motor Cortex Following Ischemic Stroke.

Background: In pre-clinical models, behavioural training early after stroke produces larger gains compared with delayed training. The effects are thought to be mediated by increased and widespread reorganization of synaptic connections in the brain. It is viewed as a time-limited period of spontaneous biological recovery during which synaptic plasticity is increased, supporting recovery. It is not clear whether a similar period of enhanced synaptic plasticity occurs after stroke in humans.
Objective: To look for evidence of a similar change in synaptic plasticity in the human brain in the weeks and months after ischemic stroke.
Methods: We used continuous theta burst stimulation (cTBS) to activate synapses repeatedly in the motor cortex. This initiates early stages of synaptic plasticity that temporarily reduces cortical excitability and motor evoked potential (MEP) amplitude. Thus, the greater the effect of cTBS on the MEP, the greater the inferred level of synaptic plasticity. Data were collected from separate cohorts (Australia and UK). In each cohort, serial measurements were made in the weeks to months following stroke. Data were obtained for the ipsilesional motor cortex in 31 stroke survivors (Australia, 66.6±17.8 years) over 12 months and the contralesional motor cortex in 29 stroke survivors (UK, 68.2±9.8 years) over 6 months.
Results: Depression of cortical excitability by cTBS was most prominent shortly after stroke in the contralesional hemisphere and diminished over subsequent sessions ($p=0.030$). cTBS response did not differ across the 12 month follow-up period in the ipsilesional hemisphere ($p=0.903$).
Conclusions: Our results provide the first neurophysiological evidence consistent with a period of enhanced synaptic plasticity in the human brain after stroke. Behavioural training given during this period may be especially effective in supporting post-stroke recovery.

ABSS Best PhD Thesis Award: Dr Mana Biabani

Uncovering brain dynamics following transcranial magnetic stimulation

Background Electroencephalography (EEG) has emerged as an important method for understanding how transcranial magnetic stimulation (TMS) interacts with cortical circuits. However, the combination of techniques has been challenged by a controversy regarding whether TMS-evoked potentials (TEPs) are a genuine marker of TMS-induced cortical reactivity or merely represent the sensory potentials inevitably evoked by the TMS clicking sound and scalp sensations.
Method Twenty-four healthy participants received TMS over the motor cortex and shoulder (as a sensory condition) using two different intensities (subthreshold and suprathreshold) and waveforms (monophasic, biphasic). Common sensory attenuation measures, including coil padding and noise masking, were adopted. First, to characterize and minimize the contribution of sensory confounds to TEPs, the spatiotemporal relationship between EEG responses to the two stimulation conditions was evaluated and the efficiency of three different cleaning procedures (independent component analysis, signal-space projection with source-informed reconstruction (SSP-SIR) and linear regression) were compared. Next, the neurophysiological information contained in TEPs was investigated by probing their relationship with local and interhemispheric excitation/inhibition measured by paired-pulse TMS-EMG paradigms.
Results The results showed that long latency TEPs (>60ms) are highly contaminated by sensory inputs, and that SSP-SIR can efficiently attenuate the contamination. Also, TMS-EMG and TMS-EEG measures of M1 excitability were differentially affected by sensory confounds at different time points, masking any actual relationship between them in the time domain. In the frequency domain, however, local high-frequency oscillations in EEG recordings were minimally confounded by sensory artefacts and demonstrated strong correlations with EMG measures of cortical excitability across time, regardless of TMS intensity or waveform.
Conclusion These series of findings have two key implications. First, TEPs elicited by motor cortex TMS reflect a combination of transcranially and peripherally evoked brain responses despite adopting the common sensory attenuation methods during experiments, thereby highlighting the importance of adopting sensory control conditions in TMS-EEG studies. Second, despite the sensory confounds, early TEPs contain distinct components that reflect genuine cortical reactivity, thereby establishing their validity as reliable markers of cortical dynamics following TMS.

14 July 2021 – abstracts (cont'd)

4:15 pm - 4:45 pm	Non-invasive brain stimulation to understand action Chair: Prof Timothy Carroll

Initial corticospinal excitability responses to visual target presentation during reaching reflect the target direction rather than the reach direction

Rechu Divakar[1], Gerald E. Loeb[2], Brian D. Corneil[3,4,5], Guy Wallis[1], Timothy J. Carroll[1]

1. Centre for Sensorimotor Performance, School of Human Movement and Nutrition Sciences, The University of Queensland, Brisbane, Australia.
2. Department of Biomedical Engineering, University of Southern California, Los Angeles, California, USA.
3. Department of Physiology and Pharmacology, Western University, London, Ontario, Canada.
4. Department of Psychology, Western University, London, Ontario, Canada.
5. Robarts Research Institute, London, Ontario, Canada.

Introduction: During visually guided reaching, proximal limb muscles can be activated within 80 ms of target appearance. Such "express" responses are invariably tuned towards the direction of the visual target regardless of the reach direction, which prompts the hypothesis that they are driven by a subcortical tecto-reticulo-spinal pathway. Here we used transcranial magnetic stimulation (TMS) to probe corticospinal excitability changes within 100ms after presentation of a visual reach target.
Methods: Twenty participants reached either towards (pro-reach) or away from (anti-reach) visual targets displayed randomly to right or left of the right hand. Electromyographic activity was recorded from right pectoralis major (PEC) as TMS was delivered over the left motor cortex to induce motor evoked potentials (MEPs) in PEC. Stimulation was delivered 60, 70, 80, 90 or 100 ms after target presentation.
Results: When the visual target and motor goal were identical in the pro-reach condition, MEPs were enhanced when PEC was agonist and inhibited when PEC was antagonist, from 70ms onwards. In the anti-reach condition, MEPs were modulated to orient the limb toward the visual target at 70 and 80 ms, but excitability reversed at 100 ms to orient the limb towards the motor goal.
Conclusions: Corticospinal excitability changes at 70 and 80 ms are oriented to the visual target rather than the motor goal, and so might reflect processing associated with express muscle responses seen in proximal muscles. Future work is required to determine whether this effect is mediated by cortical or subcortical components of the corticospinal tract.

Premovement inhibition protects motor actions from interference.

Aaron McInnes
Curtin University

Corticospinal excitability is transiently inhibited shortly before movement initiation. This phenomenon has been observed across a range of motor tasks, suggesting that it may be a obligatory component of movement preparation. We investigated whether this was also the case when the urgency to perform a motor action was high, in a situation where little time was available to engage in preparatory processes. We controlled the urgency of an impending motor action by increasing or decreasing the foreperiod duration in an anticipatory timing task. Transcranial magnetic stimulation (TMS; experiment one) or a loud acoustic stimulus (LAS; experiment two) were used to examine how corticospinal and subcortical excitability were modulated during motor preparation. Preparatory inhibition of the corticospinal tract was absent when movement urgency was high, though motor actions were initiated on time. In contrast, subcortical circuits were progressively inhibited as the time to prepare increased. Interestingly, movement force and vigour were reduced by both TMS and the LAS when movement urgency was high, and enhanced when movement urgency was low. These findings contrast previous suggestions that corticospinal suppression is an obligatory component of motor preparation. The behavioural effects we observed in the absence of preparatory inhibition were induced by both TMS and the LAS, suggesting that accessory sensory stimulation may disrupt motor output when such stimulation is presented in the absence of preparatory inhibition. We conclude that preparatory inhibition may be an adaptive strategy which can serve to protect the prepared motor action from external interference.

TMS-induced corticomotor plasticity is greater in endurance-trained cyclists following acute exercise.

Brodie J Hand, George M Opie, Simranjit K Sidhu and John G Semmler
Discipline of Physiology, Adelaide Medical School, The University of Adelaide, Adelaide, Australia

Background: Previous research using transcranial magnetic stimulation (TMS) has shown that corticomotor plasticity is greater in people who undertake regular exercise. Furthermore, there is increased corticomotor plasticity after acute exercise in untrained participants, with these effects greatest after high-intensity interval training (HIIT). The aim of this study was to examine if corticomotor plasticity following acute HIIT is modified within individuals with a history of endurance training.
Methods: 12 endurance-trained cyclists (mean ± SD; 23 ± 3.8 years) and 13 sedentary individuals (22 ± 1.8 years) performed two experimental sessions. One session included an acute bout of HIIT (stationary cycling), while another session involved no exercise (control). Following exercise (or control), repetitive I-wave TMS (iTMS) was used (1.5 ms interval, 180 pairs for 15 mins) to induce plasticity within primary motor cortex. Motor evoked potential (MEP) amplitudes from a hand muscle were recorded at baseline, after HIIT (or control), and after iTMS.
Results: Relative to baseline, there were no significant differences in mean MEP amplitude between endurance trained and sedentary groups after HIIT ($P > 0.9$) or control ($P = 0.3$) sessions. Following iTMS, endurance-trained participants showed a greater increase in MEP amplitude when preceded by HIIT compared with the sedentary group ($P = 0.02$). No difference was observed between groups after iTMS in the control session ($P = 0.8$).
Conclusions: Corticomotor plasticity induced by iTMS was greater in endurance-trained cyclists following HIIT. Levels of habitual physical activity are therefore an important consideration for understanding factors that contribute to exercise-induced plasticity.

15 July 2021 – program

9:00 am - 9:45 am	**International Keynote: A/Prof Flavio Frolich** Targeting Brain Rhythms in Psychiatry. Chair: Prof Paul Fitzgerald
9:45 am - 10:45 am	Oscillations, plasticity, and behaviour Chair: A/Prof Julia Pitcher
	Dr Hannah Filmer (10 min) Causal evidence for dissociable roles of the prefrontal and superior medial frontal cortices in decision strategies.
	Dr Nicholas Bland (10 min) It's time to bin phase-bins: The cost of back-sorting for detecting phase-dependent effects.
	Wei-Yeh Liao (10 min) Characterising the influence of cerebellum on the neuroplastic modulation of intracortical motor circuits.
	Shivani Radia (10 min) No Change in Excitability of Motor Areas of the Brain following exposure to Acute Intermittent Hypoxia.
	Suraj Suresh (10 min) Rapid timing-dependent increases in corticospinal excitability following suprathreshold paired pulse transcranial magnetic stimulation over motor cortex.
	Nathan Nuzum (10 min) Inhibition, excitation, and bilateral transfer following a unilateral complex finger-tapping task in young and older adults.
10:45 am - 11:30 am	**POSTER SESSION** 1. Adriano Moffa, UNSW, Assessing Neuromodulation Effects of Theta Burst Stimulation to the Prefrontal Cortex using TMS-Evoked Potentials 2. Mei Xu, UNSW, Does offline high-frequency repetitive transcranial magnetic stimulation (HF-rTMS) improve cognition in healthy populations? A systematic review and meta-analysis 3. Asher Geffen, UQ, Effects of Slow Oscillatory Transcranial Alternating Current Stimulation on Motor Cortical Excitability Assessed by Transcranial Magnetic Stimulation 4. Ryoki Sasaki, Adelaide Uni, Threshold tracked short-interval intracortical inhibition more closely predicts the cortical response to transcranial magnetic stimulation 5. Ellen Williams, Adelaide Uni, Does continuous theta burst stimulation alter aperiodic activity in the resting EEG power spectra? 6. Gemma Lamp, LaTrobe, A systematic review of the chronometry of visuomotor integration tasks: A Registered Systematic Review Protocol 7. Dylan Curtin, Monash, Combined effects of gamma transcranial alternating current stimulation and theta burst stimulation on motor cortex plasticity
11:30 am - 12:30 pm	Symposium: A paradigm shift in rTMS plasticity: non-synaptic and glial mechanisms Chairs: A/Prof Jenny Rodger
	Dr Alex Tang: University of Western Australia
	Dr Carlie Cullen: University of Tasmania
	Dr Darren Clarke: University of Montreal
12:30 pm - 1:00 pm	Presentation of prizes and conference close A/Prof Martin Sale and Dr Ann-Maree Vallence

15 July 2021 – abstracts

9:00 am - 9:45 am	**International Keynote: A/Prof Flavio Frolich** Targeting Brain Rhythms in Psychiatry. Chair: Prof Paul Fitzgerald

Targeting Brain Rhythms in Psychiatry.

A/Prof Flavio Frohlich

University of North Carolina

Brain networks are dynamically organized by synchronization of rhythmic neuronal activity. A decade after the discovery that such brain rhythms are surprisingly susceptible to weak electric fields, transcranial alternating current stimulation (tACS) has become an exciting approach for the targeted modulation of brain rhythms. Given the growing understanding of how pathological disorganization of brain rhythms is associated with psychiatric and neurological disorders, tACS has been recognized as a potentially effective and safe treatment platform technology. Given the infinite number of stimulation parameters and paradigms, rational design of tACS and other rhythmic brain stimulation is required to identify the most promising interventions for evaluation in clinical trials. Professor Frohlich's presentation will provide a synthesis and an outlook of how targeting brain rhythms has the potential to revolutionize psychiatry.

15 July 2021 – abstracts (cont'd)

9:45 am - 10:45 am | Oscillations, plasticity, and behaviour
Chair: A/Prof Julia Pitcher

Causal evidence for dissociable roles of the prefrontal and superior medial frontal cortices in decision strategies

Hannah Filmer, Timothy Ballard, David Sewell, & Paul Dux
The University of Queensland

The speed accuracy trade-off (SAT) is arguably the most robust finding in cognitive psychology. This simple and intuitive effect (the faster subjects respond the more likely they are to make an error) has been the subject of extensive empirical and modelling work to ascertain the underlying latent process(es). One such process is response caution – the amount of evidence to be acquired before a decision is reached – with debate regarding the involvement of another latent variable, the rate of evidence accumulation. Neuroimaging has implicated two frontal regions as neural substrates of the SAT: the posterior lateral prefrontal cortex and the preSMA (part of the superior medial frontal cortex; SMFC). However, there is no causal evidence for these regions involvement in the SAT, nor is it clear what role each plays in the underlying processes. In a double-blind, pre-registered study, we applied cathodal tDCS (offline) to prefrontal and SMFC. The SAT was measured using a dot-motion task, with differing response instructions (focus on accuracy, speed, or both). The linear ballistic accumulator model indicated performance modulations were driven by response caution. Moreover, both target regions modulated caution but in opposing directions: prefrontal stimulation increased, and SMFC stimulation decreased, caution. Discriminability (difference between correct and error evidence accumulation rates) was predominantly affected by stimulation targeting the SMFC and did not vary with response instructions. Overall, the findings indicate that while both the SMFC and the prefrontal cortex are causally involved in the SAT, they play distinct roles in this phenomenon.

It's time to bin phase-bins: The cost of back-sorting for detecting phase-dependent effects

Nicholas S. Bland [1,2]

[1] School of Human Movement and Nutrition Sciences, The University of Queensland
[2] School of Health and Rehabilitation Sciences, The University of Queensland

Phase-dependent effects—whether dependent on some endogenous oscillation in the EEG or some exogenously applied current like tACS—are often difficult to detect, or require delivery of stimuli with high-fidelity timing (e.g., to deliver TMS at the peaks or troughs of the target oscillation). However, *targeting* phase is almost always imperfect (e.g., failures in real- time forward estimation, or variable errors in stimulus delivery), or simply not attempted at all—where instead the outcome is probed randomly with respect to phase. In all cases, deviations from intended phase will diminish the detectability of phasic phenomena if grouped into *phase bins*, where all trials within a given bin are treated as occurring at the same instantaneous phase. Therefore, the most egregious loss of power occurs when an outcome is measured randomly with respect to phase but is nevertheless binned for simplicity (i.e., back-sorted)—a necessary cost for all bin-centric approaches. This resultant loss of power can be quantified *in silico* using circular-to-linear regression, which is capable of analysing both binned and continuous (bin-free) phase sampling—yet remains seldom used in the brain stimulation literature. I will demonstrate that if (when) there are errors in targeting phase, these deviations can be accounted for without loss of statistical power.

Characterising the influence of cerebellum on the neuroplastic modulation of intracortical motor circuits

Wei-Yeh Liao, John G Semmler & George M Opie
Discipline of Physiology, School of Medicine, The University of Adelaide, Adelaide, Australia

Introduction: While previous research using transcranial magnetic stimulation (TMS) suggest that cerebellum (CB) influences the neuroplastic response of primary motor cortex (M1), the role of different indirect (I) wave inputs in M1 for mediating this interaction remains unclear. The aim of the current study was therefore to assess how CB influences neuroplasticity of early and late I-wave networks.
Methods: 22 young adults (22 ± 2.7 years) participated in 3 sessions in which I-wave periodicity repetitive transcranial magnetic stimulation (iTMS) was applied over M1 during concurrent application of cathodal transcranial direct current

stimulation (ctDCS) over CB. Each session involved either iTMS targeting early I-waves (1.5 ms interval; iTMS*early*), iTMS targeting late I-waves (4.5 ms interval; iTMS*late*), or iTMS*sham* (variable interval). Effects of the intervention were quantified via changes in motor evoked potential (MEP) amplitude recorded from the first dorsal interosseous muscle of the right hand, and in the strength of CB-M1 inhibition (CBI).
Results: While MEPs were unchanged after iTMS*early*, there was a reduction in MEP amplitude following both iTMS*late* ($P < 0.05$) and iTMS*sham* ($P = 0.001$). In contrast, CBI was reduced following all interventions (all $P < 0.05$).
Conclusion: Given the response to iTMS*early* and iTMS*late* is usually excitatory, these results suggest ctDCS over CB results in generalised disfacilitation of the I-wave networks. As this resulted in overt inhibition following iTMS*late*, the late I-wave circuits may be affected more strongly by CB projections to M1.

No Change in Excitability of Motor Areas of the Brain following exposure to Acute Intermittent Hypoxia

Shivani Radia[1], Ann-Maree Vallance[2,3], Sarah Etherington[1], Hakuei Fujiyama[2], Brendan R. Scott[3,4], 5 Olivier Girard .

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Acute intermittent hypoxia (AIH) is a safe and non-invasive neurorehabilitation treatment approach using brief, repetitive periods of breathing reduced oxygen air (10% O_2) alternating with normoxia (21% O_2). While our understanding of the effects of AIH on spinal circuit excitability is growing, lesser is known on cortical excitability. This study investigated the effects of AIH on excitability of the primary motor cortex (M1). Twenty participants completed two testing sessions: AIH and normoxia. AIH comprised five cycles of three-minutes hypoxia (~10% O_2) and two-minutes normoxia. Single and paired-pulse transcranial magnetic stimulation (TMS) was delivered to M1 to examine motor evoked potential (MEP) amplitude, input/output curve, short-interval intracortical inhibition (SICI), short-interval intracortical facilitation (SICF) and intracortical facilitation (ICF) before and 0, 25, and 50 minutes after the intervention. During AIH, arterial oxygen saturation ranged between 79 to 96% across participants. There were no significant changes in MEP amplitude, SICF and ICF after AIH or normoxia (all $p > 0.05$). There was a moderate negative correlation between oxygen saturation levels and change in MEP amplitude after AIH ($r=-0.39$, $p=0.12$). Overall, these findings suggest that AIH did not modify excitability of GABAergic, glutamatergic, and I-wave generating processes acting within M1. Additionally, AIH dose might not have been sufficient to induce changes in corticospinal excitability in all participants. Future research systematically examining the effects of varying doses of AIH on cortical excitability is warranted.

Rapid timing-dependent increases in corticospinal excitability following suprathreshold paired pulse transcranial magnetic stimulation over motor cortex

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D. Lifelong Health, South Australian Health and Medical Research Institute (SAHMRI), Adelaide, Australia

Background: Repetitive paired pulse transcranial magnetic stimulation (PPS) delivered at short intervals (e.g., 1.5 ms) increases corticospinal excitability both during and beyond the period of stimulation. However, it remains unclear whether similar effects are observed at longer intervals with higher intensity stimulation. The aim of this study was to assess whether suprathreshold PPS at different inter-stimulus intervals (ISIs) alters corticospinal excitability.
Methods: We recruited 16 individuals and applied suprathreshold PPS (condition stimulus at 120% of resting motor threshold) at 8 different ISIs (10, 20, 30, 40, 50, 100, 150, 200 ms) to the motor cortex across separate blocks. 20 PPS trials were given for each ISI with an inter-trial interval of 5 s. Motor evoked potential (MEPs) following the test

stimulus were recorded during all blocks. The relationship between ISI and changes in MEP amplitude across trials was evaluated using a linear mixed-effects model.
Results: There was a main effect of trial number on MEP amplitude ($p=0.016$) with conditioned MEPs significantly increasing across trials at ISIs of 10, 20, 30, 40 and 200 ms (all $p<0.05$). The rate of change in MEPs across trials was highest for the 20 ms ISI condition, with conditioned MEPs increasing in amplitude by ~1 mV from the first to the last trial.
Conclusion: Our findings suggest that suprathreshold paired pulse TMS results in a rapid increase in corticospinal excitability at certain ISIs. These results highlight the potential of suprathreshold repetitive PPS as a novel paradigm for driving plasticity in the corticospinal system.

Inhibition, excitation, and bilateral transfer following a unilateral complex finger-tapping task in young and older adults

Nathan D. Nuzum [1], Wei-Peng Teo[1,3] , Helen Macpherson[1] , Amy Loughman [2], Ewa A. Szymlek-Gay[1], and Ashlee Hendy[1]

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Background: Neuroplasticity underpins motor learning and control, with abnormal neuroplasticity related to age-associated cognitive and motor declines. Bilateral transfer of motor learning, through rehabilitation, may mitigate these declines, however the magnitude of transfer may be reduced in older populations. Using transcranial magnetic stimulation (TMS), this study investigated neuroplasticity in both hemispheres following unilateral practice of a complex finger tapping task across ageing.
Methods: Fifteen young (26.2±3.8years) and 11 older adults (63.7±15.4years) received TMS while recording muscle activity from the extensor digitorum communis (EDC) and abductor pollicis brevis, before and after practicing the task with the dominant hand. Excitability measures, 1.2x and 1.4x resting motor threshold (RMT), short-interval intracortical inhibition, and task performance were expressed as percent change scores from pre-to-post training and assessed between groups. Investigating hemispheric differences within groups was completed for significant between group measures.
Results: Both groups improved performance post-training for the trained hand, while only the younger group improved their untrained hand (all $p<0.05$). However, there were no between group differences in task performance or bilateral transfer scores. Excitability, 1.4xRMT, of the untrained EDC muscle increased ($p=0.045$) while inhibition was reduced ($p=0.034$) in older adults compared to young. Inhibition significantly differed between hemispheres for the young group only ($p = 0.037$)
Conclusions: Following the complex task, bilateral transfer is maintained across ageing. The age-related inhibition differences may reflect altered neuroplasticity, potentially explaining how transfer is maintained. Additionally, a lack of hemispheric lateralisation in older adults provides some support for the HAROLD hypothesis.

10:45 am - 11:30 am POSTER SESSION

1. ### Assessing Neuromodulation Effects of Theta Burst Stimulation to the Prefrontal Cortex Using TMS-Evoked Potentials

Adriano H. Moffa[a], Stevan Nikolin[a], Donel Martin[a], Colleen Loo[a], Tjeerd W. Boonstra[a,b]

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Background: Theta burst stimulation (TBS) is a potent form of non-invasive brain stimulation, thought to have similar cortico-modulatory properties to longer, more commonly used repetitive transcranial magnetic stimulation protocols. However, the changes in cortical reactivity induced by TBS, when applied to the dorsolateral prefrontal cortex (DLPFC), remain unclear.
Methods: Twenty-four healthy participants (13 males, mean age 25.2±9.9 years) were assessed at three different sessions (intermittent TBS, continuous TBS and sham) using a double-blinded crossover design.

Combined single-pulse TMS and electroencephalography (TMS-EEG) were used to assess cortical excitability changes through TMS-evoked potentials (TEPs). TEPs were obtained at baseline and 2-, 15-, and 30-min post-stimulation. Four TEP components (N40, P60, N100 and P200) were analysed using mixed effects repeated measures models (MRMM).
Results: MRMM analyses of TEP amplitudes in the DLPFC showed no significant main effects of Time, Condition, or Time x Condition interaction for any assessed components (N40, P60, N100, P200). At T15, the effect size (ES) for the difference between iTBS and sham was Cohen's d = -0.5.
Conclusions: We did not find significant differences in cortical reactivity between iTBS, cTBS and sham. The pooled ES of iTBS in N100 amplitudes was smaller in our experiment than the prior finding, suggesting that the true ES is likely smaller than previously reported. Larger samples and meta-analytic methods or Bayesian approaches using informative priors are needed to overcome inter-individual heterogeneity and accurately assess TBS effects on the DLPFC.

2. Does offline high-frequency repetitive transcranial magnetic stimulation (HF-rTMS) improve cognition in healthy populations? A systematic review and meta-analysis

Mei Xu [1], Stevan Nikolin [1,2], Nisal Samaratunga [1], Esther Jia Hui Chow [1], Colleen K. Loo [1,2,3], Donel M. Martin [1, 2]

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[3]St. George Hospital, Sydney, Australia

Background: Offline high-frequency repetitive transcranial magnetic stimulation (HF-rTMS) has been proved as an effective treatment for neuropsychiatric disorders (e.g., depression). However, the utility of offline HF-rTMS for enhancing cognition remains unclear. A systematic review and meta-analysis was conducted to quantify the cognitive effects of offline HF-rTMS in healthy individuals.
Methods: We conducted a literature search across five databases (PubMed, MEDLINE, Embase, Cochrane Library and PsychINFO) up until May 2020. Randomised controlled trials with cognitive outcomes for pre and post HF-rTMS were included. Separate analyses examined the cognitive effects of excitatory and inhibitory forms of offline HF-rTMS on accuracy and reaction times across six cognitive domains.
Results: Forty-seven studies (N = 1202) met inclusion criteria. No significant effects of excitatory or inhibitory HF-rTMS were found for reaction time or accuracy for any of the cognitive domains. Excitatory forms showed a statistically significant small sized effect for improving reaction time across all domains collapsed (k = 25, g = -0.18, 95 % CI = [-0.33; -0.03], p = 0.02). In subgroup analyses, 10 Hz rTMS (k = 20, g = -0.23, 95 % CI = [-0.41; -0.05], p = 0.03) and HF-rTMS with multiple sessions (k = 10, g = -0.44, 95 % CI = [-0.72; -0.15], p = 0.01) were associated with stronger cognitive enhancement.
Conclusions: Offline HF-rTMS does not result in robust cognitive effects across cognitive domains. However, excitatory forms decreased response times for all domains collapsed, suggesting a non- specific cognitive enhancing effect for processing speed.

3. Effects of Slow Oscillatory Transcranial Alternating Current Stimulation on Motor Cortical Excitability Assessed by Transcranial Magnetic Stimulation

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Background: Converging evidence suggests that transcranial alternating current stimulation (tACS) may entrain endogenous neural oscillations to match the frequency and phase of the exogenously applied current and this entrainment may outlast the stimulation (although only for a few oscillatory cycles following the cessation of stimulation). However, observing entrainment in the electroencephalograph (EEG) during stimulation is extremely difficult due to the presence of complex tACS artefacts.
Methods: The present study assessed entrainment to slow oscillatory (SO) tACS by measuring motor cortical excitability across different oscillatory phases during (i.e., online) and outlasting (i.e., offline) stimulation. 30 healthy participants received 60 trials of intermittent SO tACS (0.75 Hz; 16s on / off interleaved) at an intensity of 2mA peak-to-peak. Motor cortical excitability was assessed using transcranial magnetic stimulation (TMS) of the hand region of the primary motor cortex ($M1_{HAND}$) to induce motor evoked potentials (MEPs) in the contralateral thumb. MEPs

were acquired at four time-points within each trial – early online, late online, early offline, and late offline – as well as at the start and end of the overall stimulation period (to probe longer-lasting aftereffects of tACS).
Results: A significant increase in MEP amplitude was observed from pre- to post-tACS (P = 0.013) and from the first to the last tACS block (P = 0.008). However, no phase-dependent modulation of excitability was observed.
Conclusions: Although SO tACS had a facilitatory effect on motor cortical excitability that outlasted stimulation, there was no evidence supporting entrainment of endogenous oscillations as the underlying mechanism.

4. Threshold tracked short-interval intracortical inhibition more closely predicts the cortical response to transcranial magnetic stimulation

Ryoki Sasaki, John G. Semmler & George M. Opie
Discipline of Physiology, School of Medicine, The University of Adelaide, Adelaide, Australia

Short-interval intracortical inhibition (SICI) is a paired-pulse transcranial magnetic stimulation (TMS) technique able to quantify intracortical inhibitory tone in primary motor cortex. While conventional measures of SICI (C-SICI) quantify inhibition by recording changes in the amplitude of the motor evoked potential (MEP) produced by TMS, alternative measures involving threshold tracked SICI (TT-SICI) instead record changes in the intensity of stimulation required to maintain a 0.2 mV target MEP amplitude. Although both C-SICI and TT-SICI are thought to reflect inhibition mediated by gamma-aminobutyric acid type A ($GABA_A$) receptors, recent evidence suggests the mechanisms involved with each measure may not be the same. The aim of this study was to use combined TMS-electroencephalography (TMS-EEG) to further investigate the mechanisms contributing to C-SICI and TT-SICI. In 20 adults (30.6 ± 8.1 years), C-SICI and TT-SICI were recorded with multiple conditioning intensities (70, 80 or 90% active motor threshold) using both posterior-to-anterior (PA) and anterior-to-posterior (AP) induced currents. The observed inhibition was then correlated against the amplitude of the TMS-evoked EEG potential (TEP) obtained with PA and AP stimulation. Correlation analysis demonstrated that, irrespective of conditioning intensity or current direction, measures of C-SICI were unrelated to TEP amplitude. In contrast, the magnitude of TT-SICI was predicted by P30 with AP stimulation (R = -0.532, P = 0.041). Our findings further demonstrate that C-SICI and TT-SICI likely reflect different facets of $GABA_A$-mediated processes, with inhibition produced by TT-SICI appearing to align more closely with TMS-EEG measures of cortical excitability.

5. Does continuous theta burst stimulation alter aperiodic activity in the resting EEG power spectra?

Ellen E. R. Williams [1,2] Carolyn Berryman [1,2] , Brenton Hordacre [3], Mitchell R. Goldsworthy[1,2] , Lynton Graetz[1,2], Nigel C. Rogasch[1,2,4]

1. Adelaide Medical School, University of Adelaide
2. Lifelong Health Theme, South Australian Health and Medical Research Institute
3. Allied Health and Human Performance, University of South Australia
4. Turner Institute for Brain and Mental Health and School of Psychological Sciences, Monash University

Background: Brain activity as measured by electroencephalography (EEG) is composed of periodic oscillations and aperiodic, non-oscillatory activity. The physiological relevance of aperiodic activity had been largely ignored until recently, as emerging studies have shown that aperiodic activity changes with different task states and arousal levels. Continuous theta burst stimulation (cTBS) is a non-invasive brain stimulation paradigm used to drive plasticity and alter oscillations, yet it is unclear whether cTBS also alters aperiodic activity in the EEG power spectra.
Methods: We compared changes in aperiodic activity measured from resting-state EEG before and after two blocks of cTBS spaced by 10 mins to the primary motor cortex. Eighteen healthy adults (23.7±6.0 years, 8 males) attended one real and one sham cTBS session, with 14 participants returning for another real session to assess reliability of effects. Aperiodic activity was quantified as the exponent value (i.e., the slope) of the 1/f-like component of the EEG power spectra fitted between 3-30 Hz using the FOOOF toolbox.
Results: cTBS did not alter the aperiodic exponent at the group level (p>0.05). However,
changes were observed on the individual level that showed moderate reproducibility between cTBS blocks (r=0.50, p=0.03) and 20 mins post-cTBS (r=0.53, p=0.02) across real sessions.
Conclusions: Our results suggest that cTBS may alter aperiodic activity in some individuals, although the direction and magnitude of change differs between individuals. Overall, this study adds to the growing body of literature demonstrating high variability in cTBS outcomes and underscores the need to personalise stimulation parameters.

6. A systematic review of the chronometry of visuomotor integration tasks: A Registered Systematic Review Protocol

Gemma Lamp[1], Robin Laycock[1,2], Bonnie Alexander[1,3,4], Rosa Sola Molina[1], Laila Hugrass[1], David Crewther[5], Sheila Crewther[1]

1. La Trobe University, Bundoora
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4. Murdoch Children's Research Insitute
5. Centre for Human Psychopharmacology, Swinburne University of Technology, Melbourne

While the neuroanatomical correlates of visuomotor behaviour are well established, the timing of activation and interaction of these defined areas awaits elucidation. Therefore, we have pre- registered a protocol to conduct a systematic review of the neural chronometry of visuomotor integration as assessed by brain stimulation in healthy adults. Study inclusion criteria include a simple visuomotor integration task requiring the participant to reach and grasp the objects presented. The primary comparators will include variations of the brain stimulation protocols utilized as follows: 1) Offline stimulation (rTMS, tDCS, TBS) and online (task-synced) TMS; 2) Neuroanatomical location of the stimulation site (i.e. parietal, motor, visual areas); 3) In the online (task-synced) TMS studies, the TMS pulse – task timing. The main outcomes will be behavioural responses (in terms of accuracy, kinematics recordings and reaction time), with additional outcomes including task paradigms and brain stimulation methodology variations. A customised quality appraisal tool will be utilised to assess general methodological quality at the study level, using established study quality checklists and specific brain stimulation guidelines. The narrative review will allow a conclusion to be made about brain stimulation, and different neuroanatomical locations targeted, and how this impacts visuomotor behaviour. The meta-analysis of timing will allow further insight into the timing of the underlying neural processes for visuomotor tasks and detail how the underlying visuomotor neuroanatomical areas function and the impact of interruption to these areas, with implications for a wide range of clinical and healthy neurological studies.

7. Combined effects of gamma transcranial alternating current stimulation and theta burst stimulation on motor cortex plasticity

Dylan Curtin, Melissa Pelly , & James P. Coxon

The Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash University, Victoria 3800, Australia

Background: The after-effects of theta burst stimulation are highly variable across individuals, hindering translation to clinical and therapeutic practice. Combining theta burst stimulation with other forms of non-invasive brain stimulation, such as transcranial alternating current stimulation (tACS), may be one way to produce more consistent effects, however this hypothesis remains largely untested.
Objective: To explore whether gamma tACS applied before intermittent theta burst stimulation (iTBS) could enhance the long-term potentiation (LTP) 'like' after-effects of iTBS, as measured by changes in motor cortex excitation and inhibition.
Methods: Sixteen healthy young adults completed two sessions involving either 20- minutes of gamma tACS (75Hz) or 'sham' stimulation over the primary motor cortex. Participants and experimenters were blinded to tACS condition. To quantify the effects on LTP, single and paired-pulse transcranial magnetic stimulation measures of motor cortex excitability and inhibition (cortico-motor excitability, short-interval intracortical inhibition, short-interval intracortical facilitation) were obtained before and after tACS (or sham) and again after iTBS.
Results: We observed no significant main or interaction effects of tACS condition following iTBS across our measures of motor cortex excitability or inhibition (all $p > .10$).
Conclusion: In contrast to previous work using co-stimulation (i.e., tACS and iTBS applied simultaneously), we found that priming with gamma tACS did not enhance the LTP-like after-effect of iTBS. In addition to administering these techniques separately, we speculate that our null results may reflect metaplastic mechanisms given the extended length of our tACS protocol (20 minutes vs ~3 mins used previously).

15 July 2021 – abstracts (cont'd)

11:30 am - 12:30 pm **Symposium: A paradigm shift in rTMS plasticity: non-synaptic and glial mechanisms**
Chairs: A/Prof Jenny Rodger

Symposium Overview. Repetitive transcranial magnetic stimulation (rTMS) is commonly used to induce neuroplasticity in clinical and non-clinical populations. For over 30 years, the dogma of rTMS research has been that rTMS drives synaptic "like" plasticity mechanisms in the brain. However, there is growing evidence from animal models that rTMS can also harness non-synaptic mechanisms in neurons and glial plasticity. This symposium brings together early-career researchers to share their rTMS research on neuronal membrane excitability, oligodendrocytes (responsible for myelination) and astrocytes (supports neuronal metabolism and ion buffering). Together, these presentations will demonstrate that rTMS induces acute and long-lasting effects that extend beyond the synapse and the need for the field to broaden its view on how rTMS affects the brain.

Abstract: Dr Alexandra Tang
School of Biological Sciences, University of Western Australia; Perron Institute for Neurological and Translational Research
Repetitive transcranial magnetic stimulation modulates intrinsic membrane properties to alter neuronal excitability.

In human studies, indirect measures of cortical excitability (e.g. motor evoked potentials) are used to characterise rTMS-induced plasticity. In animal models, more direct measurements of synaptic transmission and neuronal excitability can be made, making them a powerful adjunct to human research. In this presentation, I will discuss the work from myself and others that have shown changes to neuronal excitability that are independent of synaptic plasticity. Specifically, I will show that rTMS delivered with the intermittent theta burst stimulation protocol induces acute and chronic changes to neuronal membrane properties (e.g. resting membrane potential, spike firing frequency and action potential threshold) that regulate intrinsic excitability. In addition, I will discuss how rTMS-induced changes to neuronal intrinsic excitability vary between neuron subtype (inhibitory vs excitatory), cortical layer and age.

Abstract: Dr Carlie Cullen
Menzies Institute for Medical Research, University of Tasmania
Low-intensity repetitive transcranial magnetic stimulation facilitates adaptive myelination in the adult mouse central nervous system.

Within the central nervous system (CNS), oligodendrocytes are the cell type responsible for making myelin – the fatty insulating substance that gets wrapped around axons to facilitate the rapid and reliable, saltatory conduction of action potentials throughout the brain. New oligodendrocytes are added to the CNS throughout life, generated from immature, proliferative cells known as oligodendrocyte progenitor cells (OPCs). Neuronal activity is a potent extrinsic regulator of oligodendrocyte generation and myelination. Clinically, repetitive transcranial magnetic stimulation (rTMS) is delivered to non-invasively modulate neuronal activity, however the ability of rTMS to facilitate adaptive myelination has not been explored. Using transgenic mice that fluorescently label OPCs in the adult mouse brain, we determined that low intensity rTMS (LI-rTMS), delivered in an intermittent theta burst pattern (600 pulses, 120mT, daily for 14 days), promoted the survival and maturation of newborn oligodendrocytes, essentially doubling their number in the cortex 24hr after cessation of stimulation. By fluorescently labelling a subset of pre-existing mature oligodendrocytes in the CNS, prior to administering LI-rTMS, we found that while the gross myelinating morphology of these cells was unaltered by LI-rTMS, the average length of nodes of Ranvier was reduced by ~19% in the cortex and by ~16% in the corpus callosum (CC). This narrowing of the nodes corresponded with adaptive changes in myelin

ultrastructure. Transmission electron microscopy analysis revealed a ~7% reduction in the average myelin thickness along axons within the CC after LI-rTMS, that was primarily associated with a ~47% increase in the space between the myelin the axon known as the periaxonal space. Functionally, these Li-rTMS induced changes in node size and myelin ultrastructure slowed conduction velocity along myelinated axons in the CC by ~18%. The myelinated axon component of the compound action potentials recorded in the CC increased by ~40% and the half-width decreased by ~9%, suggesting that a greater number of action potentials arrived at the recording electrode simultaneously. These data demonstrate that LI-rTMS has the capacity to drive adaptive changes in both new and existing oligodendrocytes that these cellular responses may act in concert to fine tune neuronal signalling in the CNS.

Abstract: Dr Darren Clarke
Department of Neuroscience, Universite de Montreal
Direct effects of low intensity repetitive magnetic stimulation on astrocytes.

Astrocytes, are a major glial cell in the central nervous system, responsible for a large range of functions including modulation of synaptic activity and repair processes in the brain following injury. Despite their importance to brain function and neuroplasticity, the impact of rTMS on astrocytes remains largely unknown. To characterise the effect of rTMS on astrocyte biology, we used an in vitro model to investigate changes to calcium signalling, gene and protein expression and an in vivo model to investigate changes in the astrocyte scar response following neurotrauma. In enriched astrocytes isolated from the mouse cortex, we observed increased calcium signalling during 1Hz stimulation. Furthermore, 1Hz and 10Hz stimulation significantly reduced the expression of genes and proteins relating to calcium signalling, inflammation and plasticity. Following neurotrauma, rTMS reduced the density of astrocytes within the glial scar in adult (3 month old) and aged (18 month old) female mice but increased the density in adult and aged male mice. Interestingly, the effect of rTMS on astrocyte density was greater in the aged mice. These findings demonstrate the ability of rTMS to elicit changes in astrocyte physiology that are frequency, sex and age-dependent and suggest that astrocytes may contribute to the known effects of rTMS on neuroplasticity and brain function.

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