GONFERENCE MELBOURNE 2018



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NEUROSPEC

Research Neurosciences





Australian Research Council Centre of Excellence for Integrative Brain Function





MONASH INSTITUTE OF COGNITIVE AND CLINICAL NEUROSCIENCES



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The conference is preceded by a range of technical and ECR workshops from Tuesday 20th to Thursday 22nd November.



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DEAR COLLEAGUES, STUDENTS, DISTINGUISHED GUESTS, VALUED SPONSORS, AND SUPPORTERS

It is our great pleasure to welcome you all to the 8th Annual Meeting of the Australasian Cognitive Neuroscience Society in—some may say—the greatest city in the world: Melbourne.

We are thankful for the opportunity to organise this conference, which is clearly the highlight of every cognitive neuroscientist's academic year, and to welcome our distinguished national and international keynote speakers and colleagues. We are also very thankful for the instrumental support we have received from our sponsors, without whom this conference would not have been possible.

As in previous years, we are confident that the conference will showcase the highlights of Australasian cognitive neuroscience research, and allow us to proudly present the fascinating and ground-breaking work of our society's established and mid-career researchers, as well as of the new generation of our highly talented early-career researchers. We aim to provide you with ample opportunities for learning about new findings and methods, heated discussions, exchanging brilliant ideas, and networkingas well as for consuming great food and coffee, and having a good time with colleagues and friends. (No guarantee for the weather though; it's Melbourne after all...)

This society has always been remarkably collegial, friendly, and inspiring, and it has truly created a sense of identity for cognitive neuroscience researchers in the region. The ACNS is dedicated to gender equality for speakers, keynotes, session chairs, and leaders, and further to a strong focus on creating student opportunities and providing excellent education. This conference will be no exception, and we hope you will find the scientific program, as well as the events surrounding the conference, enjoyable. This year, we are introducing Keep Cups to help protect the environment, as well as nametag ribbons from the Trading Circle to support the fight against sex trafficking. We hope that these initiatives will catch on and inspire more support for good causes at future conferences.

Finally, we would like to thank our amazing conference organising team, as well as the team of engaged student helpers, for their hard work and sustained efforts to make this conference a success.

We sincerely hope that you have a great time in Melbourne!

Katherine Johnson & Stefan Bode Co-chairs of ACNS2018

COMMITTEES

The 8th Australasian Cognitive Neuroscience Society Conference is hosted at the University of Melbourne.

LOCAL ORGANISING COMMITTEE



Trevor Chong Monash University

Hannah Keage University of South Australia



University of Tasmania

TO THE ELDERS, PAST AND PRESENT

-5-

STUDENT VOLUNTEERS

James **Agathos** Milan **Andrejevic** Tessel **Blom** Kate **Coffey** Duy Pham **Dao** Djamila **Eliby** Ariel **Goh** Anna **Ishkova** Matthew **Jiwa** Celina Rong Chian **Lau** Qianchen Chelsea **Liang** Elektra **Schubert** William **Turner** Nicholas **Wilson** Zhi Wei Dominic **Yip**

EXECUTIVE COMMITTEE

President

Olivia Carter, University of Melbourne Secretary Hannah Keage, University of South Australia Treasurer Rob Hester, University of Melbourne Public officer & president elect Frini Karayanidis, University of Newcastle Past president Paul Corballis, University of Auckland ECR member Bryan Paton, University of Newcastle Student representative Riccarda Peters, Swinburne University General member Sharna Jamadar, Monash University

ACNS 2019

THE 9[™] CONFERENCE of the AUSTRALASIAN COGNITIVE NEUROSCIENCE SOCIETY

21st–24th November 2019

Hosted by the University of Tasmania Launceston, Tasmania



ATTENDEE INFORMATION

(Almost) everything you need to know to make your conference visit a success.

ТМ

If you are visiting the University of Melbourne from a participating **eduroam** institution you can connect to the eduroam network using your login credentials. First, select the **eduroam** wifi network from available networks. Enter your full username including domain (e.g. jsmith@institution.edu.au), then enter your password.

The **Visitor** wireless network provides wireless access to the internet to all delegates who are not from a participating eduroam institution.

Wi Fi

First, select the **Visitor** wifi network from available networks. Then launch a web browser and access any website (on some devices this will happen automatically).

Use the login credentials below and click connect or OK.

Username: **aconference** Password: **!5xgCE**



Left. The Italian restaurant district of Lygon Street is just a short walk from the Parkville campus. Photo by Chen Siyuan (CC BY-SA 4.0).

POSTER PRESENTATION INSTRUCTIONS



Both poster sessions will be held in the B117 foyer, at basement level in the Melbourne School of Design building.

Please leave your poster in place until the end of afternoon tea, and ensure that you have removed it by the end of the final session of the day.

Volunteers will be available to provide fixings to attach your poster to the boards. Please ensure that your poster is in place before the end of morning tea on the day of presentation.

ORAL PRESENTATION INSTRUCTIONS



An iMac equipped with Power-Point and Keynote software is available in each theatre. Alternatively, speakers may use their own computers or devices for their presentations.

Please help the session chairs and stay within the time allotted, as each session is under strict time limits. Each lecture theatre has a VGA and HDMI cable for connection to the multimedia system. If your device does not have a VGA or HDMI port, be sure to bring your own adaptor. All speakers must either upload their slides or connect their device at least 15 minutes prior to their assigned session. A volunteer will be available to upload speaker presentations.

VENUE MAPS

The conference main venue is north of the Melbourne Central Business District, at the Parkville campus of the University of Melbourne.

- ① Parkville Campus (Main venue)
- ② Melbourne Zoo (Conference dinner)
- ③ Princes Park (Fun run)
- ④ Vertue of the Coffee Drink (ECR mixer)
- (5) Melbourne Museum & Royal Exhibition Building
- (6) Queen Victoria Market
- ⑦ Melbourne Central Railway Station

- (8) State Library Victoria
- (9) Chinatown Melbourne
- 10 Parliament House
- (1) Bourke Street Mall
- 12 Melbourne Town Hall
- (13) Federation Square
- (14) Melbourne Cricket Ground



The Redmond Barry Building and Melbourne School of Design are located in the north-east corner of the campus, near Swanston Street and Tin Alley.

- 1 Redmond Barry Building
- 2 Melbourne School of Design
- ③ University Oval
- (4) University House
- (5) Melbourne University Sport
- 6 Union House
- 7 Grainger Museum
- ⑧ Tiegs Zoology Museum
- (9) Old Arts Building
- 10 Banks (Commonwealth & NAB)

- (1) Old Quadrangle
- 12 Ian Potter Museum of Art
- (13) The Dax Centre
- (14) Baillieu Library
- (15) Medical History Museum & Biomedical Library
- 16 South Lawn
- 17 Wilson Hall
- (18) Eastern Resource Centre
- (19) Harry Brookes Allen Musem of Anatomy & Pathology
- 20 The Co-op Bookshop



The Lyle, Lowe, and Medley theatres are located in the Redmond Barry Building, and the B117 theatre is at basement level in the Melbourne School of Design.

- 1) Lyle theatre (Ground floor)
- 2 Lowe theatre
- ③ Medley theatre

- (4) Redmond Barry courtyard
- (5) B117 theatre (Basement level)
- (6) Melbourne School of Design foyer



SOCIAL EVENTS

Alongside the scientific program, the conference features social events including a welcome reception at the Melbourne School of Design building, a fun run in Princes Park, an early-career researcher mixer off Lygon Street and a dinner at Melbourne Zoo.

WELCOME RECEPTION

Melbourne School of Design

Thursday, 22nd November @ 5:00pm

The conference's welcome reception will be held on Thursday evening, following the opening keynote, in the award-winning MSD building on the Parkville campus. Food and drink will be from Mary & Steve, who have been creating innovative, healthy and artistic catering from their North Carlton base for 40 years. They will provide a range of canapés with vegetarian, vegan, gluten free and dairy free options available; to drink, they will serve a range of Australian wines, beers, and other refreshments.



FUN RUN

Princes Park Friday, 23rd November @ 7:00am

The ACNS Fun Run is back again this year, sponsored by **Compumedics**. Held along the avenues of elm and Moreton Bay fig trees in Princes Park, views take in the city skyline across to the Melbourne General Cemetery.







The Vertue of the Coffee Drink Friday, 23rd November @ 6:30pm

The ECR group will host a special social event for early-career researchers on Friday evening. It will be held at The Vertue of the Coffee Drink, housed in an old stable in a laneway off Lygon Street. A range of canapés will be served, as well as a selection of Australian and international wines, beers, ciders and soft drinks. The Vertue of the Coffee Drink will also be providing food, refreshments and coffee during the conference.

CONFERENCE DINNER

Leopard Lodge @ Melbourne Zoo Saturday, 24th November @ 7:00pm

The conference dinner, sponsored by **Symbiotic Devices**, will be held on Saturday night at the Leopard Lodge, an exciting, new custom-built structure at Melbourne Zoo. This will be a three-course seated dinner with drinks. Looking out onto the beautiful gardens and lawns of the lower Zoo, the Lodge is close to the Big Cat habitats and attendees may even hear the lions roaring on occasion.

CONFERENCE Nametags



Your conference nametag comes from the **Welcome House** in Cebu, the Philippines via the Trading Circle. Once used at the conference, the plastic tags can be slipped off and the beaded section can be used as a necklace or bracelet. The Welcome House supports young women who have been trafficked to Cebu to work in the sex industry. Here they receive acceptance, support, counselling, accommodation and meals. They have the opportunity to learn new skills and thus an alternative way of earning money. The women are provided with more than just an income: They also share a sense of community and are able to work with dignity and self-respect.



WORKSHOPS

The conference is preceded by technical and ECR workshops from Tuesday 20th to Thursday 22nd November.

CONNECTOMICS

The human brain is a complex, interconnected network. This educational workshop provides an introduction to the burgeoning field of Network Neuroscience, which uses the concepts from network science and the mathematics of graph theory to understand the structure and dynamics of interconnected neural systems. The workshop will cover fundamental concepts and practical considerations when conducting network analyses of neuroscientific data, with a principal focus on applications to human neuroimaging. It is suitable for both researchers with a background in psychological and biological sciences looking to understand the technical and conceptual foundations of the field, and for scientists with backgrounds in computational and physical sciences seeking to understand how network science can be applied to understand the brain. Organised by Alex Fornito and Andrew Zalesky, with presentations from James Roberts, Caio Seguin, Aurina Arnatkeviciute, Mac Shine, Mangor Pederson and Marta Garrido.



Tuesday 20th November @ 12:30pm RBB MEDLEY THEATRE

MOBILE EEG AND EEG-BASED BRAIN-COMPUTER INTERFACES



Wednesday 21st November @ 9:00am R B B L Y L E T H E A T R E

This one-day, hands-on workshop will explore the use of electroencephalography (EEG) in mobile applications, EEG-based brain computer interface (BCI), and LSL, a toolbox for real-time interface with EEG technology. The program will feature Mobile Brain Imaging (MoBI) and how mobile EEG can be used to investigate brain dynamics during more natural processes, followed by an overview of mobile EEG and fNIRS technology; BCI and the application of EEG in BCI; and David E. Medine, introducing LabStreamingLayer (LSL), supported by a tutorial/hands on session on how to work with LSL. The workshop is intended for students and researchers that are interested in the use of mobile EEG and EEG-based brain-computer interfaces, and researchers interested in learning about the LabStreamingLayer (accessing data streams in real-time, for time-synchronisation between different devices, networking and centralised collection). The workshop will conclude with a live experiment using LSL with mobile EEG.



Left. St Kilda beach from the old Brooks Jetty. Photo by Bidgee (CC BY-SA 3.0).

PRACTICAL ISSUES IN DEVELOPMENTAL COGNITIVE NEUROSCIENCE

The field of Developmental Cognitive Neuroscience has taught us a great deal about the developing brain and how it relates to our cognitive development. However, there are a number of unique challenges in working with children and adolescents that need to be considered in an experimental design or analysis. This workshop will present the major conceptual and methodological challenges in working in a young population and some practical solutions, covering neuropsychological/cognitive measures and neuroimaging techniques (MRI, EEG and Brain Stimulation). The workshop is organised by Tim Silk, who will speak on Preparing children for MRI, and keeping them still. Megan Spencer-Smith will speak on Cognitive measures of development; Sarah Barton on Cognitive measures in childhood disorder; Bonnie Alexander on Issues in normalising to an adult template; Sila Genc on The influence of puberty on the developing brain; Jarrad Lum on EEG issues in infants; and Peter Enticott on Brain stimulation and EEG issues in children.



Thursday 22nd November @ 9:00amRBB MEDLEY THEATRE

#academiclife: NAVIGATING THE POST-PHD EXPERIENCE



Thursday 22^{nd} November @ 1:00pm R B B L Y L E T H E A T R E

Academia is not a job; it is a lifestyle, so some say. Come join the ACNS ECR committee as we facilitate a discussion on the challenges of the postdoctoral experience, with keen insights from our panel of distinguished researchers with unqualified success and experience in areas such as grant writing and getting a fellowship. Get invaluable advice on career planning and making a success of your postdoctoral time. We are very fortunate this year to be joined by Prof. Erica Fletcher, Head of the Visual Neuroscience Laboratory at the University of Melbourne. We will also hear from the two 2018 ACNS Young Investigator Award winners, Dr Marta Garrido and Dr Mac Shine and Emerging Research Award winners Dr Patrick Cooper and Dr Talitha Ford. This will be followed by a Q&A panel discussion. So whether you are a current postdoc, or a postgraduate student seeking to join the fray, come along and hear what our panellists have to offer and interact with your peers in a supportive and informative environment.

KEYNOTES

EMILY FALK

Neural approaches to understanding how ideas and behaviours spread

UNIVERSITY OF PENNSYLVANIA



MSD B117 THEATRE

Emily Falk is an Associate Professor of Communication, Psychology, and Marketing at the University of Pennsylvania. Prof. Falk employs a variety of methods drawn from communication science, neuroscience and psychology. Her work traverses levels of analysis from individual behavior, to diffusion in group and population level media effects. In particular, Prof. Falk is interested in predicting behaviour change following exposure to persuasive messages and in understanding what makes successful ideas spread (e.g. through social networks, through cultures). Prof. Falk is also interested in developing methods to predict the efficacy of persuasive communication at the population level. At present, much of her research focuses on health communication; other areas of interest include political communication, cross-cultural communication, and the spread of culture, social norms and sticky ideas. Prof. Falk's work has been recognized by early career awards from the International Communication Association, the Society for Personality and Social Psychology (Attitudes Division), by an APS Rising Star Award, and by funding from NCI, NICHD, NIDA/the NIH Director's New Innovator Award, ARL, DARPA and ONR. Prior to her doctoral work, Prof. Falk was a Fulbright Fellow in health policy, studying health communication in Canada. She received her bachelor's degree in Neuroscience from Brown University, and her Ph.D. in Psychology from the University of California, Los Angeles (UCLA).

In this keynote, Associate Professor Emily Falk will provide an overview of Sponsored by work linking neural responses in small groups of people to individual behaviour change and the spread of ideas outside of the lab, as well as population level behaviours that go beyond the individuals whose brains are scanned. She will also describe recent research linking brain activity to behaviour outside of the lab that incorporates social network measurements into models linking brain and behavioural outcomes.





Above. Boatsheds along the Yarra, looking east from Princes Bridge towards the Melbourne Cricket Ground.



NICK TURK-BROWNE

Rethinking how memories are stored in the brain

YALE UNIVERSITY

Nick Turk-Browne is a Professor in the Department of Psychology at Yale University. He previously served on the faculty at Princeton University (2009-2017). He obtained an HBSc from the University of Toronto (2004) and a PhD from Yale University (2009). Nick's research takes an integrative perspective, using behavioral studies, brain imaging, theoretical modeling, and computational analysis to understand how different cognitive and neural systems interact. He has published extensively on the interaction between perception (how we experience the current environment) and memory (how we draw on past experiences), including the learning mechanisms that transform perception into memory and the attentional mechanisms that regulate this transformation. Most recently, his lab has been developing techniques for brain imaging in infants and toddlers who are awake and having their behavior monitored. Nick's work has been published in journals such as Science, Nature Neuroscience, and Proceedings of the National Academy of Sciences, and has been featured in the New York Times, the New Yorker, and the Atlantic. He has been funded by the National Institutes of Health, National Science Foundation, John Templeton Foundation, and Intel Labs. He received Young Investigator Awards from the Vision Sciences Society (2016), Cognitive Neuroscience Society (2017), and Society of Experimental Psychologists (2018); the Distinguished Scientific Award for Early Career Contribution to Psychology from the American Psychological Association (2015); and he serves a Senior Fellow of the Canadian Institute for Advanced Research (since 2016).



Friday 23rd November @ 5:00pm M S D B 1 1 7 T H E A T R E

Dogma states that memory can be divided into distinct types, based on whether conscious or not, one-shot or incremental, autobiographical or factual, sensory or motor, etc. These distinctions have been supported by dissociations in brain localisation, task performance, developmental trajectories, and pharmacological interventions, among other techniques. A natural consequence is the assumption of a one-to-one mapping between brain systems and memory behaviours. Aside from theoretical concerns about dissociation logic, there have also now been several empirical demonstrations of where these boundaries break down, from contributions of the hippocampus to reward learning and motor behavior to rapid episodic-like learning in frontal cortex. These considerations suggest



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sponsored by that behaviour is overdetermined by multiple brain systems and that the dependence on any particular brain system reflects the specific computations required for that behaviour. As a case study, I will describe a series of neuroimaging, neuropsychological, and computational studies implicating the hippocampal system in statistical learning, a function more traditionally ascribed to cortical systems. I will end by considering some open questions that arise from this perspective, including about how memory systems support predictive coding and change over development.



Left, and cover. Melbourne skyline (north-, east- and south-facing views) from the **Rialto Observatory on Collins** Street. Photo by David Iliff (CC BY-SA 3.0).

INA BORNKESSEL-SCHLESEWSKY

Inter-individual differences in predictive coding during language processing

UNIVERSITY OF SOUTH AUSTRALIA



Saturday 24th November @ 9:30am MSD B117 THEATRE

Ina Bornkessel-Schlesewsky is Professor of Cognitive Neuroscience and Director of UniSA's Centre for Cognitive and Systems Neuroscience. Ina joined UniSA in 2014 from the University of Marburg, Germany. Prior to her appointment as Professor of Neurolinguistics in Marburg, she headed the Max Planck Research Group "Neurotypology" at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. Ina is passionate about understanding how the human brain processes language - an interest that she first developed due to her bilingual upbringing, after having moved to Australia from Germany at the age of 7. She has championed the perspective that, in order to truly understand how the human brain processes language, we need to take into account the full diversity of the world's 7000 languages. Her research is further inspired by the recognition that language-like all human cognitive abilities—is deeply rooted in neurobiology and basic mechanisms of information processing in the brain. With a prolific research program reflected in over 70 publications in refereed international journals and over 20 book chapters, Ina has won more than AU\$4 million in competitive grant funding. Her research has been honoured with a number of prizes, including the Heinz Maier-Leibnitz Prize (awarded by the German Research Foundation and German Federal Ministry of Education and Research), the most prestigious scientific prize for young researchers in Germany.

Predictive coding provides a compelling theory of how the human brain processes information, with the potential to provide a unified explanation across a wide range of different cognitive domains. In spite of the prominence of predictive coding-based accounts in cognitive neuroscience, however, little is currently known about whether and how predictive coding mechanisms differ between individuals. In our laboratory, we have recently begun pursuing a research program that aims to systematically examine such inter-individual differences, with a particular focus on language processing as the cognitive domain of interest. Here, I will present what we have learned so far. Our results provide

evidence for extensive inter-individual differences even in young, healthy sponsored by adults. They further suggest that this variability is related to basic neurobiological influences on perceptual sampling and information processing (individual alpha frequency), as well as to the quality of an individual's language model. I will discuss potential consequences of this variability for predictive coding architectures as well as implications for a lifespan-based perspective on the neurobiology of cognitive processing.



Right. Aerial panorama of Melbourne Zoo. The train tracks at Royal Park station are in the foreground, and the Melbourne CBD lies on the horizon. Photo by Bob Tan

(CC BY-SA 4.0).



2018 ACNS AVARD WINNERS

Congratulations to award winners Mac Shine and Marta Garrido (Young Investigator Awards), and Talitha Ford and Patrick Cooper (Emerging Researcher Awards).



Mac Shine University of Sydney YOUNG INVESTIGATOR



Talitha Ford Swinburne University EMERGING RESEARCHER Dr James 'Mac' Shine is a National Health and Medical Research Council CJ Martin Fellow working at the University of Sydney. Mac is interested in understanding how information is processed in the brain, and has a particular fascination with the neural mechanisms underlying cognition and attention, both in health and disease. In particular, his recent work has focused on trying to understand how the neuromodulatory systems of the brainstem influence and constrain cognitive processing in the brain through the modulation of whole-brain network architecture.

Dr Talitha Ford completed her PhD in 2016 at Swinburne University of Technology, and is currently a Postdoctoral Research Fellow at Swinburne's Centre for Human Psychopharmacology. Her research interests are centred around characterising the excitatory-inhibitory neurobiology of the social dysfunction that is central to several multi-dimensional spectrum conditions, particularly autism and schizophrenia. Her PhD focused on the intersection of autism and schizophrenia spectrum traits and their neural correlates using neuroimaging techniques.

Originally trained in Physics, Dr Marta Garrido found her passion in discovering how the brain works. Marta received her PhD in Neuroscience from UCL in 2008, did a postdoc at UCLA, and returned to London where she stayed until moving to the University of Queensland in 2013 with an ARC Discovery Early Career Award. She leads the Computational Cognitive Neuroscience group at the QBI. Marta's lab uses neuroimaging and computational modelling to understand how the healthy and diseased brain learns and makes predictions about forthcoming events.

Dr Patrick Cooper received his PhD from the University of Newcastle, where he is currently a postdoctoral research fellow in the School of Psychology. His research uses time-frequency decomposition techniques to focus on the neural mechanisms underpinning cognitive control. He is also passionate about public outreach for science, and is the co-founder of a small educational program called Mind Over Mario, where the public can play video games using a wireless EEG as an easily accessible pathway to learn about neuroscience.



Marta Garrido University of Queensland YOUNG INVESTIGATOR



Patrick Cooper University of Newcastle EMERGING RESEARCHER

MAC SHINE

The dynamic basis of cognition: An integrative core under the control of the ascending neuromodulatory system

UNIVERISTY OF SYDNEY

Saturday 24th November @ 9:00am M S D B 1 1 7 T H E A T R E The human brain integrates diverse cognitive processes into a coherent whole, shifting fluidly as a function of changing environmental demands. Despite recent progress, the neurobiological mechanisms responsible for this dynamic system-level integration remain poorly understood. In my talk, I will highlight several recent experiments in which we have used multi-task fMRI data in combination with computational modelling to examine the spatiotemporal architecture of cognition in the human brain. The results of these studies advance our understanding of functional brain organization by emphasising the interface between low-dimensional neural activity, network topology, neuromodulatory systems and cognitive function.

MARTA GARRIDO

The insight of blindsight: Shortcuts to the amygdala

UNIVERSITY OF QUEENSLAND

A decade ago, patient TN became cortically blind after two strokes. His visual cortex was completely destroyed as evident in his brain MRI and yet, when forced to judge the emotion of faces presented to him, he could do so above chance. This phenomenon was coined *affective blindsight*, and a possible explanation was put forward suggesting that an alternative subcortical route bypassing the visual cortex might convey this information to the amygdala, a known emotion centre in the brain. This hypothesis was contentious, however, as the very existence of this route in humans was yet to be shown, let alone its putative functional role in conveying affective information with bearing on behaviour. In this project, we have leveraged publicly available MRI data via the Human Connectome Project to show in 600+ people that an anatomical subcortical pulvinar amygdala route exists indeed and facilitates fear recognition. Moreover, we show that this circuit is functional, such that greater white matter connectivity is correlated with greater functional connectivity between the pulvinar and the amygdala. These findings demonstrate that the brain affords alternative shortcuts which may speed up and ensure redundancy mechanisms for environmental information that is critical for survival, like fear.

Friday 23rd November @ 4:30pm M S D B 1 1 7 T H E A T R E

Patrick Cooper presents "Theta activity within frontal networks reflects specific cognitive-control processes beyond general reaction-time slowing" on Saturday 24th November at 1:50pm, and Talitha Ford presents "Social dysfunctions of autism and schizophrenia are interactively modulated by excitatory and inhibitory neurotransmission" on Sunday 25th November at 11:55am. Both talks are in the RBB Lowe theatre; for abstracts, please refer to the alphabetical listing.

STUDENT TRAVEL Awards

Eleven Student Travel Awards have been offered to students in Australia, New Zealand and beyond to support their attendance at the conference.

Yann Chye, Monash University

Cortical surface morphology in long-term cannabis users: A multi-site MRI study (Saturday @ 3:15pm, RBB Lyle)

Regan Gallagher, University of Queensland

Confidence is a domain-general probe for studying perceptual aftereffects (Sunday @ 11:15am, RBB Lyle)

Sila Genc, Murdoch Children's Research Institute

Longitudinal development of white matter fibre properties in a community sample of children with and without attention difficulties (Friday @ 9:00am, RBB Lowe)



Morgan McIntyre, University of Queensland

Temporal order biases behavioural and neural measures of stimulus encoding in a complex perceptual decision-making task (Friday @ 12:20pm, MSD Foyer, #22)

Montana McKewen, University of Newcastle

Dissociable roles of phase-locked and non-phase-locked theta in task-switching (Saturday @ 2:35pm, RBB Lowe)

Denise Neumann, University of Auckland

Perinatal risk factors in early childhood cognition: Evidence from Growing Up in New Zealand (Friday @ 12:20pm, MSD Foyer, #29)

Left and Right. The Melbourne Star Observation Wheel in the Waterfront City precinct. Photos by Nichollas Harrison (Left; CC BY-SA 3.0) and Bob Tan (Right; CC BY-SA 4.0).



FOR ABSTRACTS OF AWARDEE TALKS AND POSTERS, PLEASE REFER TO THE ALPHABETICAL LISTING.

Selene Petit, Macquarie University

Discovering hidden treasures: Towards a measure of command-following abilities in non-verbal children using functional transcranial Doppler Ultrasound (Saturday @ 12:20pm, MSD Foyer, #60)

Angela Renton, University of Queensland

Implicit neurofeedback boosts feature-based selective attention in a visual decision-making task (Friday @ 12:20pm, MSD Foyer, #21)

Lina Teichmann, Macquarie University

Yellow strawberries and red bananas: Examining the temporal dynamics of object-colour knowledge (Friday @ 9:24am, RBB Lyle)

Anja Thiede, University of Helsinki

Magnetoencephalographic inter-subject correlation during listening to natural speech in dyslexia (Friday @ 10:06am, RBB Medley)

Nicholas Wilson, University of Tasmania

Exploring electrophysiological markers of inhibitory cueing effects (Saturday @ 12:20pm, MSD Foyer, #22)

SYMPOSIA

The conference features four symposia, spanning genetics and genomics, multivariate pattern analysis, prediction and prediction error, and interdisciplinary approaches in neuroscience.

DECODING THE BRAIN THROUGH INTERDISCIPLINARY APPROACHES IN NEUROSCIENCE

The brain is the most complex organ in the human body. Understanding its computational complexity and how it regulates mental processes in health and disease requires approaches from different disciplines. With this goal in mind, this symposium will bring together emerging national leaders from the Early-Mid Career Brain Science Network, an initiative of the Australian Academy of Sciences and Australian Brain Alliance, who will provide interdisciplinary perspectives to understanding the brain. Fostering new interdisciplinary approaches to problems of brain and behaviour are key for advancements in neuroscience. We now have greater opportunities to work in multidisciplinary environments to drive integrative research.

Sharath Sriram, *RMIT University* Artificial synapses using electronic materials

Subhrajit Roy, *IBM Research Australia* Detection, classification, and prediction of epileptic seizures using artificial intelligence

Deborah Apthorp, University of New England & Australian National University A multidisciplinary approach to diagnosing, tracking and predicting disease progression in Parkinson's disease

Adrian Carter, Monash University

Researchers' perspectives on the non-therapeutic use of transcranial direct current stimulation: An international survey



CHAIRS Hannah Keage University of South Australia Jess Nithianantharajah Florey Institute of Neuroscience and Mental Health

RBB Lowe Friday, 23rd November @ 11:00am



CHAIR **Claudine Krann** Murdoch Children's Research Institute

RBB Lyle Friday, 23rd November @ 11:00am

APPLICATIONS OF GENOMICS AND EPIGENETICS TO COGNITIVE NEUROSCIENCE

Genomic medicine and the new "epigenetics revolution" have fundamentally shifted the way that we study the brain, and how we diagnose and treat its disorders. This symposium discusses the future landscape of cognitive neurosciences in a world where precision medicine is commonplace, and where simple and scalable blood tests will likely inform diagnostics, patient management and response or suitability for specific clinical trials. We discuss a range of genetic, genomic and epigenetic studies that have and will continue to advance our understanding of the human brain and its amazing ability to adapt to a changing environment.

Anthony J. Hannan, *Florey Institute of Neuroscience and Mental Health* Genetic and epigenetic modulators of cognitive function in health and disease

Patrick T. Goodbourn, University of Melbourne Vision as a model system in cognitive and behavioural genetics

Claudine Krann, *Murdoch Children's Research Institute* Epigenetic DNA methylation biomarkers and the "target gene" approach

Mark Corbett, *University of Adelaide* Discovery of coding and non-coding variants that cause neurodevelopmental disorders

PREDICTION, PREDICTION-ERROR, AND THE BRAIN

One of the brain's most basic functions lies making predictions about what is likely will occur next. The difference between predicted outcomes and actual outcomes—prediction-error—has been argued to be a universal driver of learning. This symposium will comprise of four empirical studies that have used neurophysiological techniques (e.g., EEG, ERPs) to investigate the neural mechanisms undying prediction and prediction-error. These phenomena will be explored in relation to both externally- and self-generated events.

Juanita Todd, University of Newcastle

Hierarchical learning and the dominance of longer-term assumptions over local predictions

Jessica McFayden, University of Queensland

The influence of prior expectations on conscious face perception depends on emotion

Simmy Poonian, Macquarie University

How does executing an action impact the steady-state visual response?

Thomas Whitford, UNSW Sydney

Sensory predictions regarding the auditory properties of inner speech



RBB Lowe Saturday, 24th November @ 11:00am



CHAIR **Daniel Feuerriegel** University of Melbourne

RBB Lyle Saturday, 24th November @ 11:00am

USING MVPA TO UNDERSTAND HOW THE BRAIN INFERS THE WORLD

Multivariate pattern analyses (MVPA) of neuroimaging data have provided significant insights into how our visual world is represented in the brain. This symposium showcases innovative applications of MVPA to probe the robustness and malleability of neural representations across stimulus, expectancy and task contexts. Research presented within this symposium compares the neural patterns that reflect the visual stimulus with neural patterns that reflect what is subjectively perceived or expected.

Kiley Seymour, Western Sydney University & Macquarie University Characterizing the response to face pareidolia in human category-selective visual cortex

Amanda K. Robinson, *Macquarie University & University of Sydney* Linking adaptive neural responses to behaviour using magnetoencephalography

Tijl Grootswagers, University of Sydney & Macquarie University The representational dynamics of visual objects in rapid serial visual processing streams

Hinze Hogendoorn, University of Melbourne & Utrecht University Time-resolved EEG cross-classification as a window on prediction, extrapolation, and error correction

For abstracts of individual symposium presentations, please refer to the alphabetical listing.



Left. Federation Square, showing Flinders Street Station and St Paul's Cathedral. Photo by Vincent Quach (CC BY-SA 3.0). Symbiotic Devices is excited to be offering two new products for researchers who want **faster, easier and more accurate EEG recordings**.

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CONFERENCE SCHEDULE

Workshops | Tuesday 20th–Thursday 22nd November

Tuesday 1230–1715	Workshop I Connectomics	RBB Medley Theatre
Wednesday 0900–1700	Workshop II Mobile EEG and EEG-based brain–computer interfaces	RBB Lyle Theatre
Thursday 0900–1230	Workshop III Practical issues in developmental cognitive neuroscience	RBB Medley Theatre
Thursday 1300–1500	Workshop IV #academiclife: Navigating the post-PhD experience	RBB Lyle Theatre

Day 1 | Thursday 22nd November

1530-1550	Welcome and Acknowledgement of Country	MSD B117
1550-1600	ACNS Award Announcements	MSD B117
1600-1700	Keynote I: Emily Falk Chair: Stefan Bode Neural approaches to understanding how ideas and behaviours spread Sponsored by Cancer Council Victoria	MSD B117
1700-1900	Welcome Reception	MSD B117 Foyer

Day 2 | Friday 23rd November

0700-0830	Fun Run Sponsored by Compumedics	Princes Park	
		Parallel Fast Talks	
	Clinical I (RBB Lowe)	Perception (RBB Lyle)	Attention & Cognitive Control I (RBB Medley)
0900-0908	Longitudinal development of white matter fibre properties in a community sample of children with and without attention difficulties Sila Genc	Recent visual experience determines the spatial extent of a predictive memory illusion David Carmel	Distractors modulate attentional selection and evidence accumulation during perceptual decision-making Shou-Han Zhou
0908-0916	Altered network connectivity during resting state in Parkinson's disease patients with mild cognitive impairment as a marker for dementia Ji Hyun J. Yang	The P2 encodes prediction error in surface segmentation, independent of stimulus features and rarity Matt Oxner	"I did stop!": An ERP study examining neural processing during successful, partial and unsuccessful inhibitions An Nguyen
0916-0924	A novel neurocomputational model of the effect of dopamine medication and deep brain stimulation on gait dysfunction in Parkinson's disease Ahmed Moustafa	Prediction error processes in ventral and dorsal stream expectancy violations <i>Jonathan E. Robinson</i>	Retained visual working memory, but different cognitive strategy, in aphantasic individuals Rebecca Keogh
0924-0932	Aberrant microglial activation and cognitive impairment in Parkinson's disease: A potential novel therapeutic target Bianca Guglietti	Yellow strawberries and red bananas: Examining the temporal dynamics of object-colour knowledge Lina Teichmann	Sleep preferentially protects temporal aspects of memories from retroactive interference Alex Chatburn
0932-0940	Testing long-term cognitive dysfunction in an animal model of traumatic brain injury: Implications for the translatability of preclinical testing in rodents Lyndsey E. Collins-Praino	Dorsal extrastriate population receptive field estimates reflect stimulus visibility D. Samuel Schwarzkopf	What can eye movements tell us about the unconscious visual episodic memory? Haleh Khoshkhouy Delshad
0940-0950	Break	Break	Break

0950-0958	Salivary endocannabinoids show stress reactivity and are associated with cognitive performance in healthy women Luke J. Ney	Top-down feedback engaged by unreport invisible, changes Elise G. Rowe	processes are ted visible, but not	A different kind of tablet for early childhood inattention James Kean	
0958-1006	EEG functional connectivity predicting delirium severity in older cardiac surgery patients: A pilot prospective study Monique Boord	The role of hue in search for texture differences: Implications for camouflage design Dominic Yip		Alpha oscillations and inhibition during speech in noise processing in older adults with hearing loss Ira Kurthen	
1006-1014	Investigating dopamine-specific projections in the human striatum with resting-state fMRI Marianne Oldehinkel	When prediction fail extrapolation in the Qianchen Liang	s: Correction for flash-grab effect	Magnetoencephalographic (MEG) inter- subject correlation during listening to natural speech in dyslexia Anja Thiede	
1014-1022	Neural decoding of changes in perceived health attributes of snack foods after exposure to health warning labels Djamila Eliby	The contribution of monocular depth cues to size constancy in the context of the Ponzo illusion <i>Gizem Yildiz</i>		Mindfulness meditators show different differences in attention related neural activity depending on task demands Neil Bailey	
1022-1030	A biomarker for anorexia nervosa Andrea Phillipou	Event-related potent processing of centre stimuli are affected b ageing Bao N. Nguyen	tials reflecting –surround visual oy physiological	Investigating the mechanisms of selective inhibition of planned actions in young and older adults Tess Nikitenko	
1030-1100	Morning Tea			RBB Courtyard*	
		Parallel S	Symposia		
	Symposium I: Decoding the brain throu interdisciplinary approaches in neuroso Chairs: Hannah Keage & Jess Nithianantharajah	ugh cience (RBB Lowe)	Symposium II: App to cognitive neuro (<i>RBB Lyle</i>) Chair: Claudine Kr.	lications of genomics and epigenetics science ann	
1100-1115	Artificial synapses using electronic materials Sharath Sriram		Genetic and epigenetic modulators of cognitive function in health and disease Anthony J. Hannan		
1115-1130	Detection, classification, and prediction of epileptic seizures using artificial intelligence Subhrajit Roy		Vision as a model sy genetics Patrick T. Goodbourn	stem in cognitive and behavioural	
1130-1145	A multidisciplinary approach to diagnosing, tracking and predicting disease progression in Parkinson's disease Deborah Apthorp		Epigenetic DNA met approach Claudine Kraan	hylation biomarkers and the "target gene"	
1145-1200	Researchers' perspectives on the non-ther transcranial direct current stimulation: An <i>Adrian Carter</i>	apeutic use of international survey	Discovery of coding neurodevelopmenta Mark Corbett	and non-coding variants that cause I disorders	
1200-1220	Panel Discussion		Panel Discussion		
1220-1350	Poster Session I & Lunch			MSD B117 Foyer	
		Parallel O	pen Talks		
	Perception & Decision Making (RBB Lo	we)	Clinical II (RBB Lyle)	
1350-1405	Tracking adjustments to perceptual decision processes following response conflict Daniel Feuerriegel		Indexing the differen and connectomics in impairment Meg J. Spriggs	ntial modulation of human sensory LTP healthy ageing and mild cognitive	
1405-1420	Tracking the build-up of predictive motion extrapolation in the visual system using time-resolved EEG decoding Tessel Blom		Dopamine restores of disease Trevor TJ. Chong	cognitive motivation in Parkinson's	
1420-1435	Representational momentum and prediction-error signalling: Complementary insights from MEG and fMRI Jordy Kaufman		From statistical com biomarkers for cogn Dmitri K. Gramotnev	puting to clinical practice: Integrated ition in early Parkinson's disease	
1435-1450	The effect of absolute evidence magnitude on perceptual changes of mind William F. Turner		Patients with Parkin burdens than their s Kyla-Louise Horne	son's disease report higher hallucination ignificant other reporting on their behalf	
1450-1500	Break		Break		
1500-1515			The right brain and t semantic dementia Rosalind Hutchings	he right cues: Facial scanning patterns in	
1515-1530	Investigating perceptual filling-in using ste evoked potentials (SSVEPs) Matthew Davidson	ady-state visually	The predictive brain Ilvana Dzafic	in the schizophrenia spectrum	

1530-1545	Reading which way your mind spins Pat Johnston	Multivariate lesion-network mapping in stroke patients reveals connectivity patterns related to specific and global behavioural deficits Luke J. Hearne	
1545-1600	Predictive coding with neural transmission delays: A real-time temporal-alignment hypothesis Hinze Hogendoorn	Intranasal oxytocin alters a functional connectivity in Sally Grace	amygdala–temporal resting-state body dysmorphic disorder
1600-1630	Afternoon Tea		MSD B117 Foyer
1630-1700	Young Investigator Keynote I: Marta Garrido The insight of blindsight: Shortcuts to the amygdala		MSD B117
1700-1800	Keynote II: Nick Turk-Browne Chair: Katherine Johnson Rethinking how memories are stored in the brain Sponsored by the Centre of Excellence for Integrative Brain Function		MSD B117
1830-2200	ECR Mixer		Vertue of the Coffee Drink (9 Raffa Place, Carlton)

Day 3 | Saturday 24th November

	5		
0900-0930	Young Investigator Keynote II: Mac Shine The dynamic basis of cognition: An integrative core under the control of the ascending neuromodulatory system		MSD B117
0930-1030	Keynote III: Ina Bornkessel-Schlesewsky Chair: Patrick Goodbourn Inter-individual differences in predictive coding during language processing Sponsored by g.tec		MSD B117
1030-1100	Morning Tea		RBB Courtyard*
	Parallel S	Symposia	
	Symposium III: Prediction, prediction-error, and the brain (<i>RBB Lowe</i>) Chair: Thomas Whitford	Symposium IV: Using M brain infers the world (R Chair: Daniel Feuerriege	VPA to understand how the BB Lyle) I
1100-1115	Hierarchical learning and the dominance of longer-term assumptions over local predictions Juanita Todd	Characterizing the response to face pareidolia in human category-selective visual cortex Kiley Seymour	
1115-1130	The influence of prior expectations on conscious face perception depends on emotion <i>Jessica McFadyen</i>	Linking adaptive neural res magnetoencephalography Amanda K. Robinson	ponses to behaviour using
1130-1145	How does executing an action impact the steady state visual response? Simmy Poonian	Time-resolved EEG cross-classification as a window on prediction, extrapolation, and error correction Hinze Hogendoorn	
1145-1200	Sensory predictions regarding the auditory properties of inner speech Thomas Whitford	The representational dyna visual processing streams Tijl Grootswagers	mics of visual objects in rapid serial
1200-1220	Panel Discussion	Panel Discussion	
1220-1350	Poster Session II & Lunch		MSD B117 Foyer
	Parallel O	pen Talks	
	Attention & Cognitive Control II	Clinical III	

	Attention & Cognitive Control II (RBB Lowe)	Clinical III (RBB Lyle)
1350-1405	Theta activity within frontal networks reflects specific cognitive-control processes beyond general reaction-time slowing Patrick S. Cooper (Emerging Researcher Award)	Effects of treatment resistance on whole-brain gray matter integrity and related functional connectivity in major depressive disorder Nicholas Van Dam
1405-1420	Behavioural inattentiveness, orienting attention, and executive attention predict reading accuracy in first-year school children Frances C. Lewis	Neuroimaging based prediction of rTMS treatment outcome in depression Robin Cash
1420-1435	Attentional orienting in response to nonsocial cues is resistant to verbal, but not visuospatial, working memory load Louisa A. Talipski	Neural oscillatory change following Theta Burst Stimulation to the dorsolateral prefrontal cortex in Fibromyalgia Syndrome Bernadette Fitzgibbon
1435-1450	Dissociable roles of phase-locked and non-phase-locked theta in task-switching Montana McKewen	Resting-state connectivity, cognition, and fatigue in response to mental exertion: A study in adolescents with Chronic Fatigue Syndrome Elisha K. Josev
1450-1500	Break	Break

1500-1515	Testing the unified model of vision and attention: Activation in dorsal and ventral structures during attentional orienting <i>Anthony J. Lambert</i>	Transcriptional correlates of hub connectivity in the human brain Aurina Arnatkeviciute	
1515-1530	Jointly modelling response criterion and ERPs related to proactive control in task-switching Frini Karayanidis	Cortical surface morphology in long-term cannabis users: A multi-site MRI study <i>Yann Chye</i>	
1530-1545	For a minute there I lost myself Dosage-dependent increases in mind wandering with prefrontal tDCS Hannah L. Filmer	Neural mechanisms guiding choices for cannabis versus snack food in regular cannabis smokers Gillinder Bedi	
1545-1600	Head motion during MRI implicit in ADHD phenotype: Hurdles for imaging studies Phoebe Thomson	Oxytocin genetics and family adversity in the development substance use disorders Femke Buisman-Pijlman	
1600-1630	Afternoon Tea		RBB Courtyard*
1615-1715	Annual General Meeting		RBB Lyle
1900-	Conference Dinner Sponsored by Symbiotic Devices		Melbourne Zoo

Day 4 | Sunday 25th November

	Parallel Fast Talks			
	Emotion & Social (RBB Lowe)	Perception & Action (RBB Lyle)	Methods & Modelling (RBB Medley)	
0900-0908	Attention, inhibition and emotions: An emotional antisaccade study in borderline personality disorder Caroline Gurvich	Effects of accentuated auditory sequences on the stability of polyrhythmic bimanual coordination and their interaction in the EEG response Cécile J. Bouvet	The effects of a gamified cognitive training program in reducing inattentive behaviour in the classroom: A randomised controlled trial Hannah Kirk	
0908-0916	Socio-cognitive deficits in long-term opiate users: The potential role of facial mimicry Laila E. Hugrass	Facilitation of movement initiation and execution via task-irrelevant sensory stimulation Aaron N. McInnes	Development and early validation of a Bayesian spelling model Helen Mason	
0916-0924	Impaired learning from social rewards in frontotemporal dementia Stephanie Wong	Action words in working memory: An fMRI study Zubaida Shebani	Reconciling Mackintosh and Pearce– Hall: An EEG study on inhibition of return Salvatore Russo	
0924-0932	Face processing impairments in schizophrenia and other psychiatric disorders Hayley Darke	Neurophysiological signatures of motor- sequence preparation within the supplementary motor area James P. Coxon	MEMES: An open-source MATLAB toolbox for performing magnetoencephalography source analysis without a structural MRI Robert A. Seymour	
0932-0940	Cognitive reappraisal, but not expressive suppression, impairs negative affect regulation in youth with borderline personality during social rejection Elizabeth Pizarro-Campagna	Unimanual adaptation in a bimanual force-production task <i>Eleanor Taylor</i>	Inhibition in ADHD: A behavioural and diffusion imaging study Jason He	
0940-0950	Break	Break	Break	
0950-0958	Investigating the role of the ventrolateral prefrontal cortex in emotion-regulation processes using high-definition transcranial direct current stimulation Natalia Albein Urios	Autonomous system error or human error: Brain responses differ depending on who we are observing Daniel A. Rogers	Integrating functional connectome modelling and cognitive modelling to identify brain networks associated with temporal prediction and rhythmic motor control Bronson B. Harry	
0958-1006	Anger vs. fear: what's your preference? Attention for negative facial expressions and psychopathic traits Hedwig Eisenbarth	Is 'free will' just a passing phase? The influence of transcranial alternating current stimulation on the timing of voluntary movements Sam Armstrong	Threat-induced anxiety impairs inhibitory functioning: A magnetoencephalography (MEG) study Ariel Roxburgh	
1006-1014	The blind mind and emotion: Are thoughts less scary with aphantasia? Marcus Wicken	Do EMG and EEG measurements of TMS-evoked neural activity represent the same cortical mechanisms? <i>Mana Biabani</i>	Where the really hard choices are: A general framework to quantify decision difficulty Pablo Franco	
1014-1022	Ketamine enhances visual sensory evoked potential LTP in patients with treatment-resistant depression Rachael L. Sumner	Reaction-time variability predicts the accuracy of interception saccades (but not reaching movements) to moving objects Duy Dao	Frequency-dependent alterations in amplitude of low-frequency fluctuations in response to energy intake in aging Riccarda Peters	

1022-1030	Experience in action: Culture dynamically alters visual processing near the hands Jolene Cox	Disease stage dependent white-matter degeneration in Friedreich ataxia: The IMAGE-FRDA Study Louisa Selvadurai		Associations between EEG functional brain connectivity and a cognitive reserve proxy measure in healthy older adults Bahar Moezzi
1030-1100	Morning Tea			RBB Courtyard*
		Parallel C)pen Talks	
	Social & Personality (RBB Lowe)		Learning & Memor	y (RBB Lyle)
1100-1115	Predicting personality traits from resting s Multivariate Pattern Analysis Hayley K. Jach	tate EEG using	Cortical involvement identities Abbey S. Nydam	in visual statistical learning of shape
1115-1130	Mindfulness meditation modulates experience of the rubber hand illusion Tess Guthrie		Confidence is a domain-general probe for studying perceptual aftereffects <i>Regan M. Gallagher</i>	
1130-1145	Integrative self-other affective processing directly modulates activity of the anterior medial prefrontal cortex Laura Finlayson-Short		Response inhibition training improves inhibitory tone in the motor cortex Nahian Chowdhury	
1145-1155	Break		Break	
1155-1210	Social dysfunctions of autism and schizophrenia are interactively modulated by excitatory and inhibitory neurotransmission Talitha Ford (Emerging Researcher Award)		Beyond average: Modelling and characterizing variability to enable valid and accurate predictions David Moreau	
1210-1225	Turning the face inversion effect on its head Manuela Russo		Training curves on working memory training activities in children with low working memory <i>Megan Spencer-Smith</i>	
1225-1240	Oxytocin modulates socioemotional brain regions in older adults Izelle Labuschagne		The effect of behavion numeracy in 5- to 7-year Kim Cornish	oural and cognitive attention on vear-old children
1240-1310	Closing & Award Presentations Sponsored by Heathcote II			RBB Lyle

*Served in MSD B117 Foyer in the event of inclement weather



Above. Centre Place, part of an extensive network of laneways in the Melbourne CBD. Photo by Rae Allen (CC BY 2.0).

POSTERS

Poster Session I | Friday 23rd November

1220–1350 @ MSD B117 FOYER

1	The mechanisms of size perception inferred by continuous flash suppression and interocular transfer	Hayden Peel
2	Apparent motion perception in upper limb amputees with phantom sensations: Obstacle shunning and obstacle tolerance	Gianluca Saetta
3	Early functional development of zebrafish retina revealed by sponge-tip electrode electroretinogram (ERG)	Jiaheng Xie
4	Colours are not faces, are not places, are not spaces	Simon J. Cropper
5	The contribution of cognitive and sensory influences on the perceived strength of the size-weight illusion	Cody G. Freeman
6	Do size, concept-driven expectations and sensorimotor corrections influence weight perception in the size- weight illusion?	Casey E. Gardiner
7	Decoding the mind's eye: The temporal dynamics of visual imagery	Sophia Shatek
8	Linking measures of sensory brain plasticity and cognition	Philip J. Sanders
9	Saccades to the flash-grab illusion: A replication of previous findings, but no evidence for a gap effect	Kate Coffey
10	Neuromuscular coupling in rhythm perception	Patti Nijhuis
11	Neural tracking of self and other during joint movement improvisation	Manuel Varlet
12	Dopamine transporter genotype is linked to hemisphere-specific EEG markers of attentional selection and perceptual decision-making	Bridgitt Shea
13	Mind the boys! The effect of squeezing balls on visuospatial attention	Nicole A. Thomas
14	Measuring switching costs between different demands on attention	Magnus Liebherr
15	Modulation of steady-state visual evoked potentials in a spatial cueing paradigm	Jason Satel
16	General anaesthesia reduces integrated information in flies	- Angus Leung
17	The dreamcatcher test: EEG spectral power is not a genuine measure of dreaming consciousness	William Wong
18	A moment of conscious experience is very informative	Jasmine Walter
19	Does self-identified cultural background mediate the relationship between spatial attention and visual perception?	Rebecca K. Lawrence
20	Implementing attention across the senses: Testing for modality-specific versus abstract rule encoding in frontoparietal cortex	Anina N. Rich
21	Implicit neurofeedback boosts feature-based selective attention in a visual decision-making task	Angela I. Renton
22	Temporal order biases behavioural and neural measures of stimulus encoding in a complex perceptual decision- making task	Morgan E. McIntyre
23	Value modulation of the mismatch negativity signal	Oren Griffiths
24	The value of predictive information in decision-making under uncertainty	Ariel XA. Goh
25	Interactions between spatial attention and alertness in healthy adults: A meta-analysis	Dilushi Chandrakumar
26	Systemic inflammation and cognitive performance in healthy elderly participants: Results from the Australian Research Council Longevity Intervention trial (ARCLI)	Masoumeh Tangestani Fard
27	Colour memory: A study of mask-induced interference in healthy ageing	Amana L. Shanks
28	Age-related alterations in human neocortical plasticity	Claire J. Cadwallader
29	Perinatal risk factors in early childhood cognition: Evidence from Growing Up in New Zealand	Denise Neumann
30	The cerebral scars of parenthood: A study of parenthood on the late-life brain	Edwina Orchard
31	Multiband fMRI reveals differences in amygdala subregion responses to emotions and the effect of childhood maltreatment	Juan F. Domínguez D
32	Topological segregation of functional brain networks in developing brains: Minimum spanning tree analysis of resting-state MEG data	Wei He
33	The relationship between resting EEG alpha rhythm and Internet-use related measures	Grace Y. Wang
34	Integration of relevant context in a novel moral judgement updating task	Milan Andrejevic
35	Mental simulation of facial expressions: Mu suppression to the viewing of dynamic neutral face videos	Ozge Karakale
36	Early neural processing of tearful faces	Sarah Krivan
37	Investigating the effects of touch in social interactions	Anastasia Pavlidou
38	Modulation of cortical oscillations by arbitrary self-associations	Mateusz Wozniak
39	Habituation of subjective anxiety and cortical hypervigilance during image-based exposure: An ERP study	Monique Williams
40	Neural correlates of future thinking: A resting-state functional connectivity study	Ya Wang

41	Acute aerobic exercise and non-invasive brain stimulation measures of motor cortical plasticity: A systematic review	Madison Mellow
42	Characterising brain regions activated as a function of learning visuomotor associations using fMRI	Elizabeth J. Saccone
43	Contributions of striatal–cortical connectivity changes to multitasking limitations and their practice-related improvements	Kelly G. Garner
44	Physical force augments reward-based learning	Huw Jarvis
45	Bilingual language switching: MEG evidence of executive control	Judy D. Zhu
46	Encoding efficiency of an artificial language modulates sleep-related memory consolidation: Insights from event- related potentials	Lena Zou-Williams
47	Grey matter volume does not predict risky decision-making in abstinent methamphetamine users	Sabrini Sabrini
48	Binge drinking and the teenage brain: Evidence from a systematic review and meta-analysis of neural and cognitive dysfunction	Briana Lees
49	Differential use of pharmaceutical cognitive enhancement in the Australian financial services industry	Elizabeth Bowman
50	Visual processing speed as a marker of reading delay for lexical but not phonological dyslexia	Nicole Stefanac
51	Efficacy of dynamic visuo-attentional interventions for reading in dyslexic and neurotypical children: A systematic review	Jessica Peters
52	Transdiagnostic variations in impulsivity and compulsivity across obsessive-compulsive disorder and gambling disorder correlate with effective connectivity in cortical-striatal-thalamic-cortical circuits	Linden Parkes
53	Impaired perceptual sensitivity with intact attention and metacognition in functional motor disorders	Julian Matthews
54	Physical activity and cognition in young onset Parkinson's disease	Karen Biddiscombe
55	Computational models distinguish between physical and cognitive motivation in Huntington's disease	Kelly J. Atkins
56	Effect of a single bout of exercise on neuroplasticity in Huntington's disease	Sophie C. Andrews
57	Effect of uncertainty on judgements of agency in autism	Kelsey Perrykkad
58	Functional connectivity of corticostriatal circuitry and psychosis-like experiences in the general community	Kristina Sabaroedin
59	Cognitive reserve moderates the relationship between age and fluid intelligence but not brain structure in schizophrenia and schizoaffective disorder	Tamsyn Van Rheenen
60	Associations between brain morphology and cognition in individuals with schizophrenia and bipolar disorder: A review	James Karantonis
61	Measuring eye movements in natural settings for assessing spatial neglect	Meg Pittaway
62	Cognitive functioning after traumatic brain injury: Effects on university student experience	Matthew Hendrickx
63	Neuroscience in the wild: Field-side assessment of electrical brain activity to investigate the neural markers of sport-related concussion	Bianca de Wit
64	Impaired social simulation in the behavioural variant of frontotemporal dementia: A novel cognitive mechanism underlying social behaviour?	Nikki-Anne Wilson
65	The relationship between diet, glucose control and cognitive performance in age-associated memory impairment	Sarah Gauci
66	Decreasing kidney function leads to cognitive impairment in adults: A systematic review and pilot study results	Eric Tan
67	Withdrawn	
68	The expression of bradykinin and its receptors in spinal cord ischemia-reperfusion injury rat model	Bogiang Lyu
69	Unsupervised classification of sleep data using highly comparative time-series classification and <i>k</i> -means clustering	Zhao Hui Koh
70	Spatio-temporal properties of mapping sequences can bias population receptive field estimates	Elisa Infanti
71	A validation of Emotiv Extender for ERP research	Nikolas Williams
72	The impact of stimulation intensity and coil type on reliability and tolerability of cerebellar brain inhibition (CBI) via dual-coil TMS	Laura Fernandez

Right. Yarra's Edge in the Melbourne Docklands at twilight. Photo by David Iliff (CC BY-SA 3.0).



Poster Session II | Saturday 24th November

1	Investigating the role of temporal frequency adaptation on alpha-band neural oscillations	Wiremu D. Hohaia
2	The processing of images of spiders and snakes outside of conscious awareness under visual masking	Rowena Bicknell
3	Gathering evidence for the female advantage in human spatial cognition	Ashlea Segal
4	Afterimages appear longer, but not brighter, under reduced viewing conditions	Amy Siobhan Millard
5	Do you see what I feel? Visual-tactile body ownership interactions and temporal perception	Sophie Smit
6	Cultural and bilingual effects in the Navon task	Adrian Willoughby
7	Can perceived elongation of visual stimuli into the physiological blind spot can be explained by lateral V1 connections?	Mark Williams
8	Dissociating imagery and perception: The opposing effects of imagined and perceptual stimuli on visual adaptation	Thomas Pace
9	Neural processes underlying spatial imagination	Amanda K. Robinson
10	The critical reliance of early visual cortex on the fractal structure of natural scenes	Zoey J. Isherwood
11	The sleeping brain tracks informative speech in a cocktail party	Matthieu Koroma
12	The mediating effect of agency on sensory attenuation of the auditory cortex: An event-related potential study	Nathan T. Han
13	Steady-state somatosensory evoked potential responses recorded in the primary and secondary somatosensory cortex of anesthetised cats	Naotsugu Tsuchiya
14	Neuronal mechanisms of predictive coding in the primary visual cortex of the macaque	Ekaterina Levichkina
15	Assessing the temporal dynamics of object processing using rapid-MVPA	Tijl Grootswagers
16	Using rapid-MVPA to investigate target and distractor processing during the attentional blink	Nicolas A. McNair
17	Target enhancement, distractor suppression or both? Exploring the role of the N2pc in spatial attention of visual processing	Kristen Baker
18	Does time seem to drag or fly in the temporal oddball effect?	Blake W. Saurels
19	The N170 visually evoked potential, violated expectations, and prediction error	Anne Overell
20	ERP correlates and attentional consequences of sub-threshold landmark cues	Nathan A. Ryckman
21	Pre-stimulus alpha predicts inattentional blindness	Brendan Hutchinson
22	Exploring electrophysiological markers of inhibitory cueing effects	Nicholas R. Wilson
23	Multiple object monitoring: measuring sustained attention to dynamic displays when targets are rare	Denise Moerel
24	Phase and non-phase time-frequency activity in the stop-signal task	Patrick Skippen
25	Using long-duration EEG to explore complexity-based measures of levels of consciousness	Giana Patel
26	On improving the feature selection of task-switching neural data using multivariate pattern analysis	Aaron S. W. Wong
27	Motor inhibition and lateralised sensorimotor entrainment after learning a bimanual musical pattern	Olivia M. Lapenta
28	Disentangling the grasp and functional use mechanisms in pantomiming tool use	Mutindi Kithu
29	Efference copies produced by inner speech are temporally precise and content-specific	Bradley N. Jack
30	Brain mapping visuomotor networks: Synchronising high-speed motion tracking with eye tracking and brain scanning for comprehensive brain-network modelling	Rosa Sola Molina
31	Real-world transfer from a virtual world	Stefan Michalski
32	The effects of risk magnitude training on mapping risks on space	Erica Ghezzi
33	Visual expertise: Exploring the effects of salience on early visual signals using non-face-like stimuli	Manuela Russo
34	The cheerleader effect in bodies: A result of memory bias and not perceptual encoding	Jean YJ. Hsieh
35	Individual differences in anxiety and fear learning: The role of working memory capacity	Patrick Laing
36	Influence of BDNF polymorphism on synaptic plasticity following aerobic exercise	Dylan Curtin
37	The influence of training on confidence heuristics	Michelle G. Hall
38	Situation awareness mediates the relationship between working-memory ability and performance on the air traffic control task	Angela Bender
39	Learning under conditions of uncertainty and threat	Clare D. Harris
40	The effect of verb type on language processing as revealed by event-related potentials	Louise Kyriaki
41	Co-activation of alternative names: An ERP study of phonological interference in speech production	Melina Posch
42	Effects of sleep on cognitive and behavioural attention in children as they enter school	Karen Chiu
43	Oculomotor function during rapid automatised naming and its correlation with cognitive speed in young and older adults	Deena Ebaid
44	The impact of fatigue on motivation across the lifespan	Mindaugas Jurgelis
45	Mind perception modulates within-subjects neural encoding of communicative gaze	Nathan Caruana
46	A failure to launch: Boredom and self-regulation	James Danckert
47	Effects of need for certainty on reactions to worldview threats	Hannah Biddell
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ABSTRACTS

Abstracts are listed alphabetically by the presenting author's surname.

Investigating the role of the ventrolateral prefrontal cortex in emotion-regulation processes using high-definition transcranial direct-current stimulation

Dr Natalia Albein Urios Deakin University

Background: Emotional regulation can be defined as an array of thinking strategies that we use to change the way we feel, particularly in response to negative emotions. To successfully regulate emotions, we need to engage prefrontal cortical brain regions to exert top-down control over affective inputs triggered by the limbic brain. The ventrolateral prefrontal cortex (vIPFC) has been particularly involved in the process of emotional regulation. Objective: We used high-definition transcranial direct-current stimulation (HD-tDCS) to elucidate the role of the vIPFC in emotion regulation using the cognitive reappraisal task (CRT). Method: Nineteen healthy adults received both active and sham anodal HD-tDCS over the vIPFC, prior to completing the CRT in two separate weeks. The outcome measures were the behavioural ratings in the CRT, and the electroencephalography (EEG) signals of the late positive potential (LPP) in the CRT. We hypothesised that anodal HD-tDCS over the vIPFC would be specifically associated with lower scores in the CRT ratings and reduced LPP amplitudes. Results: We did not find significant differences in our two outcome variables. Although there were no statistically significant differences in LPP amplitudes, the effect sizes indicate an association between anodal stimulation of the vIPFC and higher LPP amplitudes (d = 0.52). **Conclusion:** Our findings suggest that in healthy individuals, anodal stimulation over the vIPFC alters the emotional response elicited by negative stimuli in the CRT.

Integration of relevant context in a novel moral judgement updating task

Mr Milan Andrejevic University of Melbourne

Daniel Feuerriegel, University of Melbourne William F. Turner, University of Melbourne Simon Laham, University of Melbourne Stefan Bode, University of Melbourne

In everyday life we are constantly updating our moral judgments of people and events as we learn new information. Hearing a story about Heinz who robbed a pharmacy, one may initially condemn Heinz's transgression. However, many change their minds if they are told that he did it to obtain medicine that would save his wife's life. Moral psychology typically neglects such dynamic changes, which are important components of the moral decisionmaking process. We developed a novel EEG/fMRI-compatible paradigm to investigate how people update their moral judgements after receiving relevant contextual information. Participants (N = 313) took part in a variant of the dictator game, whereby they judged whether a 'dictator' (who is given \$10) acted good or bad, based on how much of their \$10 they gave to another person (known as the 'receiver'). Following this 'context-free' judgment they made a second judgment regarding the same person, after learning how much the receiver had previously given to another person when acting as the dictator. Participants judged varying combinations of dictator and receiver offers. Functional data analyses revealed distinct moral judgment styles across participants, including endorsement of generosity, endorsement of equality/reciprocity, and lenience in condemning selfishness. These judgment styles were consistent across the context-free and contextpresent decisions, and correlated with participants' scores on relevant personality and morality scales. Our findings validate our design for investigating the dynamics of moral decision updating within a cognitive neuroscience framework, and demonstrate the range of decision-making styles that are employed in moral fairness judgments.

Effect of a single bout of exercise on neuroplasticity in Huntington's disease

Dr Sophie C. Andrews Monash University

Dylan Curtin, Monash University James P. Coxon, Monash University Julie C. Stout, Monash University

Aerobic exercise is a promising lifestyle intervention to slow disease progression in neurodegenerative diseases, including Huntington's disease (HD). HD mouse model studies indicate that exercise alters biomarkers of neuroplasticity, however, whether these changes to neuroplasticity are seen in people gene-positive for HD remains unclear. One way to assess synaptic neuroplasticity in humans is via changes to motor cortex cortical inhibition and facilitation using Transcranial Magnetic Stimulation (TMS) following intermittent theta-burst stimulation (iTBS), a type of repetitive TMS known to transiently increase cortical reactivity. In the current study, we compared the effects of two types of aerobic exercise (high-intensity interval and moderate continuous exercise) on neuroplasticity responses to iTBS in an HD sample. Twelve premanifest and early HD participants and 20 agematched healthy control participants completed three sessions on three separate days. At each session they completed 20 mins of either high-intensity interval cycling, moderate steady-state cycling, or rest. TMS was applied to the motor cortex pre- and post-exercise, and post iTBS, to measure changes to short-interval cortical inhibition (SICI) and intracortical facilitation (ICF), as markers of neuroplasticity. Three-way mixed-model ANOVAs revealed a significant Exercise × Group interaction for both SICI and ICF, where for the HD group, the moderate-intensity exercise induced the largest neuroplasticity response, whereas for the control group, the high-intensity interval exercise induced the largest neuroplasticity response. These results indicate that aerobic exercise enhances neuroplasticity in people who are gene-positive for HD, but that the optimal exercise intensity to maximise this response may differ from the healthy population. Intensity should be considered when designing exercise interventions for the HD community. This research was funded by the Huntington's Disease Society of America.

A multidisciplinary approach to diagnosing, tracking and predicting disease progression in Parkinson's disease Dr Deborah Apthorp

University of New England & Australian National University

Part of the symposium Decoding the brain through interdisciplinary approaches in neuroscience

In Parkinson's disease (PD), few reliable, objective biomarkers exist for monitoring disease progression, other than clinical scales of neurological and psychiatric disability which are not well-correlated with overall disability. There is a need for additional markers of PD severity which translate to clinical practice. In our work, we are using machine learning (ML) and signal processing to develop a composite biomarker based on non-invasive behavioural and imaging measures (e.g., postural sway, EEG, visual motion perception, eye movements, and MRI) which have previously been shown to be affected in PD. In tandem with this approach, we are using large publiclyavailable datasets from smartphone applications (e.g. mPower) to develop effective ML algorithms for these much larger but inherently more noisy types of data. Our work on feature engineering and ML using the vowel phonation and accelerometer subsets of the mPower dataset shows the
potential to detect symptoms imperceptible to a neurologist. From the signal processing work, preliminary results from clinical measures in the lab show postural sway correlates highly with cognitive and symptom severity measures. Promising new work involves the recent development of a smartphone-based app to measure finger-tapping in PD in remote locations.

Is 'free will' just a passing phase? The influence of transcranial alternating current stimulation on the timing of voluntary movements

Mr Sam Armstrong Queensland Brain Institute

Martin V. Sale, University of Queensland Ross Cunnington, University of Queensland

A central objective in the study of volition has been to identify how changes in neural activity relate to the conscious experience of deciding to act. A common approach for investigating voluntary action involves measuring electric brain signals before movement takes place. The readiness potential (RP) is observed in the electroencephalogram (EEG) as slow-building activity that precedes action onset. The current view argues that the RP reflects a specific, goal-directed process for preparing upcoming voluntary acts. In contrast, recent studies suggest the RP reflects a general, decision-making process where underlying changes in brain oscillations influence the time at which people choose to initiate action. Transcranial alternating current stimulation (tACS) enables brain oscillations to be entrained at the frequency of stimulation. The phase of tACS has been shown to influence behaviour by modulating the expression of tremor as well as the intelligibility of speech. We applied tACS over prefrontal motor areas while participants (N = 29) performed a self-paced finger-movement task that involved pressing buttons on a keyboard. We continuously recorded EEG so we could measure the phase of the stimulation when button-press actions were made. During a sham-stimulation condition, participants showed no bias for performing button-presses at any particular phase of the stimulation frequency. Conversely, during active stimulation individuals showed a bias for making button-presses during the positive phase of the tACS cycle. A Rayleigh test showed that the distribution of button-presses differed significantly from circular uniformity during active stimulation (p < .05). This indicates that non-consciously perceptible electric brain stimulation can influence the time at which participants make the volitional choice to initiate action. Our findings support the suggestion that the timing of 'free-will' decisions is influenced by the phase of underlying brain oscillations.

Transcriptional correlates of hub connectivity in the human brain

Ms Aurina Arnatkeviciute Monash University

Ben D. Fulcher, Sydney University Stuart Oldham, Monash University Alex Fornito, Monash University

The recent availability of comprehensive brain-wide gene expression atlases provides new opportunities to investigate the transcriptomic correlates of large-scale, spatially distributed neural phenotypes. Our recent work in meso-scale mouse and micro-scale C. elegans connectomes suggests that connected pairs of hubs-network elements with a large number of connections and which play a central role in integrated brain function-show increased transcriptional coupling that is, in part, driven by genes regulating oxidative metabolism. To investigate the transcriptional similarity of hub regions in the human brain we combined brain-wide microarray gene expression data from the Allen Human Brain Atlas for 10 027 genes with a representative structural group connectome derived from the diffusion-weighted imaging in 972 healthy participants from the Human Connectome Project using a high-resolution brain parcellation comprising 180 regions per hemisphere. We categorised each pair of connected brain regions as either hubhub, hub-nonhub, or nonhub-nonhub, and quantified their degree of transcriptional coupling using a Pearson correlation profile between regional expression vectors. We found that connected hub regions show the strongest transcriptional similarity, despite being separated by longer anatomical distances compared to other pairs of brain regions. These findings establish a direct link between molecular function and the large-scale topological organisation of the human connectome and indicate that tightly coupled gene expression between anatomically distributed yet topologically central hubs is highly conserved across different species and scales.

Computational models distinguish between physical and cognitive motivation in Huntington's disease

Ms Kelly J. Atkins Monash University

Julie Stout, Monash University Sophie Andrews, Monash University Trevor T.-J. Chong, Monash University

Motivational deficits such as apathy characterise a range of neurological diseases, including Huntington's disease (HD). Motivation has recently been operationalised as the willingness of individuals to exert effort in return for reward. Although a growing body of literature has examined the role of physical effort in motivation, much less is known about the willingness to exert cognitive effort in return for reward. The question of how cost-benefit trade-offs differ across the physical and cognitive domains is central to current conceptualisations of apathy, which distinguish between physical and cognitive subtypes. To determine whether and how physical and cognitive motivation is altered in HD, we administered an economic effortbased decision-making task to 28 patients who were gene-positive for HD, and 28 age- and gender-matched controls. Participants were trained on two tasks involving cognitive or physical effort. They then made decisions between a baseline low level of effort for low reward option, versus a high effort for a higher reward option. Separate choices were made for the cognitive and physical tasks, which facilitated computational models of motivation in each effort domain. Contrary to expectation, patients and controls demonstrated similar levels of physical motivation in that both groups were equally likely to invest physical effort for reward. In contrast, patients with HD were less motivated than controls to invest cognitive effort for reward, such that they consistently preferred the less cognitively effortful option. These data suggest that physical and cognitive motivation are dissociable in HD. As cognitive demands may be perceived as more burdensome than physical demands in HD, interventions which require reduced cognitive load may be better received and adhered to.

Mindfulness meditators show different differences in attention related neural activity depending on task demands

Dr Neil Bailey

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Gabrielle Freedman, MAPrc Kavya Raj, MAPrc Caley M. Sullivan, MAPrc Nigel C. Rogasch, Monash University Sung W. Chung, MAPrc Kate E. Hoy, MAPrc Bernadette Fitzgibbon, MAPrc Richard Chambers, Monash University Craig Hassed, Monash University Nicholas T. Van Dam, University of Melbourne Paul B. Fitzgerald, Epworth Healthcare & MAPrc

Mindfulness meditation has been shown to enhance attention. However, the components of attention altered by meditation and the related neural activities are underexplored. In particular, previous research has examined different components of attention (and the related neural functions) independently, and has drawn different conclusions about how meditation changes neural activity depending on the task used in each study. Additionally, it is not clear whether improvements in attention are related to increases in the strength of typically activated brain areas, or the recruitment of additional or alternative brain areas. To address these points, 35 meditators were compared to 36 age- and gender-matched controls during electroencephalography (EEG) recordings of neural activity during a Go/No-go response inhibition task, colour and emotional Stroop tasks, the Sternberg working memory task, and the N-back working-memory task. Compared with controls, meditators showed a higher percentage correct on all tasks (with no decrease in reaction time). Meditators also showed consistently more frontally distributed P3 activity across tasks, suggesting more frontal involvement in sustained attention regardless of task demands. This activity was related to higher accuracy in the majority of the tasks. Additionally, meditators showed task-specific differences, apparent in only one of the tasks: for example, anticipatory increases in neural activity over the right parietal cortex in the Go/No-go task preceding stimuli presentation, and increased right temporal activity during the recall period of the Sternberg task. These task-specific results were also related to increased accuracy. The results suggest that rather than alterations to any single neural process, meditators have an increased capacity to modulate a range of neural processes in order to meet task requirements. This increased capacity may underlie the improved attentional function observed in mindfulness meditators.

Target enhancement, distractor suppression or both? Exploring the role of the N2pc in spatial attention of visual processing

Miss Kristen Baker Queensland University of Technology

Naohide Yamamoto, Queensland University of Technology Alan Pegna, University of Queensland Pat Johnston, Queensland University of Technology

Humans are constantly exposed to a complex and rapidly changing visual environment. To cope with the computational burden this engenders, our perceptual system must simultaneously enhance areas of importance and suppress irrelevant surroundings. This study investigates neural markers (N2pc/PD) measured with electroencephalography. Previous studies used stimuli labelled with target or distractor status, appearing in a predictable location in the visual array. Yet, in a real-life visual scene inputs are both continuous and unexpected whereby stimuli appear without pre-assigned arbitrary value labels. We applied a novel experimental paradigm involving violations of visual predictions to more salient vs. less salient stimuli, accounting for the unpredictable nature of the real-life visual world. Participants viewed a sequence of shapes moving in a circular trajectory around an arrow positioned in the centre, pointing to one of the shapes (target). In predictable conditions, the shapes rotated in five step-by-step positions, in the same direction as established by the preceding steps. In unpredictable conditions, in the fifth and final step either the target or distractor moved back one step whilst the arrow continued in the same direction. It was expected enhanced N2pc/PD amplitudes would exist for predictable conditions compared to unpredictable conditions, as spatial filters are set up to enhance or suppress stimuli in predicted locations. Results found differences in N2pc and PD comparison waveforms at the final step in rotation. This indicates predictive mechanisms construct spatial filters prior to salient stimulus onset, to ensure cognitive resources are directed pre-emptively to a foreseeable important spatial location. This supports perspectives of the brain's ability to maximise cognitive efficiency by using predictive mechanisms. Implications of this can assist with understanding prediction in attention, with adaptation to investigations of individual differences.

High autism traits are associated with differences in rapid social evaluations of neutral faces: A non-conscious priming study

Ms Casey Becker RMIT University

Philippe A. Chouinard, *La Trobe University* Robin Laycock, *RMIT University*

Deficits in face-emotion recognition are suggested to be a key factor in the social communication difficulties observed in Autism Spectrum Disorder (ASD). Recent research suggests that these difficulties could stem from anomalous automatic or non-conscious processes affecting the limbic system. Thus, this research examined the rapid social judgements of neutral faces and the effect of non-consciously presented emotional primes in individuals with varying levels of autistic traits, as measured by the Autism Spectrum Quotient (AQ) questionnaire. High- and low-AQ groups completed a priming study which utilised backward masking. Fearful, happy, or neutral primes (17 ms) were presented before a target face, which was always neutral (100 ms). Target faces were rated using a Likert scale ranging from friendly to threatening. Galvanic skin responses (GSR) were recorded as a measure of physiological arousal to different prime emotions. Behavioural data revealed that the low-AQ group showed a significant happy prime effect, with happy primes rated more threatening than neutral primes for each target face, while the high-AQ group showed no prime effect. A main effect of group indicated that the high-AQ group judged target faces as more threatening than the low-AQ group, suggesting a threat bias in rapid social judgements. No interaction between group and prime emotion was established. Pilot GSR data revealed higher peak amplitude for low-AQ compared with high-AQ groups across all priming conditions. The low-AQ group demonstrated higher GSR responses for happy compared with both fearful and neutral primes. No differentiation between primes was evident

for the high-AQ group. Behavioural and physiological data appear to indicate that higher autism traits are associated with reduced sensitivity for the rapid social evaluation of emotional expressions presented outside of awareness.

Neural mechanisms guiding choices for cannabis versus snack food in regular cannabis smokers

Dr Gillinder Bedi

University of Melbourne & Orygen

Xuejun Hao, Columbia University Medical Center Nicholas T. Van Dam, University of Melbourne Margaret Haney, Columbia University Medical Center

A cardinal symptom of substance use disorders is persistent choices for drugs over more adaptive rewards. Little is known about the neural mechanisms guiding drug-related choices in humans. We investigated neural encoding of subjective value (SV; i.e., how individuals value a given reward) during choices for cannabis and a natural reinforcer (palatable snack food) in regular cannabis smokers. We also studied the impact of cannabis and food, versus neutral, cues on these processes. Near-daily cannabis smokers (N = 20; 1 female) completed a 6-day, within-subject, inpatient protocol. After sampling the rewards (6 cannabis puffs; 6 small palatable snacks), they completed 4 conditions: (1) Neutral cues + cannabis choices; (2) Cannabis cues + cannabis choices; (3) Neutral cues + snack choices; and (4) Snack cues + snack choices. In each condition, participants were exposed to cues before an fMRI scan in which they chose repeatedly between 0-6 cannabis puffs/snacks and a monetary value (individually titrated). SV for each cannabis/snack option was operationalised as how strongly each choice was preferred, on a 5-point scale. Following each scan, two choices were randomly selected for implementation that afternoon. Initial results show that SVs for cannabis correlated with activation in a region of ventromedial Prefrontal Cortex (vmPFC) previously shown to encode value signals; a similar pattern was not observed during snack choices. Value encoding in vmPFC was significantly greater for cannabis than snack food (Small Volume Correction; p < .05), with no cue effect. Cannabis smokers had intact value signal encoding for cannabis but disrupted encoding of non-drug value signals, consistent with models identifying dysregulated valuation of drug relative to alternative reinforcers as a driver of problematic substance use. Funded by the U.S. National Institute on Drug Abuse (NIDA: DA034877; DA044339).

Situation awareness mediates the relationship between working-memory ability and performance on the air traffic control task

Dr Angela Bender University of Western Australia

Today it is widely accepted that successful and safe performance of activities which frequently command the fulfilment of multiple concurrent goals in rapidly changing settings (e.g., during military operations, controlling air traffic, operating a vehicle) requires good situation awareness (SA)-i.e., the ability to be aware of the current environment and to predict what might happen next. However, it is currently unclear what cognitive abilities support SA and the underlying mechanisms that link high SA to better performance in complex and high-pressure settings. In the present study, we used an individual-differences approach to examine the relationship between SA, working memory (WM), attention control, and performance in an Air Traffic Control (ATC) task. To do so, participants completed a battery of well-established WM (change detection, operation span, Corsi block-tapping task), attention control (single vs. dual response selection task, psychological refractory period, attentional blink, Stroop), and SA measures (Situation Present Assessment Method, Situation Awareness Rating Technique). Correlations, hierarchical regression and structural equation modelling revealed that (1) WM ability, but not attention control, significantly predicted SA, and (2) performance on the ATC task was significantly related to both WM ability and SA, while attention control did not account for substantial variance in the ATC performance construct. Furthermore, based on a mediation analysis, it was found that SA partially mediated the relationship between WM and ATC performance. The findings therefore indicate that individuals with better WM tend to have higher levels of SA, which in turn may contribute to better performance in complex settings. The Commonwealth of Australia supported this research through the Australian Army and a Defence Science Partnerships agreement of the Defence Science and Technology Group, as part of the Human Performance Research Network.

Do EMG and EEG measurements of TMS-evoked neural activity represent the same cortical mechanisms?

Ms Mana Biabani Monash University

Alex Fornito, Monash University James P. Coxon, Monash University Nigel Rogasch, Monash University

Transcranial magnetic stimulation (TMS) is a powerful method for non-invasively perturbing cortical circuits in humans. Various paired-pulse paradigms (ppTMS) have been established to indirectly infer excitatory and inhibitory neurotransmission in the motor cortex (M1), by indexing changes in TMSevoked motor output measured using electromyography (EMG). Combining TMS with electroencephalography (EEG) has extended the application of TMS to study brain dynamics from non-motor cortical regions; however, the mechanisms driving TMS-evoked EEG potentials (TEPs) remain unclear. This study investigated whether the inhibitory and excitatory patterns shown by ppTMS motor evoked potentials (MEPs) can explain TEP fluctuations across time. Twenty participants received 16 blocks of various types of ppTMS over the left M1, including different conditioning intensities (i.e., sub- and supra-threshold) and inter-pulse intervals (15, 30, 45, 55, 100, 120, 180 and 220 ms), while EMG was recorded from the right first dorsal interosseous (FDI) muscle. In addition, EEG was recorded from 62-channels during 100 sub- and supra-threshold single TMS pulses over the same area. TMS was also applied to the shoulder as a multisensory control condition. We found that fluctuations in cortical excitability following TMS were similar when measured with EMG and EEG. However, three main steps were necessary to achieve a significant fit between the MEP and TEP patterns: (1) attenuating multisensory inputs to TEPs; (2) estimating the responses at the cortical (i.e., source rather than sensor) level; and (3) excluding the very early TEPs (< 15 ms) which are highly distorted by pulse artefacts. Our findings suggest that both EMG and EEG measures of TMS-evoked cortical activity reflect similar fluctuations in excitation/inhibition, given suitable controls and analyses. The methods developed in this study will aid in designing metrics for measuring excitation and inhibition in non-motor regions using TMS-EEG.

The processing of images of spiders and snakes outside of conscious awareness under visual masking

Miss Rowena Bicknell La Trobe University

Emma J. Cox, *La Trobe University* Robin Laycock, *RMIT University* Philippe A. Chouinard, *La Trobe University*

The brain is constantly surveying and selecting relevant visual stimuli to attend to. However, it has been suggested that stimuli with emotional salience (e.g., images of spiders and snakes) can bypass this processing and be processed outside of conscious awareness. To explore this possibility, two experiments were completed in which participants were presented with images of spiders and mushrooms (Experiment 1; N = 35), or snakes and flowers (Experiment 2; N = 35). These images were presented under visible (i.e., the participant was able to perceptually see the images) or *invisible* (i.e., a visual-masking technique was used to render the images perceptually invisible) conditions. Each experiment had two tasks. In the recognition task, the participant's Galvanic skin response (GSR) was recorded when viewing visible and invisible stimuli. In the priming task, the participant's reaction time was measured to a visible target stimulus preceded by either a visible or invisible prime stimulus that was either congruent or incongruent. There were no differences in GSR between conditions in the recognition task for either experiment. In the priming task, there were significant Visibility × Congruency interactions in the spider, F(1,32) = 9.47, p = .004, and snake, F(1,33) = 17.46, p < .001, experiments. Pairwise comparisons, correcting for multiple comparisons using the Bonferroni method, revealed that priming occurred in both visibility conditions with stronger effects for the visible (Experiment 1 Cohen's d = 1.22; Experiment 2 Cohen's d = 1.25) compared to invisible (Experiment 1 Cohen's d = 0.59; Experiment 2 Cohen's d = 0.53) conditions. Results from the recognition task suggest that there is no difference in the physiological response to the processing of different stimuli. However, in the priming task, results suggest that the invisible stimuli were processed outside of conscious awareness. This suggests that conscious awareness may enhance but is not always required to process certain visual stimuli.

Effects of need for certainty on reactions to worldview threats

Miss Hannah Biddell The University of Queensland

When our *a priori* predictions of the world don't match with incoming data, we experience uncertainty. The brain is motivated to minimise uncertainty either by changing the predictions to better match with the input, or by acting to make the input more consistent with predictions (Friston, 2010). When people are exposed to worldview threats, this is experienced as uncertainty. People are typically motivated to resolve this uncertainty and maintain meaning. They can do this by various means, such as reaffirming their original beliefs or unrelated beliefs, or searching for new patterns in the environment (Heine, Proulx, & Vohs, 2006). The present research aimed to assess how worldview threats affect people differently, depending on their relationship with uncertainty. One hundred and thirty-six participants completed the Need for Cognitive Closure scale (Kruglanski & Webster, 1994), followed by a Velten-style induction where they were asked to rephrase 15 statements either regarding the non-existence of free will or control statements (previously shown to reduce belief in free will; Vohs & Schooler, 2008). They then responded to series of questions assessing their experience of meaning in life, sense of agency, authenticity and propensity to perceive patterns. It was hypothesised that participants who have high need for cognitive closure would be more reactive to a successful belief threat than those low in need for cognitive closure, showing higher search for meaning following the belief threat, in both the Meaning in Life Questionnaire, and in detecting more real and illusory patterns. Data collection is in progress and results will be reported.

Physical activity and cognition in young onset Parkinson's disease

Mrs Karen Biddiscombe Australian Catholic University & La Trobe University

Ben Ong, La Trobe University Pawel Kalinowski, Cogstate Kerryn Pike, La Trobe University

A relationship has been observed between physical activity and cognition in Parkinson's disease as well as improvements in cognition after a physical activity intervention. To date, this has not been investigated in young onset Parkinson's disease (YOPD). The present study had two aims: to examine the baseline relationship between physical activity and cognition in YOPD; and to examine whether a physical activity intervention can improve cognition in YOPD. Two interrelated online studies were conducted. In the first study, 132 participants with YOPD completed self-report measures of physical activity, and objective and subjective measures of cognition. A subset of 38 participants was then randomly allocated to either a six-week physical activity intervention (additional exercise) or control condition (exercise as usual). Following the intervention, participants repeated the objective and subjective cognitive measures. No relationship was found between self-reported physical activity and objective cognition; however, there was a relationship between physical activity and subjective cognition (cognitive flexibility, multi-tasking, concentrating, making decisions and judging distances). Similarly, following the intervention significant subjective improvements were found for concentration, attention, and processing speed, but not memory. Furthermore, medium effect sizes were evident for objective measures of processing speed and small-medium effect sizes for planning and cognitive flexibility, although statistical significance was not reached. In this first study to investigate physical activity and cognition in YOPD, results suggest that increased physical activity relates to improved processing speed and attention. Replication of the intervention is recommended with a larger sample size. A longer, more intense physical activity manipulation and utilising the study's strengths of online recruitment and intervention delivery is also recommended.

Tracking the build-up of predictive motion extrapolation in the visual system using time-resolved EEG decoding

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Daniel Feuerriegel, UoM Stefan Bode, UoM Hinze Hogendoorn, UoM & Utrecht University In everyday life we are very adept at accurately interacting with moving objects (e.g., catching a ball). However, these tasks pose an intricate computational problem: Due to the time lost during neuronal transmission, the object has already moved on from its position by the time visual input has reached the cortex and that visual information is outdated. It has been proposed that cortical and subcortical extrapolation mechanisms allow the brain to represent an object's future position. However, the build-up and implementation of such extrapolation mechanisms are yet to be well-understood. To investigate this, we tested the conditions necessary for motion extrapolation by presenting observers with an apparent motion display composed of 1-44 stimuli presented sequentially in 8 possible locations around a central fixation dot. We recorded electroencephalographic (EEG) responses to each stimulus and used multivariate pattern classification to decode the position of the stimulus from the stimulus-evoked responses. Depending on the presentation number of the stimulus in the sequence, we compared the latencies at which stimulus position could be decoded. From the second presentation in the sequence onwards, a latency advantage emerged in the neural representation of the stimulus, demonstrating that a predictive advantage was evident very rapidly after initiation of a motion sequence. Furthermore, motion direction unexpectedly reversed on a proportion of trials. Following such reversals, the second presentation postreversal still showed the same latency advantage, again revealing a rapid build-up of motion extrapolation. Together, we show that predictive motion extrapolation mechanisms develop very rapidly and require only minimal information about the object's past trajectory.

EEG functional connectivity predicting delirium severity in older cardiac surgery patients: A pilot prospective study

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Delirium is a neurocognitive disorder characterised by acute and fluctuating disturbances in attention, arousal and cognition, associated with higher risks of mortality and long-term cognitive impairment. Cardiac procedures including coronary artery bypass grafting (CABG) and transcatheter aortic valve implantation (TAVI) carry around a 25% delirium incidence rate. Delirium has been theorised as a manifestation of a brain systems disintegration. Our aim was to assess if pre-procedural electroencephalogram (EEG) alpha and theta resting-state functional connectivity associated with post-procedural delirium severity in older adults undergoing CABG (N = 2) or TAVI (N = 5). Participants were 68 to 85 years; 6 were male. Delirium severity was assessed using the Memorial Delirium Assessment Scale (MDAS) daily, with the maximum value recorded used in analyses. Functional connectivity was estimated using imaginary coherency; mean functional connectivity was computed over all electrodes. Spearman correlations indicated moderate negative associations between MDAS scores and alpha functional connectivity (eyes open and closed), and weak negative associations between MDAS scores and theta functional connectivity (eyes open and closed). However, with this small sample size, no correlations were statistically significant. Stronger effects for alpha band likely reflect its key roles in mechanisms of attention and consciousness. A larger sample will be presented once this honours project is complete, and if effects hold, will indicate that lower mean alpha functional connectivity pre-procedure indexes brain vulnerability to higher delirium severity post-procedure. EEG measures of functional connectivity, reflecting brain systems disintegration, may represent incipient delirium rather than the fully established syndrome.

Effects of accentuated auditory sequences on the stability of polyrhythmic bimanual coordination and their interaction in the EEG response

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Humans have a strong capacity to synchronise their movements with external auditory rhythms. Previous research has focused mainly on the production of simple 1:1 synchronisation performance (one movement per auditory event). In contrast, the conditions that might facilitate movement synchronisation toward more complex frequency ratios and their neural bases are unclear. Recent research suggests that finger tapping to a metronome according to multiple frequency ratios is facilitated when the sounds of the metronomic sequence are accentuated every two or every three events. This is particularly visible with the 1:3 ratio, which is intrinsically less stable. Here we investigated if the accentuation advantage could be transferred to a more complex coordination task: bimanual tapping at multiple frequency ratios. Participants were asked to produce either 1:2 or 1:3 frequency ratios between their left and right fingers in synchrony with a 2.4 Hz auditory sequence with either no accentuation, binary accentuation or ternary accentuation while their movements were measured. Trial design also allowed the recording of the EEG responses to the auditory stimulus perception between two synchronisation periods of each condition. Preliminary results indicate that congruency in the frequency ratio between the accented auditory sequence and the bimanual tapping positively modulated movement synchronisation stability at both finger-finger and finger-stimulus levels. Furthermore, these effects seem to be reflected in the amplitude of the EEG responses to auditory sequences, suggesting that congruent accentuation might facilitate both perception and production of the polyrhythmic pattern. These findings provide new insights about the processes underlying polyrhythmic auditory-motor synchronisation, with potential applications for facilitating motor learning and rehabilitation with accentuated auditory sequences.

Differential use of pharmaceutical cognitive enhancement in the Australian financial services industry

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A growing interest in the non-medical use of so-called *smart drugs* (such as methylphenidate and modafinil) has been explored in college students, medical students and surgeons in the US and Europe. We present results of an anonymous online survey of smart-drug use among professionals in the Australian financial services industry. Our hypothesis was that industry sectors would report different preferences for different drugs in response to different workplace task demands. The survey was advertised to industry groups, online media articles, and social media outlets between September 2016 and October 2017. Three hundred and seventy-two responses were received, of which 140 were valid and complete, and 69 were variously incomplete but usable. One hundred and eighty-two respondents answered: "Do you believe your colleagues take any drugs that enhance their performance?". Sixty-eight (37.4%) responded Yes and 114 No. Different sectors of the financial services industry reported significantly different rates of use among colleagues, Pearson's $\chi^2(4) = 19.39$, p = .0006. Respondents from different industry sectors nominated different substances as most prevalent with significantly different frequencies, Fisher's exact test p = .014. Industry sector, hours worked per week, and other demographic and personal health factors were also surveyed. There was a significant difference in reported hours slept per night between those who reported workplace use and those who did not, $\chi^2(6) = 19.54$, p = .003. A number of side effects were also reported, including headaches and mood swings. Significant variation in the rates of reported use of pharmacological cognitive enhancers was found between different sectors of the Australian financial services industry, and different sectors displayed different preferences for different substances. This is an important first step in exploring the use of attempts at cognitive enhancement in competitive professional workplaces with diverse task demands.

Frequency of inverted/anomalous voxels in regions of cortex underlying surface veins decreases with grey matter depth

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Clusters of voxels exhibiting an anomalous haemodynamic response-specifically an inverted response-to visual stimulation have been found to concentrate in regions corresponding to the anatomical location of large draining veins on the surface of the cerebral cortex (Boyd Taylor, 2014; Puckett, Mathis, & DeYoe, 2014). Advances in fMRI technology have allowed the BOLD response to be analysed at independent depths of grey matter (Polimeni, Fischl, Greve, & Wald, 2010). We extend previous work by examining inverted voxels in human visual cortex at three independent grey matter depths. Eleven subjects participated in a retinotopic mapping paradigm using a Philips 3T MR scanner with a 32-channel head coil. Functional data were acquired at a resolution of 1.5 mm³. A T1-weighted 0.75 mm³ anatomical image was collected, and segmented using Freesurfer and ITK Gray. Three surfaces at independent grey matter depths (0, 1 and 2.5 mm from the grey/white matter boundary) were created using Caret v5.65. Data were interpolated to these surfaces using custom MATLAB scripts and displayed using mrMesh from the Vistatools software package. Findings show a large percentage of inverted voxels in regions of visual cortex directly underlying surface veins in the 2.5-mm surface, which decrease with grey matter depth. The frequency of isolated and sporadic clusters of inverted voxels increases with grey matter depth in regions not underlying large surface veins. We conclude that fMRI responses in mid-to-deep cortical layers are increasingly less affected by artefact from surface veins; however, the cause of the isolated inverted voxels in deeper grey layers is currently unknown. We additionally show that it is possible to conduct depth-independent surface analyses on moderate resolution (1.5 mm³) fMRI data.

Oxytocin genetics and family adversity in the development of substance use disorders

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Early adversity can increase the risk of mental health problems and addiction. Oxytocin is a neuropeptide which impacts on behaviour, stress regulation and mental health. Changes in oxytocin have been identified as a possible biological mechanism translating the impact of early adversity and addiction. This study investigated the impact of genetic variation in the oxytocin receptor and gene on this interaction. This study uses data from the UK Avon Longitudinal Study of Parents and Children to investigate SNPs for the oxytocin receptor gene (rs53576, rs2254298, rs4564970 and rs1488467) and oxytocin gene (rs4813625). The genotype of SNPs in the oxytocin receptor and oxytocin genes, and a measure of cumulative family adversity in early childhood were related to age at first use and risky use of alcohol and nicotine at age 21-23 years for a subset of 8795 participants. Logistic and ordinary least squares regression were used with multiplicative interaction, with coefficients being used to assess additive interaction in a sufficient-cause approach. The results strongly support an association between family adversity in early childhood and nicotine dependence at age 21-23 years, particularly for males. There is also strong support for an association between maternal smoking during pregnancy and nicotine dependence in the offspring. The results provide only weak support for a similar association with alcohol use disorders. No consistent association was found between substance use outcomes and the SNPs investigated, either alone or in interaction with family adversity. The current study did not rule out oxytocin as a mediator, but merely these SNPs. New studies can look at methylation of the genes and the functional measures of the functioning oxytocin system impacting on susceptibility to addiction. The birth cohort is financially supported by the Wellcome Trust, UK Medical Research Council and University of Bristol.

Age-related alterations in human neocortical plasticity

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Advancing age is typically accompanied by cognitive alterations including slowed learning of skills and deficits in short and long-term memory. Studies investigating the ageing process of the brain in rodents suggest that there is an age-related modulation of Long-Term Potentiation (LTP). LTP is a form of neuroplasticity which may play a central role in these cognitive changes. This study aimed to assess age-group differences in neocortical plasticity in humans. LTP was induced in the visual cortex of young and elderly participants using high-frequency presentations of either vertically or horizontally orientated sine gratings (counterbalanced)-termed a visual tetanus?. Electroencephalography (EEG) was used to measure the amplitude of the N1b component of the visual-evoked potential (VEP). Measurements were taken from the visual cortex before and after the visual tetanus while participants viewed stimuli of both orientations presented at low frequency. A significant potentiation of the N1b was seen 2 min following the tetanus in the young participants (N = 29, age range = 19-35 years) but not the elderly participants (N = 19, age range = 68–91). This result was specific to the orientation of the stimulus presented during the visual tetanus. These results support the rodent literature, providing evidence that there is an agerelated shift in the threshold for synaptic facilitation produced by LTP in humans. This study provides valuable insight into alterations in neocortical plasticity in the brains of older adults. This group will serve as an important control for the exploration of neuroplasticity changes in clinical populations such as those with dementia.

Recent visual experience determines the spatial extent of a predictive memory illusion

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After being shown a photograph, people tend to remember more of the image's background than was actually present. This visual memory illusion, known as Boundary Extension (BE), is believed to reflect automatic processes in which the visual system predicts the likely contents of the world beyond the image's edges, and memory does not distinguish these extrapolations from real sensory input. Little is known, however, about the processes that determine the spatial extent of such predictive extrapolation: Specifically, it remains unknown why the illusion is powerful for close-up images, but normally absent (or weak) for wide-angle images. The present study shows that recent prior visual experience-the types of images one is exposed to in the context of the current task-determines the spatial scale of BE. In two experiments, participants saw either close-up and wide-angle images (as is common in BE studies; Experiment 1) or wide-angle and verywide-angle images (Experiment 2). Crucially, the wide-angle images were the same in both experiments. However, whereas wide-angle images evoked very little BE in Experiment 1 (compared to the close-up images), the effect they evoked in Experiment 2 was large (similar to that found for close-up images in Experiment 1). Furthermore, a spatial attention manipulation had no effect in either experiment, attesting to the automaticity of BE. These results are consistent with a Bayesian model in which spatial extrapolation calibrates to the minimal spatial extent of recent stimuli, and suggest that although predictive extrapolation is automatic, its spatial scale is context-dependent.

Researchers' perspectives on the non-therapeutic use of transcranial direct current stimulation: An international survey

A/Prof. Adrian Carter Monash University

Part of the symposium Decoding the brain through interdisciplinary approaches in neuroscience

In the last decade, an increasing number of studies have suggested that transcranial direct current stimulation (tDCS) may enhance brain function in healthy individuals, and ameliorate cognitive and other symptoms in patients experiencing various medical conditions. This, along with its presumed safety, simplicity, and affordability, has generated great enthusiasm amongst

researchers, clinicians, patient populations, and the public (including a growing "do-it-yourself" community). However, discussion about the effectiveness and ethics of tDCS thus far has been confined to small groups of tDCS researchers and bioethicists. We conducted an international online survey targeting the opinions of researchers using tDCS who were asked to rate the technique's efficacy in different contexts. We also surveyed opinions about ethical concerns, self-enhancement and public availability. Two hundred and sixty-five complete responses were received and analysed statistically and thematically. Our results emphasise the potential uses of tDCS in clinical and research contexts, but also highlight a number of emerging methodological and safety concerns, ethical challenges and the need for improved communication between researchers and bioethicists with regard to regulation of the device. Neither the media reputation of tDCS as a "miracle device" nor concerns expressed in recent neuroethical publications were entirely borne out in expert opinion.

Mind perception modulates within-subjects neural encoding of communicative gaze

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Virtual reality has made it possible to simulate realistic human social interactions. Recent neuroimaging studies have provided evidence that attributing mental states, intelligence, agency and "humanness" (i.e., adopting an "intentional stance") during interactions with an avatar influences the neural processing of social cues. However, this evidence is limited by the use of between-subjects designs, in which different groups of participants are given different instructions about a virtual partner (e.g., instructed that an avatar is human or computer-controlled) or are exposed to virtual partners with different aesthetic features (e.g., appears more anthropomorphic) or behavioural features (e.g., displays more reciprocal social behaviour). This is problematic because such studies are unable to elucidate the specific influence that adopting an intentional stance has on social interactions with virtual agents. In the current study, we used a within-subjects design to measure the gaze-related N170, P250 and P350 event-related potentials (ERPs) of 20 healthy adults (15 females, M_{age} = 24.7 years, SD = 9.1) under two belief conditions while they initiated joint attention with an avatar. In one condition, they were told that the avatar was controlled by a human. In the other condition, they were told that the avatar was controlled by a computer algorithm. In reality, the avatar was always controlled by an algorithm that made the avatar respond congruently in half the trials (i.e., he shifted his gaze to achieve joint attention) and incongruently in the other half. Observing congruent gaze shifts generated a significantly larger centro-parietal P250 response when participants adopted an intentional stance (i.e., congruent-human) compared to all other conditions (incongruent-human, congruent-computer, and incongruent-computer). This demonstrates that adopting an intentional stance results in a within-subjects shift in the neural processing of social cues.

Neuroimaging-based prediction of rTMS treatment outcome in depression

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The neurobiology of major depressive disorder (MDD) remains incompletely understood, and many individuals fail to respond to standard treatments. Repetitive transcranial magnetic stimulation (rTMS) of the dorsolateral prefrontal cortex (DLPFC) has emerged as a promising therapy for treatmentresistant depression. However, the heterogeneity of treatment response underscores a pressing need for biomarkers of treatment outcome. We acquired resting-state functional magnetic resonance imaging (rsfMRI) data in 47 MDD individuals prior to 5–8 weeks of rTMS treatment targeted using the F3 beam approach, and in 29 healthy comparison subjects. The caudate, prefrontal cortex and thalamus showed significantly lower blood oxygenation level-dependent (BOLD) signal power in MDD individuals at baseline. Critically, individuals who responded best to treatment were associated with lower pre-treatment BOLD power in these regions (r = -.55, p = .004). Additionally, lower FC in the default mode (r = -.59, p = .001) and affective networks (r = -.40, p = .03) was associated with treatment response. We leveraged these findings to train support vector machines to predict individual treatment responses, based on learned patterns of baseline FC, BOLD signal power and clinical features. Treatment response (responder vs. non-responder) was predicted with 85–95% accuracy. The extent of reduction in symptoms was predicted to within a mean error of ±16% (r = .68, p < .001). Therapeutic outcome to DLPFC-rTMS could thus be predicted at a clinically meaningful level using only a small number of core neurobiological features of MDD. This provides a novel, transparent and physiologically plausible multivariate approach for classification of individual response to what has become the most commonly employed rTMS treatment worldwide. Our recent evidence in support of novel FC-based DLPFC targeting approaches will also be discussed.

Interactions between spatial attention and alertness in healthy adults: A meta-analysis

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The ability to attend to the environment is paramount for safety: a failure to sufficiently allocate attention in the environment can lead to accident and injury. An emerging line of research suggests that the ability to attend quickly to left- and right-sided objects varies systematically as a function of a person's level of alertness. The aims of this review and meta-analysis were (1) to collate the evidence for an association between alertness levels and shifts in spatial attention and (2), to identify modulators of this association. Searching two databases (PsychINFO and Embase), 3349 abstracts were identified, 93 meeting criteria for full-text screening, and of these 19 relevant articles were selected for the meta-analysis. Using a random-effect model a small effect (Cohen's d = 0.30, 95% Confidence Interval = 0.13-0.48) of alertness on spatial attention was found: A rightward shift in attention with reduced alertness and a leftward shift in attention with increased alertness. A range of potential modulators such as experimental design (time-on-task or sleep deprivation), alertness manipulation (increasing or decreasing alertness), measurement of alertness (objective or subjective), spatial-attention task (detection or judgement), and handedness (right-handers or non-right-handers) were investigated. Only handedness was identified as a modulator, revealing that the right-handers (Cohen's d = 0.38, p < .001) but not the non-right-handers (Cohen's d = -0.21, p = .097) showed the rightward bias in attention with decreasing alertness and a leftward bias with increasing alertness. The review was the first to collate current evidence for the association between alertness and spatial attention in the literature, and identified the absence of studies examining transfer effects of laboratory-based experiments for real-world implications, highlighting a need for future research in this area.

Sleep preferentially protects temporal aspects of memories from retroactive interference

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Theoretical perspectives suggest that the human memory system has evolved from a need for environmental navigation, suggesting that the brain may use navigational parameters (space and time) to encode episodic memories in semantic schemata. Human memory also consolidates over sleep periods. As such, we should be able to differentiate the spatial and temporal coding of episodic stimuli over sleep periods. Twenty-two subjects (M_{age} = 21 years; 17 female) were fitted with a 64-channel EEG cap and undertook a spatiotemporal learning and retrospective interference task, in which they learned the spatial locations and temporal sequence of 20 images, presented at random on a circular background. Following learning and immediate recall testing, subjects were given a 2-hour nap opportunity. On awakening, subjects were introduced to memory interference (by learning a sequence of the same images in different locations and order). Subjects were then tested on their recall of the original sequence. Performance on spatial and temporal aspects of the learned sequence were coded and the change in these from pre- to post-sleep was calculated. Sleep was scored according to Rechtschaffen and Kales (1968) protocols. Linear mixed models were constructed for spatial and temporal results. Performance on the sequential measure could be predicted from the interaction between interference learning and minutes spent in non-rapid-eye-movement (NREM) sleep, such that delayed outcome was highest when the subject had minimal learning of the interference sequence and maximal minutes in NREM sleep during the nap. Spatial elements of learning could not be successfully modelled based on these data. Results indicate a relationship between NREM sleep and sequence preservation, suggesting that sleep may preferentially consolidate the temporal aspects of episodic memory. This may represent an optimal strategy for the brain to learn statistical regularities about the world, in order to minimise surprise and free energy in the brain's predictive models of the environment.

Effects of sleep on cognitive and behavioural attention in children as they enter school

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Attention is a fundamental cognitive domain that has important implications for early learning. When difficulties occur, they can have a long-lasting detrimental impact on a child's academic and social development. When confounded with poor sleep, this can lead to a cascading profile that places a child at-risk for under-achievement. Few studies to date have examined sleep and attention in children as they start school. The aim of this present study was to examine if children with poor sleep have reduced behavioural and cognitive attention. The sample consisted of 248 Prep and Grade 1 children (144 boys, 104 girls) aged 5-7 years (M = 6.37 years, SD = .43). The Strengths and Weaknesses of ADHD Symptoms and Normal Behaviour Rating Scales was used to measure child inattentive behaviours, and the Staged Attention Network Test was used to measure child cognitive attention. Child sleep problems and sleep duration was assessed using the Children's Sleep Habits Questionnaire-Abbreviated. Results indicated that sleep problems and sleep duration did not significantly predict child inattentive behaviours in the classroom. Total sleep problems was also not associated with cognitive attention in children. Sleep duration selectively affected aspects of cognitive attention. While sleep duration did not significantly predict alerting, executive or endogenous orienting of attention, shorter sleep duration was associated with reduced accuracy of the exogenous orienting network in children. Essentially, poor sleep was associated with impairments in cognitive but not behavioural attention. Specifically, shorter sleep duration was associated with reduced accuracy of the exogenous orienting attention network in children.

Dopamine restores cognitive motivation in Parkinson's disease

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Disorders of motivation, such as apathy, are common in Parkinson's disease (PD), and a key feature of such disorders is a greater aversion to effort. In humans, the experience of cognitive effort is ubiquitous, and cognitive apathy has traditionally been considered distinct and separable from other subtypes. Surprisingly, however, the neurobiology of cognitive motivation is poorly understood, and a critical, unresolved issue is whether its facilitatory role generalises to other domains. Here, we asked how dopamine modulates the willingness of patients with PD to invest cognitive effort in return for reward. We manipulated cognitive effort in the context of a divided attention task, and compared the performance of 20 patients with idiopathic PD, who were tested ON and OFF their usual dopaminergic medication, against 20 healthy age-matched controls. After training participants to ceiling performance, we then asked them to choose between a low-effort/lowreward baseline option, and higher-effort/higher-reward offer. Computational models revealed that patients OFF medication were less cognitively motivated than controls, but that dopaminergic therapy improved this deficit. In addition, participants' choices correlated uniquely with the subscale of the Dimensional Apathy Scale that specifically indexes cognitive motivation, suggesting a close relationship between cognitive effort discounting and subjective reports of day-to-day cognitive apathy. These results are the first to reveal the critical role of dopamine in overcoming cognitive effort costs. They provide an insight into the computational mechanisms underlying cognitive apathy in PD, and demonstrate its sensitivity to dopaminergic therapy. More broadly, they offer important empirical support for prominent frameworks proposing a domain-general role for dopamine in valuebased decision-making, and provide a critical link between dopamine and multidimensional theories of apathy.

Response inhibition training improves inhibitory tone in the motor cortex

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In our previous work, we showed that intracortical inhibition in the primary motor cortex (M1), measured using paired-pulse transcranial magnetic stimulation, is related to stop-signal reaction time (SSRT), measured using the stop-signal task. In this research, we determined whether training participants in the stop-signal task leads to related changes in M1 intracortical inhibition. In this study, participants in the training group (N = 21) were trained in the stop-signal task, while control participants (N = 21) completed a choice reaction-time task. We ensured the control group made, on average, the same number of go responses as the training group. Before and after these tasks, resting-state M1 intracortical inhibition and SSRT were measured in both groups. Relative to the control group, the training group showed a small but non-significant improvement in SSRT, however there was an overall increase in M1 intracortical inhibition (p = .014). Moreover, between baseline and endpoint, changes in SSRT correlated with changes in M1 intracortical inhibition across all participants (r = 0.59, p < .001). These results show that stop training within one experimental session increases M1 intracortical inhibition. Furthermore, we showed that M1 intracortical inhibition and SSRT are temporally linked, such that changes in SSRT across time relates to changes in M1 intracortical inhibition. We are currently conducting another experiment to determine whether stop-signal task training across multiple experimental sessions leads to larger improvements in SSRT, as well as larger changes in resting-state and task-related M1 intracortical inhibition.

Cortical surface morphology in long-term cannabis users: A multi-site MRI study

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Cannabis exerts its psychoactive effect through cannabinoid receptors that are widely distributed across the cortical surface of the human brain. It is suggested that cannabis use may contribute to structural alterations across the cortical surface. In a large, multisite dataset of 120 controls and 141 cannabis users, we examined whether differences in key characteristics of the cortical surface-including cortical thickness, surface area, and gyrification index-were related to cannabis use characteristics, including (i) cannabis use vs. non-use, (ii) cannabis dependence vs. non-dependence vs. nonuse, and (iii) early-adolescent vs. late-adolescent onset of cannabis use vs. non-use. Our results revealed that cortical morphology was not associated with cannabis use, dependence, or onset age. The lack of effect of regular cannabis use, including problematic use, on cortical structure in our study is contrary to previous evidence of cortical morphological alterations (particularly in relation to cannabis dependence and cannabis onset age) in cannabis users. Careful re-evaluation of the evidence on cannabis-related harm will be necessary to address concerns surrounding the long-term effects of cannabis use and inform policies in a changing cannabis-regulation climate.

Saccades to the flash-grab illusion: A replication of previous findings, but no evidence for a gap effect

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Accurately perceiving the position of a moving object relies on the brain not only knowing where an object will be next but also when it will be there, so that we have time to move our eyes to that location. Visual motion illusions have been used to study how the brain performs this predictive timing computation based on motion and position information. The flash grab is one such illusion, in which a flash is presented superimposed on an unexpected motion reversal of a moving texture, resulting in the flash being perceived away from its physical location. A previous study demonstrated that the time it takes to initiate a saccade aimed at the perceived position of the flash (saccadic latency) correlated with the strength of the illusion. This was taken as evidence that the illusion resulted from extrapolation mechanisms processing the flash as if it were moving. To investigate the causal direction behind this effect, we attempted to directly manipulated saccadic latency using the so-called Gap Effect, a phenomenon whereby removing the fixation point immediately before a saccade results in faster saccades. Observers viewed a flash-grab display in one of three conditions: the fixation point disappeared 200 ms prior to the flash, simultaneous with the flash or at the end of the trial. Observers were asked to either make an eye movement or click on the perceived location of the flash using the mouse. Although we replicated previous reports of a correlation between saccadic latency and illusion strength, the gap manipulation failed to achieve the intended effect of reducing saccadic latency, which was comparable across all three gap conditions. Illusion strength in both saccade trials and perceptual report trials was likewise similar across all three gap conditions. Altogether, our results indicate that the gap effect may not be robust to unpredictable target locations but do corroborate the interpretation of the flash-grab effect as an extrapolation mechanism.

Testing long-term cognitive dysfunction in an animal model of traumatic brain injury: Implications for the translatability of preclinical testing in rodents

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As the number of older adults worldwide continues to rise, so too will the incidence of neurodegenerative diseases, such as Alzheimer's and Parkinson's disease, for which age is the greatest risk factor. This makes understanding the brain basis of cognitive decline in both healthy ageing and neurodegenerative disease critically important. Such research relies on experimental models of ageing and disease. Unfortunately, often, the cognitive testing performed in these models does not accurately reflect the cognitive impairment seen in the disease. For example, many studies rely on maze tasks, which are dependent on hippocampal function. However, many neurodegenerative conditions, including Parkinson's disease (PD) and chronic traumatic encephalopathy (CTE), are associated with frontal-lobe dysfunction, and thus require cognitive tasks dependent upon these regions to accurately detect impairments. The current study used the five-choice serial reaction time task (5CSRT), considered to be homologous to the human five-choice serial reaction task, to assess impairments in executive function following different severities of diffuse traumatic brain injury (TBI; mild TBI, mild repetitive TBI, or moderate-severe TBI) at 1 month, 6 months or 12 months following injury. TBI was chosen as a model disease since it leads to an increased risk of neurodegenerative diseases such as PD and CTE. Behavioural testing was conducted in the Bussey-Saksida Touchscreen operant chamber using standard parameters. Following training, animals were probe-tested on measures of executive function. Compared to standard maze tasks, such as the Y-maze and Barnes maze, the 5CSRT was significantly better at detecting both age and injury effects on frontal-dependent cognitive function. By choosing more clinically relevant tasks, we can improve translatability of our models, ultimately leading to enhanced understanding of the brain basis of cognitive dysfunction and more effective intervention strategies.

Theta activity within frontal networks reflects specific cognitive-control processes beyond general reaction-time slowing

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Over the past decade, theta (4-8 Hz) activity within frontal networks has increasingly been considered a neural marker associated with the need for and implementation of cognitive control. However, the bulk of studies that have suggested this link typically do so by reporting associations between increased theta and RT slowing. Despite RT slowing being a classic cognitive control phenotype, it does not strictly reflect the specific use of control. In this talk, I present evidence from a line of work showing that cognitive control processes that manifest beyond RT slowing are also associated with changes in theta activity. Here, I focus on work using a task switching paradigm, to show control processes associated with switch costs are linked to changes in theta dynamics. I present work from a large cohort (N = 192) that included a longitudinal subsample, to characterise (1) functional connectivity within frontoparietal networks, (2) local power and phase-coupling changes and (3) relationships between trial-by-trial fluctuations in theta power and cognitive control performance associated with the task switching switch cost. Cognitive control processes rely on theta activity within frontoparietal networks. First, distinct frontoparietal theta networks emerge when preparing to switch tasks vs. resolving target-level interference. Second, when preparing to switch, trials have increased theta power and intertrial phase coherence (ITPC) at frontal and parietal scalp locations. These changes in power and ITPC predict cognitive control efficacy across participants. Finally, using single-trial regression, trial-by-trial modulations of frontal theta power predicted the size of the switch cost-so that switch trials with increased theta produced smaller switch costs. Remarkably, these effects were reliable after a two-year interval. Together, these findings suggest theta within frontal networks supports the need for control beyond simple RT slowing at various functional levels.

Discovery of coding and non-coding variants that cause neurodevelopmental disorders

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Part of the symposium Applications of genomics and epigenetics to cognitive neuroscience

Neurodevelopmental disorders (NDD), including intellectual disability, autism spectrum disorders, epilepsy and cerebral palsy are collectively common, affecting 1 in 50, and clinically heterogeneous. The effects of these disorders are usually life long and there are very few effective treatments available. With a focus primarily on familial forms of these disorders, we have revealed a vast underlying genetic heterogeneity that implicates multiple molecular pathways in brain development. While modern sequencing technology has been highly successful for providing a molecular diagnosis, approximately 50% of individuals remain unresolved. We focused on these unresolved cases, including five X-linked families affected by intellectual disability and 186 individuals living with cerebral palsy. We performed a combined analysis of exome or whole-genome sequencing data with RNAsequencing from cell lines derived from individuals affected by NDD. We analysed these data for genomic copy-number or structural variants, singlenucleotide variants in light of recent large NDD-cohort studies and deregulated genes correlated with potential novel regulatory variants. We discovered an additional 10% of individuals with plausible disease-causing variants including a range of non-coding variants that impacted expression of genes implicated in NDD. Limited functional assays in both model cell systems and zebrafish were used to support candidate genes and variants. Our data highlight the value of retaining and reanalysing sequence data and the increased clarity of interpreting the functional effects of variants of unknown significance in light of RNA sequencing.

The effect of behavioural and cognitive attention on numeracy in 5- to 7-year-old children

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Peter Reynolds, University of Melbourne

Frances Lewis, University of Melbourne Katherine Johnson, University of Melbourne

Attention underpins cognitive function. A crucial cognitive function is the ability to manipulate numbers, or numeracy, which has both innate and taught, or culture-based, components. In this study, innate and culturebased numerical ability was assessed in a community sample of 172, 5 to 7year-old boys and girls, and regressed in multiple models against sex, age, and behavioural and cognitive measures of attention. As expected, symbolic and non-symbolic innate mathematical performance on the Numeracy Screener was predicted by age, with older children performing to a higher standard. Lower symbolic mathematical ability was predicted by poor behavioural attention control on the Strengths and Weaknesses of ADHDsymptoms and Normal behaviours rating scale and by atypical variability of response times on the Sustained Attention to Response Task (SART). Symbolic ability was also affected by behavioural attention and sex, with boys showing more accomplished maths scores at stronger levels of behavioural attention control than girls, but this sex difference was reduced at weaker levels of behavioural attention control. Greater culture-based mathematical scores on the Woodcock Johnson Tests of Achievement were predicted by stronger behavioural attention, especially for younger compared to older children. Specifically, in culture-based calculations, variability in response time also interacted with age, with atypical response time variability over the course of the SART predicting lower maths scores in older but not younger children. Overall, strength of behavioural attention control was the strongest predictor of numeracy compared to cognitive attention or biological factors.

Experience in action: Culture dynamically alters visual processing near the hands

Ms Jolene Cox

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It was traditionally thought that only the temporal and spatial properties of visual scenes drive the relative contribution of the magnocellular-dorsal and parvocellular-ventral pathways in perception, respectively. More recent research, however, indicates that visual perception can be dynamically altered by non-stimulus factors, such as attentional processes and perihand space. For example, in the near-hand-space effect, placing the hands near the visual stimuli produces a pattern of performance consistent with enhanced magnocellular-dorsal-mediated processes (e.g., temporal acuity, motion perception), while impairing parvocellular-ventral-mediated processes (e.g., spatial acuity, form perception). Here, by manipulating the perceiver's hand proximity to the visual stimuli, we tested the possibility that cultural experience may result in fundamental differences in the relative contribution of the two visual pathways to perception. Using the global motion and Glass pattern tasks to preferentially drive the two visual pathways, we found that Asian participants who strongly identified with their ethnic identity exhibited a greater near-hand-space effect than Caucasians, indicating cultural differences in the modulation of the relative contribution of the two pathways.

Neurophysiological signatures of motor-sequence preparation within the supplementary motor area

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It is known that a reduction in gamma-aminobutyric acid (GABA) inhibition within primary motor cortex is important when learning a novel motor sequence. What is unknown is whether this modulation of inhibition also occurs in other brain regions that are critical for motor sequence encoding. Here we used concurrent Transcranial Magnetic Stimulation and Electroencephalography (TMS-EEG) to investigate the role of the supplementary motor area (SMA) in sequence preparation. TMS-evoked cortical potentials were obtained from seventeen participants ($M_{age} = 24.5$ years, SD = 7.9) while they were at rest, as well as during the 'early' and 'late' phases of a

complex motor-sequence learning task. As expected, participants performed the motor-sequence task faster and more accurately with practice, resulting in a significant increase in a composite speed–accuracy measure of skill (p < .001). The N45 and N100 peaks of the TMS-evoked potential were analysed as markers of GABA-receptor mediated inhibition. Repeated measures ANOVAs with factors Condition and Time revealed no significant effects for the N45, but a significant Time × Condition interaction for the N100, F(1,16) = 4.67, p = .046, that arose from a reduction in the N100 from 'early' to 'late' learning. A cluster permutation test also revealed a reduction in oscillatory beta-band power from 'early' to 'late' learning in the SMA. These results indicate, for the first time, that reductions in inhibition in the SMA may contribute to the neuroplastic processes required for motor-sequence skill acquisition. In addition, beta power changes may mark the transition from early to late learning.

Raven's Progressive Matrices (non-verbal IQ) predict grey-matter atrophy post stroke

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Kate Noonan, La Trobe University Gemma Lamp, La Trobe University Pierrick Bourgeat, CSIRO Health and Biosecurity Tamara Tse, La Trobe University Olivier Salvado, CSIRO Health and Biosecurity Bruce Campbell, Florey Institute of Neuroscience and Mental Health Leeanne M. Carey, La Trobe University & Florey Institute of Neuroscience and Mental Health

Following ischemic stroke many patients have been shown to develop cognitive impairment (CI). We aimed to analyse grey matter (GM) volume and thickness associated with cognitive changes three months post-stroke (PS). Cognitive function was assessed using the Montreal Cognitive Assessment (MoCA), auditory Digit Span subtest of the WAIS-IV (DS), the Trail Making Test B (TMT B), the Stroop test and the Raven's Progressive Matrices (a non-verbal Intelligence measure). T1-weighted structural MRI images were processed using voxel-based analysis of GM volume and cortical thickness. Nineteen participants enrolled in the study, 8 with Left Hemisphere (LH) infarcts (7 male, aged ~65 years) and 11 with Right Hemisphere (RH) infarcts (9 male, aged ~67 years). Lesion size was not significantly different between LH and RH. General cognitive skills (DS Backwards, Stroop and TMT B) were positively correlated with the volume of the thalamic and fronto-temporal cortex structures in patients with LH infarcts. By comparison visual cognitive skills measured in the Raven's and MoCA tests correlated with reduced hippocampus, amygdala and frontal cortex in patients with RH infarcts. Overall, regardless of hemisphere of infarct, poorer performance on Raven's correlated with decreased volumes of bilateral insula, thalamus, posterior temporal lobe, middle frontal gyrus, precentral gyrus, orbitofrontal gyrus, inferior frontal gyrus, superior frontal gyrus, ipsilesional hippocampal volume, anterior temporal lobe volume, superior temporal gyrus, middle and inferior temporal gyrus, and contralesional amygdala and fusiform gyrus volume. These results suggest cognitive deficits associated with GM thinning post stroke may be better predicted using a non-verbal measure of general fluid intelligence, such as the Raven's Progressive Matrices.

Colours are not faces, are not places, are not spaces

Dr Simon J. Cropper University of Melbourne

Dr Patrick T. Goodbourn, University of Melbourne Dr Jason D. Forte, University of Melbourne

It has been suggested that eye movements both betray and influence the chosen stimulus in a judgement of facial attractiveness. We were interested in generalising this observation to see whether patterns of eye movements would change according to the type of decision to be made when faced with a series of binary choices using the same stimulus set. Two 4° colour patches were presented 8° either side of (temporary) fixation. The patches were defined along either chromatic (L–M) or luminance vectors in cardinal space, presented on a luminance pedestal. In separate blocks of the same stimulus set, subjects (N = 18) were asked to decide if the patches were the same or different (discrimination), which was redder, which was brighter, and which they preferred. They responded using a key-press, and stimuli remained on the screen until the decision was made. Eye movements were recorded monocularly for the duration of the trial with an EyeLink1000 (500 Hz; 0.1° resolution). Our main finding is that the pattern of eye movements,

in terms of position, number and duration of fixations, are uniquely related to the task at hand. Eye movements were influenced both by the difficulty of the task and whether it was a judgement of colour or luminance difference. When the task was one of preference, the eye movements did not reflect the pattern seen for facial attractiveness, but were distinct from that of discrimination, and from judgements of colour or luminance. We conclude that eye movements do provide insight into the underlying processes of stimulus analysis and decision making, but in a way that reflects an ongoing interaction between stimulus- and task-based influences.

Influence of *BDNF* polymorphism on synaptic plasticity following aerobic exercise

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The after-effects of repetitive transcranial magnetic stimulation (TMS) are highly variable across individuals, which hinders translation to clinical and therapeutic practice. Priming repetitive TMS with aerobic exercise may be one way to produce more consistent effects. One potential contributor to the variability observed following repetitive TMS is genetic variation. A common single-nucleotide polymorphism in the gene encoding brain-derived neurotrophic factor (BDNF Val66Met) is thought to modulate synaptic plasticity. However, the influence of this polymorphism on synaptic plasticity following the combination of repetitive TMS and aerobic exercise is unknown. Here, we explored whether the BDNF Val66Met polymorphism influenced motor cortex synaptic plasticity following aerobic exercise, using intermittent theta-burst stimulation (iTBS) and single- and paired-pulse TMS. Eight adults with the Val66Met polymorphism (M_{age} = 39.3 ± 15.7 years) and twelve adults (M_{age} = 32.4 ± 11.2 years) without the polymorphism (Val66Val) each completed three sessions. Measures of cortical excitability and inhibition were obtained before and after a 20-minute bout of either high-intensity interval exercise, moderate-intensity continuous exercise, or rest, and again after iTBS. Results showed that intracortical facilitation was significantly reduced in Val66Met carriers compared to Val66Val homozygotes in the high-intensity condition (p = .01, d = 1.25). Val66Met carriers also showed greater short-interval intracortical inhibition in the high-intensity condition compared to Val66Val homozygotes, although this effect was non-significant (p = .08, d = 0.80), likely owing to the small group sizes. No differences were observed between groups for cortico-motor excitability. The BDNF Val66Met polymorphism may contribute to inter-individual variability following the combination of iTBS and exercise, as well as modulate the effects of high-intensity exercise on synaptic plasticity.

A failure to launch: Boredom and self-regulation

Prof. James Danckert

University of Waterloo

Boredom is a ubiquitous human experience characterised by negative valence, failures of sustained attention, and a raft of maladaptive responses and outcomes, from increased depression and anxiety, to problem gambling and drugs of addiction. We showed recently that those who suffer from higher levels of boredom-proneness also tend to demonstrate lower levels of self-control. In addition, we've shown that boredom proneness is elevated in individuals who have sustained traumatic brain injuries, known to affect executive functions necessary for effective self-regulation. Here, I present two data sets that address the relationship between boredom and self-regulation. First, age has long been known to be negatively correlated with boredom proneness in young adults, corresponding with the final stages of frontal maturation. I present data from 9- to 14-year-olds showing an increase in boredom with age. This highlights that as young people become more emotionally reactive, but before their executive functions fully develop, boredom is on the rise. Next, I show data correlating boredom proneness with two distinct regulatory modes: a just do it mode in which individuals prefer to get on with things and a do the right thing mode in which people prefer to evaluate options for goal pursuit. Data show that those high in boredom proneness tend to adopt a do the right thing mode, exhaustively evaluating options for goal pursuit and, essentially, failing to launch into an activity. The data are cast in the context of other work in the lab using fMRI to show that insula deactivation is related to the state of being bored.

Reaction-time variability predicts the accuracy of interception saccades (but not reaching movements) to moving objects

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Delays incurred during transmission and processing of visual information cause a lag between the occurrence of an event in the world and the moment we perceive that event. For example, when we look at a moving object, it continues to move as our brain is processing it, such that the perceived location of the object lags behind its actual location. Yet mislocalisation of moving objects rarely occurs, possibly because the brain compensates for this delay by extrapolating the current location of the object. Importantly, the accuracy of such a compensatory predictive mechanism would be limited by delay variability: It cannot compensate for a delay if it does not "know" how long that delay is. Here, we tested the hypothesis that variability in neural transmission and processing time (operationalised as reaction-time variability on a simple detection task) predicted the accuracy of eye and hand movements aimed at moving targets. The results revealed no significant correlations for reaction time (RT) variability and imprecision (spatial error variability) for reaching movements to moving targets. However, there were significant correlations between RT variability and the imprecision of saccadic eye movements aimed at moving targets: Observers with high RT variability on the simple detection task showed greater variability in saccades aimed at moving stimuli. This pattern of results is consistent with the hypothesis that (at least for eye movements) variability in neural transmission time limits the accuracy of the extrapolation mechanisms that allow us to accurately interact with moving objects in the present. The discrepancy observed between hand and eye movements might suggest that separate predictive mechanisms operate for these processes. These results motivate the further hypothesis that reported increases in the variability of neural transmission time associated with healthy ageing might play a role in reductions in visuo-motor performance as we get older.

Face processing impairments in schizophrenia and other psychiatric disorders

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The ability to recognise and interpret the facial expressions of others is shown to be impaired in individuals with schizophrenia and may contribute to poor social functioning. In contrast, it remains unclear whether other aspects of face processing are also impaired, and whether such deficits correlate with specific symptoms. Face and emotion processing was explored in schizophrenia and other disorders using a novel set of video-based tasks. Schizophrenia and bipolar I groups showed similar emotion-processing impairments compared to controls and inpatients with non-psychotic disorders. While non-emotional face processing was intact in all groups, the schizophrenia and bipolar groups were impaired on a non-face control task. Overall, results suggest that deficits in emotion processing reflect symptom pathology independent of diagnosis and support the idea of a generalised cognitive deficit that is particularly prominent in patients showing positive symptoms of psychosis.

Investigating perceptual filling-in using steady-state visually evoked potentials (SSVEPs)

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Perceptual filling-in (PFI) occurs when a distinct visual target disappears to match the surrounding visual background, despite remaining physically unchanged. Similar to other multistable phenomena, contrasting the reported presence or absence of a target during PFI can reveal the neural correlates of conscious perception. Uniquely, however, PFI can also involve the disappearance of multiple spatially-separated objects offering a unique

complement to existing multistable paradigms. To investigate the neural markers of this effect, four peripheral targets were presented over a dynamically updating background (1F = 20 Hz), while participants reported on target disappearances and reappearances via button press and release. We found that as the number of targets that were filled in increased, the duration of target disappearances also increased, suggesting that targets were perceptually grouped despite being invisible, and located in separate visual quadrants. We used steady-state visually evoked potentials (SSVEPs) recorded in the electroencephalogram to entrain neural populations responding to the background, and contrasted endogenously generated PFI to the physical removal of the same visual stimuli. During PFI, we found background SSVEPs closely corresponded with perceptual contents, with opposite decreases and increases in signal-to-noise ratio during the subjective report of target disappearance and reappearance, respectively. Unexpectedly, distinct spatio-temporal correlates emerged for the SSVEP harmonics. Changes to the 2f response (40 Hz) preceded the 1f (20 Hz) response prior to PFI, yet no difference between harmonics emerged for our physically removed stimuli. These results demonstrate that physical changes in visual inputs can be distinguished from endogenous fluctuations in visual awareness via frequency-tagging.

Neuroscience in the wild: Field-side assessment of electrical brain activity to investigate the neural markers of sport-related concussion

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Concussion is a common sporting injury, especially in contact sports such as Rugby Union, Rugby League, and Australian Football, and can affect players at all levels. To ensure players' health and safety, it is crucial that a suspected concussion can be rapidly assessed field-side. Complicating this assessment, however, is the non-specificity of most concussion-related symptoms (e.g., headache, tiredness), as well as our limited understanding about the neural markers of concussion. Electroencephalography (EEG) might be able to provide a solution, especially with the emergence of portable EEG systems. Our project saw us take a first step towards using EEG as a fieldside assessment tool by taking a portable EEG system field-side to measure the electrical brain activity of Rugby Union and Rugby League players (N =31) during their 2018 season. Through the repetitive alternating presentation of black and white stimuli at 15 Hz for 2 minutes, we successfully recorded a 15-Hz Steady-State Visual-Evoked Potential (SSVER), demonstrating that EEG data can be recorded "in the wild". Ongoing data collection will build on this novel finding and investigate how the healthy brain responds to playing sports by testing brain activity at multiple points during a season, before investigating how a sport-related concussion impacts on brain function.

Multiband fMRI reveals differences in amygdala subregion response to emotions and the effect of childhood maltreatment

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The human amygdala is at the centre of emotion processing and learning, and it is of great interest for its potential role in a number of psychiatric disorders. Partly due to limitations in the resolution of functional magnetic resonance imaging (fMRI), research has focused on the amygdala as a whole, leaving aside potential functional differences between subregions within this structure. The recently developed multiband echo-planar imaging technique affords the possibility to scan the brain at a higher spatial and temporal resolution. In the present study, we used multiband imaging for the first time to tease apart different responses across amygdala and subregions in a sample of 88 healthy adults (47 females) during an emotional face matching task that included fearful, angry and happy faces. We were also interested on the effect that childhood maltreatment, as measured by the Childhood Trauma Questionnaire, may have on the amygdala and subregion responses. The whole amygdala, along with four subregions were examined, including amygdalostriatal (Astr), centromedial (CM), laterobasal (LB), and superficial (SF) nuclei. Results showed that the amygdala and all the subregions displayed significant activity relative to baseline in response to all emotions. There was also a general pattern of greater activity in the right hemisphere, with SF displaying the greatest activation followed by CM and LB, and, lastly, Astr. Childhood maltreatment was associated with increased response to fearful faces in CM, LB and SF. We found physical abuse appears to play a key role driving this response. Findings from this study significantly advance our understanding of how emotional information is handled at the level of amygdala subregions and of the impact of earlier childhood experiences on amygdala reactivity, with significant implications for healthy and clinical populations. This study also demonstrates the utility of multiband imaging to target small structures in task-based fMRI.

The predictive brain in the schizophrenia spectrum

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Recent theories in computational psychiatry have proposed that unusual perceptual experiences and delusional beliefs in psychotic disorders may emerge as a consequence of aberrant inference and disruptions in belief updating. The current study investigates anomalies in auditory prediction errors and belief updating in inpatients with a schizophrenia spectrum disorder. We characterise the underlying neural dynamics of impaired belief formation, or regularity learning, in stable and volatile contexts on 63 participants: 20 inpatients with a schizophrenia spectrum disorder (SZS), 21 nonpsychotic inpatients (NP), and 22 non-clinical controls (NC). We recorded prediction-error responses with electroencephalography and gauged regularity-learning errors to inferences on sound probabilities. Compared to NC and NP, SZS had attenuated prediction-error responses, specifically mismatch negativity (MMN), only in stable contexts. Attenuation in MMN in stable contexts was related to poorer regularity learning overall, suggesting a weaker prediction model of sensory probabilities in SZS. Whole-volume spatiotemporal activity showed smaller prediction errors for SZS compared to NC in the P300 component; the same, albeit weaker difference was also found for SZS compared to NP. No differences were found for prediction errors between NC and NP. Whole-brain source reconstruction for prediction errors revealed decreased activity in bilateral paracentral lobule, left insula and right superior temporal gyrus for SZS compared to NC; decreased activity in bilateral superior parietal lobules and right medial frontal gyrus for SZS compared to NP, and increased activity in the bilateral superior parietal lobules for NP compared to NC. The findings provide evidence that impairment in prediction-error updating of regularities is specific to the schizophrenia spectrum, related to attenuation in MMN and P300 and decreased activity in frontoparietal regions.

Oculomotor function during rapid automatised naming and its correlation with cognitive speed in young and older adults

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The human visual system is essential for guiding most behaviour and is reported to undergo profound changes across the lifespan. Oculomotor functions such as eye-gaze patterns (i.e., fixations and saccadic eye movements) are robust and non-invasive measures of cognitive function and provide extensive insight into higher-order cognitive abilities. However, no study has investigated oculomotor function in a sample of healthy educated young and older adults and compared this to performance on cognitive measures of perceptual speed. Thus, the current study aimed to compare visual attention and oculomotor function performance on a Rapid Automatised Naming (RAN) task that requires participants to name a series of common objects or alphanumeric symbols as quickly and accurately as possible in a sample of 68 young adults (18-25 years) and 37 healthy older adults (50-81 years). The study also aimed to correlate performance on the RAN task with simple and complex visual-cognitive tasks including Inspection Time (IT) and Change Detection (CD) respectively. The RAN results demonstrated that older adults only performed slower (i.e., rapidly named less stimuli) on the RAN-objects condition. Significant age-group differences in fixation and saccade durations were also demonstrated, where younger adults fixated on visual stimuli for significantly longer than older adults, whereas older adults demonstrated a longer saccade duration in the objects and alphanumeric conditions. Significant correlations between cognitive tasks, RAN, and oculomotor measures were demonstrated between the IT and the RANobjects, indicating that lower threshold exposure duration on the IT (i.e., faster performance) was significantly correlated with faster performance during RAN-Objects. Our results provide preliminary insight into eye gaze patterns and oculomotor function during RAN and show that oculomotor movements may also decline with age though does not always denote worsened performance on tasks.

Associating tDCS efficacy with brain morphometry

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Applying a weak electrical current to the cortex can have effects on a range of behaviours, including decision-making, mathematical learning, and working memory. Indeed, techniques such as transcranial direct current stimulation (tDCS) have been widely used in both research and clinical settings. However, there is significant variability across individuals' responses to stimulation, which poses practical challenges to its application. But, this characteristic offers an opportunity to utilise this variability, in an individualdifferences approach, to establish links between the brain and behaviour. Here, we assess the role of cortical structure, namely cortical grey matter thickness, for determining the influence of stimulation on decision-making performance. Specifically, we employed magnetic resonance imaging and a previously replicated paradigm where we modulated decision-making learning by applying active tDCS to the left prefrontal cortex in a large human sample. Cortical thickness of the left (but not right) prefrontal cortex accounted for almost 35% of the variance in stimulation efficacy across subjects. This study is the first demonstration that cortical architecture can interact with stimulation outcomes on behaviour, and provides an important step forward in understanding source(s) of variance in tDCS efficacy.

Anger vs. fear: what's your preference? Attention for negative facial expressions and psychopathic traits

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Negative facial expressions are not alike: While fearful expressions indicate potential threat that is not necessarily directed towards the observer, angry expressions indicate direct threat. Psychopathic traits have been linked with reduced preferential processing of negative cues, such as angry or fearful facial expressions. In order to investigate the differential impact of angry vs. fearful facial expressions on preferential processing, we measured attentional bias for angry vs. fearful vs. neutral facial expressions using steadystate visual evoked potentials (ssVEP). Based on a median split according to psychopathic traits (PPI-R-40), we compared visuocortical activity in response to competing faces in 24 low- and 23 high-psychopathic students. Analyses averaging across the 3000-ms presentation time show an interaction between condition, presentation side and group, indicating a bias for right-side-presented fear over anger, fear over neutral and anger over neutral in the low-psychopathic group, but a left-presented anger over neutral bias and no dominance of fear over neutral in highly psychopathic individuals. This pattern is most pronounced in the 500-1000-ms window, less in the 2-3-s window and not significant in the 1-2-s window. These results show some preliminary indication-only based on a median split for psychopathic traits-towards less bias for fear or angry facial expressions when paired with neutral expressions in high- vs. low-psychopathic individuals, as

well as preferential processing of left-presented angry facial expressions. Thus, not only fearful vs. angry facial expressions, but also laterality of presentation, seem to impact attention allocation differentially in high- vs. low-psychopathic individuals, and point to hemispheric processing differences of angry vs. fearful facial expressions.

Neural decoding of changes in perceived health attributes of snack foods after exposure to health warning labels

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Environments abundant with palatable food cues can adversely influence individuals' attentional and motivational processes, potentially leading to poor dietary choices, contributing to Australia's rapidly rising obesity rates. Recently, it has been suggested to implement Health Warning Labels (HWLs) on food packaging to combat this problem. Prior studies have utilised event-related potentials (ERPs) to show that exposure to HWLs can prime better food choices, reflected in several ERP components related to dietary self-control. However, little is known about whether the perception and processing of food attributes is altered after HWL exposure. This study examined how the perceived healthiness and tastiness of snack foods are represented across distributed patterns of ERPs, and whether exposure to HWLs systematically changes these neural representations. In a dietary selfcontrol task, participants gave health and taste ratings for a variety of food items before and after viewing a set of either real or meaningless control HWLs, while their electroencephalogram was recorded. Multivariate Pattern Analysis was used, which is a technique that can 'decode' the content of cognitive processes from distributed patterns of ERPs. First, it was found that health ratings, but not taste ratings, could be decoded from brain signals prior to HWL exposure in all participants. Second, no change in decodability of health aspects over time was observed in participants in the control group. However, in participants who were exposed to real HWLs, their initial healthiness ratings were no longer decodable following HWLs, indicating that the underlying neural representation had significantly changed. These findings provide preliminary evidence that HWLs may operate upon dietary decision-making by altering health-related representations of food stimuli. Our decoding approach might further provide a useful tool for the evaluation of the effects of HWLs at the neural level.

The impact of stimulation intensity and coil type on reliability and tolerability of cerebellar brain inhibition (CBI) via dual-coil TMS

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Background: Cerebellar brain inhibition (CBI) describes the inhibitory tone the cerebellum exerts on the primary motor cortex (M1). CBI can be indexed via a dual-coil transcranial magnetic stimulation protocol, whereby a conditioning stimulus (CS) is delivered to the cerebellum in advance of a test stimulus (TS) to M1. The CS is typically delivered at intensities over 60% maximum stimulus output (MSO) via a double-cone coil. This is reportedly uncomfortable for participants, reducing the reliability and validity of outcomes. Objective/Hypothesis: This feasibility study investigates the reliability and tolerability of eliciting CBI across a range of CS intensities using both a double-cone and high-powered figure-of-8 coil, the D70². It was expected that the double-cone coil would elicit CBI at intensities upwards of 60% MSO. The range for the D70² coil was exploratory. The double-cone coil was expected to be less tolerable than the D70² coil. Methods: CBI was assessed in thirteen participants (25.9 \pm 5.4 years, six female) using each coil (randomised) over intensities 40, 50, 60, 70, and 80% MSO. Tolerability was assessed via visual analogue scales. Comparisons across intensities, and tolerability were assessed non-parametrically and via a linear model. Results: The double-cone coil elicited CBI at intensities 60, 70, and 80% MSO (p < .05), with suppression elicited at 60% MSO not significantly different from that at higher intensities. CBI was not elicited by the D70² coil at any

intensity. The double-cone coil was significantly less tolerable than the $D70^2$. **Conclusion:** A CS of 60% MSO with a double-cone coil provides a balance between the reliability and tolerability of CBI.

Tracking adjustments to perceptual decision processes following response conflict

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In everyday life, we often encounter stimuli which prompt multiple, competing actions. This is exemplified in the Flanker task, whereby participants must avoid responding to peripheral distractor stimuli that are incongruent with a central target. Following exposure to such incongruent stimuli, perceptual decision processes are adjusted to better respond to incongruent stimuli in the immediate future, often at the cost of slowed responses to congruent stimuli. How such adjustments are neurally implemented remains an open question. We developed a variant of the Flanker task to track dynamic adjustments of decision processes following response conflict using electroencephalography (EEG). This design allowed us to characterise moment-to-moment changes in visual stimulus-evoked responses, perceptual evidence accumulation, and motor response preparation. In each trial participants saw two concentric rings at different eccentricities from a central fixation cross. Participants indicated whether the outer ring contained left or right-oriented diagonal stripes. The inner ring contained either stripes in the opposite direction (incongruent condition, 50% of trials) or the same direction as the outer ring (congruent condition). Following an initial response, a second grating appeared, and participants made the same perceptual judgment. The second stimulus was always congruent. As expected, responses were slower to incongruent stimuli. Surprisingly, for responses to the second stimulus we found no evidence of post-conflict slowing. Instead, we observed faster responses to stimuli following incongruent, compared to congruent, initial stimuli. Speeding effects occurred with increased response-locked beta (20-30 Hz) power in the EEG. Our findings indicate that previous observations of post-conflict slowing may be specific to the anticipation of response conflict in upcoming stimuli. Such slowing effects may also mask other critical adjustments which produce speeded responses.

For a minute there I lost myself... Dosage-dependent increases in mind wandering with prefrontal tDCS: A pre-registered study

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Allowing our mind's eye to wander to task unrelated thoughts can impact productivity and, in many everyday settings, safety. However, the drifting of our thoughts from our current task(s)/situation to others is undeniably a common occurrence and has even been associated with adaptive outcomes in terms of creativity. Previous researchers have used non-invasive transcranial direct current stimulation (tDCS), applied to the prefrontal cortex, to modulate mind-wandering occurrences. However, little is known about the influence of varying stimulation parameters, such as polarity and intensity, on mind wandering, or indeed more generally on executive function performance. In addition, no previous brain-stimulation study targeting mind wandering has been pre-registered. Here, in a pre-registered design (N = 150), we investigated the effect of stimulation polarity and intensity on mind wandering while subjects undertook a repetitive cognitive task (sustained attention to response task; SART). We found a linear effect of stimulation dosage on the propensity to have task-unrelated thoughts. Specifically, greater intensity cathodal tDCS resulted in increased mind wandering and anodal and cathodal stimulation showed the same pattern of results. These results confirm a key role for the left prefrontal cortex in mind wandering, and, of import, demonstrate that increased dosage could lead to larger effects on mind-wandering behaviours. This is in contrast to some previous reports suggesting that stimulation dosage presents a U-shaped function, highlighting the potential for optimal dosages to vary depending upon the target brain region and behaviour.

Integrative self-other affective processing directly modulates activity of the anterior medial prefrontal cortex

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Background: Both self- and other-referential processing (e.g., theory of mind) elicit activity in the default mode network (DMN), which comprises cortical midline structures and functionally connected lateral cortices. Previous research has considered these processes separately, but many naturalistic judgements activate them concurrently. This study investigated the neural correlates of integrative self-other processing (SOP), hypothesised to be in the DMN, in healthy individuals. Methods: One hundred and twelve healthy participants aged 16-25 years (M = 21.43 years, 66% female) completed a novel functional magnetic resonance imaging task that used emotional faces to elicit SOP. The task had two arms with three conditions each: an active SOP arm in which participants rated how much they related faces, and a non-SOP control arm. Conditions were differentiated by the presentation of either happy, neutral or angry faces. Self-functioning and theory of mind were measured using the Self-Concept and Identity Measure and Interpersonal Reactivity Index, respectively. Results: SOP elicited robust activity in the DMN, as well as extended areas related to facial and affective processing. Participants' ratings of relatedness directly modulated activity of the anterior medial prefrontal cortex (amPFC), such that increasing relatedness was associated with greater activity of this region. Positive emotional valence was also related to greater activity in the amPFC, and its activity significantly correlated with self-report measures. Discussion: Our results confirm that integrative SOP robustly engages major components of the DMN, including the amPFC. Importantly, we show that this region was directly modulated by self-relatedness judgments, particularly when otherprocessing was positively valenced. The association between this activity and self-report measures suggests that these neural response patterns may reflect enduring characteristics of the individual's self-concept and otherprocessing abilities.

Neural oscillatory change following theta-burst stimulation to the dorsolateral prefrontal cortex in Fibromyalgia Syndrome

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Fibromyalgia Syndrome (FMS) is a highly prevalent chronic multi-symptom disorder. There are no known mechanism-specific treatments for FMS, with available treatment options often ineffective. A crucial role for central sensitisation has been identified in the pathogenesis and maintenance of FMS. A promising new treatment option to target central sensitisation in FMS is Theta Burst Stimulation (TBS), a non-invasive technique involving the patterned application of brief magnetic pulses to change the electrical activity within cortical networks. Here we present preliminary results of a Phase II, randomised, double-blind, placebo-controlled superiority trial of TBS to the dorsolateral prefrontal cortex (DLPFC) in FMS. Patients undergo 32 sessions of TBS to the left DLPFC over four weeks and are assessed at baseline, end of treatment, and at 1-month follow-up. Outcome assessments include questionnaires and concurrent transcranial magnetic stimulationelectroencephalogram recording (TMS-EEG). In a preliminary analysis of 17 participants, we observed a trend towards reduced pain function from baseline to the end of treatment in the active group that was not observed in the sham treatment group. In an EEG power analysis, we observed a significant reduction in somatosensory gamma power at end of treatment compared to baseline in the active group compared to sham. Together, these preliminary results suggest a 4-week left DLPFC TBS treatment to have a trending impact on FMS symptoms as well a significant effect on brain function. Further analysis is needed to explore connectivity and cross-frequency coupling; analyses most likely to inform how pain is integrated in the brain.

Social dysfunctions of autism and schizophrenia are interactively modulated by excitatory and inhibitory neurotransmission

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Understanding the underlying mechanisms of autism and schizophrenia symptom dimensions is essential for elucidating their neurobiological mechanisms. An excitatory-inhibitory neurotransmission imbalance has been implicated in both conditions, particularly in social dysfunction. Increased excitation-inhibition in the superior temporal cortex (STC), a region central to social processes, has previously been associated with social difficulties in the subclinical population through the quantification of excitatory glutamate and inhibitory GABA using magnetic resonance spectroscopy (MRS); however, the extent to which glutamate and GABA interactively predict autistic and schizotypal dimensions remains unknown. The Autism-Spectrum Quotient (AQ) and Schizotypal Personality Questionnaire (SPQ) were completed by 38 adults (18 male; M_{age} = 23.2 years, SD = 5.5 years) who underwent MRS to quantify STC glutamate and GABA concentrations. Regression analyses demonstrated that right STC glutamate and GABA concentrations interactively predicted AQ (p = .039, $r^2 = .20$), the AQ Social Skills subscale (p= .008, r^2 = .27), and the SPQ Interpersonal dimension (p = .008, r^2 =.27) scores, such that when GABA is below average, higher glutamate predicted increased overall AQ (β = 4.40, p = .019), AQ Social Skills (β = 1.54, p = .004), and SPQ Interpersonal deficits (β = 4.13, p = .022). This effect of glutamate was diminished when GABA was high. The models for SPQ Psychosis Proneness (p = .365) and Disorganisation (p = .304) were non-significant. Animal models demonstrate poorer social skills following drug-induced GABA inhibition, supporting extensive human literature, suggesting that autistic social difficulties and schizotypal interpersonal deficits might be modulated by a similar excitatory-inhibitory dysregulation. Thus, glutamate-GABA dysregulation, in the direction of reduced inhibition, is proposed as a core feature for social dysfunction, regardless of the spectrum to which the social dysfunction belongs.

Where the really hard choices are: A general framework to quantify decision difficulty

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Current models of decision-making more often than not ignore the level of difficulty of choices or treat it only informally. Yet, difficulty has been shown to affect human decision quality. We propose instance complexity (IC), a measure of computational resource requirements, as a generalisable framework to quantify difficulty of a choice based on a small number of properties of the choice. The main advantage of IC compared to other measures of difficulty is fourfold. Firstly, it is based on the theory of computation, a rigorous mathematical framework. Secondly, our measure captures complexity that is intrinsic to a decision task; that is, it does not depend on a particular solution strategy or algorithm. Thirdly, it does not require knowledge of a decision-maker's attitudes or preferences. And lastly, it allows computation of difficulty of a decision task ex ante; that is, without solving the decision task. We tested the relation between IC and (i) decision quality and (ii) effort exerted in a decision using two variants of the 0-1 knapsack problem, a canonical and ubiquitous computational problem. We show that participants exerted more effort on instances with higher IC but that decision quality was lower in those instances. In a follow-up experiment we tested whether these results are generalisable to other standard computational problems, namely the travelling salesman and the Boolean satisfiability problems. We found the same effect of IC on behaviour. Together, our results suggest that IC can be used as a general framework to measure the inherent complexity of decision tasks and to quantify computational resource requirements of choices. The latter is particularly relevant for models of resource allocation in the brain (meta-decision-making/cognitive control). Our results also suggest that existing models of decision-making that are based on optimisation (rationality) as well as models such as the Bayesian Brain Hypothesis, are computationally implausible.

The contribution of cognitive and sensory influences on the perceived strength of the size-weight illusion

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The size-weight illusion (SWI) pertains to the experience of perceiving the smaller of two equally weighted objects as being heavier. Competing theories to explain the illusion can be grouped into cognitive-driven and sensorydriven theories. The current study examined the effects of attentional load on the SWI using a dual-task paradigm to determine if the illusion is more strongly driven by cognitive or sensory factors. Participants placed their hands through a curtain inside a box so they could not see the test objects. Inside the box they were presented with small and large spheres of varying weights, which they explored haptically. Participants generated magnitude estimates about each object's weight. Four experimental conditions (noload, low-load, high-load, and no-load with gloves) were included. The dualtask involved the presentation of a cross stimulus which changed in both colour and orientation. Participants responded to a target colour and/or orientation, which varied across conditions. Some conditions were more cognitively taxing than others (high > low > no-load = no-load with gloves). The no-load with gloves condition had participants wear thick winter gloves to diminish the quality of sensory information regarding the spheres' size and weight. ANOVA results revealed a main effect of condition, F(3,72) = 6.50, p = .001. Post-hoc Bonferroni pairwise comparisons revealed that the SWI was weaker in the gloved condition with no load than all other conditions (all p < .026). The SWI did not differ across the other three conditions (all p \approx 1). We conclude that the illusion is more strongly driven by sensory than cognitive mechanisms given that removing haptic information as opposed to increasing attentional load on the dual task diminished its strength.

Confidence is a domain-general probe for studying perceptual aftereffects

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We investigated how to distinguish perceptual from non-perceptual aftereffects across multiple domains. Our experiments on motion adaptation, the implied and imagined motion aftereffects, serial dependence in motion and orientation perception, rapid (temporal) recalibration, causality adaptation, and cued instruction tasks, all showed that self-reported confidence can reliably distinguish decision biases from sensory adaptation. Here, we propose a general and intuitive approach to using confidence estimates to measure perceptual aftereffects and account for decision biases. Finally, we show how this approach can be applied to a broad swathe of future experiments in psychophysical studies of perceptual decision-making.

Do size, concept-driven expectations and sensorimotor corrections influence weight perception in the size-weight illusion?

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The size-weight illusion (SWI) occurs when two differently sized objects of equal weight are not perceived as having the same weight. Rather, the smaller of the two feels heavier. The SWI remains to be fully explained despite decades of research investigating the underlying perceptual mechanisms. The current study examined the relative contributions of size, conceptual knowledge, and sensorimotor corrections during lifting on the illusion. The participants lifted four spherical test objects of the same weight (128.5 g). Two objects were familiar (softball, tennis ball) and thus provided both size and conceptual cues to expected weight. The other two were generic spheres (large, small) with the same volume as the softball and tennis ball, and thus provided size cues to expected weight only. Participants provided absolute magnitude estimations for the perceived weight of each ball. Grip force exerted during lifting was measured via force transducers. A 4

(Ball Type) × 5 (Trial) ANOVA performed on standardised magnitude estimations indicated a main effect of Ball Type, F(3, 57) = 245.3, p < .001, $\eta^2_p = .93$, in line with the SWI. Namely, weight estimates were lower for the large sphere and softball compared to the small sphere and tennis ball (all p < .001, $d \ge 3.95$). The large sphere was also perceived as heavier than the softball (p = .035, d = 0.51). The grip force data indicated a main effect of Trial, F(4, 76) = 7.47, p < .001, $\eta^2_p = .28$, indicating that participants exerted greater force on the first trial compared to the following trials, suggesting sensorimotor correction. The findings indicate that physical size cues have a greater effect on the SWI than conceptual cues. The results also do not support a contribution of sensorimotor corrections to the perceptual experience of the illusion. This is because the perceptual experience of the SWI is maintained over time while the motor system corrects applied grip force to the balls' true weight after repeated lifts.

Contributions of striatal-cortical connectivity changes to multitasking limitations and their practice-related improvements

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Although the human brain is an incredibly complex and capable information processor, we show striking limitations when simultaneously performing two novel tasks. These limitations are not absolute and are largely overcome with practice. Theories of the neural underpinnings of multitasking costs posit a causal contribution of capacity limits in frontal-parietal connectivity. An emerging alternate body of evidence implicates limitations in frontostriatal connectivity as a contributor to cognitive limitations. Comparable hypotheses have been put forward regarding the influence of practice on the functional adaptations that underpin performance improvements. To date, no large-scale studies assessing fronto-parietal-striatal (FP-S) connectivity have been conducted to address this question on a mechanistic level. Here, we applied dynamic causal modelling (DCM) to fMRI images to specifically adjudicate between these competing hypotheses. Data were recorded as participants completed a multitasking paradigm before and after practice (N = 46 practice, N = 48 active-control). We show that the FP-S network is driven by inputs to the striatum, and that connectivity between striatum and cortical regions are increased by multitasking demands. Frontal-to-parietal connectivity is also increased by multitasking demands, but not vice versa. Critically, practice specifically reduces modulations in striatal to frontal connectivity. These findings demonstrate that capacity limits in cortical connectivity alone cannot account for performance limitations induced by multitasking, and implicate a role for striatal-cortical connectivity in both the occurrence and improvement of cognitive limitations.

The relationship between diet, glucose control and cognitive performance in age-associated memory impairment

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Deteriorating cognitive performance is a risk factor for the development of Alzheimer's Disease and is influenced by various lifestyle and health factors including diet and glucose control (Francis & Stevenson, 2013; Hardman, Kennedy, Macpherson, Scholey, & Pipingas, 2016; Messier, 2005). The current study aimed to explore the relationship between adherence to either the Western Style Diet (WSD) or Prudent Style Diet (PSD), glucose control and cognitive performance in a cohort of elderly individuals with Age-Associated Memory Impairment (AAMI). The sample comprised 144 (M_{age} = 65.2 years, SD = 6.5) physically healthy participants with AAMI. Dietary information was gathered using a food frequency questionnaire, and adherence for both dietary patterns was scored using the method developed by Gardener et al. (2015). Glucose control was measured using glycated haemoglobin (HbA1c), and cognitive performance was assessed using the Swinburne University Computerised Cognitive Ageing Battery (SUCCAB) and Rey's Verbal Learning Test (RVLT). Contrary to expectations neither dietary pattern nor glucose control was related to cognitive performance individually. However, the interaction between glucose control and the PSD approached significance for the spatial working memory (SWM) subtest of SUCCAB. Interestingly, this interaction was significant in males. The interaction demonstrated that in males with high adherence to the PSD, performance on the SWM task was similar for the different levels of HbA1c. However, for those with low adherence to the PSD, performance was worse when they also had poorer glucose control (higher HbA1c) compared to those with better glucose control (lower HbA1c). The significant interaction demonstrates that diet may impact cognition in males through its relationship with glucose control. Understanding how diet is interacting with other risk factors will help tailor interventional strategies targeting individuals who are at risk for cognitive decline.

Longitudinal development of white matter fibre properties in a community sample of children with and without attention difficulties

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White matter dynamically develops across childhood and adolescence, as evidenced by cross-sectional studies using magnetic resonance imaging (MRI). Few studies have investigated longitudinal neurodevelopment using advanced estimates of white matter fibre organisation. We aimed to investigate differential white matter developmental patterns associated with age, sex, puberty, and behaviour, in children aged 9-14 years. Diffusion MRI data were acquired for 130 children (83 male) at 3 Tesla at two time-points approximately 16 months apart: time-point 1 (Mage = 10.4 years) and timepoint 2 (M_{age} = 11.7 years). Diffusion data were processed using the MRtrix3 software package, and major white matter tracts were segmented to quantify white matter fibre density and fibre cross-section in each core white matter tract. We administered a parent survey to the primary caregiver of children participating in the study at each time-point, to assess pubertal development, ADHD symptoms, and emotional/behavioural difficulties. Linear mixed-effects modelling was performed in R, to test the relationship between fibre development and the aforementioned participant characteristics. White matter development in this age range was localised to anterior and posterior callosal fibres, cingulum and superior longitudinal fasciculus. The rate of fibre development was not associated with sex or age at scan. Greater pubertal stage was associated with greater fibre density and crosssection in the right superior longitudinal fasciculus. Relatively elevated ADHD symptoms and fewer behavioural difficulties were associated with fibre properties in the right uncinate fasciculus. Using a novel image analysis framework, we demonstrated that white matter fibre density and fibre cross-section increased within a 16-month scan-rescan period, in a regionspecific fashion. These developmental patterns of association tracts appear to be influenced by puberty and behaviour.

The effects of risk magnitude training on mapping risks on space

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Despite some level of risk being inherent in every action, we are often uneducated about risk and make uninformed decisions. To increase the effectiveness of risk-communication tools, we must first determine how risk is conceptualised in order to appropriately design tools to allow ease of processing. Subjective risk perception has been shown to have a spatial representation, with people responding faster to perceived low-risk items on the left side, and high-risk items on the right side. This study investigated the effect of training objective risk information on spatial mappings of risk stimuli. Participants (N = 34) used their left and right hands to indicate whether eight objective risk stimuli were lower or higher risk than a referent activity, both before and after training. Training involved repetitively learning the objectively correct order of the same eight risk stimuli for approximately 15 minutes. No association between risk magnitude and space was found preor post-training. The lack of training effect may be due to its short length. On average, reaction times significantly increased from pre- to post-training. Previous research has demonstrated a disappearance of spatialnumerical mappings with increased task load. The increase in participants' post-training reaction times may reflect an increase in task load and lack of familiarity with risk stimuli, which could account for the lack of spatial mapping found. Future research will investigate whether an extended training design leads to a spatial mapping effect. Failure to find training effects highlights the difficulty involved in overcoming subjective risk perceptions, and the need for more research on how best to communicate risk in order to overcome these biases.

The value of predictive information in decision-making under uncertainty

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Humans exhibit a biological drive towards acquiring information. Notably, studies of humans and non-human animals suggest that information is processed by similar neural circuits that underlie reward valuation. This project investigated how humans value information that predicts, but does not change, the outcome of an upcoming event (non-instrumental information). We conducted two experiments to examine the physical effort costs individuals are willing to incur for such information. Effort was operationalised as amounts of force applied to a hand-held force-sensitive dynamometer. In the first experiment, the amount of information available was held constant, and participants chose between exerting higher effort levels to obtain predictive information about a lottery outcome, versus exerting minimum effort and foregoing such information. Results showed that participants willingly exerted effort to obtain the information, but this effect declined as effort costs increased. In Experiment 2, we manipulated the amount of information provided at the start of each trial, and thus the amount of uncertainty participants experienced. Results showed that participants invested more effort for information when prior uncertainty was high (i.e., when the outcome was ambiguous) compared to when it was low (i.e., when the outcome was predictable). Computational analyses revealed that subjective valuation of information is best modelled at the individual level as a function of both effort costs and the magnitude of available information, where information magnitude can be approximated as how much the information reduces residual uncertainty about the outcome. Overall, these data demonstrate that information's intrinsic value is based on its capacity to reduce uncertainty, and that this valuation is reflected in a willingness to trade off effort for information. This work explains the bias humans exhibit toward information acquisition, even when this is sub-optimal or inefficient.

Vision as a model system in cognitive and behavioural genetics

Dr Patrick Goodbourn University of Melbourne

Part of the symposium Applications of genomics and epigenetics to cognitive neuroscience

Since the sequencing of the human genome, cognitive neuroscientists have embraced new molecular-genetic tools in their efforts to understand brain and behaviour. Yet, on some fronts, progress in understanding how genes contribute to normal and disordered cognition has been slower than expected. The challenges of phenotypic measurement and the unparalleled complexity of the human brain have proven major stumbling blocks in applying new genetic technologies in the cognitive neurosciences. Here, I will describe a set of genetic studies focusing on visual behaviours, which can be measured with high reliability, and for which the neurobiological bases are relatively well understood. In our original genome-wide association studies, we identified a range of common genetic variants influencing visual performance, including some that may shed light on perceptual anomalies reported in schizophrenia and autism. Subsequent work has aimed to clarify the biological and functional consequences of these gene variants, both in humans and in genetic model organisms. An initial focus on sensory systems has been crucial to the development of many technologies that are now a staple of the cognitive neurosciences; our recent studies indicate that vision also offers a critical proving ground for the new cognitive genetics.

Intranasal oxytocin alters amygdala-temporal restingstate functional connectivity in body dysmorphic disorder: A double-blind, placebo-controlled, randomised trial

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The aetiology and treatment-relevant aspects of body dysmorphic disorder (BDD) are poorly understood. Our recent evidence from a functional magnetic resonance (fMRI) study suggests that intranasal oxytocin (iOT) might alter abnormal activation and connectivity of the amygdala within visual processing and cognitive control brain regions in BDD patients during an emotion processing task. However, no study to date has assessed functional changes in these neural networks in the absence of a task. Thus, the aim of this study was to investigate the effect of iOT on amygdala resting-state functional connectivity (rsFC) in BDD. In a randomised, double-blind, crossover design, 19 BDD and 17 demographically matched healthy control participants received iOT (24 IU) or placebo before resting-state fMRI. The left and right amygdala were seeded as regions of interest, and temporal correlations between the amygdalae and all other voxels comprising cortical and subcortical grey matter were investigated. Compared to healthy controls, BDD patients showed greater baseline (placebo) rsFC between the left amygdala and two clusters within the left temporal lobe, which was significantly reversed following iOT administration. In addition, oxytocin-induced changes in amygdala rsFC were associated with the level of body image concern and depression in the BDD patients. Complementing our previous results, these findings suggest that BDD patients exhibit abnormal amygdala-temporal connectivity in the absence of a task, and iOT might have a role in changing this functional relationship. These brain regions have an important role in the detail-focused biases in visual processing that characterise the disorder, such as an excessive focus on minor aspects of body image. In sum, our findings indicate that iOT has a modulatory effect on left amygdala rsFC in BDD, and in doing so, may have a potential therapeutic benefit of improving visual processing biases in the disorder.

From statistical computing to clinical practice: Integrated biomarkers for cognition in early Parkinson's disease

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Clinical and biochemical heterogeneity of Parkinson's disease (PD) presents the major challenge for the accurate prediction of its progression and the associated cognitive decline. In this study, we focus on the development of efficient integrated biomarkers for prediction of the likely rate of cognitive decline (RoCD) on the basis of linear superpositions of multiple significant clinical and biochemical measures at early stages of the disease. The sample involved 270 drug-naïve PD patients observed for more than 4 years. Nineteen variables having potential to influence RoCD of PD patients included demographic parameters (age, years of prior education, and gender), dopamine-transporter imaging, six cerebrospinal fluid and blood parameters, baseline clinical measures evaluating PD symptoms, psychological and cognition measures, and genetic risks. RoCD was evaluated from the variations in patients' scores on the Montreal Cognitive Assessment scale. The development and optimisation of the integrated biomarkers were based on the relative variable importance, logistic and receiver operating characteristics regressions. Two integrated biomarkers were developed and validated for mild-to-moderate cognitive decline (RoCD > 0.02 month^{-1}) occurring in ~38% of all patients (with 73% sensitivity and 74% specificity) and severe decline (RoCD > 0.11 month⁻¹) occurring in ~10% of all patients (with 93% sensitivity and 91% specificity). For the first time, PD cognitive decline scores were also introduced and validated for simple clinical use to predict possible cognitive deterioration among early PD patients, with sensitivities and specificities up to ~93%, enabling the determination of probabilities of cognitive deterioration for individual patients. The outcomes will be important for clinical evaluation of early PD patients, including their likely progression. Data were obtained from the Parkinson's Progression Markers Initiative (PPMI) database.

Multiple-marker characterisation of cognition deficits in early Parkinson's disease

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Cognitive deterioration is a common manifestation of Parkinson's disease (PD) patients, even at its early stages. It can have a particularly detrimental impact on the patients' quality of life and abilities to perform everyday tasks. The currently insufficient understanding of parameters which accurately predict cognitive deficits or cognitive decline presents a significant challenge at diagnosis and in subsequent prognosis. This study included 419 PD patients and 196 healthy controls. We utilised receiver operating characteristic regressions to identify the most effective cognitive measures in distinguishing early, drug-naïve PD patients from controls. Generalised structural equation modelling was then employed to develop and characterise a network of clinical and biological parameters on the cognitive measures. The Montreal Cognitive Assessment (MoCA) and Symbol Digit Modalities Test (SDMT) were most effective in distinguishing PD patients from controls. Cognition was simultaneously associated with a combination of demographic parameters, disease severity, non-motor symptoms, dopaminergic deficits, blood parameters, and amyloid plaque pathology. A significant nonlinear dependency of the MoCA on the age of PD patients was described. The outcomes demonstrate significant potential for (1) effective clinical evaluations of cognitive deficits; and (2) identification of new integrated cognition progression biomarkers. Data were obtained from the Parkinson's Progression Markers Initiative (PPMI) database.

Value modulation of the mismatch negativity signal

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Ryan Calabro, Flinders University Danielle Fogarty, Flinders University Bradley Jack, UNSW Sydney

The mismatch negativity (MMN) signal is an electrophysiological component elicited by variation in a repeating sensory pattern. In the auditory domain, a deviant tone will elicit a characteristic negative polarity deflection approximately 150–250 ms after stimulus onset. This detection is often thought to be pre-conscious or pre-attentive because it can be detected when an individual is in a non-conscious state (e.g., during coma or REM sleep) and there is mixed evidence regarding the capacity of attentional allocation to modify its magnitude. One might therefore assume that the associative value of a stimulus will not alter the magnitude of the MMN signal that stimulus generates. This assumption was tested in both the visual and auditory modality. No modulation of the visual MMN was observed (although a robust visual MMN signal was observed), whereas the value manipulation influenced the magnitude of the auditory MMN. This finding, if replicated, holds important implications for our understanding of pre-attentive selective processing.

The representational dynamics of visual objects in rapid serial visual processing streams

Dr Tijl Grootswagers

University of Sydney & Macquarie University

Part of the symposium Using MVPA to understand how the brain infers the world

In our daily lives, we are bombarded with a stream of rapidly changing visual input. Yet, when studying brain representations, stimuli are generally presented in isolation. Here, we studied the representational dynamics of human vision using a combination of fast stimulus presentation rates and multivariate decoding analyses. Using presentation rates of 5 images per second, we were able to obtain the representational structure of a large number of stimuli, and showed the emerging abstract categorical organisation of this structure. In a second experimental session, we replicated these results using an even faster presentation rate of 20 images per second. These results show that the combination of naturalistic stimulus presentation and multivariate decoding analyses has unprecedented potential for studying the temporal dynamics of the structure of representations in the human visual system.

Assessing the temporal dynamics of object processing using rapid-MVPA

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Rapid image presentations combined with multivariate analysis methods of EEG or MEG (rapid-MVPA) offer unique potential in assessing the temporal limitations of the human visual system. Recent work has shown that multiple visual objects presented sequentially in a visual stream can be simultaneously decoded from the neural signal. Interestingly, object representations reached higher stages of processing for slower image presentation rates compared to fast rates. It is unclear whether this slow rate advantage is due to longer stimulus duration, or longer inter-stimulus interval (ISI). Here, we address this question by studying the emerging neural representation of visual objects using rapid-MVPA while independently manipulating stimulus duration and ISI. Our results showed that a longer ISI enhances the decodability of the neural representations, regardless of stimulus presentation duration, suggesting that onset of the next image in the stream masks processing of the previous object. Our study disentangles the effects of duration and ISI on rapid-MVPA, paving the way for future work using this promising approach.

Aberrant microglial activation and cognitive impairment in Parkinson's disease: A potential novel therapeutic target

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Parkinson's Disease (PD) is the second most common neurodegenerative disease after Alzheimer's disease, with a prevalence projected to more than double by 2030. While classically thought of as a motor disease, cognitive impairments-ranging from mild alterations in executive function to dementia-are also major components of the disease. While cognitive dysfunction is the biggest predictor of quality of life for individuals with PD, there is currently no effective treatment strategy for these symptoms, thus representing a significant unmet clinical need. It is not currently known what drives the emergence of cognitive impairments in PD, but the neuroinflammatory hypothesis suggests that activation of microglia, the brain's resident immune cells, may lead to the release of pro-inflammatory cytokines, leading to the subsequent death of neurons in key brain regions. Previous work has shown that cognitive function is particularly sensitive to the effects of microglial activation. This study aimed to determine if inhibition of microglial activation could lead to improvements in cognitive function. An experimental model of preclinical PD was produced using intra-striatal injection of the neurotoxin 6-OHDA (5 μ g/ μ L). Animals (N = 9 per group) were given either vehicle or 3 mg/kg, 6 mg/kg or 12 mg/kg of a novel microglial inhibitor daily for 32 days via oral gavage and tested on a battery of tasks to assess learning, memory and cognitive flexibility, as well as depression and anxiety-like behaviour. Following completion of testing, a significant reduction in depressive-like behaviour between all treatment groups and controls was observed. In addition, animals in the 6 mg/kg and 12 mg/kg treatment group showed a significant improvement in recognition memory compared to vehicle-treated controls. Taken together, the results indicate a potential therapeutic benefit for the use of microglial inhibitors to treat the non-motor symptoms of PD.

Attention, inhibition and emotions: An emotional antisaccade study in borderline personality disorder

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Borderline personality disorder (BPD) is a serious and highly prevalent psychiatric disorder, characterised by a pervasive pattern of instability affecting impulse control, emotional regulation and cognitive processing. Early life adversity or trauma is reported by most BPD patients and implicated in the development of BPD. The aim of the current study is to better characterise inhibitory control and emotion processing in females with BPD and specifically investigate the influence of early life trauma. Participants included female adults with and without BPD who completed detailed clinical and cognitive assessments, including a retrospective assessment of early life trauma that measured developmental timing and chronicity of exposure to different trauma types (e.g., sexual abuse; emotional neglect). To assess inhibitory control and emotion processing, participants completed an interleaved proand antisaccade task (looking toward vs. looking away from a visual target, respectively) where the visual target was either a neutral stimulus (green target cross) or an emotional stimulus (rated for positive or negative valence). Preliminary analyses indicate that the BPD group performed antisaccade (but not prosaccade) tasks with increased latencies compared to healthy controls. There was also a significant group × task interaction for the emotional antisaccade task whereby the emotional valence of the task affected healthy control performance but not the BPD cohort. Exposure to different trauma types was also significantly associated with antisaccade performance. These results extend previous work suggesting inhibitory control deficits in BPD and broaden our understanding of the role that early life trauma plays in BPD and the enduring effects it has on cognitive control processes in adulthood.

Mindfulness meditation modulates experience of the Rubber-Hand Illusion

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Mindfulness meditation has been shown to have a range of clinical and cognitive benefits including improved emotional regulation, attention control, and introspective accuracy. However, the cognitive mechanisms behind mindfulness meditation are as yet not fully revealed. Thus, we lack a comprehensive picture of why mindfulness works or how it may be integrated into a rigorous cognitive science framework. Here, we utilise the Rubber-Hand Illusion (RHI) to explore the relation between mindfulness and bodily awareness. We reasoned that mindfulness training increases attentive bodily self-awareness and therefore hypothesised that mindfulness will systematically dampen illusory bodily awareness in the RHI. We compared two groups tested across two separate lab sessions (N = 30). One group completed mindfulness training for 14 days while the active control group practiced relaxed listening. Both groups were measured on subjective RHI ratings, proprioceptive drift towards the rubber hand, and galvanic skin response (GSR) to threatening the rubber hand. All participants were novices to meditation. Both groups experienced the RHI, as evident in a difference between synchronous and asynchronous stroking in subjective reports, drift and GSR. Both groups experienced a dampening of subjective RHI rating after the 14-day period. However, as hypothesised, linear mixed-effects models established that significantly greater dampening occurred for the mindfulness group after training. Further effects of training were observed for proprioceptive drift and GSR, which interacted with group. These findings suggest that mindfulness training leads to a more accurate perception of bodily self-awareness, thus a heightened ability to resolve cross-modal conflict associated with the RHI. Our study contributes to a broader understanding of how mindfulness interacts with multisensory integration.

Variability of the lateralisation of cerebrovascular response associated with Parkinson's disease: A functional transcranial doppler ultrasonography study

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Parkinson's disease (PD) has recently been linked with cerebrovascular abnormalities, which may provide a new neurophysiological understanding of cognitive impairments in PD. This study used functional transcranial doppler sonography (fTCD) during a word-generation task to index changes in the mean cerebral blood flow velocity of the middle cerebral artery: lateralisation index and its standard deviation and timing, along with the maximum peak velocity for the left and right side and their latency and standard deviation. The fTCD was recorded in 27 idiopathic PD patients (M_{age} = 70.6 years, SD = 8.0) and an age- and gender-matched group of 27 healthy controls (M_{age} = 71.0 years, SD = 6.8). Cognition was tested using the Addenbrooke's Cognitive Examination-Revised (ACER) in all participants. The PD patients performed significantly worse on the word-generation task than the control group, but did not significantly differ on the overall ACER score or their sub-scores. The PD group showed significantly more variability of the lateralisation index compared to the control group, but no differences in the lateralisation index itself. The left and right peak velocity showed a significant positive correlation with the word-generation performance across the groups. Normal ageing has been associated with a reduction in the lateralisation index, but without any changes in the standard deviation. Therefore, these findings suggest that the cerebrovascular changes in PD are different from those of normal ageing and highlight the need to further investigate the cerebrovascular function in PD patients as it might relate to cognitive impairment.

The influence of training on confidence heuristics

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Although confidence is typically tightly correlated with perceptual sensitivity, the two measures are dissociable. For example, previous research (Spence, Dux, & Arnold, 2016; Spence, Mattingley & Dux, in press) has shown that confidence judgements are affected by the variability of sensory signals to a greater extent than perceptual sensitivity. Thus, signal variability appears to be an important heuristic to confidence. Here, we present results from a preregistered study (N = 24) designed to investigate whether the effect of signal variability on confidence can be attenuated with training. Participants completed five sessions in which they viewed pairs of motion kinematograms and performed comparison judgements of global motion direction, followed by confidence ratings. In the pre- and post-training sessions, the range of direction signals within each stimulus was manipulated across trials. Participants were assigned to one of two training groups: a Fixed Range group, in which signal range remained constant during the training sessions, and a Variable Range group, in which signal range varied across trials. Trial-by-trial accuracy feedback was provided after each confidence judgement during training. As well as replicating the finding that signal range affects confidence to a greater extent than perceptual sensitivity, we showed that this effect was reduced following training. Interestingly, the training effect did not depend on exposure to variable signal range during training. To wit, the group exposed to fixed signal range during training showed the same attenuated effect of signal range on confidence as the group exposed to variable signal range during training. These results reveal how reliance on signal range as a heuristic to confidence can be mitigated through feedback-based training. Put differently, training appears to lead to confidence judgements that are based on more informative variables rather than non-optimal processing shortcuts.

The mediating effect of agency on sensory attenuation of the auditory cortex: An event-related potential study

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Self-generated stimuli typically evoke smaller N1 components of the auditory-evoked potential compared to the same stimuli that have been generated externally. Dubbed *sensory attenuation*, this phenomenon is thought to reflect the working of forward models that attempt to predict changes in the environment. Sensory-attenuation experiments typically instruct participants to (a) perform a motor action to generate a sound; and (b) listen to the same sound presented passively, and have found that self-generated sounds evoke smaller N1 components than externally-generated sounds. However, previous experiments have suffered from a number of methodological confounds which cast doubt on the validity of the results. We address these issues by isolating what we believe to be the key factor underlying sensory attenuation: namely, the subjective experience of agency. Forty-four undergraduate students performed a task in which they were required to inhibit the performance of a motor action in order to generate a sound. Inhibiting the performance of the action resulted in attenuation of the N1c, which is a subcomponent of the N1 sensitive to secondary auditory cortex activity. These findings suggest that the subjective experience of agency may have a mediating effect on later-stage sound processing in the auditory cortex.

Genetic and epigenetic modulators of cognitive function in health and disease

Prof. Anthony J. Hannan

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Part of the symposium Applications of genomics and epigenetics to cognitive neuroscience

We have been investigating how various environmental manipulations selectively alter gene expression, cellular plasticity and associated cognitive processes and behaviours. Huntington's disease (HD) is one of over 40 tandem repeat disorders and involves a triad of cognitive, psychiatric and motor symptoms. In a transgenic mouse model of HD, we have shown that environmental enrichment (enhancement of cognitive stimulation and physical activity) can delay onset of the cognitive, affective (depression-like) and motor endophenotypes. Environmental enrichment and physical exercise induce changes in gene expression, which exhibit temporal specificity and regional selectivity, and also act as cognitive enhancers. These findings have been extended to included stress and stress-hormone (glucocorticoid) manipulation in HD mice, and environmental manipulations in other mouse models of cognitive disorders, including schizophrenia. These approaches may also facilitate the development of 'environmetics' for a variety of brain disorders known to be modulated by environmental stimuli. We have also explored the transgenerational effects of paternal environmental exposures. Our findings reveal significant experience-dependent effects on cognitive and affective function of offspring via transgenerational epigenetic inheritance, which occurs via epigenetic modifications in the sperm of the fathers. We are exploring the impact of specific environmental and pharmacological factors, including exercise and stress-hormone elevation, and the relevance of these discoveries in mice to human transgenerational epigenetics. Our findings, and their relevance to the proposed transgenerational inheritance of increased predisposition to various cognitive and affective disorders, have major public health implications.

Learning under conditions of uncertainty and threat

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Regularity learning is the process of learning to recognise patterns in the environment based on the statistics of inter-stimulus contingencies. Violations of learned environmental regularities induce differential brain responses, known as prediction errors (PEs) or mismatch signals. The magnitude of these signals has been shown to be affected by environmental factors, including imminent threat and volatility. These factors have previously been studied separately, but it is not known if or how they interact. We investigated how PEs were affected by these two factors by inviting adult volunteers to undergo functional Magnetic Resonance Imaging (fMRI) while completing an auditory regularity-learning task involving a duration deviant oddball paradigm with either volatile or stable statistics, and under either threatening or safe conditions. Volatility was induced in half the blocks by unpredictably reversing the probabilities of the two tones, and threat was independently induced in certain blocks by providing text-based warnings of an imminent uncomfortable electric shock. Results from the first 32 (of a planned total of 46) participants show that during the regularity learning task, threat significantly increased participants' anxiety ratings (p < .001). Other behavioural findings will also be shown. The fMRI results for the first 32 participants show that the left lateral premotor cortex was more active in threatening than safe conditions (p < .05, FWE corrected). Areas that were more active in volatile versus stable conditions (all p < .01, uncorrected) included clusters in the left lateral premotor cortex, as well as near the left caudate body, and in the right pulvinar. These findings contribute to our understandings of how regularity learning is affected by imminent threat and environmental volatility respectively.

Integrating functional connectome modelling and cognitive modelling to identify brain networks associated with temporal prediction and rhythmic motor control

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Humans synchronize actions in a variety of contexts, such as during musical ensemble performance. In the Adaptation and Anticipation Model (ADAM), successful coordination of rhythmic actions relies on adaptive mechanisms that reactively correct recent timing errors, and anticipatory mechanisms that adjust responses to correct predicted timing errors. The goal of the present study was to combine connectome modelling with cognitive modelling to identify the networks associated with adaptive and anticipatory mechanisms in rhythmically timed tasks. Thirty musicians completed two auditory-paced finger-tapping tasks designed to elicit adaptive and anticipatory processes while brain activity was measured with fMRI. Estimates of adaptation were derived from responses obtained while participants synchronised with a virtual adaptive partner applying differing degrees of reactive error correction. Estimates of anticipation were derived from responses obtained when participants synchronised with sequences where tempo fluctuated predictably between 400 ms and 600 ms. The variability of internal time-keeping and motor-execution processes was also estimated. Connectome fingerprinting techniques identified the networks that covaried with behavioural model estimates. Cross-validation analysis of the networks identified for the virtual-partner task revealed significant prediction of timekeeper noise estimates from connectivity data. For the tempochange task, estimates of anticipation and timekeeper noise could be successfully predicted from connectivity data. These results demonstrate that connectome modelling can identify networks related to distinct processes associated with rhythmic motor control and prediction. Importantly, this approach identified multiple distinct networks associated with performance in the tempo-change task, a feat not possible through analysis of task performance. These findings underscore the importance of combining cognitive models with connectivity models.

Inhibition in ADHD: A behavioural and diffusion imaging study

Mr Jason He¹

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Inhibition refers to the ability to suppress or prevent behaviours that are inappropriate or no longer required and is thought to be a core deficit in attention-deficit/hyperactivity disorder (ADHD). Indeed, studies using the classical behavioural paradigm, the Stop-signal task, have consistently highlighted that individuals with ADHD are slower to respond to a signal cueing for the restraint of an action when compared to typically developing peers (i.e., longer stop-signal reaction times; SSRTs). However, recent modelbased approaches aimed at understanding performance during the Stopsignal task have brought into question the accuracy of earlier interpretations of longer SSRTs in ADHD as indicative of an inhibitory deficit. Further, while the neural network which contributes to inhibition is becoming increasingly well understood, few studies have directly investigated the white matter microstructural properties of this network in ADHD. Here, we compared a large community sample of children with and without ADHD (N = 316) on classical performance measures from the Stop-signal task (i.e., Go-trial RT and SSRT), as well as ex-Gaussian parameters (μ , σ and τ) parsed from Gotrial RT distributions. For a subset of participants (N = 144) who underwent diffusion-weighted imaging, fractional anisotropy (FA) of the fibres connecting the right inferior frontal gyrus (rIFG), presupplementary motor area (preSMA) and subthalamic nucleus (STN) were obtained and compared between those with ADHD and controls. Group differences were identified for SSRTs estimated from the Mean method, but not the Integration method. Children with ADHD also had increased σ and $\tau,$ suggestive of greater intraindividual variability of RTs and a greater frequency of abnormally long RTs that were indicative of lapses in attention. FA of the white matter tracts connecting the rIFC, STN and preSMA were significantly lower in ADHD and correlated to inhibitory performance at a group level.

Topological segregation of functional brain networks in developing brains: Minimum spanning tree analysis of resting-state MEG data

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The human brain develops its function via highly complex interactions between distributed brain regions. Thus, the conceptualisation of typical brain development from a network perspective has recently become a central focus of intellectual effort. The realisation of such effort has evolved quickly from univariate analyses, through connectivity measures, to modern network neurosciences. However, largely due to technical and methodological challenges inherent to paediatric functional neuroimaging, there remains an important gap in our knowledge regarding the typical development of functional brain networks: a crucial period of cognitive development, namely the preschool years (i.e., 3-6 years of age). In this study, we addressed this gap in the literature by employing several methods that overcome the significant impediments to observing the development of brain networks in preschool children, including the use of age-appropriate magnetoencephalography (MEG). We expected evidence for more segregated (i.e., a star-like to linelike shift of) functional brain networks, with centrality to decrease for nonhub regions, during development. We characterised age differences in network topology between 24 children aged from 4 to 12 years and 24 adults (40.6 \pm 17.4 years). Our results showed that during childhood, network topology becomes increasingly segregated, while cortical regions decrease in centrality. We propose a heuristic MST model, in which a clear developmental trajectory for the emergence of complex brain networks is delineated. Therefore, this study resolves topological reorganisation of functional networks across temporal and spatial scales in youth and fills a gap in the literature regarding neurophysiological mechanisms of functional brain maturation during the preschool years.

Multivariate lesion-network mapping in stroke patients reveals connectivity patterns related to specific and global behavioural deficits

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Measuring associations between localised brain lesions and cognitive impairments in stroke patients is a powerful approach for establishing brainbehaviour relationships. However, the distal effects of such lesions on brain connectivity and behaviour are not well understood. In the current study we hypothesised that damage to white matter tracts and highly connected cortical regions would result in widespread connectivity deficits related to multiple, correlated behaviours. We investigated this hypothesis by modelling white matter damage within a stroke patient cohort (N = 80) and related these lesion-connectivity patterns to a broad range of behavioural impairments in the domains of visual perception, attention, reasoning, language and IQ, all within a multivariate statistical framework. In doing so we found two latent patterns linking structural connectivity damage and behavioural deficits. Consistent with previous studies, the first of these patterns revealed a left-right hemispheric bias for language, on the one hand, and attention, on the other. The second pattern captured a relationship between global deficits in behaviour and loss of interhemispheric connectivity, largely within default-mode and fronto-parietal networks. Our findings highlight the importance of lesion-network approaches in explaining complex clusters of behavioural deficits following stroke, and the potential for predicting recovery and optimising rehabilitative interventions in the future.

Cognitive functioning after traumatic brain injury: Effects on university student experience

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Traumatic brain injury (TBI) is one of the most common causes of disability experienced by young adults. Individuals in this age range commonly undertake higher education such as university. University students with TBI show deficits in academic achievement due to cognitive impairments as well as reduced quality of student experience. The aim of this study was to provide an understanding of the relationship between university student experience and cognitive functioning in students who have experienced a TBI. Participants included current students who had experienced a TBI (N = 20, 9males, M_{age} = 29.2 ± 10.9 years, $M_{university education}$ = 2.8 ± 1.7 years) and those with no history of TBI (N = 30, 9 males, M_{age} = 24.3 ± 10.1 years, $M_{university ed}$ $u_{cation} = 2.3 \pm 1.4$ years). Students undertook a neuropsychological battery of cognitive functioning assessing the domains of attention, inhibition, shortterm memory, processing speed, working memory, and task-switching, as well as a measure of university student experience (USES). Results showed that the TBI group scored significantly lower on the majority of cognitivefunctioning measures and reported a reduced quality of student experience. Additionally, a linear mixed model investigating relationships between group (TBI vs. control) and cognitive measure in predicting university student experience found significant interactions between group and the following cognitive measures: Trail Making Test-Part B, and the Coding, Symbol Search, and Digit Span subtests of the WAIS-IV. These findings suggest that the cognitive deficits in domains of processing speed, attention, working memory and task-switching amongst students who have experienced a TBI negatively impact university experience. The usage of tests that assess the above domains may be sensitive to the impact of TBI on university experience. Implementation of strategies to assist students who have experienced a TBI in their education warrant further investigation.

Time-resolved EEG cross-classification as a window on prediction, extrapolation, and error correction

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Part of the symposium Using MVPA to understand how the brain infers the world

The visual-processing hierarchy is characterised by multiple interacting processing stages, which interact through feedforward, feedback, and horizontal connections. The time courses of these different neural signals overlap. This complicates the identification and characterisation of the information that is represented at different stages of the processing hierarchy. Additionally, it makes it difficult to isolate the nature of the signals transferred between multiple stages. Characterising these representations and signals is important for testing computational models of cortical processes, such as hierarchical predictive coding. Here, we apply a multivariate classification strategy to time-resolved EEG data acquired while observers viewed objects in apparent motion. Using a temporal-generalisation approach where a classifier is trained and tested on separate timepoints in an EEG epoch, we characterise the evolution of position information through the early visual-processing hierarchy. We demonstrate neural evidence of motion extrapolation, show that this predictive signal develops extremely rapidly, and also illustrate what happens when predictions are violated by unexpected trajectory changes.

Predictive coding with neural transmission delays: A realtime temporal alignment hypothesis

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Hierarchical predictive coding is an influential model of cortical organisation, in which sequential hierarchical layers are connected by feedback connections carrying predictions, as well as feedforward connections carrying prediction errors. To date, however, predictive coding models have neglected to take into account that neural transmission itself takes time. For a timevarying stimulus, such as a moving object, this means that feedback predictions become misaligned with new sensory input. We present an extended model implementing both feed-forward and feedback extrapolation mechanisms that realigns feedback predictions to minimize prediction error. This realignment has the consequence that neural representations across all hierarchical stages become aligned in real-time. Using visual motion as an example, we show that the model is neurally plausible, that it is consistent with evidence of extrapolation mechanisms throughout the visual hierarchy, that it predicts several known motion-position illusions, and that it provides a solution to the temporal binding problem.

Investigating the role of temporal frequency adaptation on alpha-band neural oscillations

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Neural activity is inherently periodic. One of the most long-standing observations from human electroencephalographic (EEG) recording is enhanced oscillatory power in the alpha frequency range (~7–13 Hz; cycles per second) during periods of closed eyes. Located primarily over occipital sensors, this was taken to reflect a particular rhythm of activity intrinsic to the visual cortex. Here, we demonstrate this rhythm is capable of being modulated by way of temporal frequency (radial) motion adaptation. This finding appears not to be tightly tuned, but broadly sensitive around 7.5 Hz and tapering off below and beyond 1 and 18 Hz. Additionally, the effect appears to persist regardless of whether the eyes are open or closed. Data to date were recorded during passive viewing. We are currently investigating whether this adaptation effect has any influence on visual perception. The effect may provide a neural marker of dynamic visual after-effects such as the motion-aftereffect (MAE), which is susceptible to storage during periods of closed eyes between adaptation and test.

Patients with Parkinson's disease report higher hallucination burdens than their significant other reporting on their behalf

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Throughout the progression of Parkinson's disease (PD) patients can experience hallucinations. They can be debilitating and are often inaccurately reported to clinicians. To determine if there is a difference between patientreported hallucination burden and significant-other (SO)-reported burden, 131 PD participants and their SO completed the Psychosis and Hallucinations Questionnaire. Based on Level II cognitive assessments, 54 PD participants were classified with normal cognition (PD-N), 53 with mild cognitive impairment (PD-MCI) and 24 with dementia (PDD). The mean hallucination scores from each group of PD participants (PD-N = 2.5, PDMCI = 5.8, PDD = 8.1) and their SO (PD-N = 0.5, PDMCI = 1.4, PDD = 5.0) were collected. Discrepancies between PD- and SO-reported hallucination scores were analysed using a Bayesian hierarchical model. PD-reported hallucination scores were higher in PD-MCI and PDD compared to the PD-N group, respectively (99.9% probability). There was no evidence of a robust difference between PD-MCI and PDD groups. When the SO-reported hallucination scores were considered, there was no evidence of a robust difference between the PD-N and PD-MCI groups. The PD-MCI and PDD groups however had higher hallucination scores reported by SOs than the PD-N group, respectively (99.9% probability). SO-reported hallucination scores were generally lower than PD-reported scores in the PD-N and PD-MCI groups. Reporting inaccuracies in the cognitively impaired PDD group may suggest that some PDD participants can no longer accurately report their hallucination burden. When hallucination type was split into visual and sensory misconceptions, the same pattern of SO under-reporting persisted for

both hallucination subtypes. Most PD patients are experiencing a greater hallucination burden than what is apparent to those around them. This is a reminder that SOs alone should not be relied upon to identify hallucinations, particularly in cognitive intact patients.

The *cheerleader effect* in bodies: A result of memory bias and not perceptual encoding

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Recent studies have shown that individual faces tend to be rated as more attractive when presented in a group compared to when presented individually. The current study clarifies the necessary conditions for the effect to be observed. In Experiment 1 we examined whether the effect is specific to faces or also extends to body perception. Images of faces and bodies were separately presented alone and in groups for a total of 3 s per trial, with a single target image indicated by a red outline. After the images were removed from the screen, participants rated the attractiveness of the target image. The results showed that face and body images were rated as more attractive when presented in groups than when presented alone, indicating the effect is not restricted to face perception. Further, the effect was significantly larger for bodies, suggesting mental representations of bodies may be less stable than faces. In Experiment 2 we replicated the testing parameters of Experiment 1, with the exception that all the images remained visible while ratings of attractiveness were provided. We found that this manipulation negated the effect, with both face and body images receiving similar ratings whether presented in groups or alone. These results indicate that the effect is due to a bias in recall and does not occur at an initial stage of perceptual encoding.

Socio-cognitive deficits in long-term opiate users: The potential role of facial mimicry

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The social difficulties experienced by long-term opiate users have been well studied, yet there has been a lack of research into the potential mechanisms underlying this dysfunction. Here we investigated whether facial emotion recognition, theory of mind, and rapid facial mimicry are impaired in opiate users. The participants were 25 long-term opiate users who were enrolled in opiate substitution programs, and 25 healthy controls. In order to measure facial emotion recognition accuracy, participants judged the emotion of 60 photographs of faces with happy, sad, angry, fearful, surprised or disgusted expressions. Theory of Mind (i.e., the ability to infer mental states in others) was measured using The Reading the Mind in the Eyes task. Electromyography (EMG) was recorded from the zygomaticus major and corrugator supercilii muscle regions. Rapid facial mimicry was measured relative to baseline EMG activity for the first 1000 ms after participants passively viewed images of happy and angry facial expressions. Relative to the control group, the opiate user group demonstrated poorer performance on the facial emotion recognition and theory of mind tasks, and they produced weaker mimicry of faces with happy expressions. These findings are interpreted in terms of existing neuroimaging evidence that long-term opiate use is associated with disruptions to the 'emotional mirroring' network. This work has potential theoretical and clinical value in understanding the social deficits associated with long-term opiate use. This research was supported by an Australian Catholic University Research Program Grant.

The right brain and the right cues: Facial scanning patterns in semantic dementia

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Face processing is a key component of social cognition, with efficient processing of emotional faces aided by preferentially attending to relevant cues (i.e., eyes and mouth). Temporal brain regions play a major role in attending to these cues but the contribution of each hemisphere remains under debate. Semantic dementia (SD) is characterised by anterior temporal lobe atrophy, which is either predominantly left- (left-SD) or right-lateralised (right-SD). Thus, this syndrome provides a unique lesion model by which to understand the role of laterality in face processing. Here, we investigated facial scanning patterns in 10 left-SD and 6 right-SD patients, compared to 22 healthy controls. Eye tracking was recorded via a remote EyeLink 1000 system, while participants passively viewed fearful, happy and neutral faces over 72 trials. Number of fixations to the eyes and the mouth were recorded. Voxel-based morphometry analyses were conducted to examine where regions of reduced grey matter integrity correlated with fixation patterns. Analyses revealed significant group differences for fixations to the eyes, but not for the mouth. Group comparisons illustrated that right-SD patients showed more fixations to the eyes than left-SD patients in all conditions (Fear, p = .02; Happy, p = .01; Neutral, p = .02), as well as marginally more fixations than controls in the Fear (p = .07) and Happy (p = .09) conditions. In contrast, no difference between left-SD patients and controls was observed. Increased fixations to the eyes were associated with reduced integrity of the right posterior superior temporal cortex. This study is the first to investigate visual attention to faces in SD, demonstrating that laterality of atrophy leads to distinct facial scanning patterns. Theoretically, these findings suggest the right superior temporal cortex plays a key role in directing visual attention to emotionally-relevant facial cues.

Pre-stimulus alpha predicts inattentional blindness

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It is well known that pre-stimulus oscillatory activity between 8 and 12 Hz, referred to as the alpha band, predicts visual awareness of stimuli across a variety of psychophysical tasks. The current study sought to examine whether this relationship holds for awareness of stimuli under conditions of inattentional blindness, using a paradigm adapted for EEG that was previously developed by Pitts and colleagues (2012). Time-frequency analyses revealed a significant increase in alpha power over parietal regions during the pre-stimulus interval in subjects who were aware relative to those who were inattentionally blind to the critical stimulus, contradicting the typically reported relationship between visual perception and pre-stimulus alpha activity. We argue these findings provide support for, and are explained by, a functional role for alpha in the suppression of task-irrelevant information.

Spatio-temporal properties of mapping sequences can bias population receptive field estimates

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Population receptive field (pRF) modelling allows mapping voxels according to their preferred location in sensory space and the tuning of such preference. We used both empirical and simulated data to investigate the reliability and biases of pRF modelling as a function of the temporal structure of the mapping sequences. We mapped polar angle preference and tuning width function of voxels in early visual areas using wedge stimuli displaying natural scenes as a carrier pattern. We compared sequences employing stimuli of different width (45° vs. 6°) that covered the entire visual field in cycles of variable duration (9 s vs. 60 s) by orderly sweeping through the

visual field or jumping from location to location. Consistent with previous studies, both simulations and empirical data suggested better model fits for ordered sequences. Yet correlations between observed time series and responses predicted using parameters estimated with ordered vs. random sequences revealed no substantial differences. This suggests that ordered sequences may not be superior to random ones. However, at least for small mapping stimuli, random designs were more susceptible to fitting errors in both polar angle and tuning width. The temporal structure of the sequences significantly affected tuning width estimates. Ordered designs with large wedges and short cycles produced systematically smaller estimates than random ones. These differences were not reflected in the simulations. We suggest that the results of ordered designs are biased by non-linearities in the spatio-temporal summation of the BOLD response when short cycles are used. Interestingly, when small wedges and long cycles were used, both simulations and empirical data showed larger tuning width estimates for ordered than random sequences. Random designs appear to systematically underestimate tuning width in these circumstances, speaking for an advantage of ordered designs that benefit from successively stimulating adjacent locations.

The critical reliance of early visual cortex on the fractal structure of natural scenes

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Despite the considerable variability across natural scenes, they share many statistical regularities. Firstly, natural scenes are similar in their photometric properties as they each share a unique distribution of luminance intensity variations known as the $1/f^{\alpha}$ amplitude spectrum ($\alpha \approx 1$). Secondly, natural scenes are similar in their geometric properties as they each contain a similar density of structure across spatial scales—a property of which deem them as fractal (i.e., the branching pattern of a tree is similar irrespective of scale). Since the visual system has evolved in a natural environment, it is likely that it is tuned to both its photometric and geometric properties-but to what extent? Is it critically reliant on its photometric characteristics, which can change dramatically depending on the illumination of a scene? Or is it preferentially tuned to its geometry, which remains stable irrespective of illumination? Building on previous work (Isherwood et al., 2017), here we use both psychophysics and fMRI to measure perceptual sensitivity (4AFC "odd one out" task) and BOLD responses in visual areas V1–V4 (N = 10) to different stimulus image types (greyscale, thresholded, and edges) across a range of input amplitude spectra (α = 0.25, 0.75, 1.25, 1.75, 2.25). While each image type shares the same geometric properties, their measured amplitude spectra differ dramatically. So, if the visual system is preferentially tuned to natural geometry, we should observe no difference in the pattern of activity across image type conditions-which is exactly what we find. Both sensitivity and BOLD activity resemble an inverted U-shape peaking for natural input $1/f^{\alpha}$ spectra ($\alpha = 1.25$) across all image types—which vastly differ in their photometric properties. This suggests that both behaviourally and physiologically, the visual system is critically reliant on the fractal structure of natural scenes-a property which remains stable irrespective of scene illumination.

Predicting personality traits from resting state EEG using Multivariate Pattern Analysis

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Over several decades of research, studies have demonstrated that certain electroencephalographic (EEG) measures relate consistently to individual differences in personality (e.g., extraversion and feedback-related negativity; neuroticism and greater left- versus right-hemisphere activity). Though these findings are promising and have advanced mechanistic theories of personality, it is possible that additional discoveries are being missed due to a focus on confirmatory hypothesis testing. A data-driven approach could help to build a bank of robust findings linking given traits to patterns of brain activity. Accordingly, we used multivariate pattern analysis (MVPA) to explore whether distributed patterns of resting state frequency-domain EEG data can predict individuals' personality traits. Participants reported personality via the Big Five Aspects Scale, and provided eight minutes of resting EEG data before (N = 168) and in some cases after (N = 96) completing tasks unrelated to the current study. We utilised support vector regression using the Decision Decoding Toolbox to predict continuous values of personality from patterns of frequency domain power across electrodes. Decoding accuracy was derived via ten-fold cross validation averaged over 10 repetitions, and this was compared to results from analyses using personality trait scores that were randomly permuted across participants. The correlation between model-predicted personality scores and actual scores was r = ~.2 for agreeableness (at ~9–18 Hz) and neuroticism (at ~3–6 Hz). These results were consistent across pre- and post-task recordings. For agreeableness, feature weights were largest at left hemisphere temporal electrodes, whereas weights were more widely distributed for neuroticism. Our results contribute to the knowledge base of findings linking personality to EEG data, providing a key first step before developing mechanistic neurobiological theories of personality.

Efference copies produced by inner speech are temporally precise and content-specific

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Efference copies are neural signals that are used to predict and suppress the sensory consequences of our actions. Recent studies suggest that efference copies may also accompany inner speech-the silent production of words in one's mind. In two experiments, we show that efference copies produced by inner speech contain information about the temporal and physical properties of inner speech. Participants viewed a ticker tape and produced an inner phoneme at a precisely-defined moment in time. An audible phoneme was presented 300 ms before, concurrently with, or 300 ms after participants produced the inner phoneme. We found that producing the inner phoneme attenuated the N1 component of the event-related potential, but only when the inner and audible phonemes occurred concurrently and matched on content. If the audible phoneme was presented before or after the production of the inner phoneme, or if the inner phoneme did not match the content of the audible phoneme, there was no attenuation of the N1. This suggests that inner speech, similar to overt speech, is accompanied by an efference copy that is both temporally precise and content-specific. These results support the notion of a functional equivalence between the efference copies associated with inner and overt speech, and are consistent with the hypothesis that inner speech is a special form of overt speech. Finally, our procedure provides a foundation for investigating abnormalities in inner speech, such as auditory-verbal hallucinations in schizophrenia, and for the development of brain-computer interface technologies capable of deciphering and utilising inner speech for people who are unable to produce overt speech.

Physical force augments reward-based learning

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Humans routinely use the outcomes of previous decisions to update their behaviour. Striatal dopamine plays a central role in this process by encoding reward prediction errors, and more recent work has emphasised the importance of dopamine in motivating the investment of physical effort in goal-directed behaviour. Based on the close neurophysiological relationship between learning and effort, we asked whether physical force could improve reward-based learning. We tested 158 healthy adults on a probabilistic reversal learning task. On each trial, participants were presented with two stimuli, one of which was correct and the other incorrect. Stimulusreward associations periodically reversed, and the task was to choose the correct stimulus based on probabilistic feedback after each trial. The probability of reward for a correct response was set at 70% for one half of the group and 80% for the other. Critically, in contrast to previous reversal learning paradigms, participants in our task registered their choices by applying either a low or high amount of force to a pair of hand-held dynamometers. We derived subject-specific parameters of individuals' learning rates for the low- and high-force conditions using a Rescorla-Wagner temporal difference learning model. Our key finding was that learning rates were significantly greater when individuals exerted high versus low force. In addition, improved learning was accompanied by higher rates of win-stay/loseswitch behaviour in the high- versus low-force conditions. These results were only found under more difficult learning conditions, when the probabilistic feedback was 70% as opposed to 80%. These data show that physical force augments reward-based learning, but only in challenging learning environments. In demonstrating how learning and motivation interact to produce adaptive behaviour, our results lay the foundation for future neurophysiological studies to characterise the role of dopamine in this complex process.

Reading which way your mind spins

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Machine learning (ML) pattern classification techniques have begun to be applied to the analysis of brain signals. Whilst this has first found favour in fMRI, it is in relation to real-time measures of brain activity (EEG) where the practical applications of such methods are likely to have the greatest application. Such techniques have most prevalently been applied to decoding from brain signals, either to distinctions in responses to physically different stimulus categories, or to envisaged imagery of differentially lateralised motor actions (in response to physically distinct stimuli). Here we attempt to apply such techniques under circumstances where the physical stimulus characteristics remains identical, but where only the perceptual interpretation of these stimuli changes. An exemplar of a particular class of visual stimuli, bistable percepts-where the exact same stimulus allows for two mutually exclusive perceptual interpretations-was exploited in order to achieve this. The stimulus is known as the Rotating Dancer Illusion. This stimulus depicts the silhouette of a rotating dancer. Because the stimulus is depicted as a silhouette, and bereft of depth cues, the same animated sequence can be interpreted as rotating either in a clockwise or anticlockwise direction, dependent solely upon the observer's assumptions as to which way the figure is facing. We collected EEG data whilst participants observed this stimulus, whilst occasionally polling them as to which way they perceived the dancer as rotating. This gave us EEG data for a set of labelled trials (clockwise vs. anticlockwise) that we used to train a Support Vector Machine (SVM). This SVM was able to correctly classify trial types at up to 90% accuracy, on the basis of alpha, beta and gamma power across 64 electrodes. This represents a significant step forward for ML analysis of EEG signals since it shows ability to classify perceptual experience in the absence of physical stimulus differences.

Resting-state connectivity, cognition, and fatigue in response to mental exertion: A novel longitudinal study in adolescents with Chronic Fatigue Syndrome

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Cognitive dysfunction and fatigue following mental exertion is commonly reported in Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME). Emerging evidence in adults suggests that central nervous system dysfunction may underlie these core CFS/ME symptoms, yet this has rarely been measured objectively or longitudinally in the paediatric population. This study used resting-state functional MRI in a novel repeated-measures design to evaluate intrinsic connectivity, cognitive function, and subjective fatigue, immediately before and after a period of cognitive exertion in 48 adolescents at the time of diagnosis (25 CFS/ME, 23 healthy controls, $M_{age} = 16 \pm 1.6$ years), and again at 2-year follow-up (17 CFS/ME, 17 controls, $M_{age} = 18.5 \pm 1.6$ years). Results revealed little evidence for a differential effect of cognitive exertion on brain functioning and fatigue in CFS/ME compared with controls, at either time point. At the time of diagnosis, both groups demonstrated a similar rate of reduced intrinsic

functional connectivity within the default mode network, reduced sustained attentional performance, slower processing speed, and increased subjective fatigue, as a result of cognitive exertion. However, CFS/ME adolescents consistently reported higher fatigue, and controls outperformed CFS/ME adolescents overall on cognitive measures of processing speed, sustained attention and new learning. At follow-up, while both groups again showed a similar rate of reduction in sustained attentional performance and increased fatigue following cognitive exertion, no main group effects in cognitive performance were observed. The findings suggest that challenging cognitive tasks may elicit similar levels of energy expenditure across all adolescents in the form of reduced brain functioning and associated fatigue. However, at least early in the illness, paediatric CFS/ME may confer a lower starting state from which to access energy reserves and cognitive resources when cognitive effort is required.

The impact of fatigue on motivation across the lifespan

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Fatigue can significantly impair motivation, and impact on quality of life. Moreover, fatigue becomes more prevalent and severe in old age. Yet the way in which fatigue modulates motivational processes remain unclear. Here, we used a neuroeconomic framework to quantify the effects of physical fatigue on effort-based decision-making across the lifespan. Fifteen young adults and 15 healthy elderly individuals completed an effort-based decision-making task, in which they had to choose between working and resting on every trial. Critically, these decisions were made across two separate phases. In one phase, we carefully minimised and controlled for the effect of fatigue. In the other, fatigue was allowed to accumulate over the course of the block. We then applied computational models of decisionmaking to examine how fatigue affected individuals' decisions of whether, and under what circumstances, to work versus rest. As expected, fatigue reduced the motivation of individuals to exert effort. Notably, however, the effects of fatigue were not uniform across all conditions; rather, they specifically affected motivation when effort requirements were high and available rewards were low. Computational models revealed that fatigue had both a short-term and long-term effect on individuals' effort-discounting parameters, and these findings were similar for both the younger and older age groups. The findings indicate that fatigue impacts motivation by modulating cost-benefit calculations when deciding to invest effort. Overall, these results reveal the selective effects of fatigue on effort-based decisionmaking, and provide a foundation to explore the neural mechanisms underlying the effect of fatigue on motivation in health and disease.

Mental simulation of facial expressions: Mu suppression to the viewing of dynamic neutral face videos

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The mirror neuron network (MNN) has been proposed as a neural substrate of action and emotion understanding. Mu suppression measured by electroencephalography (EEG) has commonly been investigated as an index of the MNN activity during execution and observation of hand and finger movements, but in order to establish its role in higher-order processes, such as recognising and sharing emotions, more research using social emotional stimuli is needed. The current study aims to contribute to our understanding of the sensitivity of mu suppression to facial expressions. To this end, we investigated the modulation of the mu rhythm in 22 participants while they observed dynamic video stimuli, including communicative facial expressions (happy and sad), neutral facial movements (mouth opening), and non-face stimuli (kaleidoscope pattern). Spectral perturbation in the alpha band in response to movement in the stimulus was calculated at central and occipital electrodes, corresponding to mu and posterior alpha activity, respectively. Viewing neutral faces evoked greater alpha suppression over the sensorimotor area than the occipital area, whereas kaleidoscope evoked greater alpha suppression in the occipital than the sensorimotor area. Alpha modulation in the sensorimotor and occipital areas did not differ for sad or happy faces, a result which contradicts our hypothesis. Source localisation (sLORETA) analysis comparing the neural sources of alpha power differences between neutral face and kaleidoscope conditions showed significantly more suppression in the primary MNN areas, including the supplementary motor area and the somatosensory cortex. Results indicate that the ambiguity or the reduced availability of emotional information in the mouth opening condition may require sensorimotor mimicry more for deciphering emotion-related information than do the full-blown happy or sad expressions which may be easily recognised.

Associations between brain morphology and cognition in individuals with schizophrenia and bipolar disorder: A review

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Although nosologically distinct, there is overlap in the disease presentation of individuals with schizophrenia (Sz) and bipolar disorder (BD). Both disorders are characterised by abnormalities in cognitive performance. Abnormalities in brain volume, surface area and cortical thickness have also been observed in both Sz and BD. It is possible that these abnormalities are related, however the nature of the brain structure-cognition relationship in these disorders is inconclusive. This review aims to elucidate the association between common measures of brain morphology and cognitive impairment in Sz and BD. Science Direct, PubMed, NCBI, and Web of Science databases were searched for papers investigating cognition and brain morphology (cortical thickness, surface area and volume) in Sz and BD. Studies indicate that grey matter volume is positively associated with cognitive performance. Evidence suggests positive relationships between premorbid IQ and volume of the frontal lobe; current IQ and the temporal lobe; and verbal memory/learning and hippocampal and amygdala volume. Positive thickness-cognition relationships included non-specific executive functioning and the frontal region; attention and the temporal region; and verbal learning and memory and the temporal region, specifically the right superior gyrus. Negative associations were identified between attention and temporal and parietal regions, and between verbal fluency and the parietal region. Only a handful of studies have investigated surface area with regards to cognitive impairment in Sz and BD, and observed positive relationships between premorbid IQ and the frontal region, and current IQ and the temporal region. Limitations of the literature stem from methodological and sampling issues, and from the disproportionate number of Sz to BD studies. There is a need for more novel approaches to uncover the nature of brain morphology-cognition relationships in BD and Sz.

Jointly modelling of response criterion and ERPs related to proactive control in task-switching

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Task-switching paradigms tap into control processes supported by frontal brain networks. While behavioural and neural measures of task-switching ability are well characterised, the link between levels of analysis require quantitative, integrative approaches that simultaneously model cognitive and neural processes. Here, we present early attempts to jointly model multiple behavioural, structural and functional neural measures of task-switching. We developed bivariate joint models using a covariance hierarchical Bayes approach to link a neural model (single-trial cue-locked EEG data) and a behavioural model (diffusion decision model, DDM). On each trial, participants completed one of three tasks using cues that that varied in amount of advance information (e.g., will repeat task A, will switch to task B, will switch to either B or C, may repeat A or switch to B). We compare results from four models: Baseline (DDM criterion), Model 1 (criterion linked with EEG), Model 2 (criterion, EEG, and isSwitch variable, denoting that task will change), and Model 3 (criterion, EEG, isSwitch variable, and isTaskPrepare variable, denoting that the task is known). For each model, beta values were extracted denoting the linking strength between the EEG and the relevant parameter. To validate the model, parameter estimates were used to reconstruct the observed data (i.e., grand average ERPs, behavioural data). The amount of information provided to the linking function proportionally aided the reconstructed grand average ERP for each condition. In Model 2, the predicted ERPs followed general trends in observed ERP, without distinction between cue types. Model 3 reconstructed a switch-related component (switch-positivity, 200–500 ms), and Model 4 also reconstructed a task-preparation component (CNV differences, 700–1000 ms). These findings support multiple preparation processes in task-switching, and point to the need for neurally-informed decision models of preparation to switch tasks.

Representational momentum and prediction-error signalling: Complementary insights from MEG and fMRI

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Representational momentum is a phenomenon whereby moving objects are perceived to appear further along their trajectory of motion than they have actually travelled. Behavioural evidence implies that stimulus motion invokes evolving neurocognitive representations. Such representations may be seen to reflect internally generated predictions. Here we use the complementary strengths of fMRI and MEG to localise brain systems underlying representational momentum and prediction error checking. Fifteen adults performed a cued emotion-discrimination task whilst in two separate sessions MEG and fMRI data were collected. Participants saw either a static image of a low-intensity emotion or a dynamic image where the expression changed from neutral to a low-intensity expressed emotion. The image was then replaced by a mask, which was then replaced by a static image of a high-intensity expressed emotion, that was either the same emotion seen during cue period or was a different emotion. fMRI and MEG showed partially overlapping brain activation to stimulus motion and stimulus incongruence. Whilst fMRI was able to resolve that MT/v5+ is more active to dynamic stimuli across the trial as a whole, MEG was able to demonstrate this area (and additionally STS) as showing increased activation during both the cue period and the mask period of the trial. The implication is that these regions are involved not only in processing viewed motion, but also in the continued active modelling of stimulus motion even when such motion is not visible. fMRI revealed a network of cortical and subcortical brain structures that showed increased activation to incongruent stimuli. The temporal resolution of fMRI does not allow disambiguation of activity relating to initial prediction error detection from later processes. A subset of these cortical regions also showed increased rapid evoked activation in MEG. We propose that these areas are likely substrates for prediction error checking.

A different kind of tablet for early childhood inattention

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The prevalence rate for children suffering significant problems with attention by the age of 4 is approximately 40%. Attention skills are strong predictors of learning, language, reading and numeracy skills; therefore, problems of attention can have a cascading impact on development and may result in lifelong challenges. Modern research utilises touchscreen-learning technology in schools and in the home to aid learning and understanding. However, these approaches are typically conducted later in childhood when many years of vital early intervention may have been missed. The current pilot trial is investigating a novel touchscreen game-based tool (TALI DetectTM) to assess attention skills in children aged 4 to 6 years. This unique trial will recruit 300 healthy Victorian pre-school and school-aged children without any developmental disorders. Participants will be recruited in equal numbers per half-year segment (4 to 41/2; 41/2 to 5; 5 to 51/2; 51/2 to 6), and include a representative sample balanced by associated demographics and socio-economic status. Pre-screening assessments will include parents completing an Early Childhood Conners Parent Rating Scale (EC Conners) assessment, as well as the Strengths and Weaknesses of ADHD symptoms and Normal behaviour rating scale (SWAN) to capture any existing behavioural issues in each child. Children will complete the TALI Detect assessment as well as the Test of Everyday Attention 2nd Edition (TEA-Ch-2) so as to measure the validity and accuracy of the TALI Detect assessment, with fifty percent of the children completing the TALI Detect assessment two weeks later. Data will be analysed using correlational, regression and analysis-of-variance techniques. TALI DetectTM aims to provide a scalable and easily accessible validated assessment method to identify early childhood attentional issues.

Retained visual working memory, but different cognitive strategy, in aphantasic individuals

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The ability to retain visual information in mind is one of our most important cognitive faculties. Despite the importance of visual memory, we are incredibly limited in the number of items we are able to reliably retain at any one time, with limits typically reaching capacity at four items, however these capacity limits vary substantially from person to person. What exactly drives these individual differences in visual working memory capacity is still unknown. Visual imagery has been proposed to be a tool that individuals use to hold visual information in mind. Visual imagery strength correlates with visual working memory accuracy and capacity, and it too has a capacity limit of around three to four items. The content of visual working memory and imagery are also able to be cross-decoded from each other using fMRI. These data have led some researchers to propose that visual imagery and visual working memory may be one and the same. To investigate this proposition, we measured visual working memory capacity limits in a special population who do not experience visual imagery: congenital aphantasics. If visual imagery is necessary for the completion of visual working memory tasks, aphantasics' performance should be impaired on visual memory tasks, but not on a general number working memory task. We compared the performance of aphantasic individuals to a group of participants with visual imagery and found no differences in performance for either the visual or number working memory tasks. However, there were significant differences in reported memory strategies used by the aphantasic individuals compared to controls. While the majority of participants with visual imagery did report imagining the memory content to some extent, aphantasic individuals were more likely to report verbally labelling the images as a mnemonic tool. These data show that although visual imagery can be utilised as a tool to solve visual memory tasks it is not necessary for their successful completion.

What can eye movements tell us about the unconscious visual episodic memory?

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Traditionally, the hippocampus-dependent memory system was thought to be involved only in the formation of episodic memories based on conscious events. There is accumulating evidence, however, that the rapid formation of novel associations (i.e., episodic memory) can also form at the unconscious level. Here, we investigated whether face-scene associations can be encoded and retrieved below awareness. We tested 32 healthy participants. Unfamiliar faces were masked from awareness and very briefly superimposed on unfamiliar scenes during the encoding. Participants were doing an unrelated orientation discrimination task throughout the encoding. During the retrieval, one scene was presented (consciously) prior to a display that contained the face that was superimposed on that particular scene during encoding as well as a distractor face that was superimposed on other scenes. We tested whether participants fixated more often and had larger pupil sizes on the related faces relative to the distractor faces as the indirect indices of unconscious memory retrieval. We excluded 12 participants who performed above chance or reported perceiving the faces on a subsequent awareness test where they were instructed to identify the masked faces from the distractors. The results of the remaining (unaware) participants showed a higher number of fixations and a bigger pupil size to the related faces compared with the distractor faces. The effect size was bigger when the target was presented in the left visual field. We interpret the change in the number of fixations and the pupil size as evidence of unconscious retrieval of the face-scene associations. These findings provide support for the existence of a memory system with the same processing characteristics of the visual episodic memory at the unconscious level.

The effects of a gamified cognitive training program in reducing inattentive behaviour in the classroom: A randomised controlled trial

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Difficulties in attention are commonly reported in childhood and have a cascading impact on subsequent behavioural regulation and learning. The current randomised controlled trial aimed to determine the immediate and long-term efficacy of a classroom-based attention training program (TALI Train) on attention, inattentive/hyperactive behaviour, working memory and numeracy in primary school children. A total of 99 children (aged 5-9 years) were randomly assigned to TALI Train, a non-adaptive placebo program or usual classroom education. Classes assigned to the TALI Train and placebo program conditions were provided with touchscreen tablets and teachers were instructed to complete their assigned program 5 times a week for a 5-week period. Primary outcome measures included neurocognitive assessments of selective and sustained attention. Secondary outcomes measures included parent/teacher rated questionnaires of ADHD symptoms, assessments of working memory and numeracy skills. Performance was assessed at the start of the trial (baseline), immediately after the 5-week training period (post), and 6 months after the training period had ceased (follow-up). The trial was registered with the Australian New Zealand Clinical Trials Registry and analyses were performed on an intention to treat basis. Latent growth models indicated that children assigned to TALI Train showed a significantly greater decline in ADHD symptoms within the classroom immediately after the training period compared to children in the control arms. There was no effect of the intervention on working memory, numeracy, selective or sustained attention. These findings suggest that for typically developing children attention training may be beneficial in reducing ADHD symptoms within the classroom. However, there is limited evidence of its effectiveness compared with control conditions in improving cognitive aspects of attention, short-term/working memory, or numeracy in young typically developing children.

Disentangling the grasp and functional use mechanisms in pantomiming tool use

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The priming of action-related properties, such as grasp and functional use, can facilitate the recognition of tools. However, it is unclear if these properties can also influence motor actions directed towards them. This issue was investigated in the current study. In two experiments, right-handed participants pantomimed the grasp and functional use actions of prime and target images of tools. Grasps and functional use to the target image were either the same as or different from the prime (four conditions). In a fifth condition, the prime and target were identical. Experiments differed in target stimulus-onset asynchrony (SOA): 2 s (N = 15) versus 3 s (N = 12). Reaction time (RT) was obtained by key release when participants began to pantomime, and accuracy of grasp and functional use movements were coded from video recordings. RT priming and accuracy difference were calculated from the prime and target stimuli. RT priming demonstrated a main effect of pantomiming condition, F(4,100) = 10.20, p < 001, $\eta^2_p = 0.29$. This was driven by negative priming (slower RTs to the target relative to the prime) in all pantomiming conditions (all p < .05) except where the prime and target object were identical images (p = 0.32). No effects were observed for grasp accuracy difference scores. Functional use accuracy differences demonstrated an interaction between pantomiming condition and SOA, $F(4,100) = 2.79, p = 0.03, \eta^2_p = 0.10$. This interaction was driven by a decrease in pantomiming accuracy for the target when the two differed in action but not in grasp at a 3-s SOA, while no other differences were observed among the other conditions. Our results demonstrate an interference in the speed of pantomiming two different tools presented in succession, regardless of the grasp and functional use attributes, and that the grasp and functional properties of tools may not be fully dissociable as the repetition of a similar grasp can decrease accuracy in pantomiming different actions.

Unsupervised classification of sleep data using highly comparative time-series classification and *k*-means clustering

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Despite the advancement of technology since the birth of sleep science, the current guidelines for sleep scoring remain limited in terms of precision and objectivity. The official sleep scoring criteria consist of rules based on what can easily and consistently be scored by the human eye. The coarse-grained scoring conventions that facilitate manual scoring artificially limit the information that is typically extracted from physiological sleep recordings, its reproducibility across scorers, and its generalisation to non-standard cases such as sleep disorders. The aim of this study is to provide a preliminary outline of an unsupervised approach to clustering sleep data that could lead to a data-driven classification system with a level of precision and breadth commensurate with the richness of sleep data. We have implemented a novel approach that uses k-means clustering to group unlabelled sleep data based on features extracted by the highly comparative time-series classification tool. We will provide, firstly, a broad overview of our method's ability to group a full night of sleep data into a small number of stages, and outline the relationship between the results of this process and those produced by the existing scoring conventions. Secondly, for validation and to serve as an exemplar for future research, we investigated whether our clustering approach could detect periods of lucid dreaming in sleep data. Lucid dreaming has been defined as an oneiric state in which the sleeper gains awareness of the fact that she is dreaming. The differentiating features of lucid dreaming are not reflected in current scoring rules or readily distinguishable to the human eye. Here, we show that our approach can subdivide sleep resembling REM (a period associated with vivid dreams) into clusters that seem to reflect the presence or absence of this metacognitive awareness, and speculate that our method may be able to detect other neurophysiologically significant changes during sleep.

A systematic review and meta-analysis of 271 PCDH19variant individuals identifies psychiatric comorbidities, and association of seizure onset and disease severity

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Girls Clustering Epilepsy (GCE) is an infantile onset disorder characterised by clusters of seizures. GCE is due to mutations in the X-chromosome gene PCDH19 and is underpinned by cellular mosaicism due to X-chromosome inactivation in females or somatic mutation in males. Intellectual disability is present in approximately 70% of cases. The prevalence of psychiatric comorbidities is unknown; however, reports suggest that autism spectrum disorder is a common feature. No association has been established between the severity of epilepsy and ID. This review characterizes the neuropsychiatric profile associated with PCDH19 mutations and examines the association of clinical and molecular factors with neuropsychiatric outcomes. We found that seizure onset \leq 12 months was significantly associated (p = 4.1 \times 10⁻⁷) with more severe ID, compared with onset > 12 months. We identified two recurrent variants, p.Asn340Ser and p.Tyr366Leufs*10, occurring in 25 (20 unrelated) and 30 (11 unrelated) cases, respectively. PCDH19 mutations were associated with psychiatric comorbidities in approximately 60% of females, 80% of affected mosaic males, and reported in nine hemizygous males. Hyperactive, autistic, and obsessive-compulsive features were most frequently reported. There were no genotype-phenotype associations in the individuals with recurrent variants or the group overall. In line with previous reports, we observe that autistic features are the most prominent psychiatric comorbidity. A novel finding to emerge is that hyperactivity is frequently observed. We have shown that seizure onset within the first 12 months is significantly associated with more severe ID. Therefore, knowledge of an individual's seizure onset will aid prognostic counselling, providing valuable information for clinicians managing affected individuals and their families.

The sleeping brain tracks informative speech in a cocktail party

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Aim: Even while asleep, the brain continues to process external auditory information and this ability depends on variables such as sleep depth and the relevance of external stimuli (e.g., one's own name). These results have been restricted so far to isolated stimulations and the question whether the sleeping brain can dynamically track auditory streams and select relevant information remains unexplored. To study the brain's auditory processing of a complex auditory scene during sleep, we designed a cocktail-party experiment in which subjects were asked to attend to one of two auditory streams, which were played simultaneously in each ear (i.e., dichotically). Methods: The stream to attend was composed of French stories (Real speech), while the stream to ignore consisted of the same set of stories from which meaningful words were replaced by French pseudo-words (Jabberwocky). Subjects transitioned from wakefulness to sleep during afternoon (Experiment 1) or morning naps (Experiment 2) while listening to pairs of real stories and Jabberwocky. Participants were instructed to maintain their attention to the meaningful speaker. Novel pairs of stimuli (i.e., never heard during wake) were played during sleep. We used electroencephalography and a linear decoding model to reconstruct the stimulus envelope from brain activity and determine whether: (i) speech is encoded during sleep and its sub-stages; (ii) meaningful speech is selectively amplified; and (iii) sleep macro- and micro-physiology account for the encoding and selection of auditory information. Results: We found that both Real and Jabberwocky speech were encoded, with a selective amplification of Real speech during light NREM and REM sleep. An analysis locked to micro- events showed that the selective amplification of Real speech during light sleep were consecutive to K-complexes and disappeared following spindles. Slow-waves were concurrent with a selective suppression of Real speech while leaving the Jabberwocky stream unaffected. REM was linked to a selective suppression of Real speech as well. Conclusions: Overall, we found evidence for the selective processing of external information during light NREM and REM sleep stages, with a strong dependence on the presence of EEG hallmarks. K-complexes appeared to promote the processing of meaningful stimuli whereas slow-waves and rapid eye movements were associated with its selective suppression.

Epigenetic DNA methylation biomarkers and the "target gene" approach

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Part of the symposium Applications of genomics and epigenetics to cognitive neuroscience

Genetic, genomic and epigenetic studies in humans often take the approach of analysing thousands of genes for expression levels (RNA sequencing), alterations in the genetic code (SNP array analysis) or epigenetic modifications (DNA methylome analysis). An alternative method is to focus on specific "target genes" to look at relationships between cognitive functioning and RNA expression or DNA methylation of one gene or a set of genes in peripheral tissues (e.g., blood or saliva), termed genotype-phenotype or epigenotype-phenotype research. This presentation discusses the "target gene" approach using the FMR1 gene, a trinucleotide gene linked to a range of health outcomes, including intellectual disability, autism spectrum disorder, schizophrenia and neurodegenerative cerebellar ataxia. We use methods that analyse DNA methylation with high CpG-site resolution, looking at cognitive and motor control performances in children with FMR1-related disorders. This work shows that both the amount of DNA methylation and its location matter for the type and severity of phenotype expression. We have expanded this work to develop a research framework to piggyback phenotypic and DNA methylation trajectory investigations onto protocols being developed for future newborn screening. Using this approach, we show that DNA methylation in retrospectively retrieved newborn blood spots (i.e., the "heel prick" test) can be used to predict severity of intellectual disability and autistic-like features in boys born with fragile-X syndrome. We also show sex differences in DNA methylation trajectories from birth to childhood. These findings demonstrate the power of gene-specific or

targeted DNA methylation analysis for understanding cognitive development and studies are underway to assess this approach in children with other neurodevelopmental disorders characterised by atypical DNA methylation.

Early neural processing of tearful faces

Miss Sarah Krivan James Cook University

Nerina Caltabiano, *James Cook University* David Cottrell, *James Cook University*

Facial expressions are a critical component of social communication. Expressions of joy are readily shared, whereas expressions of sadness are often costly to respond to. Despite this, research employing self-report methodologies has identified that tears elicit greater empathic and caregiving responses compared to other expressions. Understanding whether these differences also modulate face-specific event-related potential waveforms will allow for a unique understanding of the way that tears are processed. Fifty participants completed an emotional discrimination task of images depicting happy, sad, and neutral faces, both with and without tears. Tearful faces were found to produce a stronger central negativity and posterior positivity at 130 ms (N1/P1) than tear-free faces. The emotional content of the images modulated the VPP/N170, with a larger negative mean amplitude response to sad faces compared to happy faces. Finally, a posterior negative potential occurring between 250 and 350 ms was the earliest component in which an interaction between the presence of tears and the valence of the emotional expression was observed. These results were consistent with the behavioural evidence that tears slow down reaction time to happy faces, and decrease classification accuracy, whilst the inverse is found for tears on a sad face. We interpret these results to mean that tears are a unique facial marker, which modulate the way that people respond to faces dependent on the emotional expression. Thus, tears are processed at the neural level, and this early-level visual processing may be the basis for furthering our understanding of their communicative function.

Alpha oscillations and inhibition during speech in noise processing in older adults with hearing loss Mx Ira Kurthen University of Zurich

Jolanda Galbier, University of Zurich Moritz M. Daum, University of Zurich Martin Meyer, University of Zurich

Age-related hearing loss is not only a disorder of the inner ear, but also of the brain, which has to complement the degraded speech input while incurring structural and functional declines. This "central" hearing loss manifests itself in various aspects of the brain, such as integrity of its structure, but also in its functional properties. For example, ageing is associated with a change in absolute and relative oscillatory power in different frequency bands of the human electroencephalogram (EEG), which have consistently been found to be related to speech comprehension. Specifically, oscillatory power changes in the alpha frequency band (8-12 Hz) are related to inhibition of irrelevant stimulus information. In the current study, while their EEG from 128 electrodes was recorded, 24 older adults (aged 65-80 years) with varying degrees of sensorineural hearing loss listened to an audiobook in four different background noise conditions, embedded in a 2×2 design: The number of talkers as well as the signal-to-noise ratio were varied. We tested to what extent the modulation of alpha oscillations as a proxy for older adults' inhibition of irrelevant stimulus information would predict speech understanding in these challenging listening environments. Additionally, inhibition was measured behaviourally via a flanker task. The results showed that the behavioural measurement of inhibition predicted the ability to follow a target speaker in multi-talker background noise. However, this was not related to the modulation of alpha oscillations during the task. Also, while we found that even within a sample of older adults, age predicted the amount of alpha desynchronisation over the time course of a trial, this in turn did not predict the ability to follow the target stimulus. The results suggest that inhibition is a relevant ability for suppressing background noise, but that the function of alpha oscillations in this context warrants a more thorough investigation.

The effect of verb type on language processing as revealed by event-related potentials

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Semantic reversal anomalies (SRAs) are a linguistic manipulation known to elicit differential event-related potential (ERP) responses as a function of language. However, recent research suggests that the elicited ERP response can also be modulated by verb type. Typical English SRAs involving agentsubject verbs (ASVs; e.g., The crimes will commit the culprits on the street) elicit a P600, but SRAs involving experiencer-subject verbs (ESVs; verbs describing a psychological state such as *please*) have been found to elicit an N400-P600 pattern. The present study aimed to replicate the within-language ERP modulation and additionally investigate whether task type affected the ERP. Participants (N = 48; M_{age}= 23.2 years; 32 female) read SRAs and control sentences in a rapid serial visual presentation paradigm. They performed a judgement or comprehension task while their electroencephalogram was recorded. Data were analysed using linear mixed-effects models. As predicted, violations at the position of the ASV (i.e., commit) elicited a P600 effect. Task also modulated the ERP response: The judgement condition showed an unexpected significant N400 effect, and a larger P600 amplitude, than the comprehension condition. For the ESV verb (i.e., *please*), the predicted N400-P600 pattern was not observed. In the comprehension task, violations elicited a significant N400 response, with no significant effects in the P600 time-window. In the judgement group, neither the predicted N400 nor the P600 were observed for violation verbs. These results support the claim that verb type influences the ERP pattern elicited by SRAs, but the observed patterns differ from those in previous research. Additionally, task type modulates the ERP pattern to both ASV and ESV SRAs. Further research is required to understand the complex modulatory role of both task and verb type on the ERP correlates of language comprehension. L.K. is supported by an Australian Government Research Training Program Scholarship.

Oxytocin modulates socioemotional brain regions in older adults

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Markus Heinrichs, Freiburg University Juan Dominguez, Australian Catholic University Sally Grace, Australian Catholic University Lincoln Tracy, Australian Catholic University Gill Terrett, Australian Catholic University Peter Rendell, Australian Catholic University

Why should the young get all the attention? More than a decade of research shows that the neuropeptide oxytocin is a key mediator in the regulation of human brain processes that underlie social cognitive functions in young adults. However, little is known about oxytocin and social cognition in the ageing population. It is likely that oxytocin is also very important in the declining social cognitive skills of older adults. Using MRI to establish a neurobiological basis, we examined whether oxytocin manipulation differentially modulated key brain regions involved in social cognition in older and young adults. Participants included a pilot sample of 16 young (19-35 years; 8 females) and 16 older adults (62-80 years; 8 females). All participants underwent two separate functional magnetic resonance imaging (fMRI) scan sessions, during which they carried out an emotion recognition task (of angry, sad, fearful, happy and neutral faces). During each scan session, participants administered an intranasal spray dose of either 24 IU of oxytocin, or placebo. Region-of-interest amygdala analyses revealed a significant increase in right amygdala activity in older men on oxytocin (vs. placebo) to angry (p < .05, d = 1.13) and happy faces (p < .05, d = 0.44). Thus, oxytocin eliminated the age differences in males observed during placebo for angry (d = 1.17) and happy (d = 0.47) faces. The current study provides support for an age-by-sex modulatory role of oxytocin in restoring social cognitive brain functions for at least some emotions, which may be linked to neurobehavioural differences with age and sex.

Individual differences in anxiety and fear learning: The role of working memory capacity

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Anxiety disorders are characterised by the perception of fear and threat in stimuli that are neutral or ambiguous. Attempts in previous research to explain the relationship between anxiety and fear learning have been inconsistent, possibly due to the influence of an unmeasured mechanism that mediates the relationship between them. Working memory capacity has been suggested as one such mechanism. The current study investigated the influence of anxiety-based individual differences upon associative fear learning, while accounting for individual differences in working memory. We hypothesised that individuals high in both anxiety and working memory would show unimpaired fear learning whereas individuals high in anxiety and low in working memory would exhibit dysfunction on fear learning. Sixty participants completed a battery of anxiety and working memory tests, as well as a fear conditioning experiment that tested for blocking, conditioned inhibition and fear discrimination. We found that anxious individuals were more likely to show impaired fear discrimination only if they also had a low working memory capacity. Furthermore, anxiety was particularly associated with poorer learning about safety cues. Such relationships were not observed for blocking and conditioned inhibition. These results suggest that the relationship between anxiety and fear learning is complex and warrants further investigation of the potential mediating role of higher-order cognitive faculties.

Testing the unified model of vision and attention: Activation in dorsal and ventral visual stream structures during attentional orienting

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High-density EEG was used to test the prediction of our "unified model of vision and attention" that in a visual orienting task, landmark cues will elicit evidence of early activation in dorsal stream structures, while identity cues will elicit evidence of early activation in ventral stream structures. Participants moved their eyes left or right, in order to decide whether a peripherally presented digit was 2 or 7. Target digits were preceded by bilateral letter cues. In the landmark cueing task, targets usually appeared on the same side as a letter (e.g., X) designated as the "landmark", and opposite a letter (e.g., T) designated as the "counter-landmark". In the identity cueing task, participants were presented with two identical cue letters on every trial, and targets usually appeared on the left if both cues were, for example, X, and on the right if both cue letters were, for example, T. Early components of the event-related potentials elicited by cue stimuli were evaluated, prior to onset of muscle-related activity associated with the eye movement. When cues were presented at peripheral locations our theoretical predictions were borne out. During the early P1 epoch, more supra-threshold voxels were observed in dorsal stream structures in response to landmark cues compared to identity cues (79 vs. 8, p < .001). During the same epoch, more supra-threshold voxels were observed in ventral stream structures in response to identity cues compared to landmark cues (103 vs. 19, p < 001). Both effects were replicated during the peak P1 epoch. A different pattern was observed when landmark and identity cues were presented in central vision: Here, early dorsal stream activation was observed in response to both kinds of cue. Implications of these findings for our theoretical model are discussed. This project was funded by a Marsden Fund awarded to A. L.

Motor inhibition and lateralised sensorimotor entrainment after learning a bimanual musical pattern

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Human movements are spontaneously attracted to auditory rhythms. Previous research has shown automatic activation of the motor system when individuals listen to auditory rhythms, a phenomenon called sensorimotor entrainment. The spontaneous ability for sensorimotor entrainment is central to music perception and production, and the strength with which the motor system responds to rhythmic stimuli is affected by expertise. Here, we evaluated brain rhythmic activity and cortico-muscular coherence while non-musicians listened to a rhythmic pattern composed of low-pitch and high-pitch sounds before and after learning how to produce the pattern bimanually. Electroencephalography (EEG) and electromyographic (EMG) activity from the left and right First Dorsal Interosseous and Flexor Digitorum Superficialis muscles were recorded concurrently while participants applied constant low-intensity pressure on a force sensor held between the thumb and index finger as they listened to the rhythmic pattern before and after the bimanual training session. During the training session, participants learnt to play the rhythmic pattern-guided by visual cues and auditory feedbackby pressing the force sensors with their left or right hands in order to produce the low- and high-pitch sounds, respectively. Preliminary results indicate that training significantly increased the power of sensorimotor alphaband, suggesting greater deactivation of motor areas associated with greater effort in order not to play along following training. Furthermore, correlation analysis on the coherence between EEG and EMG signals suggest that motor entrainment became lateralised after training. Left- and right-hand EEG-EMG coherence, which was positively correlated over time before training, became negatively correlated after training. Altogether, these findings show that learning how to produce a musical pattern bimanually modulates sensorimotor entrainment, as evidenced by EEG rhythms and cortico-muscular coherence.

Does self-identified cultural background mediate the relationship between spatial attention and visual perception?

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The ability to scale spatial attention to either a narrow or broad region of the visual field has long been thought to influence all aspects of visual processing. However, recent work has shown that this is not the case. While narrowing attention improves performance on parvocellular-mediated spatial-acuity tasks, performance on magnocellular-mediated temporal-acuity tasks remains unaffected. Here, we tested whether this pattern of selective spatial enhancement was consistent across participants who self-identified as being from either a Western or East Asian cultural background. This is because a growing literature suggests that cultural background influences thinking styles, and subsequently, attentional scaling. While East Asians are thought to have a holistic thinking style, and prefer a broad scale of attention, Western individuals have an analytic thinking style, and tend to prefer a narrow attention scale. In the current study, 45 East Asian and 42 Western identifying participants completed a shape-inducer task designed to manipulate attention scale, and completed both spatial and temporal acuity tasks used to measure parvocellular and magnocellular mediated processing, respectively. Similar to past research, preliminary results suggest that attention scaling influenced parvocellular, and not magnocellular processing. Furthermore, this relationship held for both East Asian and Western identifying participants. Thus, despite showing differences in preferred attention scale, it appears that the effect of scaling on visual perception is similar across individuals of differing cultural backgrounds. Future research aims to directly test if preferred thinking styles, irrespective of cultural background may mediate this relationship. This research is supported by Australian Government Research Training Program Scholarships awarded to R.K.L, and J.A.C, and an Australian Research Council (ARC) Future Fellowship awarded to S.C.G (FT170100021).

The effect of sleep deprivation on local/global processing in the broader autism spectrum

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Alongside social-communication difficulties and repetitive behaviours, Autism Spectrum Disorder (ASD) often presents with comorbid sleep

disturbance. Previous work has demonstrated an association between sleep difficulties and daytime behavioural problems in those with ASD. However, these correlations cannot determine the causal nature of this relationship. This study aimed to investigate whether one aspect of the broader cognitive profile of ASD, the tendency to demonstrate a local bias in perceptual processing, rather than the more typical global precedence found in neurotypical populations, would be exacerbated by sleep deprivation. Two groups of neurotypical adults were recruited on the basis of having high or low selfreported autism traits, as assessed by the Autism Spectrum Quotient (AQ). Participants completed a Navon task to assess global and local visual processing after a normal night's sleep, and after a full night of sleep deprivation. Navon stimuli were hierarchical letters with a global shape created from smaller letters. Participants were required to detect a target letter appearing at either global-only or local-only (incongruent) level, or appearing at both levels (congruent) on different trials. Local (or global) interference was calculated as the reaction-time difference between congruent and global-only (or local-only) conditions. A mixed-design ANOVA (AQ group, global/local level, sleep condition) revealed a significant three-way interaction. Simple main effects suggested that the low-AQ group showed stronger local interference after sleep deprivation, whereas the high-AQ group, who started with stronger local interference were not similarly impacted by sleep deprivation. These results indicate that whilst sleep deprivation does appear to cause an increased local bias in visual processing, this was only evident in those lower on the autism spectrum. Future studies will need to examine this effect in clinical samples.

Binge drinking and the teenage brain: Evidence from a systematic review and meta-analysis of neural and cognitive dysfunction

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Background: Binge drinking is the most common pattern of alcohol use among young people in Australia. Alcohol use during adolescence and young adulthood has a higher potential for neurotoxicity and interference with ongoing neural and cognitive development. The purpose of this systematic review was to identify neural and cognitive antecedents, correlates and consequences of binge drinking in youth aged 10 to 24 years. Methods: Five peer-reviewed databases were systematically screened against eligibility criteria designed to synthesise studies that examined a young binge drinking sample and used neuropsychological, neurophysiological or neuroimaging techniques. Studies were excluded if participants had been clinically diagnosed with an alcohol use disorder, or any psychiatric, neurological or pharmacological condition. Results: A total of 57 studies met the eligibility criteria and were included in the review. A meta-analysis of neuropsychological correlates identified that binge drinking in youth was associated with deficits in recent memories (g = -0.69) and executive functions (g = -0.69) -0.34), including decision-making (g = -1.70), inhibition (g = -0.28) and working memory (g = -0.69). Identified vulnerability factors that may predispose youth to binge drink included smaller brain volume and surface area, attenuated growth in white matter structures, aberrations in brain activity during executive-functioning tasks, and poorer decision-making ability. These factors were further exacerbated by the uptake of binge drinking, in addition to deficits in delay discounting, visuoconstructional functioning and sustained attention. Discussion: This review was the first to synthesise neuropsychological, neurophysiological and neuroimaging studies examining binge drinking in youth. Vulnerability markers for binge drinking were identified and may be utilised as potential training targets for prevention and early intervention initiatives to avert the effects of long-term use.

General anaesthesia reduces integrated information in flies

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Dror Cohen, Center for Information and Neural Networks Bruno van Swinderen, University of Queensland Naotsugu Tsuchiya, Monash University The integrated information theory of consciousness (IIT) proposes integrated information (Φ) as a potential measure of both quantity and quality of consciousness. However, the most recent and theoretically attractive version of integrated information, Φ 3.0, is limited in its applicability to biological networks due to its high computational costs. Here, we applied this latest derivation to increasingly larger sets of multielectrode local field potential recordings obtained from different regions across the fly brain during wakefulness and anaesthesia, and compared it to both an alternative derivation which is computationally cheaper to apply to neural recordings, Φ^* , and the uni- and bi-variate measures power and coherence. We found both versions of integrated information to be reduced by isoflurane anaesthesia, and the reduction in Φ 3.0 allowed for better discrimination between awake and anaesthesia conditions than the other measures. for both classification within individual flies and classification across flies. We further found the magnitude of Φ 3.0 for a set of recordings to be positively correlated with the $\Phi3.0$ magnitudes of its constituent subsets of recordings. Together, these results push Φ 3.0 as a measure of consciousness and have direct implications in increasing the feasibility of its application to large sets of recordings.

Neuronal mechanisms of predictive coding in the primary visual cortex of the macaque

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A central tenet of predictive coding theory is that expectations about the future should modulate brain activity at the earliest stages of sensory processing. However, most evidence for the theory comes from human neuroimaging work. To date there has been no definitive test of the effects of stimulus expectation on responses of single neurons in early cortical areas. Here we determined whether neuronal activity in the primary visual cortex (V1) of awake, behaving monkeys is affected by expectation, independently of repetition suppression (adaptation). Fixating macaques were presented with successive pairs of gratings. In each pair, the second stimulus either repeated the orientation of the first (match) or had an orthogonal (nonmatch) orientation. The probability of each of these two trial types was either 80% match (expected pair) and 20% non-match (unexpected pair), or the opposite combination. Local field potentials (LFP) were recorded in area V1 to test for effects of prediction (expected versus unexpected orientations) on neuronal responses. We found significant LFP changes in response to unexpected stimuli in the theta frequency range, with a significantly larger V1 response to unexpected versus expected stimuli from 120-500 ms after onset of the second stimulus within a pair. The effect of an unexpected match of the two stimuli occurred between 120 and 200 ms after stimulus onset in deeper cortical layers, whereas the effect of an unexpected non-match developed later (250-500 ms after stimulus onset), had a larger amplitude and was evident across all cortical layers. Effects of repetition were associated with response maxima in V1. However, in contrast to human EEG data, we observed two types of repetition effect: suppression and enhancement. Thus, our intra-cortically obtained data support the existence of both expectation and repetition effects in primate V1, but with a more complex profile for the latter than anticipated based on previous human studies.

Behavioural inattentiveness, orienting attention, and executive attention predict reading accuracy in first-year school children

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There is evidence that behavioural attention and cognitive attention, in particular orienting and executive attention, are associated with reading ability. There is a lack of research on how behavioural and cognitive attention together may explain literacy levels in children. This study investigated if alerting, orienting, and executive attention predicted literacy skills in children. Participants were 248 children (144 males) aged 5–7 years ($M_{age} = 76$ months, SD = 5 months). Children performed a modified Attention Network Task (ANT), and the Early Years and Passage Reading components of the York Assessment of Reading Comprehension (YARC). The children's teachers completed the Strengths and Weaknesses in ADHD Symptoms and Normal-Behaviour scale (SWAN). For each literacy measure, a regression analysis was run with SWAN Hyperactivity-Impulsivity and Inattentive subscales (SWAN-H, SWAN-I) in the first step; and response-time indices of the alerting, exogenous and endogenous orienting, and executive attention networks, as well as the executive attention network accuracy index, in the second step. Phonemic Awareness and Single Word Reading were significantly predicted by SWAN-I, explaining 9% of the variance. Step two did not improve the model for either measure. Passage Reading Accuracy was significantly predicted by SWAN-I (24% variance explained); endogenous orienting speed and executive attention accuracy significantly explained an additional 6% variance. Passage Reading Comprehension was significantly predicted by SWAN-I (25% variance explained); step two did not significantly improve the model, but endogenous orienting was a significant predictor explaining an additional 4% variance. Behavioural hyperactivity-impulsivity, alerting and exogenous orienting are not predictors of literacy. In contrast, behavioural attentiveness, the ability to accurately resolve visual conflict, and the ability to orient attention based on internal rules, are important for reading accuracy.

When prediction fails: Correction for extrapolation in the flash-grab effect

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Tessel Blom, University of Melbourne Hinze Hogendoorn, UoM & Utrecht University

Motion-induced positions shifts constitute a broad class of visual illusions in which motion and position signals interact in the human visual pathway. In such illusions, the presence of visual motion distorts the perceived positions of objects in nearby space. One explanation for such effects is in terms of predictive mechanisms, which could contribute to compensating for neural transmission and processing delays. However, such mechanisms have struggled to explain why we do not usually perceive objects extrapolated beyond the end of their trajectory. Advocates of this interpretation have proposed a correction-for-extrapolation mechanism to explain this. When the object motion ends abruptly, this mechanism corrects the over-extrapolation by shifting the perceived object location backwards to its actual location. However, such a mechanism has not been empirically demonstrated. Here, we use a novel version of the flash-grab illusion to demonstrate this mechanism. In the flash-grab effect, a target is flashed on a moving background that abruptly changes direction. We manipulate the angle of the direction change to dissociate the contributions of the background motion before and after the flash. Consistent with previous reports, we observe that perceptual mislocalisation in the flash-grab illusion is mainly driven by motion after the flash. Importantly, however, we reveal a small but consistent mislocalisation component in the direction opposite to the direction of the first motion sequence. This provides empirical support for the proposed correction-for-extrapolation mechanism, and therefore corroborates the interpretation that motion-induced position shifts might result from predictive interactions between motion and position signals.

Measuring switching costs between different demands on attention

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In 1927, Jersild first described the idea of task switching. Today, task switching or set-shifting is commonly used under the umbrella term of executive functions and describes humans' ability to frequently shift between different cognitive tasks. While previous studies mostly focused on the rapid switching between small sets of simple tasks, the attentional demand of used tasks is somehow neglected. However, in the modern world—which is characterised by technical progress and new innovations—switching between tasks of selective attention (e.g., analysing data), divided attention (e.g., meetings), and other demands, such as vigilance (e.g., the drive to work) is ubiquitous. To address this aspect, we developed a task-switching paradigm that allows us to measure switching costs between tasks of selective attention, between which the participants have to switch. On the one hand, the selective-attention task asks participants to respond

to one type of stimulus and to ignore others. On the other hand, in the divided-attention task participants have to respond to various, different stimuli by pressing different buttons. Aiming to validate the paradigm at hand, we used multitrait-multimethod analysis to test for convergent and discriminant validity in a large sample size of different age groups. First results show an effect of switching between divided- and selective-attention tasks on the performance of selective attention. Along with the combination of these two demands on attention, further demands, such as vigilance need to be considered. Furthermore, future studies should additionally address neural correlates of switching between different demands of attention, by using EEG and fMRI.

The expression of bradykinin and its receptors in spinal cord ischemia-reperfusion injury rat model

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Objective: To investigate the expression of bradykinin (BK) and its receptors (Bradykinin receptors 1 and 2; B1R and B2R) in spinal cord ischemia-reperfusion injury (SCII) in rat model. **Methods:** Sprague-Dawley (SD) rats were subjected to 1h of infra-renal abdominal aorta occlusion and reperfused for 3 h to 5 d to induce SCII. The concentration of BK in serum was detected by enzyme linked immunosorbent assay (ELISA). In situ expression of BK receptors was evaluated by immunochemistry and their mRNA level was evaluated by real time quantitative-PCR (RTq-PCR). **Results:** The concentration of BK in serum was increased following SCII. Both of the BK receptors were detected in normal and injured spinal cord. And the mRNAs of B1R and B2R were up-regulated after SCII. **Conclusion:** This study provides the first evidence of the expression of BK and its receptors in SCII in rat model, and suggests that BK and its receptors may have some physiological or pathological significance in SCII.

Development and early validation of a Bayesian spelling model

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Written language is a uniquely human phenomenon involving recognition (reading) and production (spelling). In English, production is more complex than recognition, as the relationship between graphemes (letters) and phonemes (sounds) is not equal. That is, there are more ways to spell a pronunciation than there are ways to pronounce a spelling. Despite the known complexity of language production, models of spelling are typically less sophisticated than those of reading and do not adequately examine the cognitive mechanisms underlying spelling. A novel spelling model was developed in response; a simple network based on Bayesian decision making. This paper will present the development and early validation of the Bayesian spelling model. Current spelling models propose that the first stage of spelling is learning the relationships between letters and sounds: phonology. As phonology is explicitly taught in the early years of schooling, the model was trained with words from the grade-one to grade-three spelling curriculum and tested with words used in a previous NAPLAN computerised dictation task trial of grade-three students. Comparison of the model's responses with those of the students revealed statistically similar accuracy and error patterns. As the model has been shown to reproduce human spelling behaviour, this not only establishes validation of the model but also reveals information about the decisions that spellers are making in the phonological stage. Ongoing validation and examination of the model will provide further insight into human spelling behaviour and the cognitive processes underlying written language production. Further, it is anticipated that this information could be used to inform and improve spelling education.

Impaired perceptual sensitivity with intact attention and metacognition in functional motor disorders

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Functional motor disorders (FMDs) are a subset of motor disorders characterised by motor abnormalities that lack distinct neurological origin. Their pathophysiology is poorly understood but there is evidence that irregularities in perceptual and cognitive processing lie at the heart of these conditions. In this study, we draw on a predictive processing account of functional neurological disorders to study perceptual decision-making in three groups: 20 patients with FMDs, 20 with phenotypically-matched organic motor disorders, and 20 age-matched healthy controls. We examine four cognitive domains with putative roles in FMD pathogenesis: attention, expectations, sensory processing and metacognition. We employ an augmented version of the visual dual-task paradigm to investigate these domains within a single psychophysical experiment. By psychometrically adjusting sensory input (stimulus contrast) to threshold performance at a fixed level for all groups, FMD patients exhibited statistically equivalent attentional, expectational and metacognitive processing to healthy controls. However, to reach these performance thresholds they required stimulus contrast strength to be significantly increased. This increase was statistically equivalent to the contrast strength required by organic patients and could not be accounted for by medication use or comorbid psychopathology. Further, organic patients showed differences in attentional and expectational processing that were not observed in either healthy controls or the functional group. We relate these findings to an account under predictive processing that characterises the distinctive behavioural profile of FMD as arising from abnormalities in basic sensory processing with higher attentional, expectational and metacognitive mechanisms remaining intact. Our study demonstrates that conceptualising functional neurological disorders under the predictive processing framework may consolidate and refine existing theories about them.

The influence of prior expectations on conscious face perception depends on emotion

Ms Jessica McFayden University of Queensland

Part of the symposium Prediction, prediction-error, and the brain

Our survival depends on how well we can rapidly detect threats in our environment. Threatening or rewarding visual stimuli are thought to reach conscious awareness faster than neutral stimuli so as to facilitate this process. Unexpected events may also indicate a potential threat, and yet we tend to respond slower to unexpected than expected stimuli. It is unclear if or how these effects of emotion and expectation might interact with one's conscious experience. Would we become aware of threats faster if they were expected, unexpected, or does it not matter? In this study, we used breaking continuous flash suppression (bCFS) to investigate how quickly neutral and fearful faces break into consciousness when they are either expected or unexpected. Across three behavioural experiments, we show that fulfilled prior expectations accelerated conscious access to neutral faces but had little to no effect on fearful faces, which were faster to break through overall. In the third experiment, we also examined the time course of neural activity, recorded with EEG, to see when expectation effects emerged for neutral and fearful faces. Using a machine-learning approach we showed that the patterns of neural activity associated with conscious perception formed more rapidly for expected than unexpected faces, regardless of emotion. These findings present a novel interaction between emotion and expectation during interocular suppression, which has important implications for how different neural networks might convey prediction errors for neutral and emotional stimuli under ambiguous visual conditions.

Facilitation of movement initiation and execution via task-irrelevant sensory stimulation

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Welber Marinovic, Curtin University Ottmar Lipp, Curtin University James Tresilian, University of Warwick

Loud acoustic stimuli presented during movement preparation can substantially shorten reaction time and increase response vigour. We aimed to examine how muscle connectivity and prepared movement force affect reaction time and movement execution when the motor response is triggered by an intense acoustic stimulus. In Experiment 1, participants executed ballistic wrist flexion and extension movements of low and high force in response to visual stimuli. In probe trials, a loud acoustic stimulus (105 dBa) was presented simultaneously with the visual imperative stimulus (IS). In Experiment 2, participants executed ballistic wrist flexion movements ranging from 10–50% of maximum voluntary contraction with a loud acoustic stimulus presented randomly in a subset of trials. Results show that the facilitation of response initiation was not changed by muscle connectivity or prepared movement force. Facilitation of response magnitude, however, was greater for flexors and for low force movements. Changes in peak force induced by the intense stimulus indicated that the neural activity introduced to program circuits by acoustic stimulation is additive to the voluntary activity in program circuits responsible for movement preparation and initiation, rather than multiplicative.

Temporal order biases behavioural and neural measures of stimulus encoding in a complex perceptual decisionmaking task

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A number of models have been put forward to characterise the accumulation of sensory evidence from a single source in simple decision-making tasks. In the real world, however, perceptual decisions often involve averaging over multiple sensory signals, and can include noisy internal representations of previously viewed stimuli held in working memory. Here we developed a novel paradigm to investigate such complex perceptual decisions based upon multiple, temporally separated visual stimuli, with the goal of characterising the relative contributions of each stimulus to the final decision. Participants were instructed to report the average orientation of a pair of gratings presented consecutively at fixation. The orientations of the two stimuli, which were varied from trial to trial, were regressed onto the average response to determine the relative weighting of each stimulus in the decision. Participants' responses were also analysed using a mixture distribution model to characterise decisions in terms of guesses, swap errors and target responses. The regression analysis revealed a strong recency effect, such that participants relied more heavily on the orientation carried by the second grating in their average decision. The precision of participants' memory for the first and second gratings was assessed by intermixing reproduction trials amongst averaging trials, and employing a post-cue design to probe representations of the two orientations independently. We also used electroencephalography and forward encoding modelling to extract orientation-selective neural responses to each of the gratings. Preliminary findings are broadly consistent with the behavioural data in suggesting that the more recent of the two stimuli is represented with higher fidelity. We suggest that this recency bias reflects strategic retrieval of more precisely represented stimuli rather than passive memory decay.

Dissociable roles of phase-locked and non-phase-locked theta in task-switching

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In task-switching paradigms, switching tasks and repeating the same task in amongst switch trials both result in slower RT and poorer accuracy, effects typically referred to as switch and mixing costs, respectively. Event-related potentials (ERPs) and total time-frequency power analyses have shown that these performance costs are related to differential preparation for switch and repeat tasks during the cue-target interval (CTI) and implementation of the different or the same task-set after target onset. Time-frequency EEG power analysis receives independent contributions from both phase-locked activity associated with stimulus-related activity (like the ERP) and nonphase-locked activity likely to reflect ongoing processes over longer time frames (typically removed when extracting the average ERP). In the present study, we used a cued task-switching paradigm to examine whether phaselocked and non-phase-locked power are differentially modulated by switch and mixing effects in intervals associated with the need for proactive control (CTI) and reactive control (post-target). Switch and mixing effects were found in both phase-locked and non-phase-locked power, primarily in the theta band but also extending into alpha and beta bands. Phase-locked theta

activity closely resembled the total power, and was consistent with switch and mixing positivities typically seen in the task-switching paradigm. Nonphase-locked analyses showed theta/alpha power effects for both switch and mixing effects that were typically sustained across the CTI into the posttarget interval. Importantly, non-phase-locked frontal theta activity was predictive of RT mixing cost. Non-phase-locked effects were also evident in the beta band, with parietal pre-target beta predicting both RT mixing and switch costs. These findings provide novel insight into dissociable transient and sustained processes contributing to switch and mixing costs that are not evident with ERP or total time-frequency analyses.

Using rapid-MVPA to investigate target and distractor processing during the attentional blink

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Rapid serial visual presentation (RSVP) paradigms have yielded important insights into the temporal limits of perception and attention. However, it is difficult to investigate the neural mechanisms underlying behavioural effects during RSVP using electroencephalography (EEG). This is because the fast stimulus presentation results in overlapping cognitive processes. While clever subtractive designs can begin to tease them apart, the number of trials that are required to ensure good signal-to-noise in EEG measurements provides a constraint such that traditional EEG analyses are only able to examine a small number of discrete stimuli within each stream-and often this can be just one stimulus. In the present study we utilised multivariate pattern analysis (MVPA) to disentangle processing related to each of the stimuli that occur within an RSVP stream. Participants viewed sequences of object images and were required to identify two target objects amongst distractors. In this kind of paradigm, identification of the second target (T2) is typically impaired if it appears within approximately 500 ms of the first target (T1); a phenomenon known as the attentional blink (AB). Preliminary analyses indicate that the 'decodability' of neural representations of T2 stimuli is degraded if they occur during the period of the AB. Furthermore, supporting previous AB research, representations of correctly- and incorrectly-identified targets begin to diverge approximately 300-400 ms poststimulus onset. Finally, using this approach we are also able to investigate distractor-related processing to investigate how the temporal position of distractor stimuli following T1 affects the level of processing that can be decoded. Overall, rapid-MVPA provides an extremely efficient method of investigating neural processing of overlapping stimuli that occur in paradigms such as RSVP.

Risk factors for problematic ecstasy use

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Patrick T. Goodbourn, University of Melbourne Olivia L. Carter, University of Melbourne Gillinder Bedi, Orygen

A key objective in drug-use research is to understand the development of substance-use problems. Extensive research has examined the risk factors for problem use of many abused drugs, providing valuable information for targeted intervention, prevention, and education. However, little is known about the factors contributing to problematic ecstasy use. While most users consume ecstasy relatively infrequently, a proportion of users report problematic use, and experience adverse social, psychological and health-related consequences not seen in non-problem users. The current study investigated several hypothesised risk factors for development of problematic ecstasy use in two experiments. In Experiment 1, data obtained as part of a larger brain-imaging study were analysed to investigate how sex and impulsivity are related to problematic ecstasy use. Healthy, non-treatment-seeking ecstasy users (N = 52) were administered 1.5 mg/kg 3,4-methylenedioxymethamphetamine and a placebo in separate sessions, and completed a variety of measures. No significant associations were found between either sex or impulsivity and problematic use. However, this experiment was limited by strict exclusion criteria and the use of a proxy measure of problematic use. In Experiment 2, sex, impulsivity, psychological distress and coping motives for use were investigated as predictors of problematic ecstasy use. Ecstasy users (N = 600) completed an online survey. We found that while problematic use was not associated with sex, it was predicted by impulsivity and psychological distress in a combined mediation model, with the latter

relationship partially mediated by coping motives. These results indicate that targeting motives for use may be useful in efforts to prevent the development of problematic ecstasy use among recreational users—particularly those experiencing psychological distress—who, together with those high on trait impulsivity, may be at a greater risk of problematic use.

Acute aerobic exercise and non-invasive brain stimulation measures of motor cortical plasticity: A systematic review

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Mitchell Goldsworthy, University of Adelaide Scott Coussens, University of South Australia Ashleigh Smith, University of South Australia

Engaging in some forms of regular aerobic exercise is associated with acute increases in brain health measures, however, the underlying biological mechanisms of this relationship are not yet fully understood. One potential mechanism is exercise-induced enhancement of neuroplasticity. The aim of the current systematic review was to synthesise the existing literature investigating if acute aerobic exercise influences the response to experimentally induced neuroplasticity paradigms, assessed with transcranial magnetic stimulation (TMS). A systematic search of databases Medline, PsycINFO and Embase was undertaken on 26 April 2018, which resulted in six studies (containing eight experiments). Studies were included if they involved a bout of aerobic exercise; prescribed a bout of rest as a control condition; utilised a non-invasive brain stimulation paradigm to manipulate plasticity; used TMS to assess plasticity outcomes; participants were required to be healthy, 18-65 years old, with no diagnosed neurological/psychological impairment. All included studies utilised cycling as their exercise modality. Three types of plasticity paradigms were assessed in the included studies: paired-associative stimulation (PAS), continuous theta-burst stimulation (cTBS) and intermittent theta-burst stimulation (iTBS). Five of the included experiments reported a priming effect of exercise on the brain, suggesting that lower limb aerobic exercise has the ability to facilitate plasticity of a non-exercised upper limb. The greatest changes were observed when participants completed a shorter bout of high intensity interval exercise or a longer bout of low-to-moderate intensity continuous exercise preceding the plasticity paradigm. Further replication of these studies, as well as research in larger samples of older participants and in clinical populations, is recommended to confirm the aerobic exercise prescription that is most effective in inducing motor cortical plasticity.

Real-world transfer from a virtual world

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Using virtual reality (VR) as a tool for training is becoming increasingly popular. Training programs for surgeons, pilots, and firefighters are taking advantage of the realism and flexibility VR offers. A key assumption of VR training is that the learned skills and experiences transfer to the real world. Yet, in certain areas of application, such as VR sports training, there is a lack of research testing this assumption. The present study aimed to investigate transfer effects from VR sports training to the real world using the fastpaced sport table tennis. That is, it was examined whether VR table tennis training improves real-world table tennis performance compared to no training. Fifty-seven participants were either assigned to a VR training group (N = 29) or no-training control group (N = 28). Over a 3-4-week period, the VR group completed six 30-minute sessions of VR table tennis training. During training, participants were immersed in competitive table tennis matches against an AI opponent. An expert table tennis coach evaluated participants on a real-world table tennis setup before and after the training phase. Blinded regarding participants' group assignment, the expert assessed participants' backhand, forehand, and serving on quantitative (e.g., count of rallies without errors) and qualitative (e.g., technique and consistency) aspects. VR training significantly improved participants' real-world table tennis performance compared to a no-training control group in both quantitative and qualitative aspects. This study adds to a sparse yet expanding literature demonstrating real-world transfer from VR training. A next step will be to investigate whether transfer is limited to table tennis or whether training in a fast-paced sport also leads to improvements in hand-eye coordination, concentration and reaction ability.

Afterimages appear longer, but not brighter, under reduced viewing conditions

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Afterimages are vivid shadow-like impressions of images the eye retains from a stimulus no longer present in the visual field. Afterimages can be difficult to examine due to their subjective nature and as a consequence, they remain poorly understood. We aimed to shed light on this area by determining to what extent removing various depth cues impacts the perception of afterimages. An exploration into how this phenomenological experience may be affected by different viewing conditions is unprecedented. We previously reported the effects that depth cues had on the size of afterimages when projected at different viewing distances (ACNS 2017). This year, we present their vividness, onset, and duration. Afterimage vividness refers to brightness or intensity, while onset and duration respectively denote the time taken for the afterimage to first appear, and the interval between the first appearance and final disappearance of the afterimage. Participants (N = 30) projected afterimages induced by a ring of LEDs onto a board presented at ten distances under binocular, monocular, and eyes-closed viewing conditions. ANOVA revealed that viewing condition did not have an effect on afterimages vividness, F(2,44) = 1.22, p = .29, but did have an effect on the time it took for an afterimage to appear F(1,33) = 10.24, p = .002, and for how long the afterimage persisted F(1,36) = 11.53, p = .0009. Specifically, our findings show there is little consistency in the vividness of afterimages for each participant across conditions, which is in contrast to previous reports of afterimage stability at an individual level. Our data also highlight how selective attention may serve to increase afterimage strength. When viewed under the complete darkness afforded by closing one's eyes, afterimages became more salient to the viewer and took a substantially longer time to appear and dissipate when compared to both the binocular and monocular viewing conditions.

Multiple object monitoring: Measuring sustained attention to dynamic displays when targets are rare

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Alexandra Woolgar, University of Cambridge Mark Wiggins, Macquarie University Jeremy Wolfe, Brigham and Women's Hospital & Harvard Medical School William Helton, George Mason University Anina N. Rich, Macquarie University

There is a global shift towards semi-automated systems in our environment, where a human operator has to monitor the system in case of an error, but rarely has to act. These environments are often high-risk, such as in the case of power-generation and transport control. Such monitoring conditions take their toll, potentially resulting in reduced task performance over time. Classic vigilance tasks, however, lack many of the features of these real-world environments, making it difficult to determine factors that contribute to performance. We designed a task to systematically manipulate factors that are important in real-world monitoring environments. Here we present the results of an initial series of experiments in which participants monitor multiple moving dots for potential collisions. We manipulated the degree to which selection is required, the perceptual and tracking load of the task, and the time participants have to respond to a collision. In all conditions we see a decrease in performance, measured in d', over time, with the exception of situations in which the task load is extremely low. This effect did not depend on perceptual load, tracking load, or time participants had to respond. These experiments form a baseline for exploring factors that can improve performance in modern monitoring environments, increasing our understanding of sustained attention. This work was funded by ARC Discovery Project DP170101780.

Associations between EEG functional brain connectivity and a cognitive reserve proxy measure in healthy older adults

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Cognitive reserve is a concept that explains individual differences in vulnerability to cognitive impairment due to age and dementia-related neurodegeneration. The underlying mechanisms of the cognitive-reserve effect are unknown. We investigated associations between a comprehensive cognitive-reserve proxy (Lifetime Experiences Questionnaire; LEQ) and connectivity of the prefrontal cortex across the whole scalp, covarying for the level of current cognitive functioning (Addenbrooke's Cognitive Examination Revised; ACE-R), using multiblock parallel and orthogonalised partial least squares regression. EEG data were collected from 34 healthy older adults (63 to 83 years) in eyes-open and -closed resting states, and 0- and 1-back tasks. Functional connectivity was estimated using imaginary coherence in the theta and alpha frequency bands, as these bands have been heavily implicated in attention and executive functions, along with cognitive ageing. We found two clusters of electrodes where the absolute value of the regression coefficient was above threshold when covarying for ACE-R: (1) a cluster approximating the right parietotemporal region during a O-back task in the theta band with seed electrodes approximating right prefrontal cortex and (2) a cluster approximating the occipitoparietal region in the eyes-closed condition in the alpha band with seed electrodes approximating the left prefrontal cortex. Regression coefficients of clusters were negative with medium effect sizes. These inverse relationships between a cognitivereserve proxy and resting-state connectivity, within key networks and frequency bands associated with attention and executive function, is suggestive of more efficient use of fronto-parietal functional connections.

Beyond average: Modelling and characterising variability to enable valid and accurate predictions

Dr David Moreau

University of Auckland

Recent failed attempts to replicate numerous findings in psychology and neuroscience have raised concerns about methodological practices in our field. More caution appears to be required when summarising and modelling data, to enable accurate out-of-sample predictions. Here, I provide an additional element to this ongoing discussion, by arguing that signal variability, although commonly discarded in traditional cognitive neuroscience analyses, often includes meaningful and essential information. I will first illustrate how these practices can have detrimental consequences and blur evidence in entire fields of research, using examples in cognitive neuroscience research. Then, I will discuss alternative or complementary methods to better model and represent the rich information inherent to behavioural and neural data. Finally, I will conclude by emphasising the importance of probabilistic modelling in this context, in a Bayesian framework, to provide more genuine and valid inferences from complex data sets. Part of a broader effort to facilitate replication and stronger inferences, this line of work allows refining estimates of variability in our data, therefore enabling finer, more accurate evaluations of a set of individual observations, a series of experiments, or a body of research.

A novel neurocomputational model of the effect of dopamine medication and deep brain stimulation on gait dysfunction in Parkinson's disease

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Parkinson's disease (PD) is a motor disorder associated with reduced levels of dopamine in the basal ganglia and prefrontal cortex. Here, I will discuss simulation results of a novel neurocomputational model that simulate the effect of subthalamic deep brain stimulation (STN DBS) as well as dopaminergic medications on gait dysfunction. The model incorporates interactions among the cortex, basal ganglia, and cerebellum. I simulated PD by decreasing the dopamine level parameter in the model. Results show that the model captures empirical findings related to tremor and gait dysfunction in PD patients. Additional simulation studies show that while dopaminergic medications can ameliorate tremor (but not gait) in a subset of PD patients, STN DBS can effectively manage both tremor and gait dysfunction. I further discuss several applications of this model for the treatment of PD.

Examining emotional strength for individuals with low and high autistic tendency: A new method for controlling variance

Miss Eveine Mu Swinburne University of Technology

David Crewther, Swinburne University of Technology

Face sets used in affective research may be flawed with inconsistent emotional intensity between actors, with selected actors being too expressive or not expressive enough for a particular emotional state. This inconsistency may in turn influence averaged responses and the reliability of comparison between studies. Here we introduce a novel psychophysical technique, and apply it to populations with spectral autistic traits, where emotional-processing differences are known to exist. The test stimuli comprised eight actors expressing increasing degrees of emotional intensity, morphing from a neutral to a full-intensity happy or fearful expression (30 frames). We assessed individual differences in the intensity of stimuli required to confidently identify the target emotion, where greater intensity equates to poorer sensitivity. These responses were compared for groups of neurotypical adults with low (N = 19) and high (N = 20) scores on the Autism Spectrum Quotient (AQ). We found the low-AQ group required greater emotional intensity to conceptually identify fearful and happy expressions than the high-AQ group. Importantly, problematic actors were identified and adjusted to allow the formation of group-specific and controlled facial stimulus sets, with smaller variance in emotional strength between actors. We aim to utilise the updated face sets in future experimental designs.

Stress in the eye of the beholder: The effect of environment, psychosocial and physiological stress on refractive error in undergraduate students

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Loretta Giummara, Susan Ball, Kayla Caruso, Raoul Das, Claudia Drescher, Shona Flynn, Fiona Grassi, Michael Mihatsch, Aleshia Nanev, Donne Opperman, Alysha Prasad, Ayse Sakar, Abbey Smith, Jessica Soccio, Sehaj Singh Sran, Jack Stephens, Catherine Turner, Melissa Wilson, Naadirah Yakub, Celine Jiawen Yang, Agnes Hazi, & Sheila Crewther, *La Trobe University*

Evidence has shown that the incidence of myopia (short-sightedness) is increasing significantly worldwide. This is particularly true in urban and highly educated populations where lifestyle factors can lead to exposure to high levels of stress, with little time to engage in outdoor recreational activities. The current study first investigated the relationship between lifestyle factors, study habits, recreational activities, family history, state/trait anxiety, and visual acuity, refractive state, intraocular pressure and visuomotor coordination in first-year La Trobe University students enrolled in a Bachelor of Psychological Science degree. We then examined the effect of acute psychosocial stress on vision in the same students by comparing the vision measures taken in the first study, along with indices of autonomic nervous system (ANS) arousal (heart rate, blood pressure and salivary cortisol secretion), with the same vision and ANS measures taken immediately following an assessed oral presentation. Results showed that, while the rate of myopia was not as high as that observed in other populations, there were relationships between vision and the measures investigated in the first study. The second study confirmed that giving an oral presentation does increase ANS arousal, but changes in vision measures were more variable and could be moderated by individual differences such as family history and trait anxiety. In conclusion, the current investigation suggests that academic demands that influence lifestyle factors, as well as individual differences and family history, could influence a shift in refraction and visual acuity. Such a shift could be driven by repeated exposures to acute stressors that lead to a change in ANS activity that allows for initially an adaptive change in vision that could progress to higher levels of myopia. Further research is required to determine whether changes in vision following acute stress are transient or sustained.

Attentional bias in PTSD and depression: An eye-tracking study

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Mixed results have been shown in studies investigating attentional bias in trauma-related mental-health disorders. Three participant groups with a history of war-trauma exposure (trauma control, major depressive disorder, and PTSD group) were presented with a pictorial forced-choice eye-tracking task while their eye movements were tracked. The task consisted of 16 trials of four emotions (positive, dysphoric, neutral, and trauma) presented simultaneously on the screen for 30 s. Attentional-profile data of the three groups will be presented. Results from this study have the potential to further our clinical and theoretical understanding of PTSD, as delineating the attentional profile of trauma-related mental-health disorders has significant clinical and theoretical implications. Habituation to trauma stimuli is linked to a decrease in PTSD symptomatology. However, for habituation to occur, one must intentionally engage with, rather than avoid, trauma-related stimuli. Therefore, understanding the relationship between attention and PTSD is clinically significant.

Perinatal risk factors in early childhood cognition: Evidence from Growing Up in New Zealand

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The antenatal period plays a critical role for foetal brain development. Poor maternal physical and mental health and disadvantageous environmental exposures during pregnancy as well as unfavourable perinatal events are associated with adverse trajectories in offspring development. However, earlier research has mainly focused on how these factors influence children's health and psychosocial well-being. The effects on cognitive domains in early childhood is less understood and requires further investigation. The aim of the present research was to examine the association between perinatal characteristics and children's early cognitive development across three cognitive domains: inhibitory control, motor abilities and receptive language. Analyses comprised data from 5202 children and their mothers enrolled in the longitudinal, population-based Growing Up in New Zealand study. Mothers' sociodemographic profile, health and perinatal characteristics were collected in interviews during pregnancy and after birth. Children's inhibitory control (Luria hand clap task), motor skills (mothers' report) and receptive language (Peabody Picture Vocabulary Test) were observed at age 4.5 years. Covariates included maternal age, education and ethnicity, socioeconomic status, rurality, whether the pregnancy was planned, and the child's age and gender. Multivariate logistic regression analyses showed that the odds of performance below average in cognitive domains were increased in various adverse perinatal characteristics (i.e., smoking, no folate intake, perceived stress during pregnancy, low birth weight). Adverse perinatal features are related to early cognitive development and appear to influence a broader range of cognitive abilities. Improving maternal education and support for health during pregnancy is recommended in order to reduce the potential impact of deleterious maternal health behaviours on early cognitive development. The limitations of this study will be discussed.

Salivary endocannabinoids show stress reactivity and are associated with cognitive performance in healthy women

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Caleb Stone, University of Tasmania David Nichols, University of Tasmania Kim L. Felmingham, University of Melbourne Raimondo Bruno, University of Tasmania Allison Matthews, University of Tasmania The endocannabinoid system is reported to be involved in an increasingly wide range of functions, with seemingly great potential for therapeutic manipulation. In psychiatric research, the endocannabinoid system is a key mediator of the stress response and has been implicated in anxiety disorders and post-traumatic stress. Similarly, endocannabinoids may also be important to cognitive functioning, forming part of the biological aetiology of disorders such as Alzheimer's and schizophrenia. To date, endocannabinoid research has been limited in humans due to the necessity of invasive techniques such as blood sampling to assess acute responding. Using a novel method for quantifying endocannabinoid levels in saliva, we tested the responsivity of salivary endocannabinoids to the Maastricht Acute Stress Test (MAST). Further, we tested whether salivary endocannabinoids were associated with performance on the N-back task, which measures the workingmemory aspect of cognitive functioning. Preliminary data in a group of 23 healthy females shows trending reactivity of the endocannabinoid anandamide to stress compared to controls, with a reduction in salivary anandamide following the MAST observable in the stress compared to control condition. Interestingly, we also found that anandamide as well as other endocannabinoids are associated with behavioural performance on the N-back task following stress. These results show for the first time the utility of salivary endocannabinoids in acute responding, and further support the role of the endocannabinoid system in cognitive outcomes.

"I did stop!": An ERP study examining neural processing during successful, partial and unsuccessful inhibitions

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Response inhibition is often considered to be an all-or-none event, depending on whether a key-press has been registered. However, not all inhibited trials are alike. For example, it is observed that participants will sometimes initiate, but suppress their responses before they are completed. These trials are referred to as partial inhibitions, and there is evidence that brain activity during these trials is different from completely inhibited trials (successful inhibitions). However, distinctions between partial and complete failures to inhibit (unsuccessful inhibitions) are unclear. This study explored the differences between partial and unsuccessful inhibitions, with a focus on inhibition- and error-related ERPs as well as movement kinematics. Two separate experiments were conducted (Experiment 1, N = 25; Experiment 2, N= 14) where participants completed a response-inhibition task (Experiment 1, Anticipatory-timing stop-signal task; Experiment 2, Standard go/no-go task). Movement kinematics (force, RT) and ERPs (nogo-P3, ERN, Pe) to successful, partial and unsuccessful inhibitions, as well as go trials, were examined. Results were similar across experiments. Firstly, partial and unsuccessful inhibition trials pertained to different distributions in force. Secondly, nogo-P3 and Pe showed significant reductions in amplitude as a function of success (successful > partial > unsuccessful inhibitions). Notably, follow-up analyses indicated that the nogo-P3 occurred after movement onset and coincided with Pe, suggesting that these differences are likely related to outcome evaluation. Lastly, despite the observation of an ERN-like negativity, no discernible ERN effect was observed. Overall, this study demonstrates a clear behavioural and electrophysiological distinction between partial and unsuccessful inhibitions and raises questions about interpreting how outcomes are evaluated in these tasks.

Event-related potentials reflecting processing of centresurround visual stimuli are affected by physiological ageing

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Our perception of visual stimuli is influenced by the surrounding context, e.g. the perceived contrast of a target is reduced when surrounded by a high-contrast pattern. Centre-surround contrast suppression is typically stronger when the centre and surround patterns are of the same orientation (parallel) than when oriented orthogonally. Although the physical contrast is the same, perceptually parallel and orthogonal centre-surround stimuli appear markedly different. Here, we predicted that the neural activity elicited in response to parallel and orthogonal centre-surround stimuli, measured using event-related potentials (ERPs), differs. Given that healthy ageing affects centre-surround suppression, we also predicted that ERPs to centre-surround stimuli would differ between older and younger groups. The electroencephalogram (EEG) was continuously recorded (sampling rate 512 Hz, bandpass filter 0.1-70 Hz) from 64 scalp locations in 18 younger (aged 19-33 years) and 18 older (aged 60-77 years) adults. The visual stimulus (150 ms duration) was a vertical centre grating (1 c/°, 0.67° radius, 20% contrast), surrounded by either a vertical (parallel) or horizontal (orthogonal) grating annulus (1 c/°, 4° radius, 40% contrast). The first positive peak (P1) recorded from the occipital (Oz) electrode was analysed. Overall, the older group showed delayed peak latency, F(1, 33) = 16.46, p < .001, and larger peak amplitudes, F(1, 33) = 7.18, p = .01, in response to both parallel and orthogonal centre-surround stimuli. Only older adults showed an effect of orientation, i.e., P1 amplitudes for parallel stimuli were larger than for orthogonal stimuli, F(1, 33) = 5.34, p = .03. Orientation did not influence P1 peak latency (group \times orientation interaction, p = .72). By recording electrophysiological responses to centre-surround stimuli that are commonly used to investigate visual perceptual suppression, our findings suggest an orientation-specific effect of ageing on visual processing.

The role of transient ischemic attack and minor stroke on task-switching performance in older adults

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Transient ischemic attack and minor stroke (TIAMS) are brief ischemic incidents with a full functional recovery. However, up to 68% of patients show subtle cognitive deficits, primarily impacting executive functions (EF) and daily living. Disruption to frontal networks supporting efficient EF can result in subtle cognitive changes, even if patients have recovered clinically. The present study examines whether TIAMS is associated with decline in taskswitching performance, a task sensitive to EF. Participants (N = 68, 48-83years) with adjudicated TIA, MS and mimic-TIA (clinically shown to have not had a neurological effect) completed a cued-trials task-switching paradigm to derive mixing cost (e.g., task maintenance) and switch cost (e.g., task updating). TIAMS groups did not differ on mixing or switch cost for correct and error RTs. However, significant age effects (median split at 70 years) were found on both mixing and switch cost. RT distributions are ex-Gaussian, i.e., have a long tail that reflects intra-individual variability (IIV), and is often associated with attentional lapses contributing to reduced EF. We examined whether estimates of IIV derived using ex-Gaussian modelling are more sensitive to changes as a result of ischemic event. We estimated μ and σ of the normal component (linked to motor-control deficits) and τ (the combined mean/standard deviation) of the exponential component (associated with attentional lapses). Again, there were no effects of TIAMS group on ex-Gaussian parameters. However, older adults showed increased μ and σ than younger adults, and increased effects of mixing cost on these parameters. As vascular risk factors tend to vary with age, we further examine their role in this age effect.

Neuromuscular coupling in rhythm perception

Patti Nijhuis

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When we hear music we often tap along with our foot, which is one of the many demonstrations of humans spontaneously synchronising to environmental rhythms. Although spontaneous synchronisation behaviours are often encountered in daily life, their underlying neural mechanisms remain largely unknown. Recently, rhythmic stimuli have been shown to modulate ongoing neural oscillations. More specifically, the amplitude of beta-band oscillations around 20 Hz–which is generally associated with movement production–display time locking to periodic stimuli even without moving to them, suggesting an explanation for (spontaneous) movement synchronisation. Here we tested whether the time-locked modulations of the amplitude

of beta-band neural oscillations extends to the coupling of muscular activity and thereby explains the drive to move synchronously. We computed betaband corticomuscular coherence (CMC), which corresponds to the correlation between the spectral content of electroencephalographic (EEG) and electromyographic (EMG) signals, in response to auditory ternary rhythmic patterns (e.g., Waltz). The patterns consisted of 3-Hz stimuli with 1-Hz accentuation. Pattern presentation was either Discrete (D; 50-ms tones) or Continuous (C; sinusoidal amplitude modulation), resulting in 4 variations: D[1Hz]-D[3Hz], C[1Hz]-C[3Hz], C[1Hz]-D[3Hz], D[1Hz]-C[3Hz] and a control condition without stimulation. In all conditions, participants maintained constant pressure with their right index finger at 7% of their maximum voluntary exerted force while EEG and EMG of the flexor digitorum superficialis muscle were recorded. Preliminary results show decreased CMC for the D[1Hz]-D[3Hz] presentation of the Waltz pattern, which might be related to previously shown decreases in 20-Hz beta-band power and spontaneous modulation of activity in motor areas. These results suggest that discrete stimuli modulate neuro-muscular coupling in a manner that could support spontaneous behavioural synchronisation.

Investigating the mechanisms of selective inhibition of planned actions in young and older adults

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Inhibitory control is a critical aspect of human behaviour that degrades with advancing age. We are often required to inhibit one component of an action while continuing to execute other components. Here we use analyses of muscle activation patterns and computational modelling to provide insights into the neural and latent psychological mechanisms underlying this selective stopping behaviour. In Experiment 1, healthy young (19–40 years, N =28) and older (> 60 years, N = 28) adults completed a modified stop-signal task requiring simultaneous responses with the left and right index fingers. Stop signals occurred on 30% of trials requiring inhibition of either response (selective stop) while continuing to execute the contralateral response, or inhibition of both (non-selective stop) responses. Electromyographic (EMG) recordings enabled covert muscle activity (partial responses) to be observed in successfully inhibited trials. Significant delays in the non-cancelled response were observed in selective stop trials, which were longer for older, compared to young, adults (p = .001). EMG data revealed that partial responses occurred in a high proportion of correctly inhibited selective and non-selective stop trials, challenging the assumption of a traditional horserace model. Older adults exhibited more frequent partial bursts on selective stop trials (p < .001) indicating more age-related deficits in selective inhibition. Experiment 2 (19–40 years, N = 36) investigated whether proactive cues (indicating that a left or right selective stop trial might occur on a particular trial) could facilitate effective selective stopping both in terms of behavioural performance and more efficient inhibition of muscle activation. While cues led to reduced response delays in selective stop trials (p < .001) they did not affect stop-signal reaction time (p = .99). Moreover, cues did not significantly reduce the presence of covert muscle activation during correctly inhibited trials.

Cortical involvement in visual statistical learning of shape identities

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Visual statistical learning describes humans' ability to extract patterns and structure from the environment to enhance behavioural performance. Early lesion work suggested that subcortical structures, particularly the hippocampus and striatum, were critical for this learning to emerge. More recently, in neuroimaging studies, along with this subcortical involvement being consistently reported, learning has been linked with activity in cortical areas. While some findings point to a larger parietal-hippocampal network for memory, direct causal evidence of the cortical contribution remains limited. In previous work, we found that frontoparietal areas were involved in statistical learning for spatial configural information. Here, we sought to
extend this work to learning that acts on object identities. Across two preregistered experiments we found evidence for cortical involvement in the early phase of statistical learning via identity information. In Experiment 1 (N = 150; 3 groups) we investigated visual statistical learning (Fiser & Aslin, 2001) whereby passive exposure to shape arrays leads to above-chance familiarity for embedded shape-pairs. We used cathodal tDCS to perturb the left posterior parietal cortex during both the exposure and test phases, but found no effect of stimulation on behaviour compared with sham stimulation or stimulation of an active control region. In Experiment 2 (N = 80; 2 groups), we employed the same pair stimuli but created a novel paradigm with an active task that provided an online measure of learning and its time course. Applying the same stimulation parameters, we saw that tDCS influenced early statistical learning operations. Specifically, stimulation improved learning in the early epoch compared with sham. Collectively, these findings provide additional support for the hypothesis that there is causal involvement of cortical areas in a generalised visual statistical learning mechanism.

Investigating dopamine-specific projections in the human striatum with resting-state fMRI

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The striatum is a key component of the dopaminergic system and has been implicated in substance abuse. The non-invasive investigation of dopaminergic functioning is problematic as current fMRI approaches are unable to distinguish dopamine-specific from other projections in striatum. Here we use connectopic mapping (CM), a novel resting-state fMRI-based method enabling characterisation of overlapping modes of functional connectivity. We focus on the third dominant mode of connectivity in striatum and aimed to demonstrate that this mode maps onto dopaminergic projections and can be used as a marker for dopamine-related dysfunction in substance abuse. We applied CM to resting-state fMRI data of 839 subjects of the Human Connectome Project (HCP). We selected the third striatal connectivity mode and computed its spatial correlation with dopamine transporter availability (DAT)-a marker for dopaminergic projections-as shown by DAT SPECT imaging in 209 controls of the Parkinson's Progression Markers Initiative. Next, we applied trend surface modelling (TSM) to summarize the third striatal connectivity mode by fitting trend coefficients that optimally combine a set of spatial polynomial basis functions. In the 30 highest alcohol users of the HCP dataset (\geq 3 daily alcoholic drinks over the past week), we investigated associations of the TSM coefficients modelling the third striatal connectivity mode with the amount of use within the GLM framework. The third striatal connectivity mode displayed remarkably high similarity with DAT availability as revealed by the DAT SPECT scan (spatial correlation = 0.88). Furthermore, significant associations were present between the TSM coefficients modelling the connectivity mode and the amount of alcohol use $(\chi^2 = 26.8, p = .008)$. Our findings provide compelling evidence that the third striatal connectivity mode maps onto dopaminergic projections and can be used a biomarker for investigating dopamine-specific alterations in striatum.

The influence of head motion on structural connectivity under different diffusion imaging processing pipelines

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Head motion is a key confound in neuroimaging studies. Most investigations of this problem to date have focused on how motion affects functional connectivity. By comparison, we have a poorer understanding of how motion impacts on structural connectivity as measured using diffusion MRI. Given the many choices available for processing diffusion MRI data, some of which explicitly try to address motion and others which may indirectly influence what effect motion has, a comprehensive analysis of how different processing pipelines mitigate or exacerbate motion contamination in structural connectivity analyses is required. In this present study, using a healthy adult sample (N = 100), we investigated how connection weights in brain structural networks are impacted by in-scanner head motion across different

processing pipelines. We compared different choices related to explicit head motion correction, tissue masking methods for track seeding, tractography algorithms, track seeding methods, track weighting methods, and parcellations. Every possible combination of these choices was examined, resulting in a comparison of 240 pre-processing pipelines. We found that cross-subject correlations between head motion and structural connectivity strength were more prominent when using both fractional anisotropy to measure connection strength and when less extensive motion correction was applied (i.e., a simple realignment as compared to additional correction for intra-volume motion and outlier values), with 8-23% of connections significantly affected by motion. In all other pipelines, motion only affected 2-8% of connections. Additionally, head motion was not related to systematic increases or decreases in connectivity strength. Together, the results indicate that the impact of motion on structural connectivity is low compared to functional connectivity, but can still be mitigated by the appropriate choice of pre-processing steps.

The cerebral scars of parenthood: A study of parenthood on the late-life brain

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Early motherhood (pregnancy and early post-partum) delivers significant physical, emotional and environmental change, affecting every component of the human body. Recent evidence suggests early motherhood results in changes in cortical thickness, which are sustained 2-years post-partum. The persistence of these effects into old age is unknown. Rodent studies show a cognitive benefit of parenthood for both sexes; and, at least in female rodents, these benefits are sustained into older age. However, very little is known about the enduring effects this period has on the structure and function of the human brain. Even less is known about how fatherhood affects the male brain. We compared the cortical thickness of 70 brain regions between individuals with one child and individuals with no children in 82 elderly subjects, 36 male (73.4 \pm 3.7 years) and 46 female (72.8 \pm 3.3 years). We also examined the "dose" effects of parity (i.e., number of children) on cortical thickness. We correlated the number of children (range 1-6 children) with the cortical thickness of 70 brain regions for 247 males (74.1 \pm 3.5 years) and 209 females (73.9 \pm 3.4 years). For both sexes, parents and non-parents differed in cortical thickness in regions of the socio-affective network. In addition, females also showed differences in thickness between mothers and non-mothers in regions that underlie executive function. The effect of parity was only evident for females, showing a negative relationship between number of children and cortical thickness in regions implicated in higher-order cognitive functioning, including social cognition and episodic memory. Our results are the first to reveal distributed differences in cortical thickness related to parenthood that are evident beyond the postpartum period. Our findings overlap substantially with the areas found in early motherhood, suggesting that neural changes associated with early parenthood are permanent changes that persist into older age.

The N170 visually evoked potential, violated expectations, and prediction error

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For most people, visual perception is a dominant source of information for guiding cognition and behaviour. Early visual processing is a crucial period in which bottom-up gives way to top-down processing. This study used the N170 visual ERP (150–220 ms post-stimulus) to investigate top-down mechanisms, by which the brain detects mismatch between its prediction of sensory input and incoming sensory information (prediction error). We have already shown the brain can discriminate facial identity (not just form) at this stage, so this study sought to confirm those findings and test whether it applies to other visual categories. The study had four parts, each having two "identities" from within a visual category: human faces, built landmarks, natural landmarks, and tools (hammers and axes). EEG recorded responses to ambient (highly variable, naturalistic) images presented randomly and rapidly (500 ms per stimulus; 0-ms ISI)—different images of a frequent (highprobability) identity and an infrequent (low-probability) identity. This design manipulated expectation about stimulus identity (at a conceptual level,

rather than an image-identity level) based on probability, and ensured that response could be time-locked to change of identity (within visual category). We hypothesised that when context (probability) generates expectancy about identity, an unexpected (low-probability) identity will trigger increased N170 amplitude compared to a high-probability identity, as the brain detects prediction error (a top-down process), and that this response will not be confined to faces. ERP waveforms and statistical results supported the hypothesis, showing increased N170 response to low-probability identity in all visual categories. This suggests the N170 ERP is not simply a stimulus-driven response to particular visual forms—at ~200 ms post-stimulus the brain uses top-down processes to generate context-based prediction and detect prediction error.

The P2 encodes prediction error in surface segmentation, independent of stimulus features and rarity

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The visual system quickly registers perceptual regularities in the environment and responds to violations in these patterns. Errors of perceptual prediction are associated with electrocortical modulation, including the mismatch negativity (MMN) and P2. Are these prediction-error signals reflective of lower-level perceptual features, or could they encode higher-level properties like stimulus configuration? Using a roving standard paradigm, a triangle surface appeared either behind (featuring amodal contours) or in front of (featuring real contours) a second surface with hole-like windows. A surface layout appeared for 2-5 repetitions before switching to the other layout; lighting and orientation of stimuli varied across presentations. Observers responded when they detected a rare 'pinched' triangle which occasionally appeared. Cortical activity (reflected in the P2 amplitude) was sensitive to a change in stimulus layout, when surfaces shifted position in depth, following several repetitions. This P2 difference (a prediction error of surface segmentation) was independent of accompanying P2 differences encoding surface layouts and the relative rarity of specific stimulus arrangements. Comparison of the effect of repetition on this prediction-error signal suggests that it is all-or-none and not graded with respect to the number of previous repetitions, while stimulus rarity does drive a graded P2 modulation. We show that within the visual domain, unnoticed and task-irrelevant changes in scene segmentation lead to observable signals of prediction error that are dissociable from specific stimulus encoding and relative rarity.

Dissociating imagery and perception: The opposing effects of imagined and perceptual stimuli on visual adaptation

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How similar are the neurophysiological mechanisms of visual mental imagery and visual perception? Recent research has shown that imagery activates similar visual areas, albeit less strongly, as perception. Likewise, behavioural work suggests imagery has comparable effects to weak perceptual stimuli. This has led to the assumption that mental imagery operates like a weaker form of perception, where neuronal spiking in lower-level visual areas during imagery is driven by feedback connections from higher visual areas. However, neurophysiological research does not necessarily support an increase in neural spiking via feedback in these areas. Rather than driving spiking, it is possible that mental imagery can be explained by ongoing reshaping of the endogenous activity in low-level visual areas, mainly due to inhibitory influences from feedback. The current experiments investigated this hypothesis using visual adaptation and binocular rivalry. Vertical and horizontal Gabor patches were simultaneously presented to participants (one in each eye) causing binocular rivalry. Presenting either oriented Gabor alone for 3 s beforehand would bias participants to see the opposite oriented Gabor in binocular rivalry. This is caused by visual adaptation, where prolonged spiking of neurons coding for a particular stimulus leads to fatigue. This in turns makes the subsequent perception of that stimulus during binocular rivalry less likely. If mental imagery involves increases in neuronal spiking in low-level visual areas, adding mental imagery to visual perception of the same stimulus should cause an increase in the effects of visual adaptation (i.e., 3-s perception + 3-s imagination = greater adaptation). However, results showed the opposite effect: Imagery reversed the adaptation state caused by the perceptual stimulus, leading to more priming. This suggests that mental imagery involves a qualitatively different representational mechanism from visual perception.

Transdiagnostic variations in impulsivity and compulsivity across obsessive-compulsive disorder and gambling disorder correlate with effective connectivity in corticalstriatal-thalamic-cortical circuits

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Cortical-striatal-thalamic-cortical (CSTC) dysfunction is implicated in a wide array of symptomatically dissimilar disorders yet understanding of CSTC dysfunction across disorders is still lacking. We examined effective connectivity within CSTC circuits in a transdiagnostic framework looking at obsessive-compulsive disorder (OCD) and gambling disorder (GD). Specifically, we characterised the relationship between effective connectivity and dimensional phenotypes of disinhibition, impulsivity, and compulsivity. These phenotypes have a known association with CSTC function and are both implicated in OCD and GD. 579 participants were recruited to model the above phenotypes using structural equation modelling. A subset of 32 OCD patients, 21 GD patients, and 38 healthy controls also underwent resting-state functional Magnetic Resonance Imaging, upon which Dynamic Causal Modelling was used to uncover the strength and direction of connectivity between regions in the dorsal and ventral CSTC circuits. This approach allowed us to untangle top-down versus bottom-up dysfunction in CSTC circuits. Effective connectivity in CSTC circuits was found to covary with disinhibition and compulsivity when collapsing across diagnostic groups. Individuals with higher disinhibition showed reduced bottom-up connectivity in the dorsal circuit as well as increased bottom-up connectivity in the ventral circuit. Individuals with higher compulsivity also showed reduced bottom-up connectivity in the dorsal circuit. Despite only small correlations between clinical severity and our phenotypes, similar changes in effective connectivity were observed with increasing clinical severity. This demonstrates that the variation in effective connectivity explained by our phenotypes was clinically relevant. Critically, CSTC effective connectivity was better characterised by dimensional phenotypes than typical case-control or case-case comparisons.

Using long-duration EEG to explore complexity-based measures of levels of consciousness

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It has recently been claimed that measures of complexity, such as entropy and Lempel-Ziv compressibility, may provide an index of an individual's level of consciousness. Such analyses use algorithms originating in Information Theory and assess signal diversity in space and time. These studies use neural imaging data, such as electroencephalography (EEG), and typically involve comparing conditions of reduced or altered consciousness, with periods of resting wakefulness. However, wakeful rest is not necessarily representative of the entire range of conscious waking. In fact, very little is known about the degree to which such measures might fluctuate, either with or without a corresponding change in consciousness. The present study investigates complexity-based measures of consciousness by using long-duration EEG. Seventy-four hours of continuous EEG data was recorded and then sleep scored into categories: Awake, Stage N1 sleep, Stage N2 sleep, Stage N3 sleep, Rapid Eye Movement (REM) sleep, and Wake-After-Sleep-Onset. Preliminary analyses reveal that mean Lempel-Ziv complexity (LZc) of the EEG signal was significantly higher than all other categories when Awake and significantly lower than all other categories during Stage N3 sleep (deep non-REM sleep). This initial analysis supports the notion that complexity measures might indicate differences in consciousness during waking and unconsciousness during sleep. However, LZc was unable to differentiate other sleep stages (Stage N1, Stage N2, and REM sleep), or differentiate sleep from the brief periods of wake during the sleep period (Wake-After-Sleep-Onset). Further analysis will explore other sources of variation across the conscious waking range and investigate additional entropy-based complexity measures. This study will for the first time provide insight into the nature and variability of EEG-complexity measures of consciousness, by utilising the unique perspective of long-duration EEG recording.

Volatility of neural states in task-free conditions

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So-called resting-state or task-free fMRI gives us insight into the fluctuations and operations of the brain when not focused on any specific task. Sub-second sampling times in fMRI are now routinely available. The last fifteen years have seen a great deal of work emerge characterising the spatial networks of the brain under task-free conditions. These networks have often been time averaged in nature, necessarily not revealing any dynamics. High spatial and temporal resolution fMRI data for 200 individuals was obtained from the publicly available Human Connectome Project. The fMRI data, 2-mm isotropic, TR 720 ms, MB 8 were spatially preprocessed, cleaned of artefacts using the FIX pipeline and Dual Regression ICA was used to extract nodal time series over multiple ICA dimensions (scales). Across multiple scales the nodal time series were fit using the Hierarchical Gaussian Filter, a Bayesian time-series filter framework, to extract trajectories describing the volatility of the original nodal time series. Summary measures of these volatility estimates, including dwell time, were used to characterize higher-order behaviour of the individual neural states across multiple spatial scales. Whilst there is great inter-individual variability in the fluctuations of neuronal states, distributions of dwell times and volatilitybased functional connectivity measures reveal surprising commonalities across individuals. Ultimately, being able to fit time-series models to individual voxel time series in a computationally efficient manner is needed to uncover neural dynamics across multiple temporal and spatial scales.

Investigating the effects of touch in social interactions

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Touch is interpersonal, as it is shared between beings who have some mutual relation to one another, whether an intimate long-term relationship or a superficial one, and can be used to convey thoughts and feelings between conspecifics. We asked, participants to evaluate their own and someone else's preference of "which body part they prefer to touch", during observed human social touch. Participants were shown pictures of an avatar, face-on, which had an upper body to either side of it, comprised of the neck, arm and palm. Avatars expressed preferences to one of the two bodies (left or right) and one of the three body parts (neck, arm and palm), indicated through combining positive/negative facial expressions, positive/negative gestures, and head orientation. Participants were asked to infer their own (1st-person mentalising) and the avatar's (3rd-person mentalising) preference. Furthermore, driven by the notion that humans are highly susceptible to the happenings in their social environment, we introduced a third condition where the avatar showed no preference towards either body/body part (neutral condition), and asked participants to again evaluate their own preference. This allowed us to examine how social touch interactions may influence our subjective preferences. Overall, participants were faster in the neutral condition, than in the 1st-person mentalising and 3rd-person mentalising conditions. Although, participants' preference was centred on the palm during the neutral condition, this was extended to include the arm and neck during 1st-person mentalising condition, suggesting that the avatar's interaction with a specific body part influenced participants' preference. In addition, participants were highly accurate in inferring the avatar's 'preference', and showed that they were inclined to respond faster to positive facial expressions and gestures than negative, implying that they may share the touch recipient's experience.

The mechanisms of size perception inferred by continuous flash suppression and interocular transfer

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Early visual structures, like the primary visual cortex (V1), have an active role during size perception. We examined interocular transfer in a priming task both within and outside of awareness using continuous flash suppression (CFS). Specifically, stimulus sequences in which a prime and target that were either size-congruent or size-incongruent could be presented in succession to the same eye (monocular condition) or separately to each eye (dichoptic condition). This design enables one to infer the relative contributions of early and later visual structures, as monocular channels remain segregated in early visual areas (like V1 and earlier), but begin to coalesce in the cortex (V1 and beyond). Thus, equivalent reaction times across same and different eye presentations (i.e., interocular transfer) would highlight the importance of later visual areas. Thirty-five participants (M_{age} = 25.2 years) completed the experiment. Participants categorised a target stimulus as either small or large. Trials varied prime visibility (CFS vs. visible), prime and target congruency (congruent vs. incongruent size), and eye presentation (monocular vs. dichoptic). A three-way ANOVA revealed a Congruency × Visibility interaction, F(1, 34) = 6.08, p = .02, $\eta^2_p = .15$, which was driven by priming effects in the visible (p < .05, d = .25, BF₁₀ = 18.45) but not CFS (p = .99, d = .03, $BF_{10} = 0.23$) conditions. There was also an Eye × Visibility interaction, F(1,34) = 17.10, p < .01, $\eta^2_p = .34$, which was driven by a monocular advantage under CFS (p < .01, d = .36, BF₁₀ = 91.25), whereas monocular and dichoptic presentations were equivalent during the visible condition (p = .97, d = .03, BF₁₀ = .21). Taken together, priming effects in the visible but not CFS conditions suggest that awareness is an enabling factor for size perception to occur. Further, we can infer that this is likely mediated by later visual structures, as there was complete interocular transfer of the size information.

Effect of uncertainty on judgements of agency in autism Ms Kelsey Perrykkad Monash University

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While most research in Autism Spectrum Conditions is around differences in social cognition, there is also evidence that self-cognition is different (Frith & Happé, 1999; Hobson, 2011; Huang et al., 2017; Lombardo & Baron-Cohen, 2011; Molnar-Szakacs & Uddin, 2016; Uddin, 2011; Williams, 2010). Previous research suggests that judgement of agency is intact in autism (David et al., 2008; Grainger, Williams, & Lind, 2014; Russell & Hill, 2001; Williams & Happé, 2009). However, in all these studies, unlike in the real world, the relationship between the performed action and the expected consequence in the target was fully predictable. In our study, we add uncertainty to this relationship, by manipulating the variability and volatility of the sensory consequence in a task inspired by these previous studies. We are interested in differences in epistemic foraging with respect to inferring self as cause. We measure eye tracking as a proxy for hypothesis testing, behavioural performance and strategy, and collect autism quotient (AQ) scores from a neurotypical population. Initial findings (N = 19) suggest that (as expected) performance decreases in the high-variability condition, F =21.78, p < 0.001, despite increased sampling of the environment, F = 16.74, p < 0.001. Movement strategy is also significantly different between conditions, suggesting that a context of environmental uncertainty of different kinds (primarily volatility) affects policy selection (inferring which series of action maximally reduces uncertainty). We also found that policy selection under uncertainty interacts with AQ, however analysis of AQ with a small sample that is skewed towards high scores has proven uninformative overall. We provide hypotheses for eye tracking results and AQ.

Frequency-dependent alterations in amplitude of lowfrequency fluctuations in response to energy intake in ageing

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David White, Swinburne University of Technology Andrew Scholey, Swinburne University of Technology Healthy ageing has been associated with reduced appetite and energy intake and associated weight loss, which is a major contributing factor to undernutrition and adverse health outcomes. This reduction in caloric intake with increasing age has been termed anorexia of ageing. The causes for anorexia of ageing are multifactorial involving physiological and non-physiological aspects. Here we examined age-related physiological changes in brain responses associated with energy intake (glucose loading). A sample of younger (N = 16, 21-30 years) and older adults (N = 16, 55-78 years) free from major psychiatric or medical conditions participated in this randomised, double-blind, balanced, cross-over trial. Participants attended two experimental sessions after an overnight fast. On one visit they received a drink containing glucose and on the other occasion received a tastematched placebo. Blood glucose and hunger were assessed at baseline and 20 min post-ingestion, and participants underwent resting-state functional magnetic resonance imaging (rsfMRI). We examined frequency-dependent changes in slow-5 (0.01–0.027 Hz) and slow-4 (0.027–0.073 Hz) amplitude of low-frequency fluctuations (ALFF) and fractional ALFF (fALFF). There was a significant treatment \times age-group interaction in slow-5 ALFF and fALFF in the left insular cortex. Younger participants showed a decrease in BOLD amplitude, whereas older participants showed an increase. Decreased neuronal activity in brain areas related to energy homeostasis like the insula is commonly reported after energy intake in healthy adults. Here we show evidence of differential, age-related changes in the magnitude of the BOLD signal in a key region related to energy homeostasis after the ingestion of glucose compared to placebo. Further research is suggested to identify differences in homeostatic brain networks to understand physiological changes the brain undergoes in ageing and to identify targets for interventions against anorexia of ageing.

Efficacy of dynamic visuo-attentional interventions for reading in dyslexic and neurotypical children: A systematic review

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Dyslexia is associated with phonological and visuo-attentional deficits. Phonological interventions improve word accuracy and letter-sound knowledge, but not reading fluency. This systematic review evaluated the effectiveness of dynamic computerised visuo-attentional interventions aimed at improving reading for dyslexic and neurotypical children aged 5-15 years. Literature searches in Medline, PsycINFO, EMBASE, Scopus, ERIC, PubMed, Web of Science, and Cochrane Library identified 1266 unique articles, of which 18 met inclusion criteria (620 participants; 91.40% dyslexic). Three types of visuo-attentional interventions were identified. Results show that visual perceptual training (N = 5) benefited reading fluency and comprehension, visually-based reading acceleration programs (N = 8) improved reading accuracy and rate, and action video games (N = 5) increased rate and fluency. Visuo-attentional interventions are effective options for treating childhood dyslexia, improving reading generally equal to or greater than other strategies. Initial evidence indicates that visuo-attentional interventions may be efficacious in different orthographies and improve reading for at least two months after intervention. Larger sample interventions on a wider range of reading skills with follow-up assessment are needed to further clarify their effectiveness.

Discovering hidden treasures: Towards a measure of command-following abilities in non-verbal children using functional transcranial Doppler Ultrasound

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In the past decade, there has been a growing interest in using neuroimaging to assess cognitive functions in individuals who lack reliable behavioural responses. In particular, our group is interested in the covert language abilities of non-verbal autistic children. Recent evidence suggests that despite a lack of overt communication and unreliable behavioural responses, these children could retain intact language comprehension. Due to the nature of their impairment, standard behavioural tests of language comprehension are often unreliable, so we sought to develop a neuroimaging approach. We used functional transcranial Doppler Ultrasound to measure the blood flow velocity to the two brain hemispheres of 14 typically-developing children (aged 9 to 12 years) while they performed two mental tasks. In a game where children helped a pirate collect treasures, children performed either a word-generation task (thinking of words starting with a letter), or a spatialmemory task (remembering the location of letters). These tasks are believed to preferentially activate the left and right hemispheres, respectively. Given that both tasks used identical visual stimuli, a differential hemispheric activation between the two tasks would therefore demonstrate language comprehension and wilful command-following. Using machine learning to analyse the blood flow to the two hemispheres, we could reliably decode which task participants performed on different trials, both from the group data, and in a subset of individuals. This indicates that our paradigm and methods could allow the fast and inexpensive detection of hidden cognitive abilities in children. Specifically, successful decoding of the task instruction in the brain signal of a non-speaking child would indicate intact command-following abilities, and possibly open opportunities of communication through the wilful modulation of their brain activity. This study was funded by an ARC CCD cross-program grant.

A biomarker for anorexia nervosa

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Anorexia nervosa (AN), like other mental illnesses, is diagnosed based on a patient's description of symptoms and a clinician's judgment. The subjective nature of making psychiatric diagnoses is further confounded in AN by the persistent denial of illness symptoms and the secretive nature of the illness. Thus, establishing a reliable and valid objective marker or 'biomarker' for AN is critical. Our recent research identified a potential biomarker for AN; an atypical type of eye movement called square-wave jerks (SWJs). The aim of this study was to validate this biomarker by replicating this finding in individuals currently with AN (c-AN), and identifying if this biomarker is also present in those who are recovered from AN (rec-AN). Twenty c-AN, 20 rec-AN and 20 healthy controls (HC) were assessed for the presence of SWJs with an EyeLink1000 eye tracker. An increased rate of SWJs were found in c- and rec-AN, relative to HC (p < .05). SWJs were identified as a promising biomarker for AN. Establishing a biomarker is critical to: 1. provide an objective diagnostic measure for identifying AN; 2. enable early identification of the illness; 3. identify those at risk of developing AN; and 4. provide insight into the underlying biological mechanisms underpinning AN. As eye movements utilise very specific neural circuitry, the presence of SWJs also provides potential targets for neurobiological treatments, including medications and brain stimulation.

Measuring eye movements in natural settings for assessing spatial neglect

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Spatial neglect is a disorder of attention, whereby patients fail to orientate or to respond to contralesional stimuli. It is a common consequence post acquired brain injury and has negative prognostic impacts. There is evidence that some neglect patients demonstrate neglect behaviour during everyday settings despite showing no signs of neglect on standard neuropsychological assessments. This discrepancy may be attributed to the simplified and unrealistic nature of the pen-and-paper neglect tests that do not match the demanding environments of everyday life. Eye movements are a promising candidate for the assessment of spatial neglect due to the close link between spatial attention and eye movements. Eye tracking glasses allow the assessment of neglect while the patients perform everyday tasks. The current study assessed eye movements of 16 hemianopic and 4 neglect patients with right brain damage in natural settings. It was hypothesised that neglect patients miss more left-sided targets and make more right-sided eye movements than hemianopic patients when walking a designated course. The two patient groups did not statistically differ in paper-and-pencil neglect tests (line bisection, p = .178; bells task, p = .076), but neglect patients detected less left-sided targets (p = .003), made more right-sided fixations (p = .039), spent more time searching on the right (p = .039) and made more

saccades towards the right (p = .039) than hemianopic patients when walking the course. These preliminary findings are promising and highlight the potential benefit of assessing neglect in more natural settings. However, more research is needed to demonstrate the diagnostic utility of eye movements in clinical setting.

Cognitive reappraisal, but not expressive suppression, impairs negative affect regulation in youth with borderline personality during social rejection

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Emotion regulation deficits are a core feature of borderline personality disorder (BPD). Important aspects of these deficits remain unclear, such as how early in the course of BPD they occur, the specific emotion regulation strategies that are affected, and the impact across different social contexts. Twenty-nine youths with first presentation BPD, aged 15 to 25 years, were compared with 35 healthy controls (HC). Participants completed an emotion regulation task in a standard laboratory context and in the context of social rejection. They were instructed to apply expressive suppression and cognitive reappraisal to regulate their negative affect, which was assessed via self-report and facial electromyography. The groups applied both emotion regulation strategies equally well to regulate self-reported and facial negative affect in the standard laboratory context. In the context of social rejection only expressive suppression was effective for both groups, and across measures. In contrast, cognitive reappraisal was only effective for self-reported negative affect across groups, but, compared to the HC group, BPD participants were unable to apply cognitive reappraisal to regulate their negative expression. Indeed, negative facial expression increased for the BPD compared with the HC group. Therefore, youth with BPD can implement both strategies to regulate negative affect in a standard laboratory context, but social rejection impairs their ability to apply cognitive reappraisal to regulate the facial expression of negative affect. Clinicians implementing cognitive behavioural therapies should therefore do so cautiously with this clinical group, as cognitive reappraisal might be counterproductive, or even contraindicated, in the context of social rejection. Future research should explore the effectiveness of alternative emotion regulation strategies for this group across contexts. This research was supported by an Australian Catholic University Research Program Grant.

How does executing an action impact the steady-state visual response?

Dr Simmy Poonian Macquarie University

Part of the symposium Prediction, prediction-error, and the brain

When we execute a voluntary action, it is thought our brain makes predictions about the sensory world, and suppresses activity to incoming sensory events either before, during, or after action execution. It is thought that this neural suppression is an important cue we use to causally associate sensory events to ourselves and other people. While it has been shown that neural activity to sensory events is suppressed during and after action execution, the time at which this suppression begins is still to be determined. It is also unclear whether this suppression is specific to an expected sensory event or a general mechanism of action execution. Interestingly, it recently has been shown that visual events are perceived as less intense from up to 300 ms before an action is even executed, suggesting a possible time frame for when this action-related suppression occurs. The aims of this study were to investigate the time at which sensory suppression occurs when executing a voluntary action, and to determine if action-related sensory suppression is influenced by expectation, or impacts all incoming sensory events. We used magnetoencephalography (MEG) to measure brain activity while participants made voluntary movements and were presented with flickering visual stimuli (horizontal and vertical bars) to evoke a steady-state response. Data were analysed using a Fourier transform on the entire action event and a time-frequency analysis to understand the time course of any changes in power. Preliminary findings show that the execution of an action reduces the overall steady-state response, and that this reduction begins shortly before the action is executed. These findings have implications for

understanding how action-effect prediction can impact our ability to perceive incoming events, and how associating actions to their effects is reflected by anticipatory neural suppression.

Co-activation of alternative names: An ERP study of phonological interference in speech production

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When speakers name pictures (e.g., duck), distractor words phonologically related to alternative names (e.g., birch related to bird) slow down naming responses compared to unrelated distractor words. This interference effect is assumed to reflect the phonological co-activation of close semantic competitors and is critical for modelling word production. In the present study, we traced the electrophysiological correlate of this behavioural effect. We implemented two task versions: Participants either responded directly after picture onset (immediate naming) or after the appearance of a go-signal (delayed naming). Auditory distractor words were presented simultaneously with picture onset. The behavioural data revealed longer naming latencies with related compared to unrelated distractors in immediate naming, replicating the phonological interference effect. Cluster-based permutation tests applied to the ERP data revealed a significant difference between the two distractor conditions which was independent of task version. We observed two clusters, one at 305-436 ms located at left fronto-central sites, and one at 537-713 ms located at central sites with enhanced negativity in the related-distractor condition. The time window of the earlier effect corroborates the emergence of the behavioural interference effect at a phonological processing level, while the functional significance of the later effect is as yet not clear. The finding of a robust ERP correlate of the behavioural effect facilitates further research on fine-grained lexical processes during speech production. This work was supported by the German Research Council (DFG JE229/11-1).

Implicit neurofeedback boosts feature-based selective attention in a visual decision-making task

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Perceptual decisions are often based on the average of several noisy sensory stimuli, and these stimuli may be weighted more or less heavily in the decision depending on a range of factors. Here we examined the role of feature-based attention on perceptual decision weights. Microstimulation of neurons tuned to specific features has been shown to increase the decision weightings of those features. Since visual selection increases the firing of neurons tuned to the attended feature, we reasoned that it should have a similar effect on perceptual decisions. To test this idea, we developed a perceptual decision-making task that used real-time neurofeedback to implicitly bias featural attention. Participants (N = 30) were tasked with reporting the average motion direction of two spatially overlapping fields of moving bars with different orientations (-45°; +45°). To measure attentional selectivity, the two fields flickered at different frequencies, thereby inducing distinct steady-state visual evoked potentials (SSVEPs) as recorded via electroencephalography (EEG). Attentional selectivity was calculated in realtime as a direct contrast of SSVEP amplitudes for the two dot-fields. Implicit neurofeedback was used to modulate attentional selectivity in the form of dynamic variations in motion coherence. When the "trained" orientation was attended, as indicated by real-time selectivity, motion coherence increased for both fields, thereby implicitly rewarding participants with an easier averaging judgment. Implicit neurofeedback induced an attentional bias toward the trained orientation, as indexed by higher attentional selectivity for the trained orientation on a set of randomly interleaved trials delivered without neurofeedback. By contrast, there was no association between attentional selectivity measured using EEG and perceptual decision weights measured behaviourally, suggesting that decision weights might not scale reliably with attentional selectivity.

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Cognitive reserve moderates the relationship between age and fluid intelligence but not brain structure in schizophrenia and schizoaffective disorder

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Background: Inter-individual differences in cognitive performance in schizophrenia (Sz) and schizoaffective disorder (Sza) may be explained by variability in cognitive reserve but there is limited research focusing explicitly on cognitive reserve in the context of neuroimaging data in individuals with these disorders. In particular, it is unknown whether cognitive reserve buffers the influence of age on cognitive performance by either protecting against brain structural deterioration associated with cognitive performance, or by compensating for it through some other mechanism. Method: In 214 individuals with Sz/Sza we assessed whether age-related decline in cognition was moderated by degree of cognitive reserve, and determined whether this was reflected by a moderation of age-related change in related structural brain measures. Results: Individuals with higher reserve showed significantly better performance on cognitive measures tapping verbal memory and learning, processing speed and fluid reasoning. However, reserve status only moderated the adverse effects of age on performance on fluid reasoning, such that age-related deterioration in fluid reasoning was significantly less in individuals with high versus low reserve. Age-related decline in brain regions correlated with fluid reasoning were not moderated by cognitive reserve. Conclusion: In individuals with schizophrenia spectrum disorders, cognitive reserve appears partially to negate the impact of age on aspects of cognition by conferring resilience to age-related structural brain deterioration through some form of compensation.

Implementing attention across the senses: Testing for modality-specific versus abstract rule encoding in frontoparietal cortex

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A network of frontal and parietal brain areas has been implicated in the ability to adaptively attend to relevant information in the complex world around us. These *multiple demand* (MD) regions have been shown to encode rule information that changes as the task changes, at least in visual tasks. Here, we explore the degree to which this network behaves similarly when stimuli are presented in visual versus auditory domains. We used multivariate pattern analysis of fMRI data to assess whether rule information was represented in the multiple demand system when participants performed the same stimulus-response task on visual (a sequence of four lines of different lengths) and auditory (a sequence of four tones of different pitch) stimuli. We could decode task rules for both visual and auditory tasks, confirming that these regions encode task-relevant information from different input modalities. In some MD regions, the activity patterns associated with processing each rule were similar enough that we could train a classifier using the data from one modality (e.g., visual trials) and decode the rule in other modality (auditory trials). However, we did not find a uniform response across the entire network, with right intraparietal sulcus (IPS) apparently favouring visual rule information and left IPS favouring auditory information. The results suggest a combination of abstraction of the rule with modalityspecific tagging of information, particularly in the IPS. This research was funded by ARC Discovery Project DP170101840.

Prediction error processes in ventral and dorsal stream expectancy violations

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Visual perception requires the interpretation of an array of stimulus features to make meaningful inferences about the stimulus identity, location and orientation. Visual perception is commonly parsed into two distinct pathways within the brain. The dorsal stream processes time-varying features of stimuli, whilst ventral stream regions are involved in object recognition. Recent theories highlight the role of iteratively updated prediction about future sensory inputs. Previously we demonstrated signalling of violated predictions in the dorsal stream to violated expectations about stimulus trajectory. Here we investigate the predictive processes underlying dorsal and ventral stream violations. We employ a contextual trajectory paradigm to build expectations about either identity or rotation using a sequence of image presentations, which can subsequently be violated. Crucially this allows us to test double dissociations between these different types of violations. Novel MEG source localisation techniques allowed us to estimate the spatial and temporal dynamics of error signalling processes underlying these violated expectations. The study clearly identified a double dissociation of different types of perceptual violation, such that rotation violations localised to the dorsal stream and identity violations localised to the ventral stream. Differences were consistently identified for both types of violation in earlier (150-200 ms) and mid (250-350 ms) latency time windows. Our results suggest a common process for prediction error checking and context updating in high-level expectations instantiated across both perceptual streams. In line with current predictive coding models, prediction error signals appear to be initiated in precisely those cortical regions believed to be associated with sensory input driven parsing of those stimulus features, thus recasting these the regions as reconciling bottom-up and top-down influences on percept resolution.

Linking adaptive neural responses to behaviour using magnetoencephalography

Dr Amanda K. Robinson

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Part of the symposium Using MVPA to understand how the brain infers the world

The human brain is extremely flexible and capable of rapidly selecting relevant information in accordance with task goals. Regions of frontoparietal cortex flexibly represent relevant task information such as task rules (e.g., Woolgar et al., 2015) and stimulus features (e.g., Jackson et al., 2017), but the time courses of these adaptive processes are still unclear. Multivariate pattern analysis (MVPA) applied to high temporal resolution neuroimaging data offers unique potential to unpack the temporal dynamics of goal-directed behaviour. Here, we used magnetoencephalography (MEG) to measure neural responses while participants performed a difficult response-mapping task using two different rules. Time-resolved MVPA revealed different dynamics for perceptual and rule-related processes when time-locked to stimulus onset versus response. Response-locked analyses showed that decoding gradually increased prior to the correct response, suggesting evidence accumulation led to a decision. Crucially, when participants made an error, patterns of activity preceding the response resembled the incorrect stimulus, indicating that the representation was associated with the response decision. These results provide important evidence about the temporal dynamics of perceptual decision-making. Overall, it is clear that brain representations measured using MEG can provide a great deal of insight into the relationship between neural activity and behaviour.

Neural processes underlying spatial imagination

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Humans can track the position of an object in the periphery without overt eye movements. What are the neural mechanisms underlying our capacity to track moving objects when they are no longer visible, e.g., due to occlusion? One possibility is the brain "fills in" invisible objects using internally generated representations similar to those generated by feed-forward perceptual mechanisms. In the present study, we used an attentive-tracking paradigm in conjunction with electroencephalography and time-resolved multivariate pattern analyses to investigate the neural mechanisms of location processing for seen and imagined object positions. Participants tracked an object that appeared in six discrete locations in a predictable sequence and were asked to continue to track the object's position when it disappeared. Decoding analyses revealed that the location of the visible stimuli could be extracted soon after image onset, consistent with early retinotopic visual processes. Processing of imagined positions was detected earlier and sustained for longer. These results suggest that the monitoring of imagined object locations utilises similar perceptual processes as objects that are actually present, but with different temporal dynamics.

Autonomous system error or human error: Brain responses differ depending on who we are observing

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Recent reviews suggest that EEG responses to errors found during human performance monitoring may extend to the performance monitoring of autonomous systems. Limited research has shown this may be possible (e.g., the observed Error-Related Negativity has been elicited by automated system errors on an Eriksen Flanker task; de Visser et al., 2018). Nevertheless, the relevance of human performance monitoring to autonomous system performance monitoring remains unclear, as basic differences in the EEG response during monitoring of humans versus autonomous systems have yet to be established. To address this question, we recorded the EEG of twenty-six participants (18 female; M_{age} = 24.6 years) who were allocated as the monitors of either a (virtual) human or an automated system partner that was performing a target-detection task. Participants were required to locate one target image from four images presented simultaneously on screen, after which they received visual feedback informing them of the picture that their partner had identified. We calculated event-related potentials at the point of partner feedback for all trials, sorted by partner type (human/autonomous system) and partner accuracy (correct/error). Results revealed a P3b component over posterior electrodes for autonomous system errors, but not for human errors, which engendered a negativity. This was confirmed by a partner type × accuracy interaction in a linear mixedeffects analysis. The observation of a P3b only during the monitoring of autonomous system errors suggests these errors may be viewed as targets by participants, whereas errors committed by humans may be viewed in a qualitatively different manner (e.g., as a prediction error). Further analyses will consider the effect of error rate and behavioural responses, including judgements of performance level and ongoing trust in partner performance.

Top-down feedback processes are engaged by unreported visible, but not invisible, changes

Miss Elise G. Rowe Monash University

Marta Garrido, University of Queensland Naotsugu Tsuchiya, Monash University Detecting changes in the environment is fundamental for survival, as these may indicate potential rewards or threats. In our everyday lives, however, many changes occurring in our environment do not pose any threat and may go unnoticed. Recent work has shown that the visual system can unconsciously detect and represent these changes without generating any awareness. Here, we developed a novel no-report visual oddball paradigm, where participants engaged in a central letter task during EEG recordings while presented with task-irrelevant high- or low- coherence background random dot motion. Critically, once in a while, the dots changed in direction. After the EEG session, we behaviourally confirmed that changes in motion direction at high- and low-coherence were visible or invisible, respectively, for each participant. We found that unreported task-irrelevant changes in motion direction elicited event-related potentials (ERP) in visible and even in invisible conditions. To better understand the neural mechanisms underlying these motion changes, we applied Dynamic Causal Modelling (DCM) to the source-localised EEG data. We focused on the core nodes of primary visual cortex, middle temporal visual area (MT+), inferior temporal gyrus and orbitofrontal cortex. Both ERP and DCM analysis revealed left and right hemispheric lateralisation of visible and invisible motion direction changes, respectively. Furthermore, winning DCMs comprised only feedforward interactions for invisible motion direction changes, whereas both feedforward and feedback modulations were recruited for visible changes specifically between prefrontal cortex and MT+. Our findings challenge studies implicating a critical involvement of the prefrontal cortex only for report responses. Instead we propose that unreported, yet reportable, changes in visual motion direction can engage the prefrontal cortex which then modulates MT+ via top-down connections.

Threat-induced anxiety impairs inhibitory functioning: A magnetoencephalography (MEG) study

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Background: The effects of anxiety on response inhibition are unclear with evidence suggesting both facilitation and impairment. In an attempt to resolve this, we implemented a version of the stop-signal task that overcomes previous methodological issues. The neurological network involved in response inhibition has been extensively studied with the right inferior frontal gyrus (IFG) most strongly associated with inhibition. Aiming to understand how anxiety influences inhibition neurologically, we used MEG source imaging that provides high temporal and spatial resolution. Methods: We induced anxiety in healthy individuals using a threat of unpredictable shock paradigm. Participants performed a stop-signal task during alternating periods in which they were informed that aversive shocks could be delivered randomly without warning (threat) or that they were completely safe from shocks (safe). The stop-signal task presented frequent go-signals occasionally followed by infrequent stop-signals, indicating a response must be withheld. MEG recordings were simultaneously made and then analysed using whole-brain beamformer analyses. Results: Contrary to previous findings with the go/no-go task, anxiety slowed inhibitory processing with a remarkable consistency across participants. MEG data showed increased beta power (14-18 Hz) over right IFG for successful compared to failed inhibition. Unexpectedly, the interaction between anxiety and inhibition was not reflected in changes in right IFG beta power, but rather the pregenual anterior cingulate cortex. Additionally, increased beta power was seen in the temporoparietal junction for safe compared to threat conditions irrespective of inhibition. Discussion: These findings fit with the view that anxiety states are marked by cognitive inflexibility. Further, these preliminary results suggest that the influence of anxiety on inhibitory functioning may occur outside the core stopping network, in areas associated with emotion regulation. Funding provided by the Barbara Dicker Brain Science Foundation.

Detection, classification, and prediction of epileptic seizures using artificial intelligence

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Part of the symposium Decoding the brain through interdisciplinary approaches in neuroscience

Epilepsy is a family of neurological conditions that lead to recurrent seizures in patients, caused by disruptions of neuronal electrical signals in the brain. These seizures can be recorded using electroencephalograms (EEG), which are typically used to diagnose epilepsy in a clinical setting. Although possible, the manual interpretation of EEG signals can take up to several hours

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of an expert's time. Artificial intelligence (AI), algorithms that learn by example, have recently been used to not only automate the identification of patterns in signals, but also to discover novel features that may not be obvious to a human observer. It is these algorithms that enable highly automatic seizure detection and seizure type classification, which may save hours of clinicians' time. Using long-term intracranial EEG data, we demonstrate that AI can learn to differentiate interictal and preictal states, making seizure prediction possible.

Turning the face inversion effect on its head

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Face inversion effects (FIEs)-differences in responses to upside-down faces compared to upright faces-occur in both behavioural measures and electrophysiological responses when people view face stimuli. This is thought to support the idea that faces are a special class of stimuli to which evolutionary pressures have tuned our neurocognitive systems. In EEG, FIEs are often reported in the literature to lead to increased amplitudes and delayed latency of the N170 event-related potential (a component that has often historically been attributed to indexing specialised face-processing mechanisms). In fact, a careful evaluation of the literature reveals that whilst the inversion of photographic face stimuli leads to increased N170 amplitudes, schematic faces, cartoons, Mooney faces, and line drawings tend to lead to delayed N170 peaks, but not increased amplitudes. This raises the possibility that increased N170 amplitudes to inverted faces may have origins other than the inversion of the face's structural components. Recent work by our group strongly supports the idea that the N170 may in part be a prediction-error signal. Thus, we hypothesise that when viewing inverted photographs of faces, the increased N170 amplitude may in fact result from a range of expectation violations over and above structural inversion. For instance, photographed faces are usually lit from above, and the effects of gravity pull from below. To test this, we collected EEG whilst participants viewed stimuli (upright versus inverted) where the faces were lit from above versus below, and where the actors were upright, or hanging upside-down. N170 amplitudes were largest when expectations about image orientation, direction of lighting, and direction of gravity were all inverted, and were smallest when all of these factors concurred with normal expectations. We interpret this to indicate that FIEs on N170 amplitudes are driven by an interaction of multiple expectation violations.

*Presenting on behalf of Dr Alan Pegna

Visual expertise: Exploring the effects of salience on early visual signals using non-face-like stimuli

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The N170 is an electrophysiological brain response indexing higher-level vision. A larger amplitude is consistently found when participants see faces: Its peak occurs later, sometimes enhanced for upside-down faces compared to upright ones. It is commonly believed it is the neural marker for faces. This is known as the face-specificity hypothesis. Conversely, the expertise hypothesis (EH) postulates that faces are only one visual category for which we develop visual expertise, with evidence that non-face objects for which participants are expert produce similar amplitude and latency in the N170 peak. Our work builds on previous findings: (1) Research suggests N170 latencies and amplitudes are differently elicited if faces are depicted in photographs or simplified drawings, indicating that faces may be processed by the brain differently if some characteristics are changed; (2) One Chinese study showed an increase in N170 to attended Chinese characters relative to faces; (3) When cartographic contours (CC) of countries are used as stimuli, the N170 to the participant's own country contour is enhanced relative to that elicited by an unfamiliar country, supporting the EH. Since faces, and non-face stimuli (e.g., home country CC, own written language), may be considered salient stimuli, N170 responses to these categories should be interpreted in light of it. Our study investigated the contribution of salience during acquisition of visual expertise. We firstly used classical conditioning, pairing images of unknown CC (conditioned stimulus; CS+) with subjectively emotionally significant images of objects (unconditioned stimulus; US), and images of neutral objects, such as the US of another participant (neutral stimulus; NS). Then participants were exposed to degraded images of previously seen CCs and foils. Preliminary EEG data showed that participants' N170s were different to CS+/US compared to CS+/NS. Future studies should clarify whether a difference is found between salient faces and salient objects in the N170.

Reconciling Mackintosh and Pearce–Hall: An EEG study on inhibition of return

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Irina Baetu, University of Adelaide Nicholas Burns, University of Adelaide

We aimed to reconcile the Mackintosh (1975) and Pearce-Hall (1980) attentional learning theories using inhibition of return (IOR). Participants trained on a categorisation task where some stimuli were predictive (P) of the correct response while others were non-predictive (NP). These stimuli were then used as uninformative spatial cues in a dot-probe task from which we obtained behavioural (reaction time, dot-probe errors and ratings) and electrophysiological (the N2pc event-related potential) measures thought to reflect attention. We varied the stimulus-onset asynchrony (SOA) between the cues and the dot-probe target. The behavioural data indicated a response bias towards the P cues. Participants were faster to respond to the target when it appeared in the location of a P cue compared to a NP cue at each SOA. Errors made during the dot-probe task suggested that participants were anticipating that the target would appear over the P cues. Participants also indicated that they thought the target appeared more often over the P cues. However, target-elicited N2pc mean amplitudes showed an interaction between predictiveness and SOA. It appears that P cues are preferentially processed as soon as they are perceived, consistent with Mackintosh's theory. However, after processing these cues, attention shifts away from them and towards other stimuli. This IOR-like shift of attention could allow for other currently ambiguous, but potentially important, stimuli to benefit from further processing, consistent with the Pearce-Hall theory. Our results offer a novel perspective that may help reconcile these two seemingly contradictory theories.

ERP correlates and attentional consequences of subthreshold landmark cues

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According to our "unified model of vision and attention," parietal regions responsible for attentional orienting may receive input via an indirect, ventral visual stream input route, or via a direct and non-conscious dorsal visual stream input route. In this preliminary investigation participants were presented with low-contrast landmark attentional cues that were below the threshold for conscious detection. Objective visual thresholds for cue stimuli were established prior to the cueing task, and confirmed with a final cue discrimination task. Participants made a simple detection response to targets presented 167 ms after a 33-ms cue frame that comprised either a sub-threshold landmark cue or a blank screen. When present, cues predicted target location with 100% validity. Target detection times and ERP waveforms following cue-frame onset were compared for trials where the cue frame comprised either a sub-threshold cue or a blank screen. At parietal-occipital electrodes, landmark cues elicited a low-amplitude, but statistically reliable P1-N1 complex, where the N1 peak negativity coincided approximately with target onset. No-cue trials produced a highly noisy waveform with no clear P1-N1 complex. Following target onset, a clear positive going waveform was observed on both cued and uncued trials. Response times were quicker on cued compared to uncued trials. Taken together, these preliminary data suggest that, consistent with our unified model of vision and attention, landmark cues presented below the threshold for conscious awareness elicit measurable activity in dorsal visual stream structures and influence behavioural responses. This project was funded by a Marsden Fund awarded to A. L.

Functional connectivity of corticostriatal circuitry and psychosis-like experiences in the general community

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Background: Resting-state functional magnetic resonance imaging (rs-fMRI) studies have reported reduced functional connectivity in a dorsal corticostriatal (CST) circuit linking the dorsal striatum and prefrontal cortex (PFC) in first-episode psychosis patients, their unaffected relatives, and youths atrisk for psychosis. In patients, reduced coupling in the dorsal system was linked to increased psychotic symptoms. These findings suggest that dysconnectivity of the CST circuits is linked to psychosis risk. Here, we investigate whether functional connectivity of CST circuits is associated with subthreshold psychosis-like experiences (PLEs) in a large non-clinical sample. Methods: A total of 672 healthy adults (274 males; age: 18–50 years) completed a battery of seven PLE measures. Principal component analysis (PCA) was performed to obtain latent dimensions of PLE variation in our sample. PCA components were correlated with CST functional connectivity in a subsample of 353 participants who underwent our rs-fMRI protocol. Results: PCA identified two major components explaining 62% of PLE variance. The first component corresponded with positive PLEs (i.e., subthreshold delusions and hallucinations) and the second reflected negative PLEs (i.e., subthreshold social and physical anhedonia). Positive PLEs were associated with reduced coupling of the dorsal CST system, namely between the dorsal striatum with the anterior cingulate cortex and rostral dorsolateral PFC. Negative PLEs were associated with increased functional connectivity between dorsal striatal regions and visual and sensorimotor areas. Discussion: Our findings support a neurobiological continuum of positive symptomatology characterised by reduced coupling of the dorsal CST circuit. An association between negative PLEs and increased coupling in the dorsal system has not been reported in patients or at-risk groups, suggesting that negative PLEs may have distinct neural correlates from clinical symptoms.

Grey matter volume does not predict risky decisionmaking in abstinent methamphetamine users

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Neuroimaging studies have provided evidence for brain structural abnormalities in methamphetamine (MA) users relative to healthy controls. Studies using decision-making tasks have also observed higher risk-taking in MA subjects than in controls. However, little is known about the relationship between regional volume and risky decision-making in MA abusers. This study aimed to (1) assess risk-taking behaviour in recently abstinent (3-12 months) male MA subjects (N = 19) and controls (N = 11); (2) identify group differences in regional grey matter (GM) volume; and (3) investigate the relationship between regional GM volume and risky decision-making across subjects. The Iowa Gambling Task (IGT) was used to assess risk-taking behaviour. Structural images (T1-weighted) were collected using a 3T Siemens Skyra. Voxel-based morphometry analysis was performed using the Computational Anatomy Toolbox (CAT12) within the Statistical Parametric Mapping (SPM12), controlling for age and total intracranial volume. While MA subjects chose risky cards more frequently and suffered greater losses compared to controls, group differences on IGT scores were not significant. GM volume also did not differ between groups across regions. No significant correlation was observed between IGT net scores and regional GM volume. These preliminary results may suggest that GM volume is not a good predictor for risk-taking behaviour in either healthy or MA subjects. We did not observe group difference in the IGT likely due to the small sample size, or potentially the number of trials in the IGT needed to be larger in order to learn about the good versus the bad decks. The absence of group difference in GM volume may be attributed to partial recovery during the abstinence period. Thus, our next step is to examine the correlation between regional GM volume and MA-use parameters, such as cumulative use and length of abstinence.

Characterising brain regions activated as a function of learning visuomotor associations using fMRI

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The current fMRI study identified brain regions implicated in performing well-learned versus new visuomotor associations. Stimuli were two sets of six abstract images, each paired arbitrarily with a unique hand gesture. Participants rehearsed one set of pairings over 4 days and learned the other set immediately prior to scanning. Data were obtained for 14 participants, who demonstrated an average 76-ms motor reaction time advantage when performing the well-learned associations immediately prior to fMRI scanning. Regions-of-interest for the left lateral-occipital (LO), the left anterior intra-parietal (AIP) and left medial intra-parietal (MIP) areas were obtained by an independent functional localiser. Parameter estimates extracted from these regions demonstrate a greater BOLD response in left LO for new compared to well-learned associations, t(13) = 3.32, p = .006, but not left AIP or left MIP. Results suggest the left-hemisphere ventral stream is strongly activated before the automatisation of visuomotor associations.

Apparent motion perception in upper limb amputees with phantom sensations: *Obstacle shunning* and *obstacle tolerance*

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Phantom limbs (PLs) are thought to either hinder or facilitate the successful embodiment of a prosthesis depending on how they interact with physical objects. PLs with Obstacle Shunning (OS) tend to fade off from bodily awareness when their phenomenal space overlaps that of a physical object. Alternatively, PLs can also be experienced to pass through solid objects (Obstacle Tolerance; OT). Here we tested how these characteristics of the phantom influence apparent motion perception of human limbs involving either solidity or biomechanical constraints. Depending on stimulus onset asynchrony (SOA), alternation between two static pictures generates the illusory perception that the limb passes through the object (short SOA) or rotates around it along a biologically feasible way (long SOA). Combining multiple behavioural and gaze indices we tested 9 upper limb amputees (4 OS, 5 OT) and 8 able-bodied controls. Upper limb stimuli could be observed either from a first- or from a third-person perspective. The former is thought to trigger a motor simulation of the illusory movements while the latter is arguably mere based on visual processing. Multilevel logistic regressions showed that illusory percepts of amputees compared to controls were less modulated by the factor perspective, suggesting that the mapping of an observed movement onto a PL relies more on a visual rather than motor strategy. Furthermore, OS participants tended to perceive a hand to go through a solid object while in the OT group, PLs pose the same constraints as for an intact hand. These findings, together with findings in lower limb amputees, suggest an interaction between the everyday characteristics of the PL and apparent motion perception. This might open new tools for diagnostics and rehabilitation, considering that currently assessments of altered body representation are mainly based on self-report and explicit measures.

Linking measures of sensory brain plasticity and cognition

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Ageing is accompanied by both sensory and cognitive decline. The relationship between sensory and cognitive abilities is still not well understood. We theorised that age-related decline in brain plasticity may underlie both losses. Our aim was to investigate individual differences in non-invasive measures of plasticity in the sensory system and whether these related to cognitive performance in an elderly sample. Based on previous literature, we examined the N1b and P2a components of individual's visual evoked potentials before and after a period of high frequency stimulation with a visual stimulus. Changes in the amplitudes of these components after high frequency stimulation are thought to reflect a type of sensory plasticity similar to long-term potentiation. The Fluid Cognition Battery of the NIH Toolbox, made up of five cognitive tests, was also administered. Correlations between the electrophysiological and cognitive measures were explored. Preliminary results indicated a correlation between N1b magnitude change and performance on the Picture Sequence Memory test, designed to test episodic memory. P2a magnitude change showed a trend towards a correlation with the Flanker Inhibitory Control and Attention Test, designed to test executive function and attention. These preliminary results suggested that a common mechanism may be involved in both the induction of plasticity with high frequency visual stimulation and memory processes. We will present data from the completed sample.

Modulation of steady-state visual evoked potentials in a spatial cueing paradigm

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The effects of spatial attention on steady-state visual evoked potentials (SSVEPs) have been demonstrated in numerous studies by comparing signals from attended and unattended stimuli. Importantly, the magnitude of attentional modulation of an SSVEP signal has been found to scale with the amount of attention paid to the spatial location. Inhibition of return (IOR) is a phenomenon of attentional orienting that refers to slowed responses to targets presented at the same location as a preceding stimulus that is thought to begin around 600 ms after a first stimulus is attended and is sustained for a few seconds. Another inhibitory cueing effect (ICE), often referred to as sensory adaptation or input attenuation, is an early sensory input-based inhibitory mechanism that slows responses to stimuli appearing at previously stimulated locations. Using rapidly flickering stimuli in an otherwise traditional spatial cueing paradigm, the current research examined the time course of SSVEP modulations on cued and uncued trials, with and without eye movements. Results revealed behaviourally slowed responses to cued locations and SSVEP modulations at parieto-occipital electrodes (PO7 and PO8) such that SSVEP amplitude was smaller on cued trials, but only in the early time period after cue onset (100-500 ms post-cue). This SSVEP modulation thus seems to be an electrophysiological marker of early input-based ICEs (i.e., sensory adaptation), that is not affected by later output-based IOR. These findings provide further electrophysiological evidence for the theory of multiple inhibitory mechanisms contributing to overall behavioural cueing effects.

Does time seem to drag or fly in the temporal oddball effect?

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There are various means of distorting subjective time. Notable among these is the visual oddball paradigm, wherein surprising inputs can seem expanded in time relative to unsurprising repeated inputs. Previous research has failed to discern whether this effect results from surprising events being dilated, or repeated events being contracted. Here a non-relative duration reproduction task was used, which allowed for these alternative interpretations to be disentangled. We manipulated predictability via Gabor orientation over successive presentations. Overall, our data suggest that repeated stimuli induce a duration contraction, while oddball stimuli restore perceived duration to baseline. Interestingly, randomising Gabor orientation across presentations induced a similar contraction, implicating a more complex predictive code in this modulation of temporal information uptake. This idea is supported by our visual sensitivity data, which mirrored the perceived duration results pattern, such that more predictable stimuli resulted in less visual information uptake. These results are potentially explicable as free-energy suppression.

Dorsal extrastriate population receptive field estimates reflect stimulus visibility

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Local visual motion signals are thought to be processed in early visual cortex and more complex global motion at later stages in the visual hierarchy. Here we investigated whether functional magnetic resonance imaging (fMRI) can reveal spatially selective responses related to the processing of random dot stimuli defined by differences in motion. We performed population receptive field (pRF) analysis to map retinotopic cortex using bar stimuli comprising coherently moving dots. In the first experiment, we used three separate background conditions: no background dots (dot-defined bar only), dots moving coherently in the opposite direction to the bar (kinetic), and dots moving incoherently in random directions (global). Clear retinotopic maps were obtained for the bar only and kinetic conditions across visual areas V1–V3 and also in higher dorsal areas. Retinotopic maps were much weaker in early areas for the global condition, suggesting greater selectivity for local motion in this area. However, in a second experiment we found very similar results with the strongest maps in dorsal extrastriate cortex when the bar was low in visibility. This was the case both for a transparent motion stimulus, as well as a bar defined by a static low-level property (dot size) that should have driven responses particularly in V1. In fact, these extrastriate maps only manifested in participants who reported seeing this low-visibility stimulus. Our findings therefore indicate that dorsal extrastriate retinotopic maps may primarily be determined by general stimulus visibility (or salience) and suggests claims about stimulus selectivity from pRF experiments must be interpreted with caution.

Gathering evidence for the female advantage in human spatial cognition

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The hunter-gatherer hypothesis is a prominent hypothesis proposed to understand the origins of sex differences in human spatial cognition (Silverman & Eals, 1992). It suggests males and females have different spatial abilities as a consequence of the division of labour between sexes historically (females were gatherers and males were hunters). Traditionally, research has predominantly focused on exploring spatial cognition using "hunter"-specific tasks, thus yielding a male advantage. In this study we aimed to investigate if a female advantage exists within "gatherer"-specific tasks as predicted by the hunter-gatherer hypothesis. Participants (59 males, 60 females) completed a modified object-location memory task (gatherer-task), visual-search task (gatherer-task), and a mental-rotation task (hunter-task). ANOVA tests were conducted to test sex differences across conditions within each task, and then a correlational analysis was carried out for each sex. The visual search did not reveal any novel significant findings in alignment with the hunter-gatherer hypothesis. However, in support of the hunter-gatherer hypothesis, we found sex differences in the predicted directions in mental rotation (male advantage; t = 3.43, p = .001) and objectlocation memory (female advantage; F = 4.11, p = .045). However, the unique addition to the object-location task, a contextual cue (change in background image) had no impact on performance. Interestingly, we found a negative correlation between mental rotation and object-location in males and females. Contrary to the hunter-gatherer hypothesis, our results do not support the idea that there are unique specialised cognitive mechanisms as a consequence of the gathering habits of our primitive ancestors. Instead, these dimensions of spatial cognition could be considered as a single construct. Future research is needed to explore this idea by incorporating

gatherer-specific contextual, auditory and temporal cues with task-based neuroimaging.

Disease stage dependent white-matter degeneration in Friedreich ataxia: The IMAGE-FRDA Study

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Friedreich ataxia (FRDA) is a genetic, neurodegenerative disorder which preferentially impacts the spinal cord, cerebellum and cerebello-cerebral connections. While brain white-matter deficits are well established crosssectionally, there is limited investigation of their progression over time. Given the importance of understanding natural disease history and identifying potential biomarkers of disease progression, this study aimed to track white-matter longitudinally in FRDA. We compared rates of white-matter change over a two-year period between 28 individuals with FRDA and 29 age- and gender-matched controls using diffusion-tensor (fractional anisotropy, mean diffusivity, axial diffusivity, radial diffusivity), magnetisation transfer, and volumetric imaging. Changes in white-matter metrics amongst individuals with FRDA were also correlated against baseline disease severity, two-year change in severity, age of disease onset, disease duration, and genetic burden. Individuals with FRDA showed greater white-matter volume loss in the right peri-thalamic/superior temporal region and greater reduction in fractional anisotropy within the superior cerebellar peduncle. Furthermore, correlation analyses revealed that magnitude of change in disease severity was related to progression of white-matter abnormalities particularly in corticospinal and cerebellar tracts. Moreover, individuals with lower baseline severity or shorter disease duration showed greater volume loss in cerebellar tracts, while those with higher baseline severity or longer disease duration showed greater loss in cerebral parts of the corticospinal tract. These findings fit a model of early degeneration in cerebellar regions and later degeneration in the cerebrum. This raises the possibility of cerebral deficits as secondary consequences of primary cerebellar deficits. The findings also have important implications for the selection of neuroimaging biomarkers to index disease progression in clinical trials.

Characterising the response to face pareidolia in human category-selective visual cortex

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Part of the symposium Using MVPA to understand how the brain infers the world

The neural mechanisms underlying face and object recognition are thought to involve the ventral occipital-temporal cortex. A key feature of the visual ventral pathway is its category selectivity; yet, it is unclear how categoryselective regions process ambiguous visual input that violates category boundaries. One example is the spontaneous misperception of faces in inanimate objects such as the Man in the Moon, in which an object belongs to more than one category, and face perception is divorced from its usual diagnostic visual features. We used fMRI to investigate the representation of illusory faces in category-selective regions. The perception of illusory faces was decodable from activation patterns in the fusiform face area (FFA) and lateral occipital complex (LOC), but not from other visual areas. Further, activity in FFA was strongly modulated by the perception of illusory faces, such that even objects with vastly different visual features were represented similarly if all images contained an illusory face. These data show that the FFA is broadly tuned for face detection, not finely tuned to the homogeneous visual properties that typically distinguish faces from other objects.

MEMES: An open-source MATLAB toolbox for performing magnetoencephalography source analysis without a structural MRI

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It is common to acquire a structural MRI after magnetoencephalography to localise cortical response using a source-reconstruction technique. However, this is not always possible due to patient incompatibility with MRI, high cost, and ethical constraints. To address this issue, we present a MATLAB toolbox for estimating a suitable MRI for source analysis called "MEMES". Participant's scalp surface data acquired using a Polhemus digitiser is matched with a database of 95 structural MRIs using an iterative closestpoint algorithm (approach based on Gohel et al., 2017). The MRI with the least error between the surface points and structural MRI is used as the pseudo-MRI. A coregistered single-shell head model and 5-10 mm source model are automatically created using the Fieldtrip toolbox, and quality checks are performed. We demonstrate the viability of the approach by localising oscillatory power and event-related responses, using data from visual and auditory MEG paradigms in 36 participants. To validate MEMES against the "ground truth", we compare results of source analysis with real and pseudo MRIs using a frequency-domain beamformer. There is good correspondence in the coordinates of peak source power change between the real and pseudo structural MRIs, with errors less than 5 mm. We also show that including facial points and introducing a 2-3% scaling factor increases the accuracy of results. Next, the scripts were adapted for paediatric MEG data, matching head surface data with a database of age-appropriate paediatric MRI templates (Richards et al., 2016). We demonstrate the successful localisation of auditory M1 and mismatch fields to the primary auditory cortex in a group of 3- to 6-year-olds. Our approach presents unique opportunities to study source MEG responses in special populations (e.g., children and patients) without a structural MRI. Openly available scripts for adult and child MEMES can be downloaded via Github (https://github.com/Macquarie-MEG-Research/MEMES).

Colour memory: A study of mask-induced interference in healthy ageing

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Memory declines with normal ageing, although the rate and degree of decline depends upon the task involved. Recognising something as different, for instance, does not decline as rapidly as free recall. Memory for colours is of interest due to the integral nature of the stimuli. Colour memory has been shown to be affected by the amount of internal (interstimulus interval; ISI) and external (a mask) noise introduced into the task. We were interested in how discrimination is affected by the introduction of external noise in the form of a mask, and whether the size of this effect varies with the age of the subject. In a backward-masking paradigm, younger and older adults were asked to make discrimination judgments for pairs of cardinal colour patches that are embedded in a continuous, multidimensional cardinal colour space. These colours typically do not have learned names and are perceived as desaturated and more perceptually mixed than monochromatic stimuli. Stimuli were 4° centrally placed discs presented for a total of 1000 ms, gradually appearing and disappearing with 500 ms between each stimulus. The central masking stimulus was either similar in hue to the study and test items, different in hue to the study and test, or absent (leaving the interval blank). The masking conditions had virtually no impact upon similaritybased recognition judgments; this was consistent for both younger and older participants. This suggests that short-term memory for cardinal colours is robust despite the presence of external noise and does not decline with normal ageing. Furthermore, since cardinal colours do not provide clear examples of named colours, this result holds without the use of learned stimulus labels to aid memory.

Decoding the mind's eye: The temporal dynamics of visual imagery

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Mental imagery is the generation of vivid percepts in the absence of sensory input. Both perceptual visual processing from light stimulation and internally generated imagery engage large, overlapping networks of brain regions; however, it is unclear whether they are characterised by similar temporal dynamics. Recent magnetoencephalography studies suggest that object category information is available during mental imagery, but is delayed relative to perception. The current study builds on these findings, using electroencephalography to investigate the temporal dynamics of mental imagery. Sixteen participants viewed four images: two Sydney Harbour Bridges, and two Santa Clauses. On each trial, they viewed a sequence of the four images and were asked to imagine one of the images, which was cued retroactively by its temporal location in the sequence. In separate blocks, we additionally showed participants a stream of different, semantically similar exemplars to investigate the degree to which physical percepts generalise to the imagined categories. Time-resolved multivariate pattern analysis was used to decode the viewed and imagined stimuli. Our results indicate that the dynamics of imagery processes are more variable across participants compared with percepts based on physical stimuli. We use these results to explore methods to infer the mental state of observers during mental imagery.

Dopamine transporter genotype is linked to hemispherespecific EEG markers of attentional selection and perceptual decision-making

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Dopamine plays a key role in orienting attention. Extensive research suggests that allelic variation in a functional polymorphism of the dopamine transporter gene (DAT1) can influence the direction and magnitude of visuospatial bias, i.e., an individual's tendency to preferentially orient towards one visual hemifield. However, little is known about the neurophysiological substrates of this genetic effect. The central parietal positivity (CPP) and the N2 are electroencephalographic (EEG) signals of perceptual decisions. The signals reflect evidence accumulation (CPP) and early target selection (N2) and provide a neurophysiological correlate of visuospatial bias. Here, we asked whether these signals varied as a function of allelic variation in the DAT1 gene. We recorded EEG from 110 young, healthy participants while they completed a random dot motion task that required them to detect a sudden transient change in motion coherence from random noise. We previously demonstrated that this task gives rise to visuospatial asymmetries, such that response times (RTs) are faster for left, compared to right, hemifield targets across subjects. We collected saliva samples for genotyping of the DAT1 variable number of tandem repeat (VNTR) polymorphism. Individuals with zero or one copy of the 10-repeat DAT1 allele displayed a leftward bias. Specifically, targets in the left vs. right hemifield resulted in faster RTs; greater amplitude N2 in the right hemisphere; and an earlier onset CPP. Importantly, these neurophysiological asymmetries were weaker in individuals who were homozygous for the 10-repeat DAT1 allele. In summary, we show for the first time that DAT1 genotype influences underlying neural systems for attentional selection and perceptual decisions in a hemisphere-specific manner. These data add to a growing body of literature suggesting that dopamine plays a critical role in the allocation of spatial attention.

Action words in working memory: An fMRI study

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Perceiving action-related language ignites the motor cortex of the human brain. Conversely, movements of the hands or feet can impair memory performance for arm- and leg-related action words, respectively, suggesting that the role of motor systems extends to verbal working memory. We studied the neural correlates of verbal working memory for action words using event-related fMRI. Participants were presented with a series of words semantically related to actions either performed with the arms (e.g., grasp) or with the legs (e.g., kick). In each trial, four identical or four different words from the same category were presented and after a variable delay period, participants performed a nonmatching-to-sample task. Haemodynamic activity related to the information load of words at presentation was most prominent in left temporo-occipital and bilateral posterior-parietal areas. In contrast, larger demand on verbal memory maintenance produced relatively greater activation in left premotor and supplementary motor cortex, along with posterior-parietal areas, indicating that verbal memory circuits for action-related words include the cortical action system. Somatotopic memory load effects to arm- and leg-related words were not present at the typical precentral loci where earlier studies had found such word-category differences in reading tasks, although traces of somatotopic semantic mappings were observed at more anterior cortical regions. These results meet the predictions of a neurocomputational model of distributed action-perception circuits (APCs), according to which language understanding is manifest as full ignition of APCs, whereas working memory is realised as reverberant activity gradually retreating to multimodal prefrontal and lateral temporal areas.

Phase and non-phase time-frequency activity in the stopsignal task

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Response inhibition is a core component of cognitive control and often measured using the stop signal. It relies on participants cancelling a prepotent action at the presentation of a 'stop signal'. Much is known about the electrophysiological responses to the stop signal, such as an increased frontal beta response when participants inhibit their responses. However, little is known about whether this increase is phase-locked to (or evoked by) the stop signal, or time-locked but not phase-locked (i.e., ongoing, transient activity). In a large sample of healthy young people (N = 156), we compare total power, phase-locked power, and non-phase-locked power for successful- and failed-inhibition trials. This novel use of phase- and non-phasebased activity has previously given new insights into the frequency activity associated with cognitive control, yet has not been used with the stop-signal task. We show differences in alpha/beta activity between trials in the phase-locked activity, which are not present in the total power. Interestingly, the non-phase-locked activity effects mirror those of the total power. In line with previous research, total power, peri-stop delta/theta and postinhibition alpha/beta differences between trials were found. Our results highlight the need to understand electrophysiological activity in all forms, phase-locked and non-phase-locked, and is the first example of this distinction within the stop-signal task.

Do you see what I feel? Visual-tactile body ownership interactions and temporal perception

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How do you distinguish your body from the external world? One important cue is the temporal synchrony of viewed and felt touch; other cues include the plausibility of the shape and orientation of viewed body parts. It is currently debated if these cues also interact, and if visual plausibility increases visual-tactile temporal binding. Here we investigated this using a temporal-order judgement (TOJ) task. Thirty-three undergraduate participants viewed videos of a touch being applied to plausible or implausible visual stimuli for one's hand (hand oriented plausibly, hand rotated 180°, sponge) while also being touched (at varying stimulus onset asynchronies) with a tactor. Participants judged which stimulus came first: viewed or felt touch. We tested whether visual plausibility affects temporal binding using the just-noticeable difference (JND) between viewed and felt touch. A second study involved three individuals with mirror-touch synaesthesia, an unusual condition where viewing touch to another person causes a feeling of touch on the observer's own body. We hypothesised that in these individuals visual and tactile input for touch, especially when viewing hands, would be more strongly bound, causing higher JNDs for our TOJ task. A Bayesian analysis comparing the three conditions revealed that plausibility of object type and orientation do not affect JNDs, and thus the visuo-tactile temporal binding, for non-synaesthetes. A Bayesian single-case analysis comparing the results from the individual mirror-touch synaesthetes with the non-synaesthete group failed to find substantial JND differences between the two groups. Our findings suggest that viewing touch to a human hand does not affect visuo-tactile temporal perception in either mirror-touch synaesthetes or non-synaesthetes. We discuss the implications of these findings in relation to theories of body perception and mirror-touch synaesthesia.

Brain mapping visuomotor networks: Synchronising highspeed motion tracking with eye tracking and brain scanning for comprehensive brain-network modelling

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Reaching to grasp is a visuomotor integration task frequently explored in developmental psychology, stroke rehabilitation, and visual neuroscience through measuring body movements, eye movements and brain activity alongside task performance. Due to methodological limitations, most neuroimaging studies exploring the visuomotor underpinnings of reaching and grasping have employed measures of eye tracking and reaction and/or movement time of reaches to images presented on a two-dimensional (2D) screen, rather than engagement with physical 3D objects, known to be processed uniquely by the brain. Additionally, motion tracking of the hand is largely absent in neuroimaging experiments. This directly limits current understanding of visuomotor integration, both in regard to the neural activity associated with the type of object viewed and grasped, as well as the neural processing associated with important features of the movement including peak velocity, acceleration, and grip width. Therefore, we engineered a fourway system to record synchronised data with millisecond precision between high-speed motion tracking, eye tracking, 3D object illumination and magnetoencephalography. Solutions to ensure minimal interference between the two infrared tracking systems, correct positioning of eye and motion tracking cameras, calibration of eye tracking to specific location of 3D objects, and motion artefacts produced by the cameras in MEG recordings will be discussed. Our preliminary results using the system indicate considerable robustness. Experimental data are providing a precise spatiotemporal map of the various neural pathways and frequencies involved in the various aspects of reaching and grasping. This will permit assessing neural pathway interactions as represented by time-locked frequencies found across diverging pathways. In the future, similar methods may be employed to map detailed time- and space-sensitive brain functions associated with other important motor movements.

Temporal pole-amygdala dynamics in emotions induced by pictures and movies: A stereotaxic-EEG study

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The amygdala and temporal pole (TP) are believed to be involved in socioemotional processing. fMRI BOLD signals are often compromised from the amygdala and distorted in cases of the temporal pole. We took advantage of intracranial EEG recordings (stereotaxic-EEG; SEEG) from epilepsy patients with electrodes in these regions to investigate their role in emotional processing. Five patients were presented with emotionally salient stimuli (IAPS pictures and movie clips). We quantified high gamma activity (HGA) as a marker of local neuronal population activity. Power spectral density (PSD) and coherence analysis were used to infer functional connectivity between TP and amygdala. Ultimately, for effective connectivity, spectral Granger Causality (sGC) and Dynamic Causal Modelling (DCM) were used. TP and amygdala showed significantly correlated HGA. PSD and coherence analysis demonstrated power and coupling in low frequency range (0-12 Hz) for pictures as well as movie stimuli. sGC for picture stimuli demonstrated significant connectivity from TP to amygdala which was then crucially established via DCM. For movie stimuli, however, DCM revealed the connectivity from amygdala to TP. Our results demonstrate that TP and amygdala were engaged in the tasks and showed robust functional connectivity. Our seemingly contradictory results with effective connectivity via DCM for picture and movie stimuli can, however, be explained by bottomup and top-down generation of emotions. Picture viewing is an example of bottom-up emotion generation elicited largely by perceptual properties of stimuli. TP is believed to be a conceptual store or semantic hub, which can explain its modulatory influence on the amygdala in affective picture viewing. Emotion induction by movies is an example of top-down emotion generation elicited largely by cognitive appraisals. The amygdala has been known to be at the forefront of this and is also responsible for psychophysiological changes leading to a complete emotional experience.

Training curves on working memory training activities in children with low working memory

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Few child studies have examined the training curves of working memory training activities. Examining individual differences in training curves would help determine whether subgroups of children benefit more from training than others, as well as the mechanisms underpinning training effects. Using multilevel modelling, we fitted data collected during training and aimed to firstly examine training curves on a range of working memory activities, and secondly, examine whether child general intellectual ability (IQ), working memory and sex predicted the training curves. Two hundred and twentysix children aged 6-7 years with low working memory completed Cogmed Working Memory training, an intensive 5-week cognitive training program. The training curves for four working memory training activities were examined and found to be non-linear, with rapid improvement in performance in the first week on each activity followed by slowed improvement over the training period. Higher IQ and higher working memory before training commenced predicted steeper training curves on two of the working memory training activities, supporting the magnification (rather than compensation) view of training effects. Boys performed better than girls on one working memory training activity. In conclusion, our findings provide insight into the pattern of performance for children with low working memory participating in intensive working memory training, and provide evidence that subgroups of children (i.e., those with higher cognitive abilities) improve their performance at a faster rate on select working memory training activities.

Indexing the differential modulation of human sensory LTP and connectomics in healthy ageing and mild cognitive impairment

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Rachael L. Sumner, UoA Rosalyn J. Moran, King's College London Lynette Tippett, UoA & Brain Research New Zealand Suresh D. Muthukumaraswamy, UoA Ian Kirk, UoA & Brain Research New Zealand Mild cognitive impairment (MCI) is widely regarded as a prodromal phase of Alzheimer's disease (AD), however conversion to AD is not definitive. Within the neuropathological cascade of AD, an early disruption of neuroplasticity is well established in rodent models, and may provide an objective measure for distinguishing nascent neuropathology in this 'at-risk' group from the changes associated with healthy ageing. We employed an electrophysiological (EEG) paradigm for measuring visually induced Long-Term Potentiation (LTP), and hierarchical Dynamic Causal Modelling (DCM), to explore a novel biomarker of human sensory plasticity in young (N = 37), healthy older (N = 37), and amnestic MCI (N = 15) participants. Both an agerelated modulation, and MCI-related disruption of LTP were observed at the scalp level. Most strikingly, the effect of ageing at the network level revealed a consistent decrease in superficial pyramidal gain across five of the six sources in the modelled cortical hierarchy. Conversely, MCI was associated with a decrease in the inhibitory coupling between interneurons and excitatory neurons in middle occipital gyrus bilaterally. Interestingly, an exploration of the activity of these inhibitory and excitatory cell populations revealed a decrease in their interaction with decreased cognitive performance (as measured using the Addenbrooke's Cognitive Examination III). This indicates a specific inhibitory-to-excitatory coupling imbalance in MCI that is distinct from the neuronal changes associated with healthy ageing. These results demonstrate how a clinically feasible, objective electrophysiological measure of neuroplasticity can uncover biophysical markers of potential latent neurodegenerative decline, and support novel directions for future therapeutic development. MJS was supported by a Brain Research New Zealand Doctoral Scholarship.

Artificial synapses using electronic materials

A/Prof. Sharath Sriram RMIT University

Part of the symposium Decoding the brain through interdisciplinary approaches in neuroscience

Can we re-create the biological synaptic interface in an electronic device? The synaptic interface operates through ionic transport. Electronic memories based on oxide thin films with tailored oxygen deficiencies operate by vacancy transport. This represents an analogous system to demonstrate an artificial synapse. We create complementary metal oxide semiconductor (CMOS)-compatible memristors based on amorphous oxygen-deficient strontium titanate to imitate synaptic learning rules. The work will describe how vacancy transport is created, controlled, and utilised for complex information storage. The information storage occurs at the nanoscale enabling high-density memory integration. The potential of such memristors to behave as artificial synapses is demonstrated by successfully implementing high order time- and rate-dependent synaptic learning rules. Results are benchmarked against biological measurements form hippocampal and visual cortices with good agreement. This demonstration is a step towards the realisation of large scale adaptive neuromorphic computation and networks, on the basis of replicating biointerfaces.

Visual processing speed as a marker of reading delay for lexical but not phonological dyslexia

Miss Nicole Stefanac Monash University

Megan M. Spencer-Smith, Monash University Méadhbh B. Brosnan, Monash University Mark A. Bellgrove, Monash University Anne E. Castles, Macquarie University

A visual attention span (VAS) deficit has been widely reported in the Developmental Dyslexia (DD) literature, however consensus regarding what underlies this problem and the nature of its relationship with reading ability remains elusive. Thirty-two children with DD (N = 32; 15 female) were compared with age-matched (AM) controls (N = 23; 12 female) and reading-matched (RM) controls (N = 17; 9 female) on the combined Theory of Visual Attention (TVA) paradigm with letter and symbol conditions. Results of analysis of variance showed that the DD group performed more slowly than the AM controls, but similarly to RM controls. Moderation analyses revealed that the difference between the DD group and AM controls was driven by children with equivalent or relatively poorer lexical compared with sublexical reading profiles. The findings suggest that reduced processing speed indexes immaturity in reading ability, particularly in DD individuals with relative lexical reading deficits, rather than being a unique contributor to reading dysfunction.

Examining predictive coding in the hierarchy of visual perception in the autism spectrum using fast periodic visual stimulation

Mrs Min Stewart

Queensland University of Technology

Pat Johnston, Queensland University of Technology

Predictive coding has been proposed as a general explanatory framework for understanding the neural mechanisms of perception. As such, an underweighting of perceptual priors has been hypothesised to underpin a range of differences in inferential and sensory processing in autism spectrum disorder (ASD). However, empirical evidence to support this has not been well established. The present study uses an EEG paradigm involving changes of facial identity and person category (e.g., actors, singers, etc.) to explore how levels of autistic traits (AT) affect predictive coding at multiple stages in the visual processing hierarchy. The study uses a rapid serial presentation of faces, with hierarchically structured sequences involving both periodic and aperiodic repetitions of different stimulus attributes (i.e., person identity and person category) in order to induce contextual expectations relating to these attributes. It investigates two main predictions: (1) significantly larger and later neural responses to change of expected visual sequences in highrelative to low-AT; and (2) significantly reduced neural responses to violations of contextually induced expectation in high- relative to low-AT. Preliminary frequency-analysis data comparing high- and low-AT show greater and later ERPs in occipital-temporal and prefrontal areas in high-AT than in low-AT for periodic changes of facial identity and person category but smaller ERPs over the same areas in response to aperiodic changes of identity and category. The research advances our understanding of how abnormalities in predictive coding might underpin aberrant perceptual experience in ASD. This is the first stage of a research project that will inform clinical practitioners in developing better diagnostic tests and treatments for ASD.

Ketamine enhances visual sensory evoked potential LTP in patients with treatment-resistant depression

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Rebecca McMillan, UoA Meg J. Spriggs, UoA & Brain Research New Zealand Doug Campbell, Auckland District Health Board Gemma Malpas, Auckland District Health Board Elizabeth Maxwell, Auckland District Health Board Carolyn Deng, Auckland District Health Board John Hay, Auckland District Health Board Rhys Ponton, UoA Ian J. Kirk, UoA & Brain Research New Zealand Frederick Sundram, UoA Suresh D. Muthukumaraswamy, UoA

Ketamine is central to one of the most rapidly growing areas of neuroscientific research into novel treatments for depression. This is attributable to its rapid-acting and long-lasting antidepressant properties, unparalleled by existing treatments. One of the key hypotheses of how ketamine works to alleviate depression is by enhancing neural plasticity. The objective of the current study was to investigate this hypothesis in humans with treatmentresistant depression, noninvasively, using visual long-term potentiation (LTP) as an index of neural plasticity. In a double-blind, active placebo-controlled crossover trial, EEG was recorded approximately 3-4 hours following a single 0.44 mg/kg intravenous dose of ketamine or placebo (1.7 g/mL remifentanil). Results from the Montgomery-Asberg depression rating scale showed over 60% of participants experienced a 50% or greater reduction in their depression symptoms within 24 hours of receiving ketamine. Visual LTP was measured as a change in the visually evoked potential (VEP) following high-frequency visual stimulation. Potentiation was demonstrated in the N170 and P2 components, F(2,276) = 30.76, p_{FWE} < 0.001. Ketamine specifically enhanced P2 potentiation, F(2,276) = 18.29, $p_{FWE} = 0.015$, which demonstrated an emerging relationship with the antidepressant response, t(22) = 3.71, $p_{FWE} = 0.100$, or $p_{uncorrected} < 0.001$. Dynamic causal modelling (DCM) was used to investigate the underlying neural architecture of visual LTP, and the contribution of ketamine. Consistent with previous research, DCM revealed the effect of LTP modulated forward connections in the ventral and dorsal visual streams. However, there was no significant effect of ketamine in the individual parameter strengths. The current study not only provides evidence that changes to neural plasticity occur in the time-frame of the antidepressant effects of ketamine, but also that there is a possible relationship between positive changes to LTP and the antidepressant response.

Addressing the challenges of analysing mobile eyetracking data

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Zygmunt L. Szpak, University of Adelaide

Mobile eye-tracking technology makes it possible to automatically determine where a user of the technology is directing their gaze, but not what they are looking at. Since understanding what a participant is attending to is a fundamental aspect of most mobile eye-tracking experiments, researchers often have to label each gaze-point manually. The labelling is typically done by introducing a reference image and marking the actual fixations in the corresponding location of the reference image. The reference image is usually a picture of the scene or an object that a participant will be looking at. For example, it could be a picture of a poster that a participant will examine. Manually registering the gaze-points in each frame of the video against the reference view is an incredibly tedious and time-consuming process. Our contribution is to show that the registration of gaze-points against a reference view can be done entirely automatically and reliably by utilising techniques from computer vision. We focus on the particular case where the object under consideration is an approximately flat surface. While this may seem restrictive, it covers a surprisingly wide array of scenarios including walls with posters or decorations, pavements or footpaths, boardgames, maps, and books to name just a few. We demonstrate the efficacy of our approach on experimental data.

Attentional orienting in response to nonsocial cues is resistant to verbal, but not visuospatial, working-memory load

Ms Louisa A. Talipski Australian National University

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Humans are social animals, and this means we are sensitive to a variety of social cues. One of these is gaze direction, which elicits a shift of attention that some have argued to be highly reflexive. Strong evidence for the automaticity of gaze cueing is that the effect persists under conditions of reduced cognitive control; that is, gaze-cueing effects appear even when the ability to exert volitional control is taxed (e.g., via a verbal or visuospatial working-memory load; WML). Given that visual attention is a critical mechanism for interacting with the world, the question of how it is controlled, as well as whether this control differs for social versus nonsocial stimuli, is important. Therefore, we examined whether this automaticity is specific to gaze cues, which have intrinsic biological relevance, or whether it is also a feature of manufactured stimuli to which we are frequently exposed: arrows. Participants completed an arrow-cueing task under conditions of no, low, or high WML. Across two experiments, we found that our verbal WML failed to diminish the cueing effect produced by a nonpredictive arrow, despite being sufficiently effective to eliminate orienting in response to a counterpredictive arrow. In a subsequent experiment, however, we found evidence that a visuospatial WML diminished the cueing effect produced by a nonpredictive arrow. These findings suggest that automatic orienting in response to arrow cues is dependent on the availability of visuospatial working-memory resources.

Decreasing kidney function leads to cognitive impairment in adults: A systematic review and pilot study results

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Julia Brodski, Swinburne University of Technology David Castle, University of Melbourne & St Vincent's Hospital Susan Rossell, Swinburne University of Technology

There is growing evidence that decreasing kidney function has an impact on cognition. We present a review of cognitive impairment findings by disease stage in non-elderly chronic kidney disease (CKD) patients and results of a pilot cognitive study in end-stage CKD patients. Most studies to date have been conducted in older populations, which are confounded by the effects of natural age-related cognitive change. The databases PubMed and

Medline via Scopus were searched for cross-sectional or cohort studies and randomised controlled trials that assessed cognitive function in CKD individuals. CKD studies were included if participants were under 65 years old, were not on peritoneal dialysis and had not undergone a kidney transplant. Fifteen studies, totalling 9304 participants, were included. Cognitive function broadly deteriorated from stage 1 to stage 5 (d = 0.14-3.83). Earlystage CKD was associated with a drop in processing speed, attention, response speed and short-term memory abilities. Moderate-stage CKD was associated with deficits in executive functioning, verbal fluency, logical, orientation and concentration. People with end-stage CKD manifested significant deficits in all previous cognitive domains, along with cognitive control, delayed and immediate memory, visuospatial impairment and overall cognitive impairment. Preliminary data from our ongoing pilot study (12 endstage CKD patients compared to 20 healthy controls) revealed that patients were significantly poorer at processing speed, learning, problem solving, emotional management, inhibition and switching tasks, with marked lowerand higher-order cognitive deficits (p < .05). In conclusion, cognitive impairment is evident across the stages of CKD, independent of age-related changes, for both lower-order and higher-order cognitive abilities. These impairments also increase between the stages, suggesting a cumulative effect with decreasing kidney function.

Systemic inflammation and cognitive performance in healthy elderly participants: Results from the Australian Research Council Longevity Intervention trial (ARCLI)

Ms Masoumeh Tangestani Fard Swinburne University of Technology

Con Stough, Swinburne University of Technology Andrew Scholey, Swinburne University of Technology

Neuroinflammation has been suggested to be the main mechanism of the cognitive process. It is a complicated cellular and molecular cascade in the brain where several immunological principle cells and their productions have a key role in the initiation and development of the process. It is involved in several key biological and physiological processes during brain structural formation and functional performance such as maintaining brain's homeostasis, managing various cellular signalling, neurogenesis, neuroplasticity, and synaptic connection. The current study examined associations between some inflammatory biomarkers and cognitive functioning using a healthy non-demented elderly sample. The sample comprised 264 healthy volunteers (114 male, 150 female) aged 60-75 years from the Australian Research Council Longevity Intervention (ARCLI) study cohort. Serum cytokines, C-reactive protein (CRP), tumour necrosis factor alpha (TNF-α), interleukin (IL)-2, IL-4, IL-6, IL-10, IL-1 beta (β) and interferon gamma (IFN- γ), were measured, and participants completed the Swinburne University Computerised Cognitive Assessment Battery (SUCCAB) and Cognitive Drug Research (CDR) Computerised Assessment Battery. We hypothesised that participants with lower pro-inflammatory cytokines levels would exhibit better cognitive performance compared to those with higher cytokines, particularly in terms of memory. It is suggested that the hippocampus may be differentially sensitive to pro-inflammatory cytokines elevation during the aging process. Moreover, it is suggested that interventions that suppress inflammatory expression could be undertaken in order to improve memory in the elderly. Our detailed results will be presented.

Unimanual adaptation in a bimanual force-production task

Ms Eleanor Taylor Monash University

Anna Ferenc, *Monash University* Trevor T.-J. Chong, *Monash University* James P. Coxon, *Monash University*

Motor adaptation is the trial-to-trial modification of a movement that leads to gradual and consistent changes in motor behaviour. This adaptation can occur through reinforcement learning, and implicit or explicit processes. In this study we test a novel adaptation paradigm with the aim to elicit an implicit adaptation of force output by one hand during a bimanual force-production task. Participants were required to produce sufficient force to reach a computer-based target over multiple trials, with successful trials resulting in reward. To encourage adaptation, a gradual increase or decrease in force requirement was covertly applied on one hand across trials. This experiment used a between-groups design, with healthy young adults (N = 104, $M_{age} = 19.9$ years, SD = 1.4 years) randomly assigned to one of five groups,

constituting a 2×2 between-groups factorial design plus a control group. The factors were Force Adjustment Direction (increased or decreased), and Adjusted Hand (dominant or non-dominant), with the control group experiencing no change in force requirement. Results indicated a main effect of Force Adjustment Direction, F(1,72) = 74.9, p < .001, $\eta^2_p = .51$, indicating an increase or decrease in force production relative to the change in force requirement. A two-way interaction of Time \times Hand, F(4.0, 132.1) = 3.65, p = .007, $\eta^2_p = .10$, was found in groups with an increased force requirement, indicating that force production increased during training for the adjusted hand but not for the unadjusted hand. No such interaction was found for groups with a decreased force requirement. Self-reported ratings of perceived force requirement indicated the participants had no awareness of the change in force requirement in any of the groups, suggesting the changes were the result of implicit learning. These findings may have implications for the use of reward-based implicit learning paradigms in neurorehabilitation, particularly in cases of unilateral motor deficit.

Associations between severity of schizophrenia symptoms and brain activity evoked during fMRI auditory oddball task

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Kit Melissa Larsen, University of Queensland Marta I. Garrido, University of Queensland

People with schizophrenia are known to have deficiencies in encoding statistical regularities within the auditory environment, as demonstrated by reductions in prediction-error signals in the brain. Previous studies in this field have primarily focused on group differences, either between subgroups of patients and/or healthy controls. In this study, we take an individual-differences approach by analysing fMRI data acquired from 84 individuals who met the DSM diagnostic criteria for schizophrenia across three different sites, enabled by the Mental Illness and Neuroscience Discovery Institute (MIND) Clinical Imaging Consortium (MCIC). Participants performed an auditory oddball task, comprising sequences of predictable standard tones interspersed with infrequent target and novel tones. Our whole-brain, massunivariate modelling suggests that BOLD responses to novel stimuli in the supramarginal gyrus correlate positively with negative symptoms (SANS; peak-level $p_{FWE} = .031$, cluster-level $p_{FWE} = .012$, kE = 172), whilst activation associated with target stimuli correlated negatively with positive symptoms (SAPS; cluster-level p_{FWE} = .008, kE = 163) in the frontal pole, as well as the inferior frontal gyrus, the insular cortex, and the middle frontal gyrus. The next analysis steps include applications of multivariate machine learning, combining neuroimaging and behavioural features to predict symptom severity on an individual basis, and potentially aiding diagnosis based on these objective measures.

Yellow strawberries and red bananas: Examining the temporal dynamics of object-colour knowledge

Ms Lina Teichmann Macquarie University (MU)

Genevieve Quek, *Radboud University* Amanda K. Robinson, *University of Sydney & MU* Tijl Grootswagers, *University of Sydney* Thomas Carlson, *University of Sydney* Anina Rich, *MU*

Object recognition is a crucial function of the human visual system. Objects are characterised by many different properties, including form, colour, and surface texture. Successful object recognition requires binding these features into specific and robust neural representations. How does binding of features such as colour and form unfold over time? To address this question, we recorded brain activity using magnetoencephalography while participants (N = 20) viewed congruently coloured objects (e.g., yellow banana), incongruently coloured objects (e.g., red banana), achromatic objects (e.g., greyscale banana), and coloured abstract, geometric shapes. We used timeresolved multivariate pattern analyses to track how object representations unfold over time. The data showed that colour representations can be accessed via real colour perception and via greyscale objects associated with certain colours, demonstrating that canonical object-colour can be activated in complete absence of colour in the stimulus. However, explicit colour processing (e.g., invoked by seeing something red) was evident earlier in time than implicit colour knowledge (e.g., invoked by a greyscale strawberry). This delay might correspond to the time it takes to activate the conceptual object representation that contains canonical colour. To assess the time course by which bound object representations are activated, we also decoded the congruent versus incongruent stimuli, which differed only in how the features are bound together (colour with form). Accurate congruency decoding was observed at ~240 ms, indicating that object features must be bound successfully and a conceptual representation of an object must be activated by this time. These results provide evidence that the brain represents perceptual features not present in the stimulus, giving insight into the complexity of object representations and their dependence on our knowledge about the world.

Magnetoencephalographic (MEG) inter-subject correlation during listening to natural speech in dyslexia

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Neural entrainment to speech has been suggested to be impaired in dyslexia. However, the majority of studies have employed short, repetitive, or otherwise unnatural speech stimuli. Therefore, these studies have a limited capacity to explain the brain basis of natural speech processing. Here, to address this gap, we utilised a continuous 10-min natural speech stimulus and compared inter-subject correlations (ISC) in dyslexics with those in typically-reading controls. To this end, MEG of 25 dyslexic and 25 typicallyreading Finnish participants were recorded while they listened to real-life speech, comprising pieces of news, a novel read aloud, and small talk. MEG was additionally recorded during resting, which served as a control condition. For both the listening and resting conditions, band-pass-filtered MEG envelopes were correlated between subjects in the cortically-constrained source space. The resulting ISCs for both groups were contrasted with a permutation-based t-test. During listening, reduced ISCs were found in dyslexics mainly at low frequencies in temporal, frontal, and parietal regions. In the gamma band, dyslexics had enhanced ISCs in temporal regions compared to controls. The abnormal between-subjects brain synchronisation to natural speech in dyslexics speaks for deficits in the continuous processing of speech in dyslexia.

NRG1 genetic risk score predicts antisaccade and memory-guided saccade latency in schizophrenia

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Neuregulin-1 (NRG1), involved in neuronal development, migration, myelination and synaptic plasticity, has been identified as a promising candidate gene for schizophrenia risk. Several single-nucleotide polymorphisms (SNPs) in the NRG1 gene have been associated with schizophrenia and cognitive deficits such as saccadic (eye-movement) deficits. However, genetic liability for schizophrenia is multifactorial, with contributions of multiple risk variants. Therefore, analysis of genetic risk scores may better capture the genetic contribution to cognitive performance in schizophrenia. The aim was to investigate whether the genetic risk score for NRG1 predicts saccadic performance in patients and controls. One-hundred and sixty-six Caucasian participants (44 patients with schizophrenia/schizoaffective disorder and 122 healthy controls) completed the antisaccade and memory-guided saccade tasks, which engage spatial working memory and inhibition processes. Participants were also genotyped for five NRG1 SNPs (rs10503929, rs3924999, rs2466058, rs35753505 and rs6994992), and genetic risk scores were created. Antisaccade and memory-guided saccade latency and error rate were significantly different between patients and controls (p < p0.001). In patients, the NRG1 risk score significantly correlated with antisaccade latency (p = 0.04, r = 0.39) and explained 15.1% of the total variance of the model. The NRG1 risk score also significantly correlated with memory-guided saccade latency (p = 0.02, r = 0.44) and explained 18.9% of the total variance of the model. There was no relationship between NRG1 risk score with antisaccade or memory-guided saccade performance in controls. This is the first study to use risk scores to observe the relationship between *NRG1* and eye-movement performance. The results identify *NRG1* as a potential candidate gene for cognitive impairment in schizophrenia and support the use of aggregate genetic risk scores to investigate multifactorial disorders.

Mind the boys! The effect of squeezing balls on visuospatial attention

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The human body is controlled contralaterally by the brain-meaning that, in theory, contracting one hand activates the motor cortex in the opposite hemisphere of the brain. Indeed, unilateral contractions are reported to enhance or alter a wide variety of cognitive functions, including creativity, selfinfiltration, and choking under pressure. Although there is no universally accepted unilateral contraction method, typically participants squeeze a ball in one hand and then complete a task that is allegedly influenced by hemispheric activation. Unfortunately, previous research in this area has methodological concerns-namely, the use of a manipulation check has been largely absent. As such, we conducted a series of five experiments to investigate whether unilateral hand contractions activate the contralateral hemisphere in a reliable manner, by measuring pre- and post-squeezing performance on the landmark task. All participants were strongly right-handed. Based on prior research, we expected that squeezing a ball with the right (left) hand would lead baseline asymmetry scores to deviate further left (right). In our first three experiments, participants completed the ball squeezing prior to performing the second landmark task. In Experiments 4 and 5, participants gave verbal responses to the landmark task during ball squeezing. The results from each individual experiment showed unilateral contractions did not induce any reliable changes in landmark task performance. Therefore, we performed a meta-analysis on the data from all five experiments to obtain a precise estimate of the effect. Our analysis confirmed our findings, leading us to conclude that unilateral contractions are ineffective in activating the contralateral hemisphere in an observable manner. Our findings also highlight the importance of appropriately testing the experimental methodologies we intend to use-or, we run the risk of publishing false positives and contributing to the replicability crisis.

Head motion during MRI implicit in ADHD phenotype, hurdles for imaging studies

Ms Phoebe Thomson¹

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Background: ADHD is a neurodevelopmental disorder often featuring sustained attention deficits. Recent work has sought to establish the neural basis of impaired sustained attention in ADHD, however mismanagement of in-scanner head motion may have prevented clear results from emerging. Although initial studies have found a link between ADHD symptoms and greater head motion, no studies have examined the relationship between infrequent but large in-scanner head motion and sustained attention performance outside of the scanner. Methods: As part of the Neuroimaging of the Children's Attention Project, 56 ADHD and 61 control children aged 9-11 years completed the Sustained Attention to Response Task (SART), and MRI session including a 6-minute resting-state functional MRI sequence in a 3-Tesla scanner. SART omission errors and time constant (τ ; tau) in response time (RT) were obtained using signal-detection and ex-Gaussian analysis techniques. Ex-Gaussian analysis was also applied to head motion data yielding μ (mu), σ (sigma) and τ in head motion. Regression analyses examined whether performance on the SART mediated the relationship between ADHD diagnosis and ex-Gaussian head motion parameters. Results: Omission errors mediated the relationship between ADHD diagnosis and $\boldsymbol{\tau}$ in in-scanner head motion. Results were specific to τ , with neither ADHD diagnosis nor omissions predicting μ and σ in head motion. τ in RT did not mediate the relationship between ADHD diagnosis and head motion. Discussion: Results suggest an essential link between lapses in sustained attention (omissions) outside the scanner and infrequent large head motion (τ) during resting-state MRI. Standard removal of head motion from MRI data may be removing signal underlying sustained attention. Techniques such as structural equation modelling could allow future studies to consider brain activity relating to head motion as both critical signal and noise, and ultimately elucidate the neural basis of sustained attention.

Schizotypal cognitive disorganisation is associated with specific deficits in contrast sensitivity

Ms Anne Louise Thorbecke University of Melbourne

Olivia L. Carter, University of Melbourne Patrick T. Goodbourn, University of Melbourne

Schizophrenia is a debilitating psychological illness that carries substantial social and financial costs. Distinct from core symptoms, there is consistent evidence that both visual contrast sensitivity and involuntary eye movements are impaired in people with schizophrenia. This suggests a shared genetic and neurobiological basis, but the exact nature of the relationship remains unclear owing to complex interactions with medication, duration of illness, and symptom profiles. We sought to clarify this relationship by examining schizotypy, a collection of sub-clinical personality traits that map onto symptoms of schizophrenia and increase risk of subsequent transition to psychosis. Psychologically healthy participants completed a dimensional schizotypy scale (the Oxford-Liverpool Inventory of Feelings and Experiences; O-LIFE), then viewed monochromatic, drifting (10 °/s) filtered-noise textures varying in spatial frequency (0.5-16.0 c/°) and contrast (0.25-32.0%). We calculated two spatial contrast-sensitivity functions for each participant: one derived from perceptual reports (button presses), and the other from involuntary eye movements elicited by the moving stimuli (optokinetic nystagmus). We found that the schizotypal dimension of *cognitive* disorganisation was uniquely associated with contrast-sensitivity deficits at low-to-medium (2-4 c/°) spatial frequencies, but only for perceptual report. Sensitivities to other spatial frequencies, and sensitivities derived from eye movements at all spatial frequencies, were unrelated to any schizotypal dimensions. Our findings indicate that cognitive disorganisation and the conscious perception of coarse visual structure may share biological substrates. In addition, as generalised deficits in contrast sensitivity and involuntary eye movements have been observed regularly in schizophrenia, the absence of these deficits in schizotypy points to a protective mechanism that may inform our understanding of transition to psychosis.

Hierarchical learning and the dominance of longer-term assumptions over local predictions

A/Prof. Juanita Todd University of Newcastle

Part of the symposium Prediction, prediction-error, and the brain

In studies of auditory perceptual inference, a violation of a locally established pattern will elicit a component of the evoked potential known as mismatch negativity (MMN). The amplitude of MMN is considered to be "precision-weighted", where MMN is largest when the predictable pattern is very stable. Over a series of studies, we have demonstrated that the amplitude of MMN to a local pattern violation is subject to modulation by longerterm assumptions about the sound sequence structure. In this presentation two independent datasets using "multi-timescale sequences" will be used to expose how MMN amplitude to a local pattern violation is significantly reduced after a longer-term assumption about the sequence has been violated. This higher-order modulation is so strong that it yields a much stronger influence over MMN amplitude than the period of stability in the local pattern. The data speak to the ability of the auditory system to learn predictable structures on multiple timescales simultaneously, and to how layers of prediction interact to impact auditory evoked potentials.

Cognition in body dysmorphic disorder: Where are we up to now?

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David Castle, St. Vincent's Hospital

& University of Melbourne Susan Rossell, Swinburne University of Technology

& St Vincent's Hospital

Background: Body dysmorphic disorder (BDD) is characterised by an excessive preoccupation, alongside repetitive behaviours and/or mental acts, in response to imagined or perceived flaws in physical appearance. To date, there is still a lack of understanding with respect to the cognitive profile of individuals with the disorder. This study aimed to amalgamate our series of empirical studies delineating cognitive performance in BDD across a range of neuropsychological measures. Method: Participants were 21 BDD patients, 19 obsessive-compulsive disorder (OCD) patients, and 21 healthy controls (HCs). Experimental paradigms employed were the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), a facial affect recognition task (with an incorporated eye-tracking paradigm), an emotional Stroop task, and a modified Mooney faces task. Results: Clinical participants exhibited significant deficits in immediate memory and attention based on the RBANS. The BDD group was also poorer at identifying facial emotions, exhibiting a significant angry recognition bias, alongside an atypical scanning strategy. On the emotional Stroop, BDD participants displayed a significant attentional bias to negative disorder-relevant words only. A significantly reduced face inversion effect was also identified in BDD using the Mooney faces task. Conclusion: These findings will make a noteworthy contribution towards establishing an inclusive etiological model underpinning BDD, and also convey fruitful therapeutic implications. However, further questions are also raised as to the nosological suitability of classifying BDD under the obsessive-compulsive and related disorders in DSM-5, especially given significant group differences between BDD and OCD in emotion processing (and related eye tracking), selective attention and visual perception.

Steady-state somatosensory evoked potential responses recorded in the primary and secondary somatosensory cortex of anesthetised cats: Non-linearity characterised by multiples of the fundamental frequencies and intermodulatory frequencies

A/Prof. Naotsugu Tsuchiya Monash University

Rannee Lee, *Monash University* Spencer Chen, *University of Texas* Richard Vickery, *UNSW Sydney* John Morley, *Western Sydney University*

When presented with an oscillatory input at a particular frequency, F Hz, neural systems respond with the corresponding frequency, f Hz, and its multiples (e.g., 2f, 3f...). When two frequencies (e.g., F1 and F2) are non-linearly integrated in the system, responses at inter-modulatory frequencies (i.e., $n_1F_1 + n_2F_2$ Hz) emerge. Utilising these properties, the steady-state evoked potential (SSEP) paradigm allows us to characterize linear and non-linear neural computation performed in cortical neurocircuitry. Here, we applied the SSEP on the local field potentials (LFPs) recorded from the primary (S1) and secondary (S2) somatosensory cortex of the anaesthetised cats while we presented slow (F_1 = 23 Hz) and fast (F_2 = 200 Hz) somatosensory vibration on to the contralateral paws and fingers. Over nine sessions, we recorded LFPs from 1620 and 1008 sites in S1 and S2, respectively, using multiple array electrodes. Power spectral analyses revealed strong responses at (1) the fundamental (f_1, f_2) and (2) its harmonic (n_1f_1) frequencies; (3) the intermodulation frequencies $(n_1f_1 + n_2f_2; n_1 = 1, -1, -2... \text{ and } n_2 = 1);$ and (4) broadband frequencies (50-150 Hz). We observed the broadband response only in S2 but the other types in both S1 and S2. In contrast, we did not observe corresponding responses in our previous single and multiple spiking analyses (Carter et al., 2014), except for the slow fundamental frequencies (f_1). Combined with our current analysis of LFPs, our paradigm offers a rare opportunity to study how spiking outputs can arise from local computations which are modulated in various frequencies and constrain the computational architecture of hierarchical organisation of S1 and S2.

The effect of absolute evidence magnitude on perceptual changes of mind

Mr William F. Turner University of Melbourne

Daniel Feuerriegel, University of Melbourne Milan Andrejevic, University of Melbourne Robert Hester, University of Melbourne Stefan Bode, University of Melbourne

To navigate the world safely, we rely heavily on our ability to make accurate perceptual decisions. However, errors do inevitably occur. In these situations, rapid 'changes of mind' are required to correct ongoing actions. An

extension of the Drift Diffusion Model states that relative evidence, the difference in evidence for opposing choices, continues to be accumulated even after the initial decision is made, driving such changes of mind. However, perceptual decisions might also be sensitive to absolute evidence magnitude, i.e. the sum of evidence for opposing choices. In the current study, we investigated if absolute evidence influences the frequency and timing of changes of mind. Participants (N = 30) indicated which of two flickering greyscale squares was brightest. Critically, following the initial decision, the stimuli remained on screen for a brief period (1 s) during which participants could change their response. To investigate the effect of absolute evidence, the total luminance of the two stimuli was varied whilst relative differences in luminance were held constant. It was found that increases in absolute luminance were associated with faster, less accurate initial responses. However, high levels of absolute evidence were also associated with slower, less frequent changes of mind. These observations challenge the dominant assumption that changes of mind are driven solely by ongoing accumulation of relative evidence. Interestingly, the effect of absolute evidence magnitude on the timing and accuracy of initial decisions is consistent with the proposal that high absolute evidence increases the variability of the decision process. Given this, the observed change of mind dynamics suggest that change of mind decisions depend, in part, on evidence reliability.

Effects of treatment resistance on whole-brain grey matter integrity and related functional connectivity in major depressive disorder

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Treatment-resistant depression (TRD), defined as failure to respond to one or more antidepressant treatment trials in patients with major depressive disorder (MDD), represents a major public health problem. We examined the relationship between brain structure and treatment-resistance in a sample of unmedicated patients with MDD (N = 61) and demographically similar healthy controls (N = 41). All subjects underwent structural and functional neuroimaging with MRI at 3T and current depression severity was measured. Patients were classified by treatment resistance according to the Maudsley Staging Model (MSM). Whole-brain voxel-based morphometry (VBM) analysis was conducted for grey matter using Advanced Normalisation Tools (ANTs). We additionally examined resting-state functional connectivity among identified regions of reduced grey matter volume (GMV). Greater number of antidepressant failures was associated with decreased GMV in a cluster centred on the left thalamus (x = -12, y = -20, z = 2, k =14 598 mm³) and extending into the hippocampus and fusiform gyrus, controlling for current symptom severity. Traditionally defined TRD (two or more antidepressant medication failures) was associated similarly with decreased GMV in the fusiform gyrus (x = -36, y = -63, z = -17, k = 3812mm³). Conservatively defined TRD (MSM score > 2) was negatively associated with GMV in the right retrosplenial cortex and precuneus (x = 15, y = -55, z = 14, k = 693 mm³). Within the same model, MDD diagnosis was negative associated with GMV in the dorsolateral prefrontal cortex (x = -42, y = -45, z = 6, k = 732 mm³) compared to healthy controls. Among a subset of patients who received ketamine infusion for TRD, resting state connectivity between a seed centred on the retrosplenial cortex and the ventromedial PFC was related to treatment response. These findings have potentially important implications for understanding and treating TRD.

Neural tracking of self and other during joint movement improvisation

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Humans coordinate their movements to perform everyday tasks together. Optimal joint performance requires individuals to continuously anticipate and adapt to spatial and temporal characteristics of each other's movements. Here we investigate with dual EEG and frequency tagging techniques the neural tracking of self- and other-generated movements during

a joint visuomotor improvisation task. We examined neural responses to self and other movement in dyads producing synchronised horizontal forearm movements when leader–follower relation was manipulated. The results indicated that participants exhibited large EEG responses to other-produced movement but also to their own movement and that the amplitude of those responses was modulated depending on leader–follower constraints. A positive correlation between the amplitude of EEG responses and interpersonal movement synchronisation was also found, opening new perspectives to understand perceptual-motor mechanisms underlying joint action.

A moment of conscious experience is very informative

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Our visual experience of the world seems highly rich. This subjective richness has proven difficult to verify in traditional psychophysics experiments in which people are asked to report on items (such as letters or coloured disks) that are present in a briefly displayed image. In these tests, the number of items that can be recalled is very limited, a result which is often taken to indicate that the perceived richness of our experience is illusory, and that the "bandwidth of consciousness" is in fact quite low (lower than 40 bits/s). However, these tasks are typically designed such that the limiting factor is not conscious bandwidth, but other cognitive functions such as visual working memory or the types of questions per se. Here, we used a large repository of natural scene images and associated descriptors and non-descriptors and asked people to determine whether a suggested descriptor matched or not with the contents of a briefly viewed (< 133 ms) scene. Participants demonstrated a much higher bandwidth (at least 100 bits/s) in this task, accompanied with high metacognition, and without significant decay over time. Our results offer a way of extending the lower bound of the estimated bandwidth of consciousness. We will propose an explanation of the remarkably good performance we observed in this task (and of the relevance of absent stimuli to our perceptual experience) that draws on Integrated Information Theory, according to which any given subjective experience is partly defined by its differentiability from other possible experiences.

The relationship between resting EEG alpha rhythm and Internet-use related measures

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Evidence suggests that the harmful effects associated with addictive use of the Internet need to be addressed. This study investigated the electrophysiological activity associated with vulnerability of problematic Internet use in a non-clinical population. The resting EEG spectrum of alpha (8-13 Hz) rhythm was measured in 22 healthy subjects who have used the Internet for recreational purposes. The vulnerability of problematic Internet use was assessed using Young's Internet Addiction Test (IAT) and Assessment for Computer and Internet Addiction-Screener (AICA-S). Depression and impulsivity were also measured with the Beck Depression Inventory (BDI) and Barratt Impulsiveness Scale 11 (BIS-11) respectively. The IAT was positively correlated with alpha power obtained during eyes-closed (EC; r = 0.50, p =.02) but not during eyes-open (EO) conditions. This was further supported by a negative correlation (r = -0.48, p = .02) between IAT scores and alpha desynchronisation (EO-EC). These relationships remained significant following correction for multiple comparisons. Furthermore, The BDI score showed positive correlation to mid-lateral (r = 0.54, p = .01) and mid-frontal (r = 0.46, p = .03) alpha asymmetry during EC, and to mid-frontal (r = 0.53, p = .03)p = .01) alpha asymmetry during EO. The current findings suggest that there are associations between neural activity and the vulnerability of problematic Internet use. Understanding of the neurobiological mechanisms underlying problematic Internet use would contribute to improved early intervention and treatment.

Neural correlates of future thinking: A resting-state functional connectivity study

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Background: Previous studies suggest that thinking about the future activates brain regions that largely overlap with default mode network (DMN), which is normally activated when people are at rest. However, few studies have examined the neural correlates of individual differences in future thinking. This study examined this issue using a resting-state functional connectivity (FC) approach. Method: Forty undergraduate and graduate students underwent resting-state fMRI scanning and completed the Future Event Sentence Completion Test after scanning. Eleven core brain areas from the DMN (Andrews-Hanna et al., 2010; Dodell-Feder et al., 2014) were used as seeds to examine FC underlying neural correlates of future thinking performance. **Results:** Our results showed correlations between resting-state FC of DMN and specificity of future thinking, namely, FC between: posterior cingulate cortex and medial frontal gyrus; dorsomedial prefrontal cortex and caudate, postcentral gyrus, cingulate gyrus, superior temporal gyrus; lateral temporal cortex and middle temporal gyrus, superior temporal gyrus; hippocampal formation and superior frontal gyrus, medial frontal gyrus, inferior frontal gyrus, insula, inferior parietal lobule, superior temporal gyrus. All of these FC measures showed negative correlations with specificity of future thinking. Discussion: These results suggested that resting-state functional connectivity in the human brain is associated with future thinking. It highlighted the functional link between DMN at rest and human cognitive processes.

Sensory predictions regarding the auditory properties of inner speech

A/Prof. Thomas Whitford UNSW Sydney

Part of the symposium Prediction, prediction-error, and the brain

It is well established that the brain makes predictions regarding the sensory consequences of overt movements. The present electrophysiological study employed a novel design to show that inner speech-the silent production of words in one's mind-is also associated with a sensory prediction. Fortytwo healthy participants produced one of two inner phonemes (/ba/ or /bi/) at a time that was precisely specified by means of a visual animation. At this same exact time, an audible phoneme was concurrently presented to participants' headphones. The audible phoneme could either match (e.g., imagine /ba/, hear /BA/) or mismatch (e.g., imagine /ba/, hear /BI/) the inner phoneme. The production of the inner phoneme resulted in suppression of the N1 component of the auditory-evoked potential, but only if the content of the inner phoneme matched the content of the audible phoneme. These results demonstrate that inner speech-a purely mental action-is associated with a sensory prediction with detailed auditory properties. Given that similar results have been observed in response to overt speech, the current results also suggest that inner speech and overt speech are closely related.

The blind mind and emotion: Are thoughts less scary with aphantasia?

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For most people, visual mental imagery is a ubiquitous component of cognition. One proposed function of imagery is to make thoughts more emotionally evocative. This is because imagery's sensory, *as-if-seen* quality has been proposed to induce stronger emotions than abstract, verbally-based thoughts. However, evidence for this proposition is based on subjective self-reports of both imagery and emotions, and often assumes good metacognition and control of imagery itself. Here we report new data testing the relationship between imagery and emotions, utilising a newly documented special population of individuals born without any visual imagery ability or experience: congenital aphantasics. We first assessed self-identified aphantasics' sensory-imagery strength using the documented binocular-rivalry technique and excluded participants with sensory-imagery strength above a minimal threshold. Next, aphantasic and non-aphantasic (normal imagery) control participants read a series of frightening fictitious scenarios, while we continuously recorded their skin conductance level as an objective measure of fear response. While control participant data monotonically rose, the aphantasic skin conductance level flatlined, suggesting significantly less fear response to the frightening stories. To control for a general skin-conductance difference, we exposed aphantasic and control participants to emotionally charged perceptual images, which induced monotonic increases in skin conductance for both groups. These data together suggest the emotional response to reading fictitious scenarios is contingent on intact mental imagery. This adds strong support to clinical theories that mental imagery holds a special and strong relationship with emotions, underpinning imagery's pivotal role in mental disorders and their treatment.

Can perceived elongation of visual stimuli into the physiological blind spot can be explained by lateral V1 connections?

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Visual experience is underpinned by compensation for missing information by the brain. The physiological blind spot is a classic example of this: It is perceptually "filled in" via extrapolation of information from the surround, such that we perceive a seamless visual world. The mechanism for this has long been debated. The blind spot could be filled in through feedback from higher cortical regions, sending activity back to the blind spot representation in primary visual cortex (V1), or through lateral spread within V1, propagating activity inward from the borders of the blind spot representation. We tested the lateral spread hypothesis using a width judgement task to measure the perceived elongation of stimuli into the blind spot. After replicating the partial filling-in phenomenon by presenting stimuli in cardinal orientations at blind spot borders, we presented stimuli oriented either radially or tangentially to the fovea so as to align or misalign stimuli with the arrangement of lateral connections in V1. We find that perceived elongation toward the centre of the blind spot is dramatically affected by stimulus orientation relative to the fovea. When stimuli are presented radially, filling-in is maximised; when stimuli are presented tangentially, filling-in is all but extinguished. These findings reveal the importance of V1 lateral connections for partial filling-in of the blind spot, consistent with the lateral spread hypothesis.

Habituation of subjective anxiety and cortical hypervigilance during image-based exposure: An ERP study

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In the present study, habituation (decreased response to stimuli with repeated exposure) of attentional hypervigilance (preferential allocation of attention to feared stimuli) was investigated in specific fear. Participants with a high (N = 12) or low (N = 13) fear of spiders passively viewed bird (neutral) images and progressively 'scarier' spider (fear-relevant) and snake (negative) images, in separate six-stage hierarchies. Stage six contained the image from stage one repeated. Electrophysiological (EEG) activity was recorded throughout and the P100 event-related potential was taken as a cortical measure of attentional hypervigilance at a central occipital site (Oz). Participants rated their subjective anxiety (Subjective Units of Distress Scale; SUDS) at four time-points for each stage (0, 30, 60, and 90 s). Both groups showed reductions in P100 amplitude across some stages of the spider and snake hierarchies, and some evidence of subsequent reinstatement of cortical attentional hypervigilance at latter stages. High but not low spider fear participants showed habituation of subjective anxiety within stages, but there was little evidence of habituation between stages. Together the findings do not provide evidence for a fear-specific neural mechanism during exposure. However, it is possible that participants engaged in avoidance strategies (e.g., covertly redirecting attention) during the passive viewing tasks.

A validation of Emotiv Extender for ERP research

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The purpose of this study was to validate event-marking hardware used in electroencephalogram (EEG) research. This hardware is specifically used to time-lock EEG measurements with experimental stimuli to investigate event-related potentials. In this study we assessed two pieces of hardware. One was a custom-built unit that converts an audio signal into an electrical pulse which is then injected into two channels of an EEG device. The other unit, called Extender, was developed by Emotiv Pty Ltd. This device receives electrical pulses and injects them into the EEG data stream as event markers. We compared the performance and reliability of the two event-marking devices across two different portable EEG systems, EPOC+ and EPOC Flex. We found that Extender was capable of reliably recording event times, but only when the EEG devices were in the 128 Hz sampling rate mode. In 256 Hz mode, event-marking with Extender was unreliable.

Cultural and bilingual effects in the Navon task

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Variations of the Navon task have been used extensively to study global and local processing. In general, results have shown a global precedence effect-that is, responses to global stimuli are faster than those to local stimuli. However, cross-cultural research has shown a reduction in global precedence for Western populations, suggesting a more analytical processing style. In addition to this approach, the Navon task has also been used to study inhibitory control by manipulating the congruity of the global and local stimuli. Previous research has suggested a bilingual advantage in executive control resulting from continual inhibition of competing lexical representations. In this study, English monolinguals, English/Chinese bilinguals, and English/Malay bilinguals performed the Navon task. The bilingual participants were born and grew up in East or South-East Asia (mainly China and Malaysia). Given previous research, we expected to see a larger global precedence effect in Chinese and Malay participants compared with English participants, and a reduction in interference caused by incongruent stimuli in bilingual participants. Preliminary results demonstrate the expected global precedence effect across all groups; and while Western participants showed a decreased global precedence effect, it did not reach statistical significance. Furthermore, no significant difference was found across congruity conditions between monolinguals and bilinguals (i.e., there was no group \times congruity interaction). This result adds to the literature that has found no evidence for a generic bilingual executive-control advantage. In addition to the behavioural results, we also explored the relationship between global/local processing and inhibitory control, and various ERP components, including the P1, N2 and P300.

Exploring electrophysiological markers of inhibitory cueing effects

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An inhibitory cueing effect (ICE) refers to any slowed response to a target stimulus caused by previous exposure to a cue at the same spatial location. ICEs have been predominantly observed with spatial cueing tasks in the form of slower reaction times to cued as compared to uncued trials. Evidence accumulated over the past four decades has demonstrated that ICEs can be generated by mechanisms closer to the input end of the processing pathway (e.g., sensory adaptation) as well as mechanisms closer to the output end of the processing pathway (e.g., inhibition of return). While behavioural data on ICEs is well established, researchers are yet to find a reliable electrophysiological marker of either input- or output-based ICEs. The present study (N = 40) explored event-related potential (ERP) components (P1, Nd, and N2pc) within a spatial cueing task across two oculomotor status

conditions: (1) to generate input-based ICEs, the eyes remained fixated for the entire trial (oculomotor suppressed); and (2) to generate output-based ICEs, participants were required to make a saccade to the cue (oculomotor activated). A distractor stimulus also appeared simultaneously with a coloured target to balance sensory input and add a measure of spatial discrimination. Results demonstrated ICEs behaviourally in both oculomotor status conditions (cued trials were slower than uncued trials). However, cueing did not modulate either P1 or N2pc amplitudes. These P1 results were unexpected as most previous studies have observed a P1 cueing effect (reduced amplitudes for cued compared to uncued trials) when peripheral cues and targets are used. This provides further evidence that there is not necessarily a relationship between the often-observed P1 cueing effect and behaviourally observed ICEs. Additionally, based on these results, it seems unlikely that N2pc modulation is a reliable electrophysiological marker of input- or output-based ICEs.

Impaired social simulation in the behavioural variant of frontotemporal dementia: A novel cognitive mechanism underlying social behaviour?

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The behavioural variant of frontotemporal dementia (bvFTD) is a progressive neurodegenerative disorder characterised by pronounced social dysfunction and cognitive deficits, including memory. We previously demonstrated that the capacity to mentally simulate atemporal scenes, a process suggested to rely on episodic memory, is impaired in bvFTD. Here, we used a novel approach to determine whether social simulation is disproportionately disrupted in bvFTD. Eighteen bvFTD and 20 healthy controls completed a mental simulation task involving imagining social (e.g., busy restaurant), and non-social (e.g., forest) scenes. Scene descriptions were scored for contextual detail. A significant main effect for group (p < .001) revealed bvFTD patients produced fewer contextual details than controls across conditions. Further, a significant group by condition interaction (p = .046) revealed bvFTD patients performed significantly worse on social (M = 17.67, SD = 5.19) compared to non-social (M = 18.94, SD = 5.41) simulations. There was no significant difference between social (M = 23.45, SD = 3.00) and non-social (M = 22.80, SD = 2.74) simulations in controls. Correlations including all participants revealed the abnormal behaviour subscale of the Cambridge Behavioural Inventory was significantly associated with performance on social (r = -.39, p = .010), but not non-social (r = -.26, p = .072), simulations. This study demonstrates disproportionate deficits in social simulation in bvFTD, offering a novel cognitive mechanism potentially contributing to social dysfunction in this disorder.

Impaired learning from social rewards in frontotemporal dementia

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The ability to learn from social feedback is critical for adaptive behaviour in social settings. Evidence from clinical populations suggests that social dys-function may stem from deficits in processing social rewards. Individuals with behavioural-variant frontotemporal dementia (bvFTD) show deficits in social cognition and reward processing. However, it is unclear whether the ability to adapt their behaviour in response to social stimuli is impaired, and whether these impairments are specific to social rewards. This study contrasted reward learning for social versus monetary rewards. Here, bvFTD patients (N = 12) and age-matched healthy controls (N = 12) performed two computerised probabilistic reward learning tasks, one involving social feedback (pictures of smiling/angry faces) and the other involving monetary feedback (winning/losing money). While overall learning accuracy was lower in the bvFTD patients compared to controls, performance in the social condition was disproportionately impaired in bvFTD. Conversely, controls showed preserved learning, which was similar across social and monetary

feedback. Our findings demonstrate a greater deficit in reward learning for social relative to monetary rewards in bvFTD. Disproportionate impairments in social-reward processing may contribute to the social dysfunction observed in bvFTD. Future group studies will explore associations between physiological and neural markers of social-reward processing in bvFTD.

The *dreamcatcher* test: EEG spectral power is not a genuine measure of dreaming consciousness

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The dreamcatcher test can be described as a Turing test for consciousness science. To pass the dreamcatcher test would mean to have discovered the mechanisms of phenomenal consciousness in the brain. This is the first published attempt at the dreamcatcher test. In a sleep study, one team of scientists collected participants' brain activity measurements and subjective dream reports, and provided only the brain data to a second, blind team. The goal for the second team was to predict better than chance whether a participant had had a dream experience, based solely on the brain data prior to awakening and report. We used a serial awakening paradigm to collect brain activity data and dream reports from nine participants who slept in the laboratory over 4 nights. The first team prepared 54 one-minute polysomnograms of NREM sleep-27 of dreamful sleep and 27 of dreamless sleep (three per condition for each of nine participants)-and redacted all associated participant and dream report information. The second team attempted to classify each recording as either dreamful or dreamless using an unsupervised machine learning classifier, based on extracted features of EEG spectral power and electrode location, as supported by literature. The first team assessed the accuracy, and the procedure was repeated over five iterations with a gradual removal of the imposed blindness. None of the classifications performed significantly better than chance at any level of blindness. This suggested that EEG spectral power does not constitute a genuine discovery of the mechanism of phenomenal consciousness in the brain. More importantly, following several post-hoc analyses, we have demonstrated an outright failure to replicate the key findings of recently reported correlates of dreaming consciousness: specifically, those of Siclari and colleagues (2017), and Scarpelli and colleagues (2017). This replicability issue warrants further investigation.

On improving the feature selection of task-switching neural data using multivariate pattern analysis

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Multivariate pattern analysis (MVPA) was applied on data collected from a Cued Task-Switching Paradigm (N = 201, Mage = 21.3 years, 91 male) in order to enhance specificity of feature selection of EEG signals in an autonomous, data-driven manner, so that these features can inform the prediction of outcomes related to cognitive control. For an in-depth description of the task-switching paradigm, dataset, and pre-processing see Wong, Cooper, et al. (2018). MVPA, using the DDTBox (Bode et al., 2018), consists of training many Support Vector Machines (SVM) to perform a discrimination task, i.e., a classification task of EEG trial to obtain the condition label. From the input data, these SVMs are trained to classify topography, time or both, 'spatiotemporal'. Spatio-temporal discriminations, using the LIBLINEAR library, were computed using clean 64-channel 512-Hz EEG data between SwitchTo vs. Mix-Repeat Conditions (Switch Cost), and Mix-Repeat vs. All-Repeat Conditions (Mix Cost), for time intervals of -100 to 2000 ms (Cue:Baseline, -50 to 50 ms) and -900 to 2000 ms (Target:Baseline, -950 to 1050 ms, appears at 1000 ms). For each subject × discrimination × time interval, SVMs were trained on sequential non-overlapping windows of 10 ms using a 10×10 -fold cross-validation for both null and discrimination. Analysis of classification rates revealed significant discriminations (p < .05,

Bonferroni corrected) for all discriminations, with initial discriminations appearing around 150 ms after cue onset, peaking around 250 ms at 56%, and 200 ms at 55%, for Switch and Mix Cost respectively during the cue baseline. Target classification rates were around 52%, and first appearing at 1200 ms for both Switch and Mix Cost. Feature weights were correlated against reaction time costs, where interestingly around the time when classification rates peaked, significant topographical components (p < .05), similar to components previously reported in Wong, Cooper, *et al.* (2018) were found.

Modulation of cortical oscillations by arbitrary selfassociations

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Self-associated information is typically prioritised in cognitive processing, as evidenced by faster reaction times and lower error rate. It also affects the amplitude of event-related components such as P3 and N2 which are frequently associated with attentional processing. Here, we investigated whether arbitrary self-association can also influence induced oscillatory activity. Participants were told to associate three arbitrary faces with three identities: themselves, a friend, and a stranger. In a perceptual matching task, they were first presented with a label for one of the three identities and then, after a 1.5-s delay, with one of the three faces. Their task was to judge whether the face matches with the label. EEG was recorded using a 64-channel system. To investigate preparatory induced oscillatory activity, we conducted time-frequency analysis on the period between presentation of a label and a face. We found that presentation of a self-related label elicited two effects: (1) it decreased frontal beta-band power between 600-900 ms after presentation of the label; and (2) it decreased alpha power at the posterior electrodes during the last 700 ms before presentation of the face. Our results show that abstract concepts, such as the self, can modulate preparatory oscillatory brain activity. The decrease in frontal beta-band power may reflect content reactivation. If this is the case, then our result may reflect the fact that self-associated information forms a stronger prior and therefore its reactivation requires less cognitive effort. On the other hand, posterior prestimulus alpha power decrease has been frequently shown when one expects motivationally salient stimuli (self-associated face in our task), indicating facilitated pre-activation of the visual cortex. These results can be interpreted in terms of the message passing scheme associated with predictive coding, throwing light on the cognitive basis of selfrelated processing.

Early functional development of zebrafish retina revealed by sponge-tip electrode electroretinogram (ERG)

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The zebrafish (Danio rerio) has become a popular model in visual and cognitive neuroscience because of its rapid neurodevelopment and genetic conservation with other vertebrates. The electroretinogram (ERG) has long been used to assess visual function, including in zebrafish. While most studies of zebrafish retinal development focus on the period that external food is not required (up to 7 days post-fertilisation; dpf), functional changes in the ERG across this period have not been reported. The most popularly used recording electrode in zebrafish ERG to date is the glass micropipette electrode, which requires careful liquid control during measurements and specialised equipment for its manufacture, presenting a challenge for laboratories with limited resources. Here, we report the functional development of the zebrafish retina assessed using the sponge-tip electrode ERG. We modified the chlorinated silver-wire electrode commonly used for rodent ERG by attaching a cone-shaped PVA sponge with a ~40 μ m apex as an electrode tip. The larval zebrafish scotopic ERG was measured at 4-7 dpf with white flashes at 10 intensities ranging from -2.75 to 2.48 log cd.s.m⁻². At each age, we found that the a- and b-waves grew as the intensity increased. While the a-wave generated by photoreceptors did not change markedly with age, the b-wave response to higher-intensity flashes, derived from the bipolar cells, increased significantly. This rapid increase in visual function is consistent with our previous behavioural measurements across this developmental period. Given that retinal morphology has been reported to be highly stable across these ages, we suggest that improvements may be underpinned by maturing synaptic connectivity. Our results also demonstrate that zebrafish ERG can be successfully measured using the economical and practical sponge-tip electrode.

Altered network connectivity during resting state in Parkinson's disease patients with mild cognitive impairment as a marker for dementia

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Cognitive disturbances in Parkinson's disease (PD) contribute to a high disease burden. Mild cognitive impairment (MCI) is common in PD and is a prodromal state of dementia. This study aimed to investigate brain connectivity associated with PD-MCI during resting-state fMRI. This may extend understanding of the neurobiology of pre-clinical dementia in PD. Fortytwo PD patients and 22 healthy controls (HC) were scanned (3T Siemens PRISMA). Seed-based functional connectivity analysis was performed to identify altered connectivity between seeds in the default mode networks (DMN), fronto-parietal network, and dorsal attention network (DAN) to other regions between groups. The prevalence of MCI in PD patients was 38% (16 of 42). Medial prefrontal cortex in DMN to left calcarine gyrus and right cuneus showed greater connectivity in HC compared to PD non-MCI (nMCI). When compared to HC, the connectivity between the left intraparietal sulcus (IPS) in DAN and left inferior frontal gyrus; left IPS and left middle frontal gyrus; and right IPS and right middle frontal gyrus was decreased in PD-MCI. Whereas, in PD-nMCI compared to HC, the connectivity between left IPS and right inferior frontal gyrus and right IPS and right temporal gyrus. PD-MCI and PD-nMCI showed altered connectivity in DMN and DAN. Although there was no significant difference between PD-MCI and PD-nMCI, different regions were highlighted when compared to HC. This finding could potentially explain that networks in PD-MCI and PD-nMCI may operate differently. PD-MCI and PD-nMCI showed significantly lower connectivity in bilateral IFG which are part of Broca's area compared to HC. Use of task-based fMRI will provide in-depth knowledge of altered functional connectivity in cognitively impaired PD. We hope to investigate an accurate approach to identify MCI and explore precise restingstate analysis methods.

The contribution of monocular depth cues to size constancy in the context of the Ponzo illusion

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Size constancy refers to our ability to perceive objects as having the same size regardless of changes in viewing distance. It is unclear whether some monocular depth cues exert a stronger influence on size constancy than others. We systematically added or removed linear perspective and texture cues in a Ponzo-like illusion display of a hallway to determine how these manipulations changed the perceived size of rings in the foreground (near) and background (far). The point of subjective equalities (PSEs) among four experimental conditions (linear perspective cues + textures, linear perspective cues, textures, no cues) were compared with each other for the near and far rings. Linear perspective cues and textures both produced a strong illusion. An interaction was observed between Depth Cue and Ring Positioning, F(3, 33) = 25.88, p < .001. Post-hoc Bonferroni pairwise comparisons showed that the size of the far ring was consistently overestimated on each experimental condition with depth cues as compared to without any cues (all p < .03), while the size of the near ring was consistently

underestimated but only when it was presented on a scene with linear perspective cues (all p < .01). There were no statistical differences between linear perspective and texture cues (all $p \ge .09$). We further analysed the contribution of depth cues with the maximum-likelihood estimation model (MLE) and found that textures provided more reliable information for the far ring (weight = .59, r(11) = .58, p = .05) as compared to the linear perspective cues which provided more reliable information for the near one (weight = .56, r(11) = .79, p < .001). We conclude that both textures and linear perspective cues contribute to size constancy mechanisms in the Ponzo illusion but their reliability changes as a function of where the stimuli are placed in the visual scene.

The role of hue in search for texture differences: Implications for camouflage design

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The purpose of camouflage is to be inconspicuous against a given background. However, designing camouflage still remains more art than science. Colour is an important component of camouflage and its ability to guide attention is paramount to the design principles. When a camouflage pattern is intended to be effective against multiple different backgrounds, the question arises how best to achieve this compromise. For instance, if two multicoloured backgrounds differ on the presence or absence of a single colour, is optimal concealment across the two backgrounds achieved by including or excluding this colour in the camouflaged target? Here, we used a visual search paradigm with backgrounds drawn from a carefully controlled colour gamut and targets defined by the presence or absence of unique hues. Targets could be either patches of five colours against a four-colour background (patches), or patches of four colours against a five-colour background (holes). We observed a search asymmetry for number of hues: Observers were faster and more accurate at detecting patches than holes. Furthermore, we observed a linear separability effect: Search for a target was particularly difficult when the hue that defines it is within the gamut of distractor colours (e.g., orange amongst red and yellow). Conversely, search was easier when a linear boundary in colour space can separate the target hue from the distractor hues (e.g., red amongst orange and yellow). Our findings provide new insights into how search asymmetries can be extended to complex texture properties. Overall, the findings help inform the design process of camouflage: When designing a pattern for multiple backgrounds, the optimal target includes only colours present in both backgrounds.

Attention-network functioning in children with varying levels of ADHD and anxiety symptoms

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The behavioural symptoms associated with both Attention Deficit Hyperactivity Disorder (ADHD) and anxiety include difficulties with concentration and attention control. The association between the behavioural attention deficits and cognitive attention deficits, however, are not well understood, in either those children with high symptoms of ADHD and those with anxiety. The present study aimed to investigate the functioning of cognitive attention networks in children with varying levels of ADHD and anxiety symptoms. The Staged Attention Network Test (SANT), an adapted version of the adult ANT, was used to measure the functioning of the cognitive attention networks, using mean response time. ADHD symptoms were measured using the teacher-rated SWAN, and anxiety levels were measured using the teacher-rated School Anxiety Scale. Participants were 248 preparatory and first-grade children (144 boys, 104 girls, M_{age} = 76 months). The higher a child's ADHD symptoms, the worse the child's alerting-network functioning; in contrast, the higher a child's anxiety symptoms, the better the child's alerting-network functioning. The levels of ADHD and anxiety symptoms negatively affected a child's ability to use the endogenous orienting cue. Levels of ADHD and anxiety symptoms did not predict children's executive and exogenous orienting network functioning. The levels of ADHD and anxiety symptoms influence children's alerting and endogenous orienting network functioning but have no effect, at this age, on children's executive and exogenous orienting network functioning.

Distractors modulate attentional selection and evidence accumulation during perceptual decision-making

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The influence of task-irrelevant distractors on attention is well-established, yet the neurophysiological mechanisms underlying this effect remain contested. One outstanding question is whether attentional resources facilitate target processing alone, or whether they are concurrently involved in distractor suppression. Here, we examine the effect of distractors on modulating both attentional selection and evidence accumulation during perceptual decision-making. We focused on two electroencephalographic (EEG) markers of perceptual decisions: the N2 (a bilateral negative posterior deflection reflecting attentional selection), and the centro-parietal positivity (CPP, which reflects the process of evidence accumulation). We recorded EEG data from 21 healthy participants during a motion-discrimination task. Participants were required to discriminate the direction of coherent dot motion in a target patch presented to the left or right of fixation, which was accompanied on a random 50% of trials by task-irrelevant distractor motion in the alternate hemifield. Behavioural data confirmed that reaction times were significantly slower when distractors were present versus absent. EEG analyses revealed two key findings. First, the N2 ipsilateral to the target had a greater peak negativity in the presence of distractors. Second, distractors led to an overall slower CPP build-up rate, relative to when distractors were absent. Together, these data suggest that the effect of a distractor stimulus is to capture attentional resources (the N2 effect), which subsequently leads to less efficient processing of the primary target (the CPP effect). These results demonstrate the dynamic nature in which distractors can modulate both attentional and evidence processing during perceptual decision making.

Bilingual language switching: MEG evidence of executive control

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Bilinguals have a remarkable ability to control which language to speak at any given time, and to switch between languages seamlessly. It has been suggested that bilinguals rely on executive control and inhibition of the nontarget language in order to speak the desired language. An important question is at what stage these control processes occur in language switching. Previous EEG/MEG studies report mixed findings, possibly due to inconsistent design choices between studies. We addressed these design issues in the current study. Sixteen Mandarin–English bilinguals were tested in the MEG. Participants were instructed to name the digit they saw on each trial in either Mandarin or English, according to a face cue (Chinese or Caucasian). To eliminate the possible confound of cue-switching, we used two faces for each language and ensured the cue changed on every trial. We controlled for trial-sequence effects by inserting a filler trial after every switch trial, so that no critical trial was affected by a preceding switch trial. Behavioural naming latencies were submitted to linear mixed-effect modelling with language (Mandarin/English) and switch (stay/switch) as factors. An interaction was found between language and switch, replicating the well-known switch-cost asymmetry. Analysis of MEG sensor data in the time domain (i.e., ERFs) revealed a main effect of switch between 425-550 ms following cue onset. ROI analyses using beamforming for source reconstruction showed a main effect of switch in the left DLPFC 420-450 ms following cue onset, and a main effect of language in the right ACC 45–50 ms prior to target onset. These findings suggest that there are two stages of control in language switching: upon seeing the face cue, bilinguals perform shifting and updating of task goal, switching to the other language as needed; right before the anticipated onset of naming target, bilinguals proactively inhibit the non-target language in order to produce speech in the target language.

Encoding efficiency of an artificial language modulates sleep-related memory consolidation: Insights from eventrelated potentials

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Language learning is a dynamic and complex process, with recent studies demonstrating a beneficial effect of sleep during consolidation. Cortical slow oscillations (SOs; < 1.0 Hz) and sleep spindles (~10–16 Hz) provide a marker of memory-trace reply within the hippocampo-cortical network. However, it is unknown how these oscillatory mechanisms are involved in the consolidation of sentence-level combinatorics, and how this effect manifests in language-related electrophysiological activity. In this language-learning study, we examined sleep-based consolidation effects on event-related potentials (ERPs) in response to word-order violations in an artificial

language modelled on Mandarin Chinese. Seventeen monolingual English speakers (9 male, 23.6 ± 5.8 years) completed an implicit learning phase, baseline sentence comprehension task, followed by an 8-hour sleep opportunity, and a delayed comprehension task. EEG was recorded during the tasks and sleep. ERPs were extracted within a 300-500 ms time window at the critical word that determined correct and incorrect word-order variations, while spindle-SO co-occurrence (SOC) was quantified during NREM sleep. There was no significant effect of SOC on probability of correct response when controlling for baseline performance. However, a linear mixed-effects model showed that subjects who demonstrated a stronger left-lateralised ERP negativity during the baseline task (violation condition) also demonstrated greater positive SOC-ERP associations during the delayed task. SOc appears to provide a fine-tuned temporal frame for the transfer of hippocampal memory traces, with this effect manifesting in a stronger left-lateralised negativity during the detection of word-order violations. This effect was enhanced for subjects who demonstrated a stronger negativity during the baseline task, highlighting the importance of encoding efficiency on subsequent sleep-related consolidation of complex sentencelevel combinatorics.



Above. Old Arts Building (1919-24) at the Parkville Campus of the University of Melbourne. Photo by Polly Clip (CC BY-SA 3.0).

