ACNS

Australasian Cognitive Neuroscience Society

6th Australasian Cognitive Neuroscience Society Conference

ACNS 2016

Conference Proceedings

hosted by

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

24-27 November 2016 | Shoal Bay, Australia

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Welcome

Dear Colleagues and Friends,

It is our great pleasure to welcome you all to beautiful Shoal Bay – a favourite destination for many Novocastrians, and one that we are delighted to be able to share with you.

Thank you for making the journey to join us for the 2016 offering of cognitive neuroscience in Australasia. We are looking forward to a great programme, and to hearing about your research.

With deep gratitude, we thank our keynote speakers for their long travel to our shores. We also thank our many sponsors, without whom we could not have hosted this event. Finally, the conference would not be possible without the many loyal ACNS researchers, as well as the ever increasing number of enthusiastic students who become our future cognitive neuroscientists.

On that note, we wish you all a wonderful few days in the Port Stephen's area, relax and enjoy the Australasian Cognitive Neuroscience Society Conference 2016.

Frini Karayanidis and Juanita Todd
Co-Chairs of ACNS-2016

ACNSC2016

The 6th Australasian Cognitive Neuroscience Society Conference is hosted by the University of Newcastle. ACNS-2016 is being held at the Ramada Resort, Shoal Bay. The township of Shoal Bay is part of the larger Port Stephens and Hunter Valley areas.

Local Organising Committee

Chairs: Frini Karayanidis and Juanita Todd
Pat Michie
Alex Provost
Bryan Paton
Jaime Rennie
Hannah Keage, *University of South Australia, Chair ACNS 2017*
Paul Corballis, *University of Auckland, Chair ACNS 2015*

Conference Support Staff

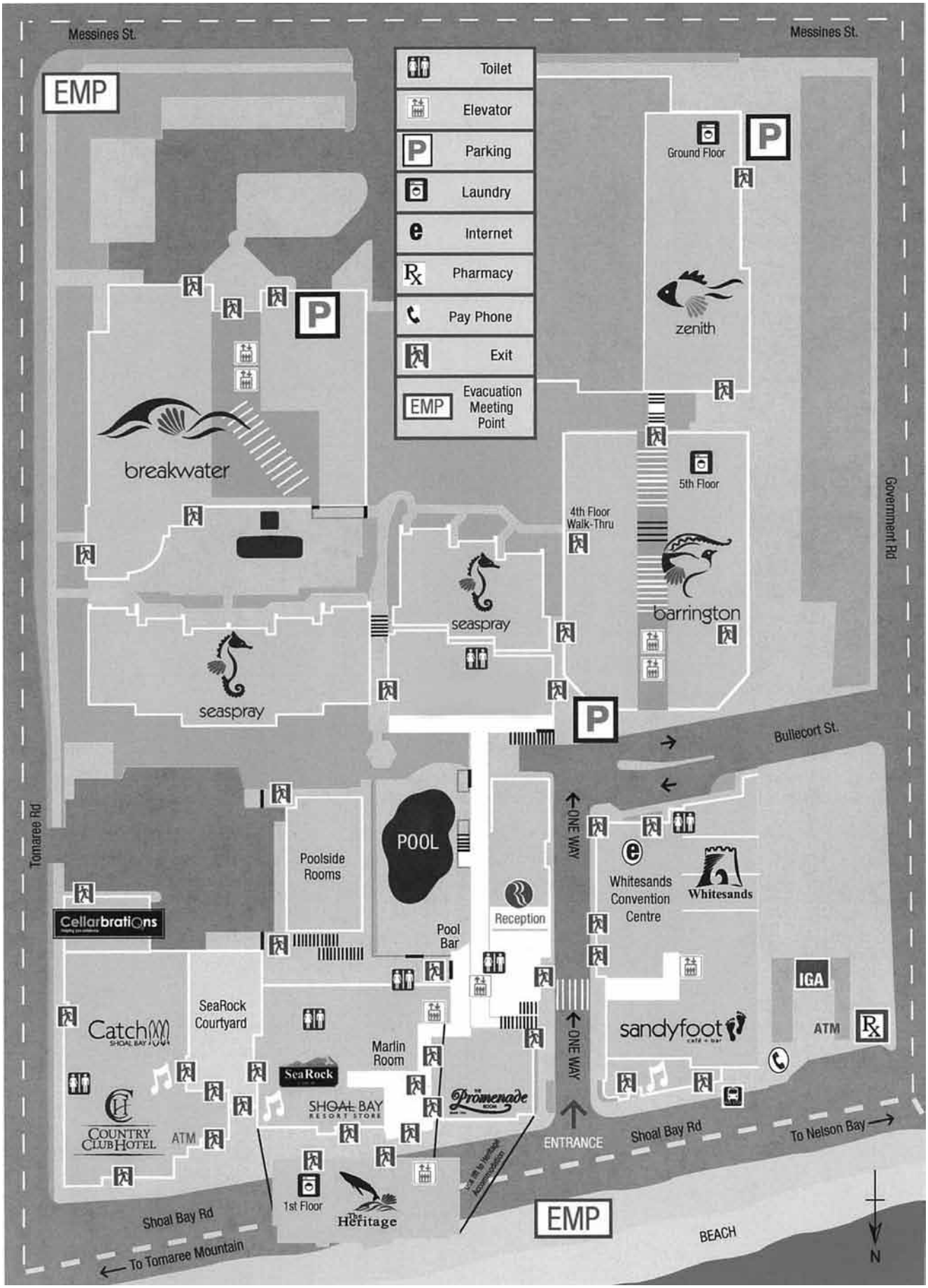
Christine Torrance
Olivia Whalen
Aaron Wong
Maighan Hassett
Ariel Dunn
Rosemaree Miller
Bronte Speirs

Scientific Committee

Alison Fox, *University of Western Australia, Australia*
Ben Harrison, *University of Melbourne, Australia*
Marc Seal, *Murdoch University, Australia*
Alex Fornito, *Monash University, Australia*
Nadia Solowij, *University of Wollongong, Australia*
Ottmar Lipp, *Curtin University, Australia*
Steve Provost, *Southern Cross University, Australia*
Gina Grimshaw, *Victoria University, New Zealand*
Bruce Christensen, *University of New South Wales, Australia*
Michael Ridding, *University of Adelaide, Australia*

7th Australasian Cognitive Neuroscience
Conference ADELAIDE
23 - 26 November 2017

Venue Map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Bullecort St.
Tomaree Rd
POOL
Poolside Rooms
Cellarbrations
Pool Bar
Reception
ONE WAY
Whitesands Convention Centre
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IGA
ATM
sandyfoot
SeaRock Courtyard
Catch
Marlin Room
SeaRock
SHOAL BAY RESORT STORE
Promenade
COUNTRY CLUB HOTEL
ATM
ENTRANCE
Shoal Bay Rd
To Nelson Bay
1st Floor
The Heritage
Shoal Bay Rd
To Tomaree Mountain
EMP
BEACH
N

Social Events

ECR Social Events

Thursday 24 November

1:00pm	Meet at Ramada Reception for a hike around the scenic Tomaree National Park.
8:30-11:00pm	Port Stephens Country Club – No need to preregister; just turn up.

Welcome Reception

Thursday 24 November **6:30-8:30pm**

The Welcome Reception will take place immediately after the opening address and first keynote speaker. This complimentary event will include a full BBQ buffet.

To facilitate catering, please use the buffet in the resort restaurant that corresponds to your dinner ticket.

Poster Gala

Friday 25th November **6:30-8:30pm**

The conference will feature a single poster session in the Whitesands Conference Area.
This event will include complimentary canapés and a cash bar will be available for drinks.

Conference Dinner

Saturday 26th November **6:30-10:30pm**

The conference dinner will take place at Broughtons at the Bay (https://www.broughtonsatthebay.com.au/).

Broughtons is located on the top floor at d'Albora Marinas Nelson Bay, overlooking the pristine waterways of Port Stephens.

Tickets are $90 for a 2-course meal, canapés on arrival and one free drink. Limited number of additional tickets available. Please check at Registration Desk.

Information about transport to and from Broughtons will be provided.

Workshops

Early Career Researcher (ECR) Workshop
Thursday 24th November 9:00 am - noon

Sponsor: ARC Centre for Excellence in Cognition and its Disorders

The ACNS Early Career Researcher Day will take place on Thursday the 24th of November, from 9am to 12:00, with an optional hike around the beautiful Mount Tomaree from 1 to 3pm, and drinks at the Port Stephen Country Club to finish off the day.

The workshop will be focused on the nitty gritty of applying for ECR-related grants, such as the DECRA and NHMRC ECR fellowships, as well as the challenges involved in navigating the early years of one's career, such as balancing a busy research environment with personal commitments. The morning will feature individual researcher talks as well as a panel discussion. This workshop is ideal for those finishing up their PhDs or in the first few years of their postdoctoral career, but all who identify as early career researchers are welcome to attend. There will be multiple opportunities to network with others in a similar stage of their career, during the morning tea break, hike, or at drinks after the conference opening.

Confirmed speakers or panel members at the ECR workshop day will include

- Dr Ian Harding, *(Monash University) NHMRC ECR fellow*
- Dr Ann-Maree Vallence, *(Murdoch University) NHRMC Peter Doherty Research Fellow*
- Dr Suresh Muthukumaraswamy, *(University of Auckland) (Rutherford Discovery Fellowship*
- Dr Hannah Keage, *(University of South Australia) NHMRC Mental Health Grant Review Panel and NHMRC ECR Fellow*
- A/Prof Frini Karayanidis, *(University of Newcastle) Australian Research Council (ARC) College of Experts*

Mid-Career Researcher (MCR) Workshop
Thursday 24th November 1:00 – 4:00 pm

We are introducing an MCR workshop that will focus on pathways beyond ECR status. This workshop is targeted towards the transition from senior post-doc to junior faculty, and balancing research, teaching, admin, family etc. Emeritus Professor Pat Michie will moderate the brief presentations by researchers at various levels of seniority followed by discussions and input/ questions from the audience

Speakers & topics:

- Professor Jason Mattingley *(The University of Queensland)*: **What activities additional to your research should you engage in and which should you try to avoid?**
- Associate Professor Frini Karayanidis *(Newcastle University)*: **Experiences of hiring academics: what are we looking for?**
- Associate Professor Paul Dux *(The University of Queensland)*: **Starting a lab**
- Dr Irina Harris *(USyd)* & Dr Hannah Keage *(University of South Australia)*: **Developing lectures without losing research momentum: is it possible?**
- Dr Olivia Carter *(University of Melbourne)* & Dr Muireann Irish *(UNSW/NeuRA)*: **Decisions to make: moving between teaching-and-research and sole research positions.**
- Dr Ann-Maree Vallence *(Murdoch University)* & Dr Nicolas Badcock *(Macquarie University)*: **Managing yourself, your grants, and other people.**

Need more information?
Email Associate Professor Anina Rich:
anina.rich@mq.edu.au
(ANCS president & chair of the MCR organising committee)

ACNS Equity Policy Launch

Sponsor: ARC Centre for Excellence in Cognition and its Disorders

On Saturday, we will launch of our new Equity and Diversity Policy, that has been developed by an ACNS working group chaired by Associate Professor Anina Rich (ACNS President) and Professor Jason Mattingley. A/Prof. Rich and Prof. Mattingley will give a brief presentation on the current state of ACNS in terms of gender equity, and an overview of the goals of the policy.

Professor Penny Jane Burke will then give a presentation and officially launch the policy.

Exploring Gender Equity

Professor Penny Jane Burke, Global Innovation Chair of Equity and Director of the Centre of Excellence for Equity in Higher Education at the University of Newcastle

Professor Penny Jane Burke has published extensively in the field including Accessing Education effectively widening participation (2002), Reconceptualising Lifelong Learning: Feminist Interventions (2007, with Sue Jackson) and The Right to Higher Education: Beyond widening participation (2012) and Changing Pedagogical Spaces in Higher Education (2016 with Gill Crozier and Lauren Ila Misiaszek). Penny is Editor of Teaching in Higher Education and Access and Widening Participation Network co-Convenor for the Society for Research into Higher Education. Penny has held the posts of Professor of Education at the University of Roehampton, the University of Sussex and Reader of Education at the Institute of Education, University of London.

ACNS Equity Working Group:

Chairs: Anina Rich & Jason Mattingley

Working group: Donna Rose Addis, Olivia Carter, Paul Dux, Muireann Irish, Katherine Johnson, Hannah Keage, Melanie Murphy, Simmy Poonian

Please note that, this is a free but ticketed event. A sit-down lunch will be served in the Promenade room for delegates who have indicated that they want to attend the launch. Some tickets are still available. Please enquire at Registration Desk. Lunch for other delegates will be served in the Whitesands reception area.

Keynote Addresses

Keynote Speaker 1

Sponsor: UON Priority Research Centre for Brain and Mental Health

Thursday 24 Nov - 5.30pm to 6.30pm ***WhiteSands Ballroom***

Dr David Strayer

Professor, Department of Psychology, University of Utah
Director for the Center for the Prevention of Distracted Driving

The multitasking driver: Why talking to your phone will drive you to distraction

Driver distraction is increasingly recognized as a significant source of injuries and fatalities on the roadway. In fact, naturalistic studies have found that up to 90% of the crashes involved driver distraction in one form or another. Driver distraction can arise from visual/manual interference, for example when a driver takes his or her eyes off the road to interact with a device. Impairments also come from cognitive sources of distraction when attention is diverted from safely operating the vehicle. In the latter case, the driver's eyes may be on the roadway and their hands on the steering wheel, but they may not be attending to the information critical to safe driving. Concern over distracted driving is growing as more and more wireless devices are being integrated into the vehicle. Working with AAA Foundation for Traffic Safety, we developed and validated a metric of distraction associated with the diversion of attention from driving. Our studies show that the distraction potential can be reliably measured, that cognitive workload systematically varies as a function of the secondary task performed by the driver, and that many activities, particularly newer voice-based interactions in the vehicle, are associated with surprisingly high levels of mental workload. Using the new technology in the vehicle has unintended consequences that adversely affect traffic safety.

David Strayer is a professor of Cognitive Neuroscience in the Department of Psychology at the University. He received his Ph.D. from the University of Illinois@ Urbana-Champaign in 1989 and worked at GTE laboratories before joining the faculty at the University of Utah. Dr. Strayer's research examines attention and multitasking in real-world contexts such as driving an automobile. He has published over 150 scholarly articles in this area and for over a decade has focused on understanding driver distraction stemming from voice-based interaction in the vehicle. Dr. Strayer is a member of the Human Factors and Ergonomic Society, the Psychonomic Society, and is a Fellow of the Association for Psychological Sciences. In 2010, received the University of Utah Distinguished Scholarly and Creative Research Award.

Keynote Speaker 2

Sponsor: QIMR Berghofer Medical Research Institute

Friday 25 Nov - 9.00am to 10.00am ***WhiteSands Ballroom***

Dr Rosalyn Moran

Senior Lecturer in Mathematical Neuroscience
Department of Engineering Mathematics, University of Bristol, UK.

Aging under the Free Energy Principle

The neurobiology of aging has, to date, focused on the idea that altered patterns of brain activity in older compared to younger adults during cognitive task performance is a result of compensatory mechanisms for a system under aging pressures. In this talk I will present an alternative view based on the Free Energy Principle, a theory of hierarchical empirical Bayesian inference in the brain (Friston 2013). Bayesian inference is a now ubiquitous framework used to inform the principles of perception, action and decision-making, accounting for how sensory information combines with our own prior beliefs about the world to shape brain activity and behavior. There are many ways that a brain could perform Bayesian inference and the hypothesized scheme under the Free Energy Principle posits a variational algorithm where posterior density estimation is recast as an optimization problem. In this guise the scheme becomes a predictive coding algorithm, with hierarchical structure and attribution of optimization dynamics to particular components of neuronal circuits. I will present evidence from neuroimaging studies of brain circuits (using dynamic causal models) that age-related connectivity changes are commensurate with long-term Free-Energy minimization. I will present work from sensory learning, memory and decision making paradigms that show that the neurobiological implementations of prior beliefs grow stronger in older brains.

Dr Moran's research investigates how different neurotransmitters & neuromodulatory systems shape the dynamics of neuronal communication in human brain networks by developing Bayesian approaches to brain analysis namely - dynamic causal modeling (DCM). She is a co-author of the academic software package Statistical Parametric Mapping (where DCM is implemented) and serves on its faculty at courses internationally. She is Section Editor at Neuroimage: Clincal (Elsevier) with responsibility for brain connectivity and epilepsy. She is also a member of the Editorial board of Network Neuroscience: MIT Press (Associate Editor) and Computational Psychiatry: MIT Press. Her research is funded by the NIH and the NSF, from grants awarded during her tenure at Virginia Tech Carilion Research Institute.

Keynote Addresses

Keynote Speaker 3 Sponsor: UON Priority Research Centre for Stroke and Brain Injury

Saturday 26 Nov - 9.00am to 10.00am ***WhiteSands Ballroom***

Dr Denise C. Park

Director of Research at the Center for Vital Longevity,
Distinguished University Chair in Behavioral and Brain Sciences, and Regents' Research Scholar,
University of Texas, Dallas.

Scaffolding of the Aging Mind: How Neural Depletion and Neural Enrichment Factors Affect Cognition

NB We are sad to announce that Dr Denise Park will not be able to deliver the scheduled keynote lecture at ACNS 2016, due to unexpected health complications. Her work will be presented by her two close collaborators, Dr Sara Festini and Michelle Farrell.

Cognitive function tends to decline with increasing age. However, there is substantial variability in cognitive performance, such that some older adults show better maintenance of cognition. The Scaffolding Theory of Aging and Cognition (Park & Reuter-Lorenz, 2009) posits that individuals can make use of compensatory neural scaffolding in response to neural challenge in order to maintain cognitive performance. Moreover, the revised model (STAC-r; Reuter-Lorenz & Park, 2014) proposes that lifecourse factors may neurally enrich or deplete brain structure, function, and compensatory scaffolding. The Dallas Lifespan Brain Study (DLBS) and Synapse Project were developed to examine the effects of possible neural depletion and enrichment factors on the brain and cognition. One neural depletion factor that has been a major focus of the DLBS is amyloid deposition. Amyloid is a hallmark of Alzheimer's disease and is present in around 30% of healthy older adults. Using the DLBS healthy lifespan sample, we have found that greater levels of amyloid are associated with impaired cognitive performance, cognitive decline, hyperactivation in the hippocampus, and decreased activation in frontal and lateral temporal regions. We have also examined the possibility of sustained mental engagement as a neural enrichment factor in the Synapse Project. This experimental evidence indicated that sustained new learning improved episodic memory in older adults. Moreover, engagement led to increased modulation of brain activity and increased neural efficiency in older adults. Although cognition generally declines with age, we show evidence that certain lifecourse factors can modify cognitive trajectories.

Sara B. Festini, Ph.D.

Aging Mind Foundation Postdoctoral Research Associate, Center for Vital Longevity
University of Texas at Dallas

I joined the Park Aging Mind Lab at the Center for Vital Longevity in September 2014 and now serve as an Aging Mind Foundation Postdoctoral Fellow. I completed my doctoral training in the Cognition and Cognitive Neuroscience Area of the Psychology Department at the University of Michigan under the guidance of Dr. Patricia Reuter-Lorenz, investigating the consequences and mechanisms of directed forgetting in working memory. At the University of Michigan, I also worked with Dr. Rachael Seidler, using fMRI data to study cerebellar resting state functional connectivity in Parkinson's patients ON and OFF medication, and examining the effect of emotion on motor learning. Prior to my doctoral work, I earned a B.A. with Honors in Psychology and a minor in Biology from Scripps College in Claremont, California. I also completed a Summer Research Experience for Undergraduates (REU) program on the mind and brain at Colorado State University in Fort Collins, CO.

Michelle E. Farrell

Center for Vital Longevity
University of Texas at Dallas

I joined the Park Aging Mind Lab in 2012 as a Ph.D. student at the University of Texas at Dallas in Cognition and Neuroscience, investigating the impact of amyloid deposition on cognition in cognitively-normal adults. I previously worked as a research assistant to Joy Taylor at the Stanford/VA Aging Clinical Research Center in Palo Alto, California, examining how aging affects expertise in older pilots. I received a Bachelor's degree from the University of California Berkeley in 2007, with a double major in Molecular and Cell Biology and Integrative Biology and a minor in Celtic Studies. While at UC Berkeley, I worked with Rebecca Spencer and Rich Ivry, studying the impact of aging on sleep-dependent memory consolidation.

Keynote Addresses

2016 ACNS Young Investigator Award

Sponsor: ACNS

Sunday 27 Nov - 9.30am to 10.00am ***WhiteSands Ballroom***

Associate Professor Paul Dux

ARC Future Fellowship
School of Psychology, Faculty of Health and Behavioural Sciences, The University of Queensland
Affiliate Associate Professor, Queensland Brain Institute

On the Capacity Limits of Cognitive Control and its Enhancement: Neural Mechanisms and Transfer

The "Information Age" frequently requires individuals to perform multiple decisions concurrently. Under such multitasking conditions, one must invoke cognitive control processes in order to manage capacity limited attentional resources. Of import, many psychiatric and neurological conditions, along with normal ageing, are associated with compromised functional capacity due to impairments in cognitive control (executive function). Here, I will present evidence from a range of cognitive neuroscience methods (e.g., fMRI, EEG, tDCS) to argue that cognitive control limitations occur because frontoparietal and subcortical (FP-SC) brain regions both serve a broad range of mental functions and are limited information processors. In addition, I will show that training improves multitasking ability by segregating tasks representations in FP-SC regions and that brain stimulation can lead to generalised training benefits for decision-making and multitasking by increasing the rate of evidence accumulation. Collectively, the results shed light on the neuro-cognitive mechanisms of cognitive control limitations and those that underlie the enhancement of associated operations.

A/Prof Paul E. Dux is a psychologist and neuroscientist who received his PhD from Macquarie University and then undertook a postdoctoral fellowship at Vanderbilt University. He is faculty in the School of Psychology at The University of Queensland, where he is currently an ARC Future Fellow. Dux leads a group that studies the cognitive and neural underpinnings of human information-processing capacity limitations in health and disease. Specific interests are the mechanisms of attention and the efficacy of cognitive training and how it changes the brain to improve performance. Dux has published widely, received several early career research awards and attracted funding from both the ARC and NHMRC.

Symposia

Symposium 1 - NeuroEng: Computational Neuroscience and Neuromorphic Engineering

Sponsored by Compumedics

NeuroEng is a community and meeting place in Australia for researchers with an active interest in computational neuroscience and neuromorphic engineering. There is increasingly a great deal of overlap between the cognitive neurosciences and its more computational and engineering minded sister disciplines. With an aim to foster greater and more fertile collaborations between ACNS attendees and NeuroEng members this symposium will show case some of the exciting work being undertaken by Australian NeuroEng researchers as well as highlight some of the many ways in which we can collaborate.

Chair
Bryan Paton, *University of Newcastle*

Speakers

Michael Breakspear, *QIMR Berghofer Medical Research Institute*
Nonlinear models of large-scale brain activity

David Grayden, *University of Melbourne*
Minimally-invasive intracranial electrodes for brain-computer interfaces

Steven Wiederman, *University of Adelaide*
A spotlight on attention and prediction in the dragonfly

Paula Sanz Leon, *University of Sydney*
Neuroinformatics tools for simulating realistic brain activity

Symposium 2 - Neuroethics: When neuroscience meets society

Sponsored by the Australian Research Council Centre of Excellence for Integrative Brain Function

Advances in neuroscience are set to transform our understanding of human cognition and behaviour. They may change how we think about and treat people with behavioural or psychiatric disorders and challenge society's views of decision-making and judgments of moral responsibility. This symposium will cover a selection of these issues currently being examined in Australia:

- Will neurobiological explanations of mental illness reduce the stigma of mental illness and improve access to effective medical treatment?
- How will neuroscience change our judgments of moral or legal responsibility?
- Will cognitive neuroscience challenge our understanding of fundamental human concepts such as personality, identity and gender?
- How should society respond to the use of emerging neurotechnologies to modify cognition or predict behaviour?

Chair
Adrian Carter, *Senior Research Fellow and ARC DECRA Fellow*

Neuroethics and Policy Group, Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Monash University, and

Director, Neuroethics Program, ARC Centre of Excellence for Integrative Brain Function

Speakers

Olivia Carter, *ARC Future Fellow, Melbourne School of Psychological Sciences, University of Melbourne*
The role of cognitive neuroscientists in the future of cognitive enhancement

Colin Klein, *ARC Future Fellow, Department of Philosophy, Centre for Agency, Values and Ethics, and ARC Centre of Excellence in Cognition and its Disorders (CCD), Macquarie University*
Delusions and conspiracy theories: cognitive neuroscience meets corpus analysis

Cordelia Fine, *Melbourne School of Business, University of Melbourne*
Sex and the City Brain: Rethinking sex, gender and adaptive traits

Nicholas Haslam, *School of Psychological Sciences, University of Melbourne, Melbourne, Australia*
Misery in the brain: The mixed blessings of neuroscientific understandings of mental illness

Paula Sanz Leon, *University of Sydney*
Neuroinformatics tools for simulating realistic brain activity

Invited Symposia

Symposium 3 - Recent advances in consciousness research

Sponsored by Sonoray

Consciousness research has recently emerged as a core topic in cognitive neuroscience. Among recent advances, four speakers will present their latest research from both empirical and theoretical studies, from sensory to cognitive processing. The topics include mental imagery, hallucination and dreams, as well as neural correlates of sub-conscious and conscious visual perception, which are investigated with multi-modal methodologies ranging from phenomenology, psychophysics and neuroimaging to computational and theoretical neuroscience. Following the presentations, we will have a panel discussion on recent progress as well as controversies on how to measure subjective consciousness with objective methods.

Chair:
Naotsugu Tsuchiya, *Monash University*

Speakers:

Joel Pearson, *University of New South Wales, Australia*
Seeing what's not there and measuring it

Jennifer Windt, *Monash University*
Questions & Challenges for Future Research

Marta Garrido, *The University of Queensland*
Detecting unseen change

Naotsugu Tsuchiya, *Monash University*
Empirical testing of integrated information theory of consciousness

Symposium 4 - Dynamic functional architectures of the human brain

Sponsored by Symbiotic Instruments

Recent advances in neuroimaging have shown that macroscopic functional brain networks reorganize spontaneously and in support of cognitive task demands. Capturing meaningful fluctuations in macroscopic network activity remains, however, a major challenge for modern neuroscience. Likewise, the functional relevance of such fluctuations for adaptive and maladaptive behaviour remains unclear. This symposium will bring together two internationally recognised experts in macroscale connectomics and two talented young researchers. Our speakers will discuss how network dynamics can be measured, linked to fundamental principles of brain function, and associated with behavior. The symposium will also highlight current advances and pitfalls in assessing dynamic changes in brain network activity across time and psychological contexts. Overall, this symposium will provide an introduction to a new paradigm aiming to assess the neural underpinnings of human perceptual and cognitive functions.

Chair:
Luke Hearne, *Queensland Brain Institute*

Speakers:

Luca Cocchi, *QIMR Berghofer Medical Research Institute*
Neural decoding of visual information varies with fluctuations in global network efficiency

Luke Hearne, *Queensland Brain Institute*
Dynamic brain modular architectures supporting higher cognition

Jessica McFayden, *The University of Queensland*
Dynamic causal modelling reveals a rapid subcortical route to the amygdala in visual and auditory processing

Andrew Zalesky, *The University of Melbourne*
Time-resolved connectomics

Awards

ACNS offers two types of awards:

1. Student Travel Awards

Sponsored by the ARC Centre of Excellence in Cognition and its Disorders (CCD).

Huge congratulations to our 10 Student Travel Award winners. Each will receive $250 to support their travel to the Shoal Bay. It was a very competitive year, with many fantastic applications submitted. Thank you to all those who applied. Our winners are:

- **Alie Male,** Murdock University
- **Aimee Martin,** The University of Queensland
- **Amy Maddock,** Victoria University of Wellington
- **Daniel Feuerriegel,** University of South Australia
- **Elizabeth Thomas,** Monash University
- **Jonathan Robinson,** Queensland University of Technology
- **Julian Matthews,** Monash University
- **Noam Gordon,** Monash University
- **Manuela Russo,** Queensland University of Technology
- **Tijl Grootswagers,** Macquarie University

2. Presentation awards

Sponsored by ACNS

Junior post-doctoral researchers and students are also eligible for oral and poster presentation awards.

To be eligible for a presentation award, post-docs and students must be:

- A current student (PhD, Masters, Honours, undergraduate) or have graduated with a PhD in the last 12 months
- The presenting (first) author
- A current ACNS student member
- Registered for ACNS2016

Presentation awards will be announced on Sunday 27th November starting at 1:00pm, before the AGM.

Poster Sessions

Poster #	Presenter	Article Title
1	Lydia Barnes	Distinguishing confounds from true meditation effects: Insights from auditory ERPs.
2	Stefanie Becker	Tuning attention to relative features affects early perceptual processes - behavioural and electrophysiological evidence.
3	Méadhbh Brosnan	Plasticity of the sustained attention network in ageing: a simultaneous tDCS-EEG approach.
4	Bill Budd	ERP and behavioural evidence for multisensory integration of odour and image valence.
5	Adelaide Burt	Early cortical P1 ERP differences in high autistic tendency during fearful face processing.
6	Megan Campbell	Training the mirror system not to imitate: changes in proactive and reactive control processes.
7	Nathan Caruana	Human agency beliefs influence the neural processing of gaze during joint attention.
8	Trevor Chong	Dissociation of Reward and Effort Sensitivity in Methcathinone-Induced Parkinsonism.
9	Philippe Chouinard	Individual differences within retinotopically defined primary visual cortex (V1) as a function of the autism-spectrum quotient.
10	Carlee Cleeland	The acute effects of nutritional supplements containing caffeine on human neurochemistry and alertness.
11	James Collett	Is reward-based cognition a specific impairment in bipolar disorder? A pilot study using set-shifting.
12	Elaine Corbett	The magical number one-on-square-root-two: the double-target detection deficit in brief visual displays.
13	Nina Coy	The role of relative pitch in the active discrimination of complex sound patterns.
14	David Crewther	Red light reduces parvocellular, but not magnocellular components of non-linear VEP.
15	Christel Devue	TMS investigation into the role of the left and right dorsolateral prefrontal cortices in control of emotional distraction.
16	Ariel Dunn	Effect of maternal immune activation and sex on electrophysiological features related to schizophrenia.

Poster #	Presenter	Article Title
17	Ruth Elijah	Using training to modify the neural expectation that sensations follow immediately from actions.
18	Peter Goodin	Characteristics and differences of somatosensory impairment post-stroke based on lesioned hemisphere.
19	Irene Graafsma	Neural correlates of filling-in using steady state visual evoked potentials (SSVEP).
20	Bronson Harry	Structural networks associated with rhythmic motor control and temporal prediction: An individual differences approach.
21	Christopher Hewitson	Interlimb generalisation of Bayesian sensorimotor learning occurs in extrinsic coordinates.
22	Laila Hugrass	Non-linear VEP analysis of orientation selective surround suppression.
23	Zoey Isherwood	Nice and slow: Measuring the sensitivity and aesthetic preference of naturalistic stimuli varying in their amplitude spectra in space and time.
24	Gemma Lamp	Meta-analysis of touch studies reveals laterality effects in activation of secondary somatosensory cortices.
25	Yu Li	Early feedback from frontal to occipito-temporal cortex during visual word recognition.
26	Sol Libersman	Interpreting the amplitude of auditory signals through visual cues to sound source distance.
27	Tobias Loetscher	Walking reduces spatial neglect: An eye tracking study.
28	Amy Maddock	Motivation enhances suppression of irrelevant emotional distractors.
29	Ely Marceau	Cognitive remediation improves executive functions, self-regulation and quality of life in residents of a substance use disorder therapeutic community.
30	Aimee Martin	How does knowledge affect attentional capture vs. dwelling and awareness? Evidence from EEG and eye movements.
31	Fernanda Mata	Reduced willingness to expend effort for reward in obesity: Link to weight loss outcomes.
32	Rosemaree Miller	Action disposition influences response selection towards aversive images of humans.
33	Eveline Mu	The effect of red diffuse light on early ERPs in individuals with low and high autistic tendency.
34	Alysha Nguyen	Biases in perceiving gaze vergence.

Poster #	Presenter	Article Title
35	Korinne Nicolas	A systematic review of the effects of transient ischaemic attack on resting-state and task-based electroencephalography.
36	Sylvie Nozaradan	Tracing the neural transforms of rhythm in the human auditory system.
37	Colin Palmer	Functional mechanisms encoding others' direction of gaze in the human nervous system.
38	Lindsay Peterson	Structure-from-motion and lightness perception: understanding the interaction between lightness and high-level motion.
39	Simmy Poonian	Differences in neural oscillations for optimal movements and goal attainment when observing others actions.
40	Alexander Provost	Modelling Distraction.
41	Emmanuel Peng Kiat Pua	The challenge of heterogeneity in Autism Spectrum Disorders (ASD): Characterizing differences in monozygotic twins concordant or discordant for ASD.
42	Gina Rippon	Brain oscillations and connectivity in ASD: insights from atypical sensory and perceptual processing?
43	Jonathan Robinson	Bayesian-like processing in visual perception: an index of prediction errors.
44	Urte Roeber	When stochastic rules are not deterministic enough: An MMN study.
45	Sebastian Rogers	Evidence of an abnormal state in non-clinical hallucinations.
46	Manuela Russo	Domain specific processing or visual expertise? Exploring the neural mechanisms underlying face processing using electroencephalography.
47	Kiley Seymour	More than meets the eye: effects of task instruction on direct gaze biases in schizophrenia.
48	Leah Sharman	Coping through crying.
49	Maria Soloveva	The quality of visual information modulates response inhibition in the modified stop-signal paradigm.
50	Branka Spehar	Universal preferences and individual differences in aesthetics: An exploratory comparison between vision and touch.
51	Maria Viktoria Stuckenberg	Investigation of auditory processing differences with synchronous vs. asynchronous bimodal stimulation.

Poster #	Presenter	Article Title
52	Jamesha Subachandran	Schizotypy and form perception through pooling: an application of the oblique superiority effect.
53	Philip Sumner	Semantic priming and self-reported thought disorder.
54	Eric Tan	Neurocognition and formal thought disorder in schizophrenia: do impairment profiles differ between symptoms?
55	Matthew Tang	Do repetition suppression and expectation have different effects on the fidelity of sensory representations?
56	Nicole Taylor	Habitual physical activity levels, the P300 and the significance of alpha power.
57	Christine Torrance	Cognitive improvement during stroke rehabilitation: Spontaneous recovery or practice effects?
58	Alba Tuninetti	Speech normalisation in EEG: an optimal paradigm?
59	Sreekari Vogeti	The effect of competiton and adaptation on the amplitude of the event-related potential N170.
60	Grace Wang	The association between internet use and cognition: A pilot study.
61	Olivia Whalen	The role of infant and maternal factors on the early development of infant cognition.
62	(Charles) Adam Wigley	Examining the auditory mismatch negativity in adults with and without developmental coordination disorder (DCD): a pilot study.
63	Royce Willis	EEG Theta/Beta ratio, pro-environmental attitudes, and self-reported pro-environmental behaviour.
64	Aaron Wong	Replication and effects of practice using cued task-switching paradigm through evidence accumulation model: robust EZ diffusion.
65	Alix Woolard	The association of infant temperament and maternal pitch contours.
66	Katie Wykes	Individual differences in binocular rivalry across autistic personality traits.
67	Ashley York	Top-down modulation of onset capture by feature relationships, within and between feature dimensions.

Detailed Program

Day 1 | Thursday 24 November

9.00 - 10.30	**Early Career Research Workshop** **Speakers**: Ian Harding, Ann-Maree Vallence, Suresh Muthukumaraswamy, Hannah Keage, Frini Karayanidis *Sponsor: ARC Centre for Excellence in Cognition and its Disorders*	Sea & Star Room
10.30 - 11.00	**Morning Tea**	
11.00 - 12.00	**ECR Q&A Session**	
12.30	**Registration Desk Opens**	
13.00 - 14.30	**Mid-Career Research Workshop;** **Speakers:** Jason Mattingley, Frini Karayanidis, Paul Dux, Irina Harris, Olivia Carter, Ann-Maree Vallence *Sponsor: ACNS*	
14.30 - 15.00	**Afternoon Tea**	
15.00 - 16.00	**MCR Q&A Session**	
17.00 - 17.30	**Conference Opening** **Welcome & Acknowledgement of Country** Frini Karayanidis & Juanita Todd **Opening Address:** *Alan Brichta*	WhiteSands Ballroom
17.30 - 18.30	**Keynote 1: Dr David Strayer,** *University of Utah.* The multitasking driver: Why talking to your phone will drive you to distraction. **Chair:** David Crewther *Sponsor: UON Priority Research Centre for Brain and Mental Health*	
18.30 - 20.30	**Welcome Reception** *Sponsor: University of Newcastle*	Promenade & Sandyfoot
20.30 - 23.00	**ECR Social Drinks**	Port Stephens County Club

Day 2 | Friday 25 November

9.00 - 10.00	**Keynote 2: Dr Rosalyn Moran,** *University of Bristol.* Aging under the Free Energy Principle **Chair:** Michael Breakspear *Sponsor: QIMR Berghofer Medical Research Institute*	WhiteSands Ballroom
10.00 - 10.30	**Morning Tea**	

	Open Talks: A1 - Sun Room **Attention, Sensation & Perception 1** *Sponsor: University of Newcastle*	**Open Talks: B1 - Sea & Star Room** **Motor Processes** *Sponsor: University of Newcastle*
	Chair - Steve Provost	**Chair - Hannah Keage**
10.30	**Action- and context-based prediction-error signals interact at the P3** Bradley N. Jack *University of New South Wales, Australia*	**Sustained attention as a predictor of antisaccade performance in schizophrenia** Elizabeth Thomas *Monash Alfred Psychiatry Research Centre, Alfred Hospital and Monash Central Clinical School*

Day 2 | Friday 25 November

10.50	**Neural processing of visible orientations** Robert P. O'Shea *Murdoch University*	**Short interval intra-cortical inhibition and stop signal reaction time** Nahian Chowdhury *University of Sydney*
11.10	**Towards the development of psychosis biomarkers: Functional and structural brain networks in the continuum of psychosis** Lena Oestreich *The University of Queensland*	**Connectivity between the supplementary motor area and the primary motor cortex declines with age.** Ann-Maree Vallence *Murdoch University*
11.30	**Evidence for an effect of stimulus probability in the visual oddball paradigm with Fast Periodic Visual Stimulation** Daniel Feuerriegel *University of South Australia*	**Dynamical entrainment of corticospinal excitability to observed rhythmic movement** Manuel Varlet *Western Sydney University*
11.50	**Attention shifting performance in regular cannabis users following prolonged treatment with cannabidiol (CBD)** Nadia Solowij *University of Wollongong*	**Modulation of spontaneous eye blinks during the stop-signal task** Ross Fulham *Newcastle University*
12.10	**Timing is everything: Context-based modulation of sensory inference.** Juanita Todd *University of Newcastle*	**No effect of tDCS on motor ERPs in healthy young and old controls or in stroke patients.** Frini Karayanidis *University of Newcastle*
12.30 - 13.30	**Lunch**	Promenade
	Symposium A1: Sun Room **Neuroethics: When neuroscience meets society** *Sponsor: ARC Centre for Excellence in Cognition and its Disorders*	**Symposium B1: Sea & Star Room** **NeuroEng: Computational Neuroscience and Neuromorphic Engineering** *Sponsor: Compumedics*
	Chair: Adrian Carter	**Chair: Bryan Paton**
13:30	**The role of cognitive neuroscientists in the future of cognitive enhancement.** Olivia Carter *University of Melbourne*	**Nonlinear models of large-scale brain activity** Michael Breakspear *QIMR Berghofer Medical Institute*
13:45	**Delusions and conspiracy theories: cognitive neuroscience meets corpus analysis** Colin Klein *Macquarie University*	**Minimally-invasive intracranial electrodes for brain-computer interfaces** David Grayden *The University of Melbourne*
14:00	**Sex and the City Brain: Rethinking sex, gender and adaptive traits** Cordelia Fine *The University of Melbourne*	**A spotlight on attention and prediction in the dragonfly** Steven Wiederman *The University of Adelaide*
14:15	**Misery in the brain: The mixed blessings of neuroscientific understandings of mental illness** Nicholas Haslam *The University of Melbourne*	**Neuroinformatics tools for simulating realistic brain activity** Paula Sanz-Leon *University of Sydney*
14:30	**Panel Discussion**	**Panel Discussion**
15.00 - 15.30	**Afternoon Tea**	
	Fast Talks A1: Sun Room *Sponsor: UON Priority Research Centre for Brain and Mental Health*	**Fast Talks B1: Sea & Star Room** *Sponsor: UON Priority Research Centre for Brain and Mental Health*

Day 2 | Friday 25 November

	Chair - Muireann Irish	Chair - Bill Budd
15:30	**Shepard tones test prediction: Amplitude of mismatch negativity is determined by the size of prediction error** Alicia Lawrinson *Murdoch University*	**Visual processing: conscious until proven otherwise** Tarryn Balsdon *University of New South Wales, Australia*
15:40	**An ERP study investigating memory-theory and predictive-coding of visual mismatch negativity (vMMN)** Alie Male *Murdoch University*	**See me, feel me: Do bodily-self cues affect visual-tactile asynchrony detection?** Robert Keys *Macquarie University*
15:50	**More than just a face: Expectations about person identity modulate the face-sensitive N170** Anne Overell *Queensland University of Technology*	**Local/global influences on attention orienting across the subclinical autism spectrum** Melanie Murphy *La Trobe University*
16:00	**Does sequence foreknowledge or concurrent task affect first impression bias in mismatch negativity (MMN)?** Jade Frost *University of Newcastle*	**Examining the symptomology network of ADHD: A new way to view ADHD symptoms.** Tim Silk *Murdoch Childrens Research Institute*
16:10	**Differences in first-impression bias patterns to spatially distinct monaural and binaural sounds** Kaitlin Fitzgerald *University of Newcastle*	**A shared autism and schizophrenia spectrum trait phenotype may be marked by increased glutamate/GABA ratio.** Talitha Ford *Swinburne University of Technology*
16:20	**Beyond brain decoding: Searching for information in the brain that also predicts behaviour** Tijl Grootswagers *Macquarie University*	**Are two brains better than one? Evidence of neural synchrony across co-actors in a visually guided movement task** Angela I. Renton *The University of Queensland*
16:30	**Electrophysiological response to duration deviants in Schizotypy** Roshini Randeniya *Queensland Brain Institute*	**Individuals with higher autistic-like traits show reduced face-inversion, but increased car-inversion effects in Saccadic choice tasks** Robin Laycock *RMIT University*
16:40	**Statistical Learning of Irrelevant Visual Information is Disrupted by Electrical Stimulation of Frontoparietal Cortex** Abbey Nydam *The University of Queensland*	**Decoding the nonconscious dynamics of thought generation** Roger Koenig *Universtiy of New South Wales, Australia*
18.30 - 20.30	**Poster Gala Session** *Finger food will be served; Cash Bar available*	WhiteSands Ballroom

Day 3 | Saturday 26 November

9.00 - 10.00	**Keynote Lecture 3: Dr Sara Festini and Michelle Farrell,** *University of Texas at Dallas* Scaffolding of the Aging Mind: How Neural Depletion and Neural Enrichment Factors Affect Cognition **Chair:** Anina Rich *Sponsor: UON Priority Research Centre for Stroke and Brain Injury*	WhiteSands Ballroom
10.00 - 10.30	**Morning Tea**	

	Open Talks: A2 - Sun Room **Attention, Sensation & Perception II** *Sponsor: University of Newcastle*	**Open Talks: B2 - Sea & Star Room** **Cognition & Decision-making I** *Sponsor: University of Newcastle*
	Chair - Olivia Carter	**Chair - Paul Dux**
10:30	**Distinct cerebellar contributions to cognitive-perceptual dynamics during natural viewing** Vinh Nguyen *QIMR Berghofer*	**Multivariate pattern analysis of event-related potentials predicts the general desirability of objects** William Turner *University of Melbourne*
10:50	**Posterior parietal cortex, where working memory meets selective attention.** Mojtaba Kermani *University of Melbourne*	**Are cognitive processes facilitated by motor demands?** Magnus Liebherr *Hochschule Fresenius - University of Applied Sciences*
11:10	**Functional mechanisms encoding others direction of gaze in the human nervous system** Colin Palmer *University of New South Wales, Australia*	**A novel approach to characterising (relatively) complex decision-making using electroencephalography** Dragan Rangelov *The University of Queensland*
11:30	**Measuring the effects of attention to single fingertips using ultra-high field (7T) fMRI** Alexander Puckett *The University of Queensland*	**Monoamine alterations in the dorsal striatum and behavioural flexibility in persistent neuropathic pain and acute stress** David Mor *University of Sydney*
11:50	**Early decision-related information predicts response times: a jackknifing approach for MVPA for ERPs** Stefan Bode *The University of Melbourne*	**Goal-directed and habit-like modulations of stimulus processing during reinforcement learning** David Luque *University of New South Wales, Australia*
12:10	**Seeing the trees through the forest: characterizing selectivity in neural population codes.** Thomas Carlson *University of Sydney*	**Functional gradients of prefrontal cortex organisation have corresponding oscillatory hierarchies** Patrick Cooper *University of Newcastle*

12.30 - 13.30	**ACNS Equity Policy Launch and Lunch (Free, Ticketed Event)** *Sponsor: ARC Centre for Excellence in Cognition and its Disorders*	Promenade
	Other Lunch	WhiteSands Reception

	Symposium A2: Sun Room **Dynamic functional architectures of the human brain** *Sponsor: Symbiotic*	**Symposium B2: Sea & Star Room** **Recent advances in consciousness research** *Sponsor: Sonoray*
	Chair: Luke Hearne	**Chair: Naotsugu Tsuchiya**
14:00	**Neural decoding of visual information varies with fluctuations in global network efficiency** Luca Cocchi *QIMR Berghofer Medical Institute*	**From hallucinations to the imagination: Seeing what's not there and measuring** Joel Pearson *University of New South Wales, Australia*

Day 3 | Saturday 26 November

14:15	**Dynamic brain modular architectures supporting higher cognition** Luke Hearne *Queensland Brain Institute*	**Consciousness in dreaming & dreamless sleep: Questions & challenges for future research** Jennifer Windt *Monash University*
14:30	**Dynamic causal modelling reveals a rapid subcortical route to the amygdala in visual and auditory processing.** Jessica McFayden *The University of Queensland*	**Feedback loops in detecting (un)seen change** Marta Garrido *The University of Queensland*
14:45	**Time-resolved connectomics** Andrew Zalesky *University of Melbourne*	**Empirical testing of integrated information theory of consciousness** Naotsugu Tsuchiya *Monash University*
15:00	**Panel Discussion**	**Panel Discussion**
15.30 - 16.00	**Afternoon Tea**	
	Fast Talks A2: Sun Room *Sponsor: UON Priority Research Centre for Brain and Mental Health*	**Fast Talks B2: Sea & Star Room** *Sponsor: UON Priority Research Centre for Brain and Mental Health*
	Chair - Talitha Ford	**Chair - Paul Corballis**
16:00	**Attentional enhancement of event-related potentials in a multilingual dichotic listening task** Vivian Eng *University of Nottingham Malaysia Campus*	**Decoding dice and digits with Magnetoencephalography: How long does it take to access magnitude?** Lina Teichmann *Macquarie University*
16:10	**Determinants of variation in rapid temporal processing ability: How do behaviour, function, and structure relate?** Jesse Bourke *University of Newcastle*	**Resting state functional coupling between the ascending synchronising system, limbic system and the default mode network** Bryan Paton *University of Newcastle*
16:20	**Patterns of sedentary behaviour are associated with cognitive performance and cardiovascular disease risk in mid to late life** Ashleigh Smith *University of South Australia*	**Pushing attention to one side: Force field adaptation alters attentional processing in the healthy brain.** Eva-Maria Reuter *The University of Queensland*
16:30	**Spontaneous Blink Rate in Anorexia Nervosa: Implications for Dopaminergic Activity in Anorexia Nervosa** Andrea Phillipou *St Vincent's Hospital*	**Rapid Adjustments of Frontoparietal Networks Underpin Proactive Cognitive Control** Montana McKewen *University of Newcastle*
16:40	**Transcranial magnetic stimulation reveals distinct implicit learning mechanisms for first-order and second-order sequences** Gillian Clark *Deakin University*	**Combinatorial processes of arithmetic and enumeration revealed by subset grouping.** Jason Forte *University of Melbourne*
16:50	**Separable effects of perceptual form and memory on hemispheric lateralisation during spatial memory tasks: An ERP study** Adam Bentvelzen *Macquarie University*	**Decoding voluntary decisions: perception of freedom is dependent on keeping your options open** Natalie Rens *The University of Queensland*
17:00	**Investigating the developmental course of letter recognition in the brain by varying typeface** Owen Churches *Flinders University*	**Trigger Failure in the Stop-Signal Task Triggers Re-interpretations of Electrophysiological Relationships with Inhibitory Ability** Patrick Skippen *University of Newcastle*

Day 3 | Saturday 26 November

17:10	**Cerebral compensation during motor function in individuals with cerebellar degeneration** Ian Harding *Monash University*	**Necessity tamed: metacognition in the near absence of attention** Julian Matthews *Monash University*

18.30 - 23.30	**Conference Dinner** Paid Ticketed Event *Sponsor: University of Newcastle*	Broughtons at the Bay

Broughtons at the Bay

Day 4 | Sunday 27 November

9.30 - 10.00	**2016 ACNS Young Investigator Award: Dr Paul Dux,** *The University of Queensland* On the capacity limits of cognitive control and its enhancement: neural mechanisms and transfer **Chair:** Jason Mattingley *Sponsor: ACNS*	WhiteSands Ballroom
10.00 - 10.30	**Morning Tea**	

	Open Talks: A3 - Sun Room **Cognition & Decision-making II** *Sponsor: University of Newcastle*	**Open Talks: B3 - Sea & Star Room** **Language, Learning & Memory** *Sponsor: University of Newcastle*
	Chair - Tobias Loetscher	**Chair - Alex Provost**
10:30	**Do cannabis users show differences in brain activity for risk and reward related processing?** Louise Curley *The University of Auckland*	**Don't get too excited: Higher levels of visual cortex excitability predict smaller visual working memory capacities** Rebecca Keogh *University of New South Wales, Australia*
10:50	**Indexing Vascular Cognitive Impairment in the older population using event-related potentials** Hannah Keage *University of South Australia*	**Distinct cortical contributions to recent and remote autobiographical memory retrieval - a longitudinal neuroimaging study in dementia** Muireann Irish *University of New South Wales, Australia*
11:10	**Neurocognitive correlates of reduced thalamus volume in men who carry premutation expansions of the FMR1 gene.** Rachael Birch *University of New South Wales, Australia*	**How do you take your language lateralisation: Two lumps or three?** Nic Badcock *Macquarie University*
11:30	**Partial inhibition reveals age-related change during response inhibition in mid-to-late adolescents** An Nguyen *The University of Western Australia*	**High-intensity Training Enhances Executive Function in Children** David Moreau *University of Auckland*
11:50	**Neuroimaging white matter in attention/ deficit-hyperactivity disorder: understanding impulsivity with diffusion tensor imaging** Fiore D'Aprano *The University of Melbourne* *Murdoch Children's Research Institute*	**Using low-cost portable neuroimaging to detect receptive language ability in children** Selene Petit *Macquarie University*
12:10	**Hierarchical Frequency Tagging reveals neural markers of predictive coding under varying uncertainty** Noam Gordon *Monash University*	**Don't judge a book by its cover - case of a minimally-verbal Autistic child with excellent receptive and productive language.** Alexandra Woolgar *Macquarie University*

12.30	**Working Lunch**	Promenade
13.00 - 14.30	**Annual General Meeting** Includes: **Election outcomes & new ACNS executive committee** **Student and Post-doctoral awards** AGM feature event: **Sharing insights from ARC and NHMRC panels**, Hannah Keage, Frini Karayanidis, Jason Mattingley. Q&A with ACNS members who have recently been on these panels. **Introduction to Australian Brain Alliance,** Pat Michie	Promenade

How do you take your language lateralisation: Two lumps or three?

Dr Nic Badcock, Postdoctoral Research Fellow
Macquarie University

A/Prof Margriet Groen, *Radboud University*
Ms Hannah Rapaport, *Macquarie University*
Ms Julianne Pascoe, *Macquarie University*
Prof I.C. McManus, *University College London*

The majority of people are left lateralised for language processing: when completing a language task, the left hemisphere of the brain is more active than the right. Knowing this is important for surgical procedures to reduce seizures in epilepsy. It may also have implications for the development of language and reading. The methods and tools used to determine language lateralisation have been cross-validated and are considered to be reliable. However, there's an anomaly when examining the distribution of language lateralisation collected with functional Transcranial Doppler Ultrasound (fTCD) and functional Magnetic Resonance Imaging (fMRI). FTCD produces laterality indices that are readily fitted by two Gaussian distributions: the majority of individuals are left lateralised and a small portion are right. FMRI produces laterality indices that are better fitted with three distributions - left, right, and bilateral. Here we report on two fTCD tasks that contrast easy and hard language production and reception. These tasks put the participants under significant pressure and return laterality indices consistent with the bilateral distribution apparent in fMRI. We question whether stress associated with the fMRI scanner introduces an artefact in some individuals. This may be an important consideration when examining individual differences in language lateralisation.

Visual processing: conscious until proven otherwise

Ms Tarryn Balsdon, PhD Candidate
UNSW Australia

Prof Colin Clifford, *UNSW Australia*

Unconscious perception, or perception without awareness, describes when an observer has no phenomenal awareness of a stimulus yet their behavior or decisions are still influenced by that stimulus. Perception without awareness is often demonstrated by a difference in thresholds for tasks that do and do not require awareness, for example, a difference in the threshold for detecting the stimulus (requiring awareness) and the threshold for making accurate semantic judgements about the stimulus (based on unconscious perceptual evidence). Although a difference in thresholds would be expected if perceptual evidence were being processed without reaching awareness, the difference does not necessitate that this is actually occurring: a difference in thresholds may also have arisen from confounds in the measurements of thresholds, such as response bias, or because of differences in the tasks used for obtaining thresholds. Here we propose a different tactic for establishing perception without awareness: we ask instead whether the pattern of performance suggestive of perception without awareness could be obtained if the observer used only perceptual evidence that they were aware of in making their perceptual decisions. A backwards masking paradigm was designed based on previous experiments in the literature; using Arabic digits as target stimuli, with task difficulty being controlled by the length of time between target and mask. Performance was measured over three tasks: a detection task, a graphic discrimination task, and a semantic discrimination task. Despite finding a significant difference in thresholds measured using proportion correct, and significant differences in observer sensitivity for each decision, modelling suggests that these differences were not the result of perception without awareness. That is, the pattern of performance could have been achieved even if the observer was only using conscious information to make decisions.

Distinguishing confounds from true meditation effects: Insights from auditory ERPs

Ms Lydia Barnes, Master of Research Candidate
Macquarie University

Prof Genevieve McArthur , *Macquarie University*
Dr Britta Biedermann, *Curtin University*
Dr Peter de *Lissa, ARC Centre of Excellence in Cognition and its Disorders*
Dr Vince Polito, *Macquarie University*
Dr Nicholas Badcock, *Macquarie University*

Recent studies provide evidence that meditation affects early auditory processing, as measured through auditory ERPs (Cahn & Polich, 2009). However, meditation effects in these studies are difficult to distinguish from experimental confounds introduced by unbalanced condition order and unequal task requirements in meditation and control conditions. Biedermann et al. (2016) reported N1 attenuation during meditation, compared to a mind-wandering control condition for novice meditators. In a series of studies, we investigated the role of meditation and experimental confounds in this design. Experiment 1 replicated the effect (d = -1.18). Experiment 2 tested whether mental state influences (high or low arousal) on repetition suppression were responsible for the effect. Eliminating the opportunity for mental state-induced differences in repetition suppression by reducing the inter-stimulus interval did not eliminate the effect (d = -0.97). Experiment 3 tested whether divergent tone-related instructions in the original experiment acted as a mediator of mental control in the meditation and mind-wandering conditions. Presenting uniform tone-related instructions for both conditions did not eliminate the effect (d = -1.27). Experiment 4 replicated the findings of Experiments 2 and 3 with reduced inter-stimulus interval and uniform instructions (d = -1.92). The N1 attenuated during the meditation condition (second condition) in Experiments 1-4, as in Biedermann et al. (2016). Experiment 5 reversed the order of the experimental conditions so that meditation occurred before the mind-wandering condition. N1 was attenuated during the control condition (d = -0.94). Thus, we conclude that N1 attenuation during first-time meditation, compared to a mind-wandering control condition, is an effect of condition order. These findings have critical implications for the design and interpretation of meditation and early auditory processing research.

Tuning attention to relative features affects early perceptual processes - behavioural and electrophysiological evidence

Dr Stefanie Becker, ARC Future Fellow
The University of Queensland

Dr Josef Schönhammer, *University of Geneva*
Prof Dirk Kerzel, *University of Geneva*
Dr Anna Grubert, *Durham University*

How do we select relevant information from cluttered visual scenes? A widely held belief is that we select important information by tuning attention particular elementary feature values of sought-after items (e.g., red, yellow). However, recent studies showed we often select a target item in a context-dependent manner, by tuning attention to its relative features, that is, to the features that the target has relative to other items in the surround (e.g., redder, yellower). So far, the evidence for this relational account is exclusively based on behavioral studies that do not allow safe inferences about early perceptual processes. The present study provides a critical test of the relational account, by measuring an electrophysiological marker in the EEG of participants (N2pc). In a first experiment, the target could be discriminated from the non-targets by its relative color, as the target and nontarget color were always kept constant across trials. In line with a relational account, we found that a pre-cue attracted attention only when it had the same relative color as the target (e.g., reddest item), regardless of whether the cues had the same physical color as the target or not (e.g., orange or red). In a second experiment, we investigated whether attention can also be efficiently biased to the exact target feature value (e.g., orange), by presenting the target in a randomly varying context. The results showed that in this condition, only target-matching orange cues elicited a significant N2pc indicative of attracting attention. Taken together, these results provide the first electrophysiological evidence that attention can modulate early perceptual processes differently - in a context-dependent manner versus a context-independent manner, which results in marked differences in the range of colors that can attract attention.

Separable effects of perceptual form and memory on hemispheric lateralisation during spatial memory tasks: An ERP study

Dr Adam Bentvelzen, PhD/Master of Clinical Neuropsychology
Macquarie University

Dr Nicholas Badcock, *Macquarie University*
Prof Genevieve McArthur, *Macquarie University*
Prof Greg Savage, *Macquarie University*

Neuroimaging evidence for material specific hemispheric lateralisation during memory tasks (verbal: left; spatial: right) is usually assumed to reflect differences in the way materials are remembered. Material type and perceptual form are potentially confounded, however, due to a lack of precise stimulus control, but there have been surprisingly few investigations aimed at teasing apart these influences. Furthermore, while neuroimaging methods provide high spatial resolution in investigating hemispheric lateralisation, their low temporal resolution means that they struggle to detect very early perceptual lateralisation effects. In this vein, this study compared the effects of memory-related and stimulus-related processing on lateralisation during memory for different materials (verbal, spatial). Event-related potentials were measured in 20 healthy adults at parietal electrodes during recognition of previously learned verbal materials (letter triplets) and spatial materials (positional arrays) that differed in task-irrelevant perceptual form (standard: form reflected material to-be-remembered; hybrid: form controlled as verbal-spatial composite stimulus). The results showed that spatial memory and spatial form were independently associated with right-lateralisation of the N170 peak. Verbal memory did not show expected left-lateralisation. These findings support previously findings that spatial processing is right-lateralised per se and additionally suggest that right-lateralisation observed during spatial memory tasks is due to separable perceptual- and memory-related components.

Neurocognitive correlates of reduced thalamus volume in men who carry premutation expansions of the FMR1 gene.

Dr Rachael Birch, Lecturer
UNSW Australia

Dr Darren Hocking, *La Trobe University*
A/Prof Wei Wen, *University of New South Wales*
Prof Kim Cornish, *Monash University*
Prof Nellie Georgiou-Karistianis, *Monash University*
Ms Carolyn Rogers, *Hunter Genetics*
Prof Julian Trollor, *University of New South Wales*

Fragile X-associated tremor ataxia syndrome (FXTAS) is an inherited neurodegenerative disorder caused by premutation (PM) expansions of the Fragile X Mental Retardation 1 (FMR1) gene. Recent evidence suggests that thalamus volume loss is associated greater motor symptom severity in male PM carriers, but no study to date has investigated the relationship between thalamus volume and neurocognitive function in this group. This study investigated the relationships between thalamus volume and neurocognitive performance in 19 PM males (aged 26-80 years, 6 with FXTAS) and 24 controls (aged 26-77 years). Neurocognitive function was examined using measures of executive function (Behavioral Dyscontrol Scale), working memory (Letter Number Sequencing), information processing speed (Digit Symbol), and fine motor function (Lafayette Grooved Pegboard). PM males had significantly reduced thalamus volume ($F(1,39)=14.118$, $p<.006$), and demonstrated poorer performance on measures of executive function ($F(1,39)=9.742$, $p=.003$), working memory ($F(1,39)=4.257$, $p=.046$), and information processing speed (controlling for fine motor function, $F(1,38)=4.772$, $p=.035$), compared to controls. In PM males, reduced thalamus volume was associated with poorer performance on measures of executive function ($r=.833$, $p<.001$), working memory ($r=.542$, $p=.025$) and information processing speed ($r=.545$, $p=.024$), however the latter was no longer significant after controlling for fine motor function ($r=.384$, $p=.142$). No significant associations between thalamus volume and neurocognitive function were found in controls. Collectively, these findings provide the first evidence of associations between thalamus volume and neurocognitive function in male PM carriers. These findings have important implications for guiding future research exploring the use of sensitive measures to determine risk for FXTAS, track symptom progression, and the development of targeted treatments.

Early decision-related information predicts response times: a jackknifing approach for MVPA for ERPs

Dr Stefan Bode, Senior Lecturer / Research Fellow
The University of Melbourne

Dr Hannah Keage, *University of South Australia*
Mr Daniel Feuerriegel, *University of South Australia*
Prof Michael Nicholls, *Flinders University*
Dr Owen Churches, *Flinders University*

Recently, multivariate pattern classification analysis (MVPA) has been applied to spatially distributed patterns of event-related potential (ERP) data to predict the outcome of upcoming simple decisions. However, the extent to which such early information is directly translated into overt behaviour is an open question. The present study therefore investigated whether decodable decision-relevant information also predicted the timing of behavioural responses. For this, participants performed simple identity decisions, whereby two consecutively presented letters were shown in different rotation angle conditions, while the electroencephalogram (EEG) was recorded. Decision outcomes were predicted from spatio-temporal activity patterns before response execution using a moving-window support vector machine (SVM) MVPA approach. The first predictive time windows were identified at ~200-260 ms after presentation of the probe stimulus. Using a jackknifing procedure, the change in average classification accuracy was then correlated with the change in average response times (RT) for each rotation angle condition when excluding each participant once. On average, decision-relevant information (as denoted by classification accuracy) started to significantly correlate with RT at 260 ms after the probe stimulus, peaking at ~400ms, which corresponded to the beginning of the response period. This suggests that when more information was represented in activity patterns during early time windows, decisions were made faster. These results show that MVPA for ERPs can reveal accumulation of information in the brain that is directly relevant for upcoming decision behaviour. Funding: ARC DECRA (DE140100350) to S.B.

Determinants of variation in rapid temporal processing ability: How do behaviour, function, and structure relate?

Mr Jesse Bourke, PhD (Clinical Psych) Candidate
University of Newcastle

A/Prof Juanita Todd, *University of Newcastle*
Prof Ulli Schall, *University of Newcastle*

Effective processing of rapid temporal cues in sound is essential for accurate perception of auditory stimuli, particularly for speech (Zatorre & Gandour, 2008). Poor rapid temporal processing (RTP) ability has been widely linked with disorders of speech and language processing (e.g., Cardy, Flagg, Roberts, Brian, & Roberts, 2005; Farmer & Klein, 1995). Todd, Finch, Smith, Budd, and Schall (2011) demonstrated that pre-attentive psychophysiological processing of RTP cues typically produces a right ear-advantage, depending on the individual's behavioural ability to consciously discriminate RTP cues. A mismatch negativity (MMN) paradigm and gap detection threshold task (GDT) was used to measure behaviour and function respectively. Although neuroanatomical substrates of these effects have not yet been established, leftward structural lateralisations of the planum temporale (PT) may be a potential determinant (Elmer, Hänggi, Meyer, & Jäncke, 2013; Griffiths & Warren, 2002). In the present study we extended Todd et al.'s study by comparing behavioural and functional indices of RTP, with measures of the PT using structural and diffusion weighting MRI in a sample of 63 healthy participants (aged 18-46). Cognitive measures were also included. This presentation will focus on preliminary structural and cognitive relationships with RTP. For example, a positive correlation of leftward PT volume asymmetry with RTP ability

was found. However, general strength of asymmetry (i.e., left or right) seems more strongly related. General processing speed and fluid intelligence also showed positive relationships with RTP. Overall, these findings affirm the PT as a potential neuroanatomical substrate of the relationship of behavioural RTP, and encourage integrative approaches to cognitive neuroscience.

Nonlinear models of large-scale brain activity

Dr Michael Breakspear
QIMR Berghofer Medical Research Institute

Movement, cognition and perception arise from the collective activity of neurons within cortical circuits and across large-scale systems of the brain. While the causes of single neuron spikes have been understood for decades, the processes that support collective neural behaviour in large-scale cortical systems are less clear and have been, at times, the subject of contention. Modelling large-scale brain activity with nonlinear dynamical systems theory allows the integration of experimental data from multiple modalities into a common framework that facilitates prediction, testing and possible refutation. This talk will review the core assumptions that underlie this computational approach, the methodological framework that fosters the translation of theory into the laboratory, and the emerging body of supporting evidence.

Plasticity of the sustained attention network in ageing: a simultaneous tDCS-EEG approach.

Ms Méadhbh Brosnan, PhD Student & Marie Curie Early Stage Researcher
The University of Dublin, Trinity College & Monash University

Dr Mahnaz Arvaneh, *University of Sheffield, United Kingdom*
Prof Ian Robertson, *Trinity College Dublin, Ireland*
Dr Paul Dockree, *Trinity College Dublin, Ireland*

While accumulating evidence suggests the right prefrontal cortex (PFC) plays a crucial role in sustained attention, whether this region can be targeted in older adults to improve age-related declines in this capacity has not been explored. We recruited 49 older adults (60-82 years) for two separate experiments and employed transcranial direct current stimulation (tDCS), a non-invasive brain stimulation technique, to increase activity in the right prefrontal cortex while monitoring sustained attention performance.
In experiment one, performance was assessed using the Sustained Attention to Response Task (SART) and electroencephalography (EEG) markers of attention were monitored simultaneously with tDCS. During active relative to sham tDCS accuracy on the SART improved. Importantly, these benefits were task specific and were not observed on a modified version of the paradigm where reliance on sustained attention was reduced, while all other aspects of stimulus characteristics and task requirements were held constant. Improvements in attention were accompanied by enhanced ERP markers of early visual attention deployment, stimulus selection and conflict monitoring over occipito-parietal and frontal scalp regions. Spectral analyses revealed that midline frontal theta, a putative marker of cognitive control, was enhanced during active stimulation. These results were recapitulated in a separate behavioural experiment using a task sensitive to attentional decrements over time; when excitability in the right PFC was increased exogenously using tDCS, accuracy on the sustained attention task improved. Collectively, these findings suggest that the right PFC is a promising target region to improve sustained attention in an ageing population.

ERP and behavioural evidence for multisensory integration of odour and image valence.

Dr Timothy Budd, Lecturer
University of Newcastle

Mr Grant Macphail, *University of Newcastle*
Dr Bryan Paton, *University of Newcastle*
Prof John Prescott, *University of Florence, Italy*

The perceived pleasantness of olfactory stimuli is strongly influenced by simultaneous stimulation in other sensory modalities. Evidence for multisensory integration in olfaction has been demonstrated in for cross-modal manipulations of auditory, tactile and visual stimulation. Previous studies have indicated that the P3-2 component of the olfactory ERP (OERP) may be uniquely sensitive to the affective valence of odours. The aim of the present study was to examine whether the amplitude of P3-2 component of the OERP is modulated by the cross-modal valence of simultaneously presented images. To achieve this the presented study used a six channel liquid dilution olfactometer to present unpleasant, pleasant and neutral odours simultaneously with pleasant, unpleasant and neutral images from the International Affective Picture (IAP) database during an EEG recording. For each each trial participants rated both the pleasantness and intensity of either the odour or image. OERPS were averaged according to the rated odour valence to determine the influence of cross-modal valence on P3-2 amplitude.
The results showed a significant effect of odour pleasantness on cross-modal image valence, where odour pleasantness ratings were significantly greater when pleasant images where simultaneously presented than when unpleasant images were presented. Similarly, unpleasant odours where rated as significantly more unpleasant when unpleasant images where simultaneously presented. No significant effect was found for odour intensity indicating that the influence of cross-modal valence was specific to odour pleasantness. While ERPs where obtained to all odour stimuli, analysis of difference waves comparing odour and non-odour stimuli revealed no significant OERPs. These results are discussed in terms of the difficulty inherent in recording OERP responses due to poor time-locking for olfactory stimulation and the benefits of using measures of inspiration cycle and time-frequency analyses.

Early cortical P1 ERP differences in high autistic tendency during fearful face processing.

Miss Adelaide Burt, Student
Swinburne University of Technology

Dr Laila Hugrass, *Swinburne University of Technology*
Prof David Crewther, *Swinburne University of Technology*

Low spatial frequency (LSF) signals mediate rapid fearful face processing at the P1 ERP component (“100ms) across parieto-occipital cortices. In Autism Spectrum Disorder (ASD) low level perceptual processing appears to function atypically, including a reduced P1 response to fearful emotion presented in LSF. It is proposed that magnocellular impairments may contribute to differences in the low-level perceptual processing of a face, resulting in reduced P1 response to LSF fearful expression. An ERP study was conducted on a neurotypical population of low and high autistic tendency (AQ), to determine whether fearful content and spatial frequency altered the early P1 response. The study included 16 low AQ participants (3 male; 13 female; Mean age= 24.19, SD= 5.41) and 17 high AQ participants (11 male; 6 female; Mean age= 25.29, SD= 5.72). Hybrid face stimuli were presented to participants while requiring report of either a fear or neutral percept at high (HSF) or low spatial frequency (LSF). In addition, we aimed to examine whether magnocellular differences contributed to the rapid P1 evoked response for LSF fear present in low and high AQ groups. A non-linear multifocal task was presented to determine whether magnocellular input rapidly enhanced activation of primary visual cortex (V1), which has previously differentiated high and low AQ groups. The current findings demonstrated low AQ individuals confirmed coarse; LSF fear input mediated the rapid appearance of P1 at parieto-occipital cortex, while this effect was not present in the high AQ group. For the first time, a neurotypical population with high autistic traits has presented early differences in cortical P1 response, with no sensitivity to emotion or spatial frequency content. Importantly, non-linear multifocal responses in V1 for the high autistic tendency group suggest impaired magnocellular function may contribute to atypical fear processing within the early visual stream.

Training the Mirror System not to imitate: changes in proactive and reactive control processes

Ms Megan Campbell, PhD Student
The Queensland Brain Institute

Ms Stacey Logan, *The University of Queensland*
Prof Ross Cunnington, *The University of Queensland*

The contentious issue of whether the mirror neuron system is innate or acquired continues to garner debate. This study extends our previous fMRI work which dissociated the engagement of proactive cognitive control for task-dependent modulation of mirroring. Using the same behavioural paradigm to measure the effects of sensorimotor training interventions on intentional and inciden-

tal imitation and counter-imitation. Pre and post-tests involved 2 tasks: an action imitation/counter-imitation task; and similar task with non-action stimuli manipulating low-level stimulus-response spatial compatibility rather than imitative compatibility. Both tasks also manipulated action preparation context (predefined vs stimulus-dependent). We compared three training interventions: counter-imitation (CIT, opposing action responses to action stimuli), imitation (ImT, performing the same actions as observed action stimuli) and spatial-incompatibility training (SIT, opposing button-press response to arrow stimuli, e.g. stimulus: right-ward pointing arrow; response: press left button). Behavioural performance indicated distinct effects of ImT and CIT on intentional sensorimotor mapping. CIT lead to faster reaction times at post-test for mismatched actions, and removed the response-time facilitation effect of matched actions. ImT merely strengthened standard stimulus-response compatibility effect, with overall pattern across conditions conserved at post-test, only faster. Hence intentional counter-imitation can be trained to overcome existing stimulus-response pairings so that incongruent stimulus-response pairs become the default response. In ongoing work we use these training paradigms to examine neural correlates related to these changes in preparatory versus reactive control processes for modulating newly acquired action pairings. This work lends weight to the mounting evidence supporting the view that mirroring is acquired not innate, and hence malleable to experience and context.

Seeing the trees through the forest: characterizing selectivity in neural population codes.

A/Prof Thomas Carlson, Associate Professor
University of Sydney

Mr Tijl Grootswagers, *Macquarie University*
Dr David Leopold, *U.S. National Institute of Mental Health*
Dr David McMahon, *U.S. National Institutes of Health*

Neuroscience has produced a variety of metrics aimed at characterising the responses of neurons from single unit recording studies and regions of interest (ROIs) from fMRI. Many of these metrics were developed in the context of univariate measures of neuronal activity (e.g., spike rates from single neurons, BOLD activation in ROIs). Over the past two decades, multivariate recordings of neuronal activity have become standard for the field, and there has been a corresponding development of multivariate methods for analysing these data. In the present study, we evaluated the efficacy of various measures of category selectivity to study neuronal activity at the population level. We applied these measures to spiking activity in 36 neurons located in macaque's anterior fundus "face patch" in response to 2,500 individual object exemplars from 10 different categories, including human and primate faces. We broadly observed that population activity was effective at distinguishing faces from other object categories (i.e., categorization); and importantly also distinguishing individual faces within the category (i.e., individuation). While most current selectivity metrics performed adequately in characterizing the categorical response, they overlooked the population's capacity for individuating exemplars within the preferred face category. Moreover, some metrics that pooled the categorization and individuation components of the response produced both false positives (i.e., identifying non-preferred categories as preferred) and false negatives (i.e., identifying preferred categories as non-preferred). To overcome the limitations of current selectivity metrics in the population context, we propose a new metric, "chirps," that correctly parses both the categorization and individuation components of the population response.

The role of cognitive neuroscientists in the future of cognitive enhancement.

Dr Olivia Carter, ARC Future Fellow
University of Melbourne

What would society look like if we had access to pills or devices that could safely and reliably improve our mood and cognitive abilities beyond normal function? There is nothing new about the desire for people to "improve themselves," nor is it unique that there are products claiming to deliver this goal. But things are changing in the cognitive enhancement landscape with the rapid production, modification and online distribution of new technologies. This talk will provide an overview of the existing international government initiatives established to identify and address neuroethical issues associated with cognitive enhancement. I will also summarise some of the neuroscientific research behind a range of currently available cognitive enhancing drugs and devices. Finally the talk will consider the existing disconnect between the scientific research versus the claims of safety and efficacy in the popular press and supplier websites.

Human agency beliefs influence the neural processing of gaze during joint attention

Dr Nathan Caruana, Postdoctoral Research Fellow
ARC Centre of Excellence for Cognition and its Disorders, Macquarie University

Dr Peter de *Lissa, Macquarie University*
Prof Genevieve McArthur, *Macquarie University*

Background: The neural mechanisms of social gaze processing are difficult to investigate using ecologically-valid experimental protocol because they can only be measured during online interactions.
Method: We developed a virtual reality paradigm to simulate an ecologically-valid interaction within a neuroimaging environment. Participants played a cooperative game with an avatar, whom they believed was controlled by another participant but was, in reality, controlled by a gaze-contingent algorithm. On each trial, participants initiated joint attention towards a target. The avatar averted his gaze congruently (achieving joint attention) or incongruently (avoiding joint attention) with equal probability. We measured event-related potentials (ERPs) to the avatar's response to determine the neural time course of evaluating the achievement of joint attention. We also investigated the influence of agency beliefs on these ERPs in two further experiments. First, we manipulated the visual properties of the stimulus by replacing the avatar's gaze with a non-interactive arrow (Experiment 2). Second, we instructed participants that the avatar was controlled by a computer program, rather than a human.
Results: Larger peaks were observed at centro-parietal sites, 350 ms (P350) after the onset of incongruent gaze shifts, compared to congruent gaze shifts. This P350 effect was absent when the avatar's gaze was replaced with non-interactive arrows (Experiment 2), and when participants believed that the avatar was controlled by a computer (Experiment 3)
Conclusions: These data reveal that the centro-parietal P350 may provide a neural marker for evaluating social outcomes from gaze, and that this neural process is influenced by whether participants believe they are interacting with an intentional human agent.

Dissociation of Reward and Effort Sensitivity in Methcathinone-Induced Parkinsonism

Dr Trevor Chong, NHMRC Neil Hamilton Fairley Early Career Research Fellow
Monash University

Dr Trevor Chong, *Monash University*
Dr Valerie Bonnelle, *University of Oxford*
Miss Kai-Riin Veromann, *University of Oxford*
Dr Julius Juurmaa, *University of Tartu*
Dr Pille Taba, *University of Tartu*
Prof Masud Husain, *University of Oxford*

Methcathinone-induced Parkinsonism is a recently described extrapyramidal syndrome, characterised by globus pallidus and substantia nigra lesions, which provides a unique model of basal ganglia dysfunction. We assessed motivated behaviour in these patients to establish whether they exhibit altered sensitivity to either reward or effort. A novel cost-benefit decision-making task was used to evaluate effort and reward sensitivity in six methcathinone-induced Parkinsonism cases. On each trial, participants decided whether they were willing to allocate varying levels of physical effort for different levels of reward. The reward required to motivate individuals to exert each level of effort on 50% of trials established their reward indifference points. Patients required greater rewards than controls to motivate them to exert intermediate levels of effort. However, the corresponding analysis on effort indifference points showed that patients and controls were no different in the amount of effort they were willing to invest for a given reward. Importantly, these results were not due to motor differences between groups. These results show a dissociation between reward and effort sensitivity in methcathinone-induced Parkinsonism. Pallidonigral complex dysfunction appears to bias cost-benefit decision-making, causing patients to become less sensitive to rewards, while maintaining normal sensitivity to effort costs.

Individual differences within retinotopically defined primary visual cortex (V1) as a function of the autism-spectrum quotient.

Dr Philippe Chouinard, Lecturer
La Trobe University

Mr Julian Vilsten, *La Trobe University*
Ms Alyse Brown, *La Trobe University*
Dr Oriane Landry, *La Trobe University*
Prof Sheila Crewther, *La Trobe University*

Large-scale studies using magnetic resonance imaging (MRI) demonstrate thicker grey matter in early visual areas of the occipital lobe in people with autism spectrum disorder compared to typically developing people. What remains unclear is if similar variations in structure are present in the general population as a function of autistic traits. We performed MRI to determine if grey matter thickness in five early visual areas (V1, V2d, V2v, V3d, and V3v) correlates with the Autism-Spectrum Quotient (AQ) in twenty typical individuals (AQ range: 1 to 33, M = 14.3; Age range: 19 to 36; M = 27.3). Two T1-weighted structural scans with a voxel size of 1 mm3 were collected for each participant to allow for high resolution grey matter boundaries to be determined in Freesurfer. Specifically, boundaries for each of the different visual areas were defined manually in each individual after superimposing their retinotopic maps obtained from functional MRI over an inflated cortical reconstruction of their brain. The average grey matter thickness for each visual area was then determined. Our analyses revealed that AQ correlated with grey matter thickness in V1 ($r = .46$, $p = .042$) but not the other visual areas ($r < .30$, $p > .183$) nor the overall cerebrum ($r = .13$, $p = .580$). From these results, we infer that the cortical structure of V1 differs as a function of autistic traits, which may shed light to numerous studies highlighting differences in visual processing in people with higher AQ scores.

Short interval intra-cortical inhibition and stop signal reaction time

Mr Nahian Chowdhury, PhD Student
University of Sydney

Prof Justin Harris, *University of Sydney*
Dr Evan Livesey, *University of Sydney*
Prof Alex Blaszczynski, *University of Sydney*

Transcranial Magnetic Stimulation (TMS) provides a useful way of investigating inhibitory control, specifically when used to measure intra-cortical inhibitory mechanisms. A widely studied measure is short-interval intra-cortical inhibition (SICI), which is a reduction in a motor evoked potential (MEP) elicited by a TMS pulse that is immediately preceded by a weak "conditioning" pulse separated by a very short interval (2-5 ms). This reduction occurs due to the activation of inhibitory interneurons by the conditioning pulse. Although many studies have identified deficits in SICI in clinical populations characterised by poor behavioural control, studies have not yet determined whether SICI can indeed distinguish individuals who have good or poor behavioural inhibition. Accordingly, our goal was to determine whether there is a relationship between SICI and the latency for an individual to stop a cued response, measured as Stop Signal Reaction Time (SSRT). In our study, we compared MEPs evoked by single and paired pulse (3ms interval) TMS to measure SICI from the FDI muscle at rest. Participants (n=32) also completed the stop-signal task to obtain an estimate of SSRT. Results revealed a significant correlation between SICI and SSRT, such that those with longer SSRTs had weaker SICI, $r = 0.7$, $p < .0001$, which suggests that resting SICI may predict how quickly an individual can stop a response. Future experiments are planned to build on this by measuring SICI "online" during the stop signal task. After estimating SSRT in an initial phase, participants will complete the stop-signal task whilst receiving single and paired pulse TMS at fixed time points after stop signal onset. Stop signal onset will be adjusted according to each individual's SSRT estimate in the initial phase. We will test whether the magnitude of SICI during the attempted inhibition of a response is weaker in individuals with longer SSRTs.

Investigating the developmental course of letter recognition in the brain by varying typeface

Dr Owen Churches, Research Fellow
Flinders University

Ms Rebecca Callahan, *University of South Australia*
Dr Scott Coussens, *University of South Australia*
Dr Myra Thiessen, *University of South Australia*
Ms Jessica Hofmann, *Macquarie University*
Prof Mike Nicholls, *Flinders University*
Dr Hannah Keage, *University of South Australia*

Our group has previously found that in adults, visual letter form (ie. font) affects the processing of letters up to 600 milliseconds, a stage by which the abstraction of letter identity has already occurred. We sought to investigate this phenomenon in primary school aged children, an age during which there are great changes in reading ability. Thirty one right handed participants aged between 8 and 12 years took part in one-back task where letters were presented in easy to read typefaces (fluent stimuli) or difficult to read typefaces (disfluent stimuli). Task instructions necessitated that participants focused on letter identity rather than visual letter form. Event-related potentials were measured following each letter stimuli. Differences were found between fluent and disfluent stimuli in this sample. However, this was to a much lesser extent than that previously found in adults. The P3a component was found to be most sensitive to fluency in children. It showed an overall increase in activation for fluent stimuli over disfluent stimuli. This effect was additionally modulated by the relevance of the stimuli to the task, such that there was a greater difference between fluent and disfluent stimuli for non-targets than for targets. The absence of differences in earlier, visual ERP components, especially in the N1, in this younger sample likely suggests that font tuning is still developing at this age. And thus, pronounced and early differences only occur with greater visual expertise for fonts.

Transcranial magnetic stimulation reveals distinct implicit learning mechanisms for first-order and second-order sequences

Ms Gillian Clark, PhD student
Deakin University

Dr Jarrad Lum, *Senior Lecturer of Deakin University*

The serial reaction time task (SRTT) involves implicitly learning a visuospatial sequence. The learning that takes place on the task is thought to be supported by the cortico-striatal procedural memory system. However, there has been some debate over whether implicit sequence learning might be supported by different networks in the brain depending on the structure of the sequence. Using continuous theta burst stimulation (cTBS), this study investigated the effects of disrupting the procedural memory systems on the implicit learning of sequences.

In this study, 26 healthy adults were presented with two SRTTs that assessed the implicit learning of first-order conditional (FOC) or second-order conditional (SOC) sequences. In FOC sequences, a single position within the sequence predicts the next above chance levels. Processing FOC sequences is dependent on cortico-striatal networks. For SOC sequences, transitions between individual positions are at chance levels. It has been proposed these types sequences might be processed by the hippocampus supported declarative memory system. Before completing the tasks, participants received either sham or active cTBS to primary motor cortex. The active stimulation aimed to disrupt activity in the cortico-striatal procedural network. It was hypothesised that the stimulation group would show poorer learning of the FOC sequence than the SOC sequence, and that the difference in performance between sequence types would be larger for the stimulation group than that for the sham group.

In line with our prediction, the stimulation group performed significantly better on the SOC than the FOC sequence. The sham group showed no significant difference in performance between the two sequences. This provides evidence that processing FOC and SOC sequences might involve different neural networks.

The acute effects of nutritional supplements containing caffeine on human neurochemistry and alertness

Miss Carlee Cleeland, PhD Candidate
Swinburne University of Technology

Dr David White, *Swinburne University of Technology*
Prof Andrew Scholey, *Swinburne University of Technology*
Dr Matthew Pase, *Boston University*

Dr Shakuntla Gondalia, *Swinburne University of Technology*
A/Prof Andrew Pipingas, *Swinburne University of Technology*

While there is a sum of research examining the cognitive and behavioural effects of multi-nutrient supplements and nootropics, there is a paucity of research examining neurochemical underpinnings. The aim of the current study was to investigate the effect of dietary supplements containing caffeine on neurochemistry and alertness. This was a randomised, double blind, placebo controlled, cross-over trial. Nineteen young adults (M: 26 years; SD = 7.75 years) completed three testing sessions where they took one of the three supplements (placebo, multi-nutrient supplement with high caffeine and a multi- nutrient supplement with low caffeine) at each testing session. Neurometabolites were assessed using magnetic resonance spectroscopy (1H-MRS) and alertness was measured with mood scales assessed prior to and following performance of cognitive demand battery (CDB). The analysis compared the differences in neurometabolite concentrations between the active supplements and the placebo supplement following acute supplementation. Neurometabolites were quantified using the time-domain analysis implemented in TARQUIN and referenced to an external water signal. Analysis of mood scales showed that the active supplements significantly reduced the mental fatigue effects induced by the cognitive demand task. Neurometabolites glutamate/glutamine and N-acetyl aspartate (NAA) displayed a positive trend nearing significance when comparing the active supplements to the placebo supplement. However, no significant relationship was found in neurometabolite levels when the change in salivary caffeine concentration was taken into account, suggesting that other nutrients in the supplements may have contributed to these neurometabolite changes. Overall, 1H-MRS may be a useful measure to help understand the interactions between diet, neurocognition and neurochemistry.

Neural decoding of visual information varies with fluctuations in global network efficiency

Dr Luca Cocchi, Senior Research Fellow
QIMR Berghofer Medical Research Institute

Background: Functional magnetic resonance imaging (fMRI) studies have shown that neural activity fluctuates spontaneously between different states of global synchronization over a timescale of several seconds. Such fluctuations generate transient states of high and low correlation across distributed cortical areas, resulting in changes in the network's capacity to support parallel transfer of information, and thus its processing efficiency. It has been hypothesized that periods of high global efficiency might facilitate the integration of information by specialised brain areas relative to periods of low network efficiency. Methods: In this talk I will discuss a recent study in which we tested the prediction that ongoing fluctuations of global neural efficiency varies the amount of stimuli-related information stored in specialised brain areas. I will describe how we used a linear decoder to discriminate patterns of neural activity elicited by face and motion stimuli presented periodically while participants underwent time-resolved fMRI. Results: Decoding was reliably higher during states of high global network efficiency than during states of low efficiency, and this difference was evident across both visual and non-visual cortical regions. Conclusions: Our results indicate that slow ongoing fluctuations in global network efficiency are associated with variations in the relative strength of local neural representations of distinct categories of visual stimulus. I will conclude my talk by highlighting the importance of understanding the impact of ongoing, stimuli-unrelated, global neural dynamics on specialised, stimuli-driven, neural processes.

Is reward-based cognition a specific impairment in bipolar disorder? A pilot study using set-shifting

Mr James Collett, Associate Lecturer
RMIT University

A/Prof Conrad Perry, *Swinburne University of Technology*
Prof Greg Murray, *Swinburne University of Technology*

Bipolar disorder is a mood disorder that may be aetiologically related to abnormalities in the behavioural activation system (BAS), a neurobehavioural system manifesting as reward sensitivity. Bipolar disorder is characterised by a range of cognitive deficits, however cognitive deficits are not specific to bipolar disorder. In the present study, it was theorised that cognitive deficits in contexts involving reward stimuli might constitute a more specific impairment in bipolar disorder. Set-shifting, an indicator of cognitive flexibility, was used to test this prediction. A dimensional approach was adopted where a non-psychiatric sample (N = 118) were assessed for trait vulnerability to bipolar disorder using the 7 Up 7 Down Inventory. A contingency-shifting variant of the Iowa Gambling Task (CS-IGT) was used to examine set-shifting in the context of reward stimuli, whilst the Wisconsin Card-Sorting Test (WCST) was used to examine set-shifting with minimal reward cues present. Contrary to predictions, no correlation was found between trait vulnerability to bipolar disorder and either CS-IGT or WCST set-shifting. It is possible that cognitive deficits are largely non-specific across mental disorders, or that set-shifting deficits are a qualitatively distinct characteristic of bipolar disorder that are only testable within a clinical population.

Functional gradients of prefrontal cortex organisation have corresponding oscillatory hierarchies

Mr Patrick Cooper, PhD Student
University of Newcastle

A/Prof Frini Karayanidis, *University of Newcastle*
Prof Francisco Barceló, *University of the Balearic Islands*

Extensive frontal networks enable top-down control over thoughts and behaviours. The prefrontal cortex (PFC) plays a critical role in guiding goal-appropriate behaviour, functioning as a major hub for facilitating higher order cognition. PFC can be functionally divided along a gradient of complexity, where simple, concrete associations are enabled by posterior portions of PFC and abstract, future-oriented goals engage anterior PFC. However, while there is consensus regarding spatial organisation of PFC, the neural mechanisms that support this gradient are incompletely understood. We utilised electroencephalography (EEG) to quantify underlying oscillatory activity as a functional mechanism of PFC engagement. Thirty-one participants completed a series of three top-down control tasks (oddball, go/nogo and switch) while EEG was simultaneously recorded. To recruit PFC hierarchical organisation, identical sets of stimuli were presented across tasks (i.e., matched probabilities/perceptual features) with only task demands differing. That is, we manipulated task rule complexity associated with these stimuli to engage more distinct portions of PFC. Functional mechanisms associated with these tasks were characterised as average power across a broad frequency spectrum (2–30Hz). Our manipulation of hierarchical demands was successful. Simple task rules were performed faster/more accurately than complex task rules. Additionally, tasks that relied on posterior PFC and simple associations utilised lower-frequency power exclusively (i.e., delta, 2–4Hz and theta, 4–8Hz). In contrast, tasks relying on abstract rules (and anterior PFC) were associated with enhancement of these lower frequencies plus higher-frequency responses (i.e., alpha, 8–13Hz). The functional hierarchy of the PFC was found to have a corresponding frequency hierarchy. Top-down control appears to arise from a complex frequency landscape, sensitive to information-processing demands associated with current tasks/goals.

The magical number one-on-square-root-two: the double-target detection deficit in brief visual displays

Dr Elaine Corbett, Research Fellow
University of Melbourne

Prof Philip Smith, *University of Melbourne*

How limited representational capacity is divided when multiple items need to be processed simultaneously is a fundamental question in cognitive psychology. The double target deficit is the finding that, when monitoring multiple locations or information streams for targets, identification of two simultaneous targets is substantially worse than is predicted from the cost of divided attention alone. This finding suggests that targets and nontargets are treated differently by the cognitive system. We investigated the double target deficit in four different visual decision tasks using noisy, backwardly-masked targets presented for a range of exposure durations to test the theory that the deficit reflects a capacity limitation of visual short-term memory (VSTM). We quantified the deficit using a sample-size model of VSTM and two different models of the decision process: a signal detection MAX model and an optimum likelihood ratio model. We found a double target deficit in all four tasks which increased in magnitude for briefer displays. For shorter exposures the deficit was consistent with the capacity limits of VSTM, but for longer exposures it was diminished. We explained the exposure dependency using a competitive interaction model in which non-targets compete for access to VSTM at a slower rate than targets, allowing non-targets access to VSTM only when the exposure duration was sufficiently long. Our findings are supportive of two-stage models of visual search in which the most target-like stimuli are filtered into VSTM before the decision process begins.

The role of relative pitch in the active discrimination of complex sound patterns

Miss Nina Coy, Masters student
Leipzig University

Miss Maria Bader, *Leipzig University*
Prof Erich Schröger, *Leipzig University*
Dr Sabine Grimm, *Leipzig University*

The human auditory system shows the amazing ability to recognise complex auditory regularities even when absolute features undergo variability, such as when a melody is played in different keys. Thus, the melody is an invariant, defined by relative relations of specific auditory stimulus features, i.e. its Gestalt. By analysing behavioural performance and the event-related-potential (ERP), the current study investigated the role of absolute and relative pitch information in the active discrimination of complex melodic patterns. In a roving standard paradigm melodic patterns were presented for a certain number of times until a new pattern was introduced. Patterns within a stimulus train were either repeated identically (absolute repetition), carrying absolute frequency information about the pattern, or shifted in pitch (relative repetition), thus only relative frequency information was available to extract the pattern identity. Results showed that participants were able to use relative pitch to discriminate patterns, though they were less sensitive and took longer to behaviourally react to pattern changes when there was no absolute pitch information. The change-specific MMN-component of the ERP, indexing a sensory memory comparison process, was elicited at approximately 216 ms after stimulus onset at frontocentral electrodes, irrespective of whether patterns were defined by absolute or relative pitch. Increased latencies but no differences in amplitudes of the N2b and P3b suggest that further processing is more demanding when, in the absence of absolute pitch cues, relative pitch has to be extracted. This is in accordance with recent findings on implicit auditory learning processes and suggests that a slowing of target selection rather than a slowing of the auditory change detection process causes the deterioration in behavioural performance in the absence of absolute pitch cues.

Red light reduces parvocellular, but not magnocellular components of non-linear VEP

Prof David Crewther, Professor
Swinburne University of Technology

Ms Laila Hugrass, *Swinburne University of Technology*
Mr Thomas Verhellen, *Swinburne University of Technology*
Ms Caitlin Mallon, *Swinburne University of Technology*
Ms Eleanore Morrall-Earney, *Swinburne University of Technology*

Single cell studies demonstrate suppression of LGN magnocellular neural firing when red light is added to the surround of their receptive fields. Based on such observations, human studies have used red light to suppress contributions magnocellular responses in a variety of psychological tasks, including fearful face processing and reading. However, human studies have not directly addressed whether peripheral red light specifically suppresses M responses. Studies of the Wiener kernel components in non-linear VEP have shown the major components of the second order first slice (K2.1) and second slice (K2.2) waves are generated by the M and P pathways, respectively. Here we use non-linear VEP to investigate the effects of red and green surrounds on K2.1 and K2.2 responses to a central grey patch. Contrary to expectations, there was no effect of red surround on the K2.1 response. However, there was a significant reduction in the amplitude of the major K2.2 response. The effect was greater at high (70%) cf low (10%) luminance contrast, consistent with parvocellular origin. Our findings call into question interpretations of psychological studies that have used red light to isolate the M-pathway. Smaller second order amplitude corresponds to more efficient temporal recovery of the parvocellular system, providing a testable psychophysical prediction.

Do cannabis users show differences in brain activity for risk and reward related processing?

Dr Louise Curley, Lecturer in Pharmacy
The University of Auckland

Ms Carolyn McNabb, *The University of Auckland*
Mr Mohamad Al-Attar, *The University of Auckland*
Ms Phoebe Bint, *The University of Auckland*
Ms Tayla Bowers, *The University of Auckland*
Mr Jordan Hinton, *The University of Auckland*
A/Prof Robert Hester, *University of Melbourne*
A/Prof Bruce Russell, *The University of Otago*
Prof Ian Kirk, *The University of Auckland*
Mr Rohan King,, *The University of Auckland*
Ms Justinn Cochran, *The University of Auckland*

Cannabis is one of the most commonly used illicit substances worldwide and has been associated with deficits in learning, memory and reward-related functioning as well as decision making. However, research on long-term cannabis use and decision making is limited compared to other substances such as alcohol and tobacco. To date, studies investigating brain activity associated with risk-based decision making have not typically dissociated probability of risk from magnitude of reward. In addition, research investigating brain activity based on feedback has been limited. This study aimed to determine if long-term cannabis users show differences in reward related behaviour in comparison to non-users using a novel task (the passive task) and electroencephalography (EEG). The task differentiated risk from magnitude of reward by modulating task difficulty based on speed of response. We were particularly interested in group differences at P300 and feedback related negativity (FRN), as these have been associated with the anticipation and feedback stages of similar tasks.Data were analysed using Brain Vision Analyser software. Data was compared with respect to their P300 and FRN responses at three electrode sites (Fz, Cz and Pz). Reaction time (RT) and ERP data were compared between groups using ANOVA in SPSS. The influence of previous outcomes on future RT was also assessed. Data analysis showed significant main effect differences between trial type and electrode position for both P300 and FRN. In addition, a significant difference ($p<0.05$) between cannabis users and non-users was found at FRN over all outcome types at Fz. No differences were found in RT. Cannabis users in this study demonstrated different patterns of activation related to risk and reward processing compared to non-cannabis-using controls. This finding is in line with previous studies showing that chronic cannabinoid exposure can potentially affect reward related processing.

Neuroimaging white matter in attention/deficit-hyperactivity disorder: understanding impulsivity with diffusion tensor imaging

Miss Fiore D'Aprano, Student
The University of Melbourne/Murdoch Childrens Research Institute

Dr Timothy Silk, *Murdoch Childrens Research Institute*
Ms Sila Genc, *Murdoch Childrens Research Institute*
A/Prof Robert Hester, *The University of Melbourne*

Attention/deficit-hyperactivity disorder (ADHD) is a prominent neurodevelopmental disorder characterised by problems of inattention and hyperactivity/impulsivity that are thought to depend on white-matter connectivity between cortical regions. Given the prevalence and long-term ramifications of ADHD, the current study aims to examine the white-matter microstructure underlying impulsivity-characterising this phenotype categorically and dimensionally in a community-based sample. Using data acquired on a 3T Magnetic Resonance Imaging scanner, Diffusion Tensor Imaging was used to examine white-matter organisation in 47 diagnostically-confirmed children with ADHD, and 59 typically-developing controls, (overall sample mean age = 10.41, standard deviation = 0.47, 74 males). Participants completed a computerised Stop-Signal Task where Stop-Signal Reaction time (SSRT) provided an estimate of impulsivity. Using Tract Based Spatial Statistics, general linear models were tested to examine microstructural organisation and to identify significant clusters where organisation related to SSRT. There were no significant differences between ADHD and controls, or between subtypes in SSRT or microstructural organisation. Dimensionally, greater white-matter microstructural organisation within the body and genu of the corpus callosum was significantly related to inhibitory control, pFWE = .04, but not to symptom severity or subtype. This relationship was not significantly different between ADHD and controls. Further investigation using multiple tests of inhibitory control and optimised assessment of white-matter will inform symptomatology, neuropsychology, heterogeneity, and neurobiology. Overall, this study found that inhibitory control

was linearly related to white-matter organisation, and independent of ADHD diagnosis. This may suggest a dissociation between cognition and behavioural presentation-warranting models addressing aetiological heterogeneity. NHMRC project grant #1065895.

TMS investigation into the role of the left and right dorsolateral prefrontal cortices in control of emotional distraction.

Dr Christel Devue, Teaching Fellow
Victoria University of Wellington

Dr David Carmel, *University of Edinburgh*
Ms Mihaela Taranu, *PLymouth University*
Dr Gina Grimshaw, *Victoria University of Wellington*

Emotional information is important and tends to be prioritised by our attentional system. Sometimes however, it needs to be ignored so that we can focus on our current goals. The Asymmetric Inhibition Model (AIM; Grimshaw & Carmel, 2014) proposes that the control of distraction from positive and negative distraction is lateralised in dorsolateral prefrontal cortices (DLPFC); with the right hemisphere supporting inhibition of positive distractors and the left hemisphere supporting inhibition of negative ones. We tested this assumption by means of theta burst (inhibitory) stimulation on the right and left DLPFC of 18 participants confronted with positive, negative and neutral distractors while they were engaged in a simple visual search task. Based on the AIM, we expected increased distraction by positive stimuli after targeting the right DLPFC and by negative stimuli after stimulating the left DLPFC. Contrary to our predictions, although emotional distractors impaired search performance more than neutral ones, theta burst stimulation over the right or left DLPFC had no significant effect on performance compared with stimulation on a control site (i.e. vertex), and did not significantly decrease performance by comparison with a pre-test baseline condition. We discuss alternative explanations for this null effect.

Effect of maternal immune activation and sex on electrophysiological features related to schizophrenia

Miss Ariel Dunn, PhD Candidate
University of Newcastle

Dr Lauren Harms, *University of Newcastle*
Dr Ross Fulham, *University of Newcastle*
Dr Aaron Wong, *University of Newcastle*
A/Prof Juanita Todd, *University of Newcastle*
Prof Deborah Hodgson, *University of Newcastle*
Prof Ulrich Schall, *University of Newcastle*
Prof Patricia Michie, *University of Newcastle*

Maternal immune activation (MIA) in response to gestational infection is a risk factor for the development of schizophrenia in offspring. Previous studies have shown that MIA in rats and mice, induced by the non-infectious viral mimic Poly(I:C), produces a variety of schizophrenia-like behavioural, cognitive and morphological alterations. However, it was unknown if MIA altered electrophysiology in rats. The current study therefore investigated the impact of MIA on two electrophysiological features altered in schizophrenia, gamma activity and mismatch negativity (MMN). Furthermore, our study investigated these features in both male and female rats. Pregnant Wistar rats were exposed to either Poly(I:C) (MIA) or saline during late gestation (gestation day 19). Offspring underwent surgery in adulthood to implant skull electrodes which were used to assess the neurophysiological phenotypes of gamma activity and MMN. Gamma activity was measured using an auditory steady state response (ASSR) task, while MMN was measured via an oddball and many-standards control paradigm. MIA rats had reduced gamma power ($p = .018$) and phase-locking ($p = .020$) between 30 and 50 Hz. No sex effects were found for gamma activity. MMN-like responses were found and female animals had higher overall responses than males early in the MMN waveform, a novel finding ($p = .029$). No significant treatment effects were found for any MMN component. A multiple hit model of MIA, or a two-hit model of a variety of risk factors will be implemented in the future to investigate more reliable and robust electrophysiological alterations. Our findings of sex differences suggest that animal research should consistently include both sexes to improve the validity of current models of schizophrenia.

On the Capacity Limits of Cognitive Control and its Enhancement: Neural Mechanisms and Transfer

A/Prof Paul Dux,
University of Queensland

The "Information Age" frequently requires individuals to perform multiple decisions concurrently. Under such multitasking conditions, one must invoke cognitive control processes in order to manage capacity limited attentional resources. Of import, many psychiatric and neurological conditions, along with normal ageing, are associated with compromised functional capacity due to impairments in cognitive control (executive function). Here, I will present evidence from a range of cognitive neuroscience methods (e.g., fMRI, EEG, tDCS) to argue that cognitive control limitations occur because frontoparietal and subcortical (FP-SC) brain regions both serve a broad range of mental functions and are limited information processors. In addition, I will show that training improves multitasking ability by segregating tasks representations in FP-SC regions and that brain stimulation can lead to generalised training benefits for decision-making and multitasking by increasing the rate of evidence accumulation. Collectively, the results shed light on the neuro-cognitive mechanisms of cognitive control limitations and those that underlie the enhancement of associated operations.

Using training to modify the neural expectation that sensations follow immediately from actions

Ms Ruth Elijah, PhD/Masters student
UNSW Australia

Dr Mike Le *Pelley, University of New South Wales*
Dr Thomas Whitford, *University of New South Wales*

In order to determine if a sensation is self-generated, the brain employs a prior belief that any resultant sensation should occur immediately after a self-initiated movement. The current study aimed to determine whether this temporal expectation could be modified with repeated exposure to a delayed, self-initiated auditory sensation. Participants underwent electroencephalographic (EEG) recordings while undergoing a task where they pressed a button to produce a tone. The onset of the tone occurred either immediately after the button-press, or after a 100ms delay. Training comprised of repeated exposure to the delayed tone and, as a comparison, repeated exposure to the immediate tone. Pre- and post- training measures of the auditory-evoked response to the tone were assessed to determine the effect of training. In the pre-training phase, delayed tones evoked a larger N1 amplitude, compared to immediate tones. However, across two experiments, it was demonstrated that training to the delayed tone resulted in a reduction in N1 amplitude, such that there was no difference in N1 amplitude post-training between the immediate and delayed tones. This suggests that it is possible to modify the neural assumption that sensations follow immediately from actions.

Attentional enhancement of event-related potentials in a multilingual dichotic listening task

Dr Vivian Eng, Lecturer
School of Psychology, University of Nottingham Malaysia Campus

Mr Alfred Lim, *University of Nottingham Malaysia Campus*
Ms Su Ren *Gan, University of Nottingham Malaysia Campus*
Mr Shamsul Azrin *Jamaluddin, University of Nottingham Malaysia Campus*
Dr Jessica M. *Price, University of Nottingham Malaysia Campus*
Dr Jason Satel, *University of Tasmania*

In the traditional auditory dichotic listening task – designed to investigate selective auditory attention – two different messages are presented to subjects simultaneously and they are instructed to pay attention to one or the other sound source. This task has been extensively investigated, demonstrating that characteristics such as the pitch, rate, direction, and even the gender of the speakers can affect human ability to distinguish between the messages. When the task is performed with electroencephalography, early sensory probe-elicited event-related potentials (ERPs) are enhanced when presented on the same side as the attended stimuli, relative to the unattended side. In this project, we presented participants with two short stories simultaneously – one to each ear – in different languag-

es (English or Mandarin); all participants were fluent in both English and Mandarin. Short comprehension questionnaires were presented after each story and any trials or participants that scored poorly on the comprehension questions were removed. Auditory probes of both languages (congruent and incongruent) were presented at regular intervals during both the attended and unattended stories. These probes were carefully designed to be phonemes distinct to each language exclusively. As expected from previous work, probes of the same language as the presented stimuli (congruent probes) elicited attentional enhancement effects of the early sensory probe-elicited ERPs for attended versus unattended stimuli, regardless of the language of presentation. However, when probes were incongruent (opposite language of the same-side stimuli) there were no attentional enhancement effects on the probe-elicited ERPs. These results suggest that subjects were able to filter probes that did not align with the language of presentation. This work was supported by a Fundamental Research Grant Scheme from the Malaysian Ministry of Education.

Evidence for an effect of stimulus probability in the visual oddball paradigm with Fast Periodic Visual Stimulation

Mr Daniel Feuerriegel, PhD Candidate
University of South Australia

Dr Genevieve Quek, *University of Louvain*

Dr Hannah Keage, *University of South Australia*

Prof Bruno Rossion, *University of Louvain*

The experimental manipulations that produce visual oddball responses in the EEG are currently unresolved. Classical oddball designs confound effects of stimulus repetition and stimulus presentation probability. These designs also require long testing sessions for few useable epochs, limiting sensitivity to identify true effects. To determine the experimental manipulations (stimulus repetition and stimulus probability) that produce visual oddball responses we used a visual oddball paradigm with Fast Periodic Visual Stimulation (FPVS). In the stimulation sequences a single face identity was presented by sinusoidal contrast modulation at a rate of 6Hz (i.e. a base rate of 6 images/second). Every seventh face image (the oddball stimulus) was 20% larger in size and either the same or a different identity compared with the base rate faces. We manipulated whether the identity change was common (90%) or rare (10%) across sequences, throughout which participants monitored a central fixation cross for brief colour changes. EEG responses to each oddball stimulus type were quantified in the time and frequency domains. Larger responses in the frequency domain were evoked by rare compared to common oddballs, the effects of which were largest when there was a face identity change relative to base rate faces. Common/rare comparisons in the time domain showed an occipitotemporal negativity 200-350ms from oddball stimulus onset resembling the visual mismatch negativity (vMMN). EEG habituation occurred across the sequences but did not account for the observed time domain effects. These results indicate an effect of stimulus probability in the visual oddball FPVS paradigm which is modulated by face identity repetition. Our FPVS design shows potential as a shorter and more sensitive design for measuring the vMMN in healthy and clinical samples.

Sex and the City Brain: Rethinking sex, gender and adaptive traits

A/Prof Cordelia Fine, A/Prof
University of Melbourne

To many, including many scientists, to say that a sex difference in human brain and behaviour reflects an evolved adaptation is to set limits on possible future male/female patterns of behaviour, and thus arrangements of social life. Although not always made explicit, a common assumption is that proximal mechanisms of genetic and hormonal sex, ultimately shaped by the differential reproductive challenges of ancestral males and females, create timeless, universal, and immutable sex-specific adaptations of brain and behaviour. In the past few decades, however, there have been major advances and conceptual shifts in evolutionary biologists' conceptualisation of the evolution and development of adaptive behaviour, and in neuroscientists' models and understanding of sexual differentiation of brain and behaviour. Considered together, these conceptual shifts have important and, to date, largely unexplored implications for thinking about sex, brains, and evolution.

Differences in first-impression bias patterns to spatially distinct monaural and binaural sounds

Miss Kaitlin Fitzgerald, PhD (Clinical Psychology) Candidate
University of Newcastle

Dr Alexander Provost, *University of Newcastle*

Professor István Winkler, *Institute of Cognitive Neuroscience and Psychology, Budapest, Hungary*

A/Prof Juanita Todd, *University of Newcastle*

First-impression bias in auditory processing refers to the observation that the initial context in which a sound is encountered has a lasting effect on future processing of that sound. This has been uncovered through modulation of the amplitude of mismatch negativity (MMN) which is elicited to unexpected deviations from established regularities in the environment. Traditional predictive coding accounts suggest that MMN amplitude will faithfully reflect the local probabilities of sounds at any given time, being largest to deviations of the most repetitive sequences. However the bias demonstrates a resistance to re-evaluation of initial tone roles via (1) reduced MMN to an initially repetitive sound when it later becomes deviant, and (2) no effect of sequence stability on MMN following a change from initial tone roles. Whilst widely replicated in pitch and duration processing, the aim of the present study was to investigate this effect in the processing of spatial location. Sixty-two participants were exposed to a variation of the oddball paradigm previously used to show the bias, where two tones alternated in the role of standard and deviant over multiple timescales and event-related potentials were recorded using electroencephalogram (EEG). Sounds differed only on localisation to the left or right of space, and the inter-aural level difference used to create this localisation was manipulated between subjects to give a monaural left-first deviant, monaural right-first deviant and binaural right-first condition. Whilst there was clear replication of both characteristic bias patterns in the binaural group, there were differences in the monaural groups. Patterns were partially present for the monaural group with a left sound as first deviant whilst in the right-first condition they were largely absent. The bias may be an even more complex phenomenon than previously believed, and may depend on the relative activation of afferent pathways from the left and right ears.

A shared autism and schizophrenia spectrum trait phenotype may be marked by increased glutamate/GABA ratio.

Ms Talitha Ford, Ph.D student
Swinburne University of Technology

Prof David Crewther, *Swinburne University of Technology*

Mr Richard Nibbs, *Swinburne University of Technology*

The phenotypes of autism and schizophrenia spectrum disorders are substantially overlapping both in the clinical and non-clinical population. This phenotype has been conceptualised as Social Disorganisation (SD). This study investigates whether differences in the excitatory glutamate to inhibitory alpha-aminobutyric acid (GABA) ratio exist between those with high and low levels of trait SD, as abnormalities in these neurotransmitters have been reported in both autism and schizophrenia. A low (n=18, 10 female) and high (n=19, 9 female) SD scoring group aged 18 to 40 years underwent resting state proton magnetic resonance spectroscopy (1H-MRS) for glutamate and GABA concentrations in a superior temporal cortex (STC) voxel. Reduced right STC GABA concentration ($p= 0.024$) and increased glutamate/GABA ratio ($p= 0.005$) was found for the high SD group; no group difference in left STC voxel was found. Glutamate concentration as significantly increased across the hemisphere ($p= 0.004$), but there was no hemisphere by group interaction ($p= 0.367$). Results suggest excess glutamate to GABA, which may suggest increased excitation to inhibition, as a function of reduced GABA in the right STC for those with high scores on the shared autism and schizophrenia spectrum phenotype, SD. These findings have important implications for future research into autism and schizophrenia spectrum disorders, and bring into focus the importance of recording and reporting non-clinical spectrum traits across experimental groups.

Combinatorial processes of arithmetic and enumeration revealed by subset grouping.

Dr Jason Forte, Senior lecturer
The University of Melbourne

A/Prof Robert Reeve, *The University of Melbourne*

The speed of specifying the number of dots in a display (enumeration) is predictive of the time taken to add numbers (arithmetic). This relationship is the basis for theories about core numerical processes that underlie differences in normal and poor arithmetic abilities. The strength of the arithmetic/enumeration relationship may depend on the degree to which specific arithmetic and enumeration tasks require the same combinatorial processes. Typical random dot displays are unconstrained in the number of subgroups that may be combined to achieve a numerical answer, whereas arithmetic tasks using double single addition are highly constrained - requiring combination of two items. We manipulated enumeration and arithmetic displays to make them equivalent in combinatorial complexity and determine if similar combinatorial processes underlie the arithmetic/enumeration relationship. Sixty undergraduates enumerated sets of dots and added numbers with totals from 1 to 16. Stimulus dots were arranged randomly (unconstrained combination) or grouped into four subsets (quad combination). Addition displays comprised two Arabic numerals (constrained combination) or four Arabic numerals (quad combination). As predicted the correlation between RTs for quad combination arithmetic/enumeration tasks was significantly higher than the correlation between RTs for traditional arithmetic/enumeration tasks. This suggests subset grouping and accrual in enumeration is a similar process to cumulative summation in symbolic arithmetic. Furthermore, systematic patterns of non-linear RTs for quad versions of arithmetic/enumeration task, as function of set size, suggest the numerical similarity of subsets has an important influence on the integration of multiple quantities in computing answers.

Cognitive manipulations change the impact of first-impressions in sequence learning.

Ms Jade Frost, Phd Candidate (Clinical Psychology)
University of Newcastle

Miss Kelly McDonnell, *University of Newcastle*

A/Prof Juanita Todd, *University of Newcastle*

Prof István Winkler, *Research Centre for Natural Sciences, MTA*

First impressions are automatic beliefs that are formed quickly and are resistant to updating even when counter-evidence is available. Remarkably, the brain also forms a first impression bias based on initial exposure to sound information that alters later learning about sound. The brain is effective at using sound patterning to model, and therefore predict, the next most likely sound event given previous experience. The evoked-potential component mismatch-negativity (MMN) is elicited upon detection of any pattern-deviation and reflects a 'prediction-error'. MMN amplitude is proportional to 'certainty' in underlying predictions; MMN is largest when patterns are stable. Using a 'multi-timescale' paradigm, we have shown that MMN does not faithfully reflect sequence stability but instead succumbs to a first-impression bias that is coupled to initial tone roles. In the paradigm participants hear two-tone sequences in which tones alternate roles of standard (p = .875) and deviant (p = .125). In stable sequences, roles alternate every 2.4min (480 tones/block; 420-standard, 60-deviant). In unstable sequences, roles alternate every 0.8min (160 tones/block; 140-standard, 20-deviant). The bias refers to the observation that only MMN in the first stimulus configuration show the expected stability-modulation: stable>unstable. To date all multi-timescale paradigms have been presented while participants have no knowledge of the sequence structure and watch a silent movie. Here we attempted to disrupt the bias by modifying engagement of higher-level brain areas in monitoring longer-term patterns thought to underpin it. The primacy bias pattern did not occur when participants performed a demanding concurrent N-Back task (study-1) or were first informed about the sequence structure (study-2) before watching a silent movie. Our results are interpreted as evidence that engagement of higher-order brain areas is required to make predictions about patterning over longer timescales.

Modulation of spontaneous eye blinks during the stop-signal task

Dr Ross Fulham, Research Officer
The University of Newcastle

Mr Patrick Skippen, *The University of Newcastle*

Ms Kristee Jobson, *The University of Newcastle*

Prof Patricia Michie, *The University of Newcastle*

A/Prof Frini Karayanidis, *The University of Newcastle*

Unlike reflexive eye blinks, spontaneous eye blinks are triggered rhythmically by a central generator which can be modulated by attentional processes. When participants perform visual tasks, blinks are suppressed immediately before an anticipated visual stimulus and re-emerge approximately 200 ms post-stimulus. Here we report novel findings showing modulation of the blink response by both response-elicitation and response-inhibition within the stop-signal paradigm. Within this task, participants must inhibit an ongoing pre-potent motor response when an auditory stop-signal is presented. Eye blinks were monitored in 195 healthy participants (18-25y) taking part in an EEG study within the Age-ility project. On go-trials, blink latency and response latency were largely independent; however there was an enhanced blink response 40 ms after a motor response, which we suggest is associated with triggering of ballistic motor responses. On stop-trials, the auditory stop-signal suppressed blinks during a well-defined 150 ms interval on both stop-success and stop-failure trials. The data are interpreted to (a) suggest the stop process produces global rather than local inhibition; (b) support the primary assumption of the horse-race model of the stop-signal paradigm concerning the independence of the stop and go processes; and (c) provide direct evidence that stop signal reaction time variance is small relative to that of the go-process. Finally, stop-failure trials, but not go-trials, had a bimodal blink distribution following motor responses, possibly due to error monitoring processes. We suggest that the distribution of eye blinks provides novel data which is complementary to the response time distributions and ERP measures which have previously been used to develop cognitive models for this task.

Feedback loops in detecting (un)seen change

Dr Marta Garrido, Group Leader
University of Queensland

Detecting changes in the environment is fundamental for survival, as these may indicate potential rewards or threats. It is unclear, however, the extent to which conscious awareness is necessary for change detection. In this EEG study, we asked whether the awareness of a change was necessary to trigger a prediction error response in the brain. We found that, not only such sensory prediction error is elicited even in the absence of conscious awareness, but also it peaks earlier without than with awareness. Moreover, with Dynamic Causal Modelling, we found that the brain networks underlying unconscious prediction errors engaged forward interactions between visual cortex, inferior temporal gyrus, and prefrontal cortex. Conscious prediction errors on the other hand, engaged feedback loops amongst these regions, with a specific top-down connection between prefrontal cortex and the middle temporal complex. Our findings demonstrate that unseen changes evoke prediction errors and provide a mechanistic explanation for how these might be generated in the brain. In addition, we show further empirical support for the notion of pre-attentive predictive coding mechanisms in the brain.

Characteristics and differences of somatosensory impairment post-stroke based on lesioned hemisphere.

Dr Peter Goodin, Research Officer
Florey Institute of Neuroscience and Mental Health

Ms Gemma Lamp, *Florey Institute of Neuroscience and Mental Illness*

Dr Rishma Vidyasagar, *Florey Institute of Neuroscience and Mental Illness*

Prof Rudiger Seitz, *University of Dusseldorf*

Prof Leeanne Carey, *Florey Institute of Neuroscience and Mental Illness*

Aim: Impairment in sensation post-stroke is common with estimates ranging between 49 to 80%, however our understanding of the neural networks impacted and associations of severity of sensation impair-

ment are lacking. We aimed to examine changes in functional connectivity post stroke and explore differences in connectivity that may be due to lesioned hemisphere.
Methods: In this study we examined tactile dysfunction using the Tactile Discrimination Test (TDT) and functional connectivity at rest between right handed healthy controls (n=14) and two right handed chronic stroke subgroups - those with lesioning in the left hemisphere (n=14) and those with right hemisphere damage (n=14). BOLD signal from four regions (left / right S1 / S2) was correlated with intrinsic voxel BOLD signal for all participants.
Results: Preliminary analysis showed spatially similar lesioning severity between the two stroke subgroups. Severe tactile dysfunction was observed in the contra-lesional hand. Functional imaging results showed a range of differences between the three groups, including expected intra and inter-hemispheric functional connectivity in contra-lesional region. The left lesioned group showed decreased functional connectivity in bilateral regions of the Dorsal Anterior Network while right lesioned participants showed both decreases and increased in functional connectivity in areas of the right Fronto-Parietal Network.
Discussion: These results suggest the importance of accounting for lesioned hemisphere when assessing change in functional connectivity linked somatosensory networks. Additionally, these results highlight the potential usefulness of resting state analysis to examine neural correlates of tactile dysfunction post-stroke.

Hierarchical Frequency Tagging reveals neural markers of predictive coding under varying uncertainty

Mr Noam Gordon, PhD student
Monash University

Dr Roger Koenig-Robert, *The University of New South Wales*
A/Prof Jeroen vanBoxtel, *Monash University*
A/Prof Nao Tsuchiya, *Monash University*
Prof Jakob Hohwy, *Monash University*

Understanding the integration of top-down and bottom-up signals is essential for the study of perception. Current accounts of predictive coding describe this in terms of the interaction between state units encoding expectations or predictions, and error units encoding prediction error. However, direct neural evidence for such interactions has not been well established. To achieve this, we combined EEG methods that preferentially tag different levels in the visual hierarchy: Steady State Visual Evoked Potential (SSVEP at 10Hz, tracking bottom-up signals) and Semantic Wavelet-Induced Frequency Tagging (SWIFT at 1.3Hz tracking top-down signals). Importantly, we examined intermodulation components (IM) as a measure of integration between these signals. To examine the influence of predictions on the nature of such integration, we constructed 50-second movie streams using house and face images and modulated expectation levels for upcoming stimuli by varying the proportion of images presented in each trial. We found SWIFT, SSVEP and IM signals to differ in important ways. SSVEP was strongest over occipital electrodes and wasn't modified by certainty. Conversely, SWIFT signals were evident over temporo- and parieto-occipital areas and decreased with increasing certainty levels. Finally, IM components were evident over occipital electrodes and increased as a function of certainty. These results link SSVEP, SWIFT and IM signals to sensory evidence, predictions, prediction errors and hypothesis-testing- the core elements of predictive coding. These findings provide neural evidence for the integration of top-down and bottom-up information in perception, opening new avenues to studying such interactions in perception while constraining neuronal models of predictive coding.

Neural correlates of filling-in using steady state visual evoked potentials (SSVEP)

Ms Irene Graafsma, Master Student
Monash University

Dr Matthew Davidson, *Monash University*
A/Prof Naotsugu Tsuchiya, *Monash University*
A/Prof Jeroen van *Boxtel, Monash University*

In perceptual filling-in phenomena, a peripheral target disappears from conscious awareness and is replaced by the surrounding image texture. Despite such disappearance phenomena having been studied using psychophysics, single unit neural recordings and imaging, the underlying, system-level neural mechanisms remain largely unknown. Here we used the Steady State Visually Evoked Potential (SSVEP) and whole head Electroencephalography (EEG) to understand the temporal dynamics of these perceptual experiences. We investigated the spatio-temporal changes in frequency tagged activity during perceptual disappearance and reappearance, focusing on the interactions between targets and their surrounds. We compared these changes to those induced by the physical disappearance and reappearance of the same targets. Twenty-nine participants tracked the visibility of four targets simultaneously, presented on a 20Hz flickering background. Interestingly, targets simultaneously disappeared more frequently than would be expected based on reshuffled data, implying that the neural representations of separate targets and/or their surrounding background may interact over relatively long distances. Indicative of this target/background interaction, we found that the 20Hz SSVEP power of the frequency tagged background increased significantly during filling-in, and that this increase became larger as more targets disappeared. By contrast, physical target disappearances showed the opposite trend, as 20Hz power decreased over occipital sites. This trend implies that the 20Hz SSVEP may emerge in middle visual areas, similar to what has been reported for areas V3/V4 in previous fMRI studies. Our results suggest that distinct long-range neural mechanisms may operate under perceptual and physical disappearances, providing an avenue for future research.

Minimally-invasive intracranial electrodes for brain-computer interfaces

Mr David Grayden, Professor
The University of Melbourne

Brain-machine interfaces enable control of prostheses for people with spinal cord injury, loss of limb and other movement disorders. Many sophisticated prostheses have been developed that provide many degrees-of-freedom of operation. However, to provide adequate input to these systems has so far required direct implantation of electrodes into the brain via open craniotomy. We have developed a passive stent-electrode recording array, called the "Stentrode", that provides a minimally invasive approach that avoids brain trauma by placing the electrodes within a blood vessel in the brain. We have so far demonstrated feasibility of chronically recording brain activity from within veins for up to 190 days in pre-clinical trials, and are now gearing up for human trials by early 2018. The Stentrode may also have application for other neurological conditions.

Beyond brain decoding: Searching for information in the brain that also predicts behaviour

Mr Tijl Grootswagers, PHD Candidate
Macquarie University

Dr Radoslaw Cichy, *Free University Berlin*
Dr Thomas Carlson, *University of Sydney*

An implicit assumption often made in the interpretation of brain decoding studies is that if information is decodable from a brain region, then the brain is using this information for behaviour (but see Williams et al., 2007). In the present study, we sought to study the dissociation between "decodability" and neural correlates of behaviour. This was achieved by constructing spatially unbiased maps of where decodable information relates to behaviour.

We used a support vector machine classifier and searchlight analysis to first identify regions of the brain that could decode whether visually presented objects were animate or inanimate from two fMRI datasets (n=16 and n=15) that used (92/118) different stimuli. A second searchlight analysis was then performed on the same data, where the distance of individual exemplars to the decision hyperplane in each voxel sphere was correlated to human reaction times (RT) on an animacy yes/no categorisation task (n=50, collected on Amazon's Mechanical Turk). The decoding and RT-searchlight maps were tested for significance at the group level.
In both datasets, we found decodable information along the entire ventral-temporal pathway. Regions that also correlated with RT behaviour were however restricted to inferior temporal cortex (ITC). These results support ITC's important role in object categorisation behaviour, consistent with previous region-of-interest based findings (Carlson et al., 2014). Our results further show that our behavioural RT-searchlight method complements standard searchlight decoding analyses by differentiating between information that is merely decodable, and information that is more directly related to behaviour.

Cerebral compensation during motor function in individuals with cerebellar degeneration

Dr Ian Harding, Research Fellow
Monash University

Dr Ian Harding, *Monash University*
Dr Louise Corben, *Murdoch Childrens Research Institute*
Prof Elsdon Storey, *Monash University*
Prof Gary Egan, *Monash University*
Ms Monique Stagnitti, *Monash University*
Prof Martin Delatycki, *Murdoch Childrens Research Institute*
Prof Nellie Georgiou-Karistianis, *Monash University*

Motor planning, execution, and coordination rely on neural activity within interconnected regions of the cerebellum and cerebrum. Degeneration of the cerebellum, such as in Friedreich ataxia (FRDA), results in profound motor impairments. However, the impact of cerebellar damage on movement-related cerebral function remains unclear.
In this study, 25 individuals with FRDA and 33 healthy controls performed two finger tapping tasks concurrent with whole-brain fMRI. Self-paced uncued tapping involved tapping the index finger to the thumb at a rate trained prior to scanning. During unpredictable cued tapping, visual cues indicated a required tap of the index, middle, ring, or little finger with the thumb. Each task consisted of four tapping blocks of 24s, interleaved with 16s rests.
During self-paced finger tapping, cerebral hyperactivation in individuals with FRDA at the lower end of clinical severity and cerebral hypoactivation in those more severely affected was observed in premotor/ventral attention brain regions, including the supplementary motor area and anterior insula. Greater activation in this network also correlated with greater offline motor precision. This pattern of results is consistent with capacity-limited neural reserve, whereby mechanisms of functional compensation may operate early in the course of disease, but fall away with continued progression.
Cued finger tapping was also associated with cerebral hyperactivation, but in this case within dorsolateral prefrontal regions of the executive control network and superior parietal regions of the dorsal attention system. Poorer offline motor precision correlated with greater dorsal attention activations. These findings suggest that individuals with greater motor deficits may employ alternative task strategies that rely on higher-order brain regions.
These findings together provide evidence of compensatory cerebral function during movement generation in individuals with cerebellar damage.

Structural networks associated with rhythmic motor control and temporal prediction: An individual differences approach.

Dr Bronson Harry, Post Doctoral Fellow
MARCS Institute

Prof Peter Keller, *MARCS Institute*

Human interaction often involves the rhythmic coordination of actions across multiple individuals, such as in ensemble musical performance. According to the adaptation and anticipation model (ADAM), stable sensorimotor synchronization (SMS) relies on two processes; adaptive mechanisms that correct for asynchronies in a reactive manner, and predictive mechanisms that estimate the timing of upcoming actions via internal simulations. The present study examined the brain networks associated with adaptive and anticipatory processes with diffusion tensor imaging (DTI) and Tract Based Spatial Statistics (TBSS). To quantify adaptive and anticipatory mechanisms, we fitted a computational implementation of ADAM to data collected from two SMS tasks. Estimates of adaptation were derived from a SMS task involving an adaptive virtual partner, wherein participants drummed in synchrony with an adaptive metronome that implemented varying levels of phase correction. Estimates of anticipation were derived from a task in which participants drummed in synchrony with sequences with constantly varying tempo. Differences in adaptive and anticipatory parameters were correlated with differences in factional anisotropy derived from diffusion tensor modeling. TBSS revealed a positive correlation between adaptation and FA in the arcuate fasciculus, suggesting that simple sensorimotor synchronization relies on white matter pathways mediating the coupling of auditory and motor cortices. Anticipation demonstrated a negative correlation with FA in the posterior corpus callosum corresponding to tracts connecting the temporal lobes bilaterally. This latter finding mirrors recent evidence that adaptation to meter changes in SMS tasks correlates negatively with FA in posterior corpus callosum. Taken together, the present findings suggest that processing of meter and aperiodic predictable sequences rely on communication between bilateral temporal lobes.

Dynamic brain modular architectures supporting higher cognition

Mr Luke Hearne, PhD Student
Queensland Brain Institute

Background: Our capacity for higher cognitive reasoning allows us to understand abstract ideas and solve complex problems. Previous fMRI studies have shown that reasoning performance is positively correlated with task-induced neural activity in segregated functional networks (Gray et al., 2003). More recently, it has been proposed that widespread neural networks can rapidly and flexibly reconfigure their patterns of functional connectivity in response to complex cognitive tasks (Braun et al., 2015), but the importance of these dynamic reconfigurations in network topology for reasoning abilities is unclear. In this talk I will present a study where we assessed the hypothetical link between neural network reconfiguration and reasoning performance. Methods: We collected functional MRI (fMRI) data using a 7T MR scanner while 50 individuals completed a non-verbal reasoning task, akin to Sudoku, at three discrete levels of reasoning difficulty (The Latin Square Task, Birney et al., 2006). To assess reconfigurations in modular architectures, resting state acquisitions were completed both before and after the task. Results: Reasoning task performance was characterized by the fusion of visual, subcortical and fronto-parietal modules. We found that these modular changes were coupled with changes in network efficiency. Conclusions: Our results suggest that the modular architecture of the human brain can be rapidly renegotiated in response to task demand, moreover, the subsequent changes in network efficiency were related to individual differences in reasoning performance.

Interlimb generalisation of Bayesian sensorimotor learning occurs in extrinsic coordinates

Mr Christopher Hewitson, Masters Student
Macquarie University

A/Prof Paul Sowman, *Macquarie University*
Dr David Kaplan, *Macquarie University*

An emerging paradigm shift is currently underway in neuroscience involving the modelling of neural systems using the mathematical framework of Bayesian decision theory, and more significantly, treatment of the brain itself as a Bayesian machine. Recent work suggests that the brain represents probability distributions and performs Bayesian integration during sensorimotor learning, but the evidence remains inconclusive. In this study, we provide additional behavioural evidence concerning the representation of Bayesian sensorimotor learning. Using a novel variation of an interlimb generalisation paradigm involving a stochastic visuomotor perturbation (i.e., a distribution of visuomotor shifts with a fixed mean and variance), in which visual uncertainty about the shift was manipulated, we tested whether Bayesian integration occurs during sensorimotor learning and transfers to the other limb. Relatedly, we tested whether the representation of this learned visuomotor perturbation is encoded in an extrinsic or intrinsic reference frame. We found that learning transfers from one limb to the other only when the visuomotor perturbation is congruent in extrinsic coordinates. We also found that although the learned prior distribution transfers relatively rapidly to the untrained limb, information about visual uncertainty (the likelihood distribution) does not, indicating that the prior and likelihood are represented independently of one another. This study provides valuable information about the nature of the representations underlying Bayesian integration in sensorimotor learning and opens up intriguing paths for future investigation.

Non-linear VEP analysis of orientation selective surround suppression

Ms Laila Hugrass, Research Associate
Swinburne University of Technology

Prof David Crewther, *Swinburne University of Technology*
Mr Thomas Pham, *Student of Swinburne University*
Mr Nathan Ferrer, *Student of Swinburne University*
Ms Viola Putri Permadi, *Student of Swinburne University*

The response of visual neurons can be suppressed by surrounding stimuli that fall outside of their classical receptive field. Suppression is stronger when the central and surrounding stimuli share similar features, such as orientation. Primate neurophysiological studies have shown that extra-classical surround suppression occurs for magnocellular (M) but not parvocellular (P) cells in the retina and LGN. Contributions from the M and P visual pathways in humans can be investigated noninvasively, with studies of contrast response functions demonstrating the first major K2.1 component and the second major K2.2 component are likely to be of M and P origins, respectively. Here we used non-linear VEP to compare the effects of parallel and orthogonal surrounds on responses to a central, contrast-reversing grating. To further investigate the origins of the K2.1 and K2.2 components, we recorded responses at both low (0.5 cpd) and high (3 cpd) spatial frequencies. Consistent with a magnocellular origin, we observed orientation-specific surround suppression (OSSS) in the first component of the K2.1 response, at low but not high spatial frequency. No OSSS was observed in the second major component of K2.2 response, however consistent with a parvocellular origin, the amplitude was greatly reduced at low spatial frequency. To our knowledge, this is the first study to use non-linear VEP to separate the M and P pathway contributions to OSSS.

Distinct cortical contributions to recent and remote autobiographical memory retrieval - a longitudinal neuroimaging study in dementia

Dr Muireann Irish, Senior Research Fellow
University of New South Wales

Dr Ramon Landin-Romero, *Neuroscience Research Australia*
Ms Annu Mothakunnel, *Neuroscience Research Australia*
Dr Sharpley Hsieh, *Brain and Mind Research Centre*
Prof John Hodges, *Neuroscience Research Australia*
A/Prof Olivier Piguet, *Neuroscience Research Australia*

Compromised autobiographical memory (ABM) retrieval is well established in dementia, attributable to degeneration of a core memory brain network. It remains unclear, however, how the progressive spread of atrophy through large-scale functional brain networks with advancing disease severity impacts ABM retrieval across life epochs. To this end, we conducted a longitudinal study of recent and remote ABM using the Autobiographical Interview in Alzheimer's disease (n=11) and frontotemporal dementia (n=13), and contrasted their performance with healthy older Controls (n=23). Patients were re-assessed approximately one year following their initial visit and underwent repeat ABM testing and structural brain imaging. Linear mixed modelling neuroimaging analyses were used to explore disease-specific cortical changes driving ABM alterations over time. At baseline, ABM was globally impaired in Alzheimer's disease relative to Controls, with no evidence of significant deterioration at follow-up. Notably, however, cortical thinning of lateral temporal regions was associated with memory performance at follow-up in Alzheimer's disease. This association was further qualified on the behavioural level by robust correlations between semantic processing and ABM integrity at follow-up. In contrast, frontotemporal dementia patients demonstrated relatively preserved recent memory at baseline in the context of impaired remote memory. At follow-up, however, recent memories were disproportionately disrupted in the frontotemporal dementia group, attributable to cortical thinning in posterior brain regions, including the lingual gyrus bilaterally and right posterior cingulate cortex/precuneus. Our findings offer new insights regarding the potential time-specific role of discrete cortical regions in modulating recent and remote ABM retrieval and provide novel evidence regarding the fate of personally salient memories with disease progression in dementia.

Nice and Slow: Measuring the sensitivity and aesthetic preference of naturalistic stimuli varying in their amplitude spectra in space and time

Ms Zoey Isherwood, PhD Candidate
UNSW Australia

Prof Colin Clifford, *University of New South Wales*
A/Prof Branka Spehar, *University of New South Wales*

Background: The 1/f^a amplitude spectrum is a statistical property of natural scenes characterising a specific distribution of spatial and temporal frequencies and their associated luminance intensities. This property has been studied extensively in the spatial domain whereby sensitivity and aesthetic preference overlap and peak for slopes within the natural range (a=1.2). However, little is known about sensitivity and aesthetic preference to these statistical properties in the temporal domain. It is unknown whether sensitivity and aesthetic preference would be highest in response to a natural distribution of temporal frequencies (a=1.2), and whether they closely match across a range of slopes. Methods: To address this, a 4AFC task was used to measure sensitivity and a 2AFC task was used to measure aesthetic preference across a wide range of spatial (0.25, 1.25, 2.25) and temporal slopes (0.25, 0.75, 1.25, 1.75, 2.25). Stimuli with shallow temporal slopes move rapidly (i.e. 0.25), whereas stimuli with steep slopes move slowly (i.e. 2.25). Results: In both tasks, a significant effect was found for temporal slope variations, however the effect of spatial slope was non significant. Interestingly, sensitivity and aesthetic preference did not closely overlap. Sensitivity was highest for the most natural temporal slope in our stimulus set (1.25), however preference was highest for a temporal slope of 2.25. Discussion: While the sensitivity of the visual system is highest for our intermediate speed stimulus (1.25), which is most abundant in nature, the slowest moving stimulus (2.25) seemed most preferred. A potential reason for these results might be related to the significance of these signals in evolutionary terms. Consider the cases of waves slowly vs. rapidly crashing on a beach or fast vs. slow animals. In both instances the slowest option is often the safest and preferential, which may be the reason for this deviation in sensitivity and aesthetic preference.

Action- and context-based prediction-error signals interact at the P3

Dr Bradley N. Jack, Postdoctoral Researcher
University of New South Wales
Dr Mike E. Le Pelley, *University of New South Wales*
Dr Oren Griffiths, *University of New South Wales*
Dr David Luque, *University of New South Wales*
Dr Thomas J. Whitford, *University of New South Wales*

The human brain makes predictions about upcoming sensory input in at least two ways. First, it predicts sensations that result from actions producing them: Self-generated sounds elicit smaller neural responses than externally-generated sounds. Second, it predicts sensations based on past experience and context: Frequent sounds elicit smaller neural responses than infrequent sounds. The theory is that predictions prepare sensory and associative cortices to receive and 'explain away' sensory input, meaning that less cortical activation is required to process predicted sounds than mispredicted/unpredicted sounds; that is, sounds that elicit prediction-error. We set out to study the relationship between brain signatures of action- and context-based prediction-errors by measuring event-related-potentials (ERPs) to sounds that orthogonally varied in production (self- vs. externally-generated) and probability (frequent vs. infrequent). Consistent with previous research, we found that the N1 indexed action-based prediction-error signals and that the mismatch negativity (MMN) indexed context-based prediction-error signals. At the P3, we found that action- and context-based prediction-error signals interacted: Self-generated, infrequent sounds elicited the P3 whereas externally-generated, infrequent sounds did not. Using standardized low-resolution brain electromagnetic tomography (sLORETA), we found that the action- and context-based prediction-error signals at the P3 originated in the right frontal lobe and in the left parietal and temporal lobes, respectively. These results show that, although action- and context-based prediction-error signals interacted during the time range of the P3, they have discrete neural sources. We conclude that prediction and prediction-error signals are the common computational principles underlying action and perception.

Indexing Vascular Cognitive Impairment in the older population using event-related potentials

Dr Hannah Keage, Senior Lecturer
University of South Australia

Miss Danielle Greaves, *University of South Australia*
Miss Emma Tregoweth, *University of South Australia*
Mr Daniel Feuerriegel, *University of South Australia*
Dr Ashleigh Smith, *University of South Australia*

Vascular disease is the primary modifiable risk factor for late-life dementia. A current focus is understanding the clinical trajectory of cognitive impairment with a vascular origin: from no impairment, to Vascular Cognitive Impairment No Dementia (VCIND), a form of Mild Cognitive Impairment, to dementia. This study aimed to investigate cross-sectional associations between cardiovascular risk burden, cognitive performance (Addenbrooke's Cognitive Examination/ACE-III) and ERPs during an executive function task. A total of n=77 (56% female) adults between 50 and 80 years of age completed a graded difficulty n-back task – 0, 1 and 2-back – from which ERPs were calculated. Cardiovascular risk was characterised using multiple standardised tools: Exercise and Sports Science Australia Pre-exercise, Framingham, and Cardiovascular Risk Factors Aging and Incidence of Dementia (CAIDE). Mixed-effects modelling showed that the early P1 and N1 components were not associated with cardiovascular risk burden. The P3 component was significantly attenuated in those with high cardiovascular risk across all difficulty levels (i.e. no interaction between cardiovascular risk and difficulty). Increasing age and a lower ACE-III score also predicted attenuated P3 responses, with smaller effect sizes than cardiovascular risk. A significant interaction between ACE-III and cardiovascular risk burden showed that increased risk associated with attenuated P3 amplitudes more so for those with better cognitive performance; in fact, there was no relationship in those under the Mild Cognitive Impairment threshold. Findings indicate that cardiovascular disease and risk factors are independently associated with attenuated P3 responses recorded during an executive function task, a domain known to be first affected in VCIND. This relationship was most pronounced in those with pre-clinical impairment, the period in which we to need to implement and track preventative interventions for dementia.

Don't get too excited: Higher levels of visual cortex excitability predict smaller visual working memory capacities

Miss Rebecca Keogh, Post-doctoral Researcher
University of New South Wales

A/Prof Dr Joel *Pearson, University of New South Wales*

Despite the rich detailed sensation many of us feel when remembering visual scenes, our visual memory is severely limited, with individuals only being able to remember, on average, 3 items, however these estimates vary considerably with individual capacity limits ranging from 1-5 items. Exactly what drives these individual differences in visual working memory (VWM) capacity at a neuronal level remains unknown. Recent neuroimaging research has indicated that the early visual areas are used to hold low-level sensory information in mind when completing VWM tasks. Conversely, higher-level regions, such as the frontal and parietal areas, are thought to be involved in general task demands rather than representing low-level visual information in mind. Most research into individual differences in VWM has assessed high-level attentional cognition. Here we aimed to investigate how individual differences in the functionality of low-level visual areas might also drive the widely observed differences in VWM capacity limits. To do this we first measured the levels of visual cortex excitability (using magnetically induced phosphene thresholds (TMS)) and correlated this with an individual's VWM capacity. We found there was a negative correlation between visual cortex excitability and an individual's VWM capacity; that is the less excitable an individual's visual cortex was, the more items they could hold in mind. Next we manipulated the excitability of visual cortex using anodal and cathodal transcranial direct current stimulation (tDCS). We found that increasing visual cortex excitability (anodal tDCS) resulted in poorer performance on the VWM task, whereas cathodal stimulation resulted in a slight increase in performance. These findings provide both correlational and causal evidence that the excitability levels of the visual cortex may regulate the number and quality of items an individual can hold in mind.

Posterior parietal cortex, where working memory meets selective attention.

Mr Mojtaba Kermani, PhD student
University of Melbourne

Dr Ekaterina Levichkina, *University of Melbourne*
Dr Yuri B *Saalmann, University of Wisconsin, Madison, USA*
Prof Trichur R *Vidyasagar, University of Melbourne*

How the brain selectively attends to an object or a feature in the visual scene has been of much interest to psychologists and physiologists alike. The Guided Search model, inspired by early psychological studies proposes a first parallel stage that selects salient target locations and maintains a working memory buffer to drive a second stage that processes signals from these locations serially using a roving 'spotlight of attention'. How such temporarily stored information is transferred to attention-related cells is poorly understood.
We previously reported that when a monkey selectively attends to a location, neural activities between the lateral intraparietal area (LIP) within the PPC and an earlier visual area (area MT) become synchronized, with enhanced activity in some (AE+) neurons in LIP providing top-down modulating signals to enable focal attention.
We analysed local field potentials (LFPs) in LIP of 2 macaques during an attention-demanding, delayed match-to-sample task. Monkeys were briefly (100ms) presented with two consecutive grating patches, with a 800ms interval and had to match their orientation and location.
We found a subset of LIP neurons (AE- cells) that showed poor attentional enhancement, but significant feature selectivity. Time-frequency spectral analysis of LFP signals at these sites in frequency bands relating to feature discrimination revealed spectral power peaking 50 msec after offset of the first stimulus and remaining high during the delay. This suggests a working memory role for AE- cells. On the other hand, spectral power at sites close to the AE+ cells show delay period activity only towards the end of the delay and for 200-300 msec before the onset of the second stimulus, which could contribute to the attentional enhancement seen in LIP and in MT. The results suggest that LIP may be the site where salient spatial locations are selected for further processing, based upon feature information kept in a working memory buffer.

See me, feel me: Do bodily-self cues affect visual-tactile asynchrony detection?

Mr Robert Keys, Graduate Student
Macquarie University

A/Prof Anina Rich, *Macquarie University,*
Dr Regine Zopf, *Macquarie University,*

Bodily-self perception is essential for interacting with our environments, and successfully tracking our own bodies. Research into this area has implications for our understanding of multisensory processes, and clinical populations, such as schizophrenia and autism spectrum disorders, who have altered experiences of the bodily-self. Bodily-self perception relies on multisensory cues, such as the plausibility of viewed body form and orientation, as well as spatially and temporally congruent multisensory inputs. Previous research shows that particular bodily-self cues influence spatial aspects of visual-tactile processing. These cues can also modulate the temporal processing of visual-proprioceptive information - for example, individuals are more sensitive to asynchronies between seen and felt movements when viewing a plausible hand orientation. One hypothesis for this interaction is that bodily-self cues directly modulate multisensory processing, and that bodily-self cues have a general effect on multisensory temporal processing. Here, we investigated whether this temporal modulation in own-body contexts occurs for visual-tactile perception. In two experiments, we manipulated bodily-self cues (viewed hand orientation and multisensory synchrony) and employed a two-interval forced-choice task to measure asynchrony detection thresholds. Participants detected asynchronies between an LED flash and a tap on the middle finger. We used Bayesian analyses to test evidence for the hypothesis that plausible bodily-self cues increase the sensitivity for visual-tactile asynchrony judgments, compared to implausible cues. Calculations of the Bayes factor were all < 1/3, strongly suggesting that bodily-self cues do not affect visual-tactile temporal accuracy. This indicates that bodily-self cues do not lead to a general improvement in multisensory temporal processing, and that previously found effects might be particular to movement and spatial processing.

Delusions and conspiracy theories: cognitive neuroscience meets corpus analysis

Dr Colin Klein,
Macquarie University

Conspiracy theorists are often compared to patients who suffer from clinical delusions. Conspiracy theorizing does seem to involve serious breakdowns in rationality. Yet it is not obvious that conspiracy theorists form a homogenous group, and selection bias may ensure that we encounter only the most committed and least socially adept conspiracy theorists. We attempt to get a more nuanced picture by looking at a large sample of comments from the conspiracy forums at reddit.com. Using a combination of network analysis and topic modelling, we explore similarities and differences between conspiracy theorists of various stripes, showing (among other things) the unexpectedly high numbers of casual conspiracy theorists, the persistent role of racism in generating and maintaining conspiracy theories, and the differing epistemic concerns, motivations, and doxastic attitudes between enthusiastic and casual conspiracy theorists. "

Decoding the nonconscious dynamics of thought generation

Dr Roger Koenig, Postdoctoral fellow
University of New South Wales

Dr Joel Pearson, *University of New South Wales*

Much of economics, psychology and neuroscience have focused on thought dynamics and how they control our behavior, from individual moral choices to the irrationality of market dynamics. However, how much of our thoughts we actually control when we feel we make deliberate choices remains unknown. Here we show that the content of thoughts can be decoded from activity patterns as early as 11 seconds before individuals report having made the volitional thought. Participants freely chose which of two differently oriented and colored patterns to think about visually. Using functional magnetic resonance imaging and pattern classification methods we consistently classified the contents of thoughts using activity patterns recorded before and after the thought was reported. We found that activity patterns were predictive as far as 11 seconds before the conscious thought, in visual, frontal and subcortical areas. These predictive patterns contained similar information to the responses evoked by unattended perceptual gratings and were evident in individual visual areas. Interestingly, neural information present before the decision was associated with the vividness of future thoughts, suggesting that preceding nonconscious sensory-like representations can impact the content and strength of future conscious thoughts. Our results suggest that thoughts and their strength, can be biased by spontaneous nonconscious perception-like representations, advancing theories of free will and models of intrusive and repetitive thought production.

Meta-analysis of touch studies reveals laterality effects in activation of secondary somatosensory cortices

Ms Gemma Lamp, Research Officer
Florey Institute of Neuroscience and Mental Health

Dr Peter Goodin, *Florey Institute of Neuroscience and Mental Health*
Dr Susan Palmer, *Florey Institute of Neuroscience and Mental Health*
Ms Essie Low, *La Trobe University*
Dr Ayla Barutchu, *University of Oxford*
Prof Leeanne Carey, *La Trobe University*

Brain regions involved in processing somatosensory information have been well documented through lesion, animal and more recently, neuroimaging studies. While functional neuroimaging studies characterise responses related to somatosensory processing, a synthesis of this knowledge is currently lacking. Further in-depth knowledge of the regions involved in somatosensory-related tasks may also be confounded by motor influences. Our Activation Likelihood Estimate (ALE) meta-analysis sought to quantify brain regions that are involved in the tactile processing of the individual right (RH) and left hands (LH), with the exclusion of motor related activity. The majority of studies (n=36) only measured activation for RH touch stimulation, and these were separated into those which conducted whole brain analyses (n=25) and those which examined specific regions of interest (ROI; n=11). Brain activation associated with RH stimulation (whole brain) studies revealed large clusters in left somatosensory area one (S1) and bilaterally in somatosensory area two (S2), in addition to the left insula and anterior cingulate. Comparison between findings from RH whole brain and ROI studies revealed that ROI studies were potentially limited by investigation of activation only in the contralateral (left) hemisphere. In contrast, RH whole brain studies indicate the importance of taking into consideration bilateral activation, particularly in S2. Due to the small number of studies which examined LH stimulation (n=5), preliminary analyses only revealed one small cluster within the right (S2). These findings highlight the importance of S2 activation in touch stimulation, particularly the role of right S2 across both hands. The implications of this lateralised pattern of somatosensory activation for further research and for possible differences in right and left hemispheric stroke lesions are discussed.

Shepard tones test prediction: Amplitude of mismatch negativity is determined by the size of prediction error

Ms Alicia Lawrinson, Honours student
Murdoch University

Dr Urte Roeber, *Murdoch University*

The mismatch negativity (MMN) is an automatic brain response to perceived irregularity in the auditory environment. It is greater negativity in the event-related potential (ERP) occurring approximately 100-250 ms after the onset of an irregular, deviant tone compared to that from identical, standard tones. We aimed to test whether the MMN could occur when the standards changed on every trial in a predictable way and whether the size of the MMN is dependent on the magnitude of difference between the predicted tone and the deviant. We presented 20 participants with discrete Shepard scales created from 12 equally spaced Shepard tones. In half of the blocks, the Shepard scale descended continuously, in the other half it ascended continuously. We then randomly violated the scale with four kinds of deviants. Two had their base frequency between those of the preceding and the next, predicted standard (we call this the PNS condition) with one being farther from the predicted (Dev1) and the other being closer to the predicted (Dev2). The other two had their base frequency between those of the next, predicted standard and the standard after that (we call this the NSA condition), with one being closer to the predicted (Dev3) and the other being farther from it (Dev4). We found larger MMNs to deviants more different from the predicted tone, confirming that prediction is important in generating the MMN. We also unexpectedly found larger PNS MMNs than NSA MMNs, needing further exploration.

Individuals with higher autistic-like traits show reduced face-inversion, but increased car-inversion effects in saccadic choice tasks

Dr Robin Laycock, Lecturer
RMIT University

Ms Kylie P. Wood*, La Trobe Univeristy*
Prof Melvyn A. Goodale*, University of Western Ontario*
Prof Sheila G. Crewther*, La Trobe Univeristy*

Individuals on the autism spectrum are reported to exhibit impairments in face processing, including identity recognition and emotion processing. One aspect of typical face processing reported to be impaired in autism spectrum disorder (ASD) is the face inversion effect in which recognition of inverted faces is more difficult in individuals with normal development, whilst there are usually no inversion effects for other object categories. Although some studies have documented reduced face inversion effects in ASD, this has not been well replicated, with many studies in fact finding the typical inversion effect in ASD populations. We employed a saccadic choice task requiring participants to make a saccade towards one of two pictures of natural scenes containing a target, presented left and right of fixation. Across four tasks, the target to be detected was either a face or a car with the second photo consisting of a neutral distractor picture, with all pictures presented either upright or inverted by 180 degrees, in a factorial design. Two groups of non-clinical participants with either higher or lower levels of autistic-like traits completed the tasks, with saccade onset times directed towards targets compared between groups and task conditions. A three-way

interaction indicated that the high- compared with the low- autistic-trait group demonstrated a reduced inversion effect for faces. Furthermore, whilst the low autistic-trait group revealed no inversion effect for cars, the high autistic trait group demonstrated a small car inversion effect. These results indicate that reduced face inversion effects in individuals with higher autism-like traits may reflect constraints on rapid visual orienting to global information. However, these effects are specific to faces, with saccades towards cars and faces apparently treated in a similar fashion for individuals with higher autism like traits.

Early feedback from frontal to occipito-temporal cortex during visual word recognition

Mr Yu Li, PhD student
Macquarie University

A/Prof Sachiko Kinoshita, *Macquarie University*
A/Prof Paul Sowman, *Macquarie University*
Prof Anne Castles, *Macquarie University*

Previous studies have shown that skilled readers can rapidly differentiate visual words from symbol strings: differences in the evoked responses become apparent by about 200 ms after stimulus onset. A recent MEG study further found that during the very early stages of visual word processing, activity in the left inferior frontal gyrus (left IFG) exerts a stronger top-down influence on the left ventral occipito-temporal cortex (left vOT) for real words than for meaningless symbols (Woodhead et al., 2014). However, questions remain about the nature of this top-down influence, specifically whether it reflects lexical-semantic or phonological effects. The aim of the current study was to shed light on this question using dynamic causal modelling (DCM). Fifteen adults participated in a MEG experiment in which they viewed four types of visual stimulus: real words (RW), pseudowords (PW), consonant strings (CS) and false fonts (FF). Six nodes including bilateral IFG, bilateral vOT and bilateral primary occipital cortex (OCC) were chosen in the DCM analysis. Through the specific contrasts of RW vs PW (lexical-semantic effect), PW vs CS (phonology effect) and CS vs FF (low-level letter effect), we were able to examine the nature of the early top-down influences. The results showed that within 200 ms after stimulus onset, the connection from left IFG to left vOT was stronger for PW than for CS and for RW than for PW, indicating that both lexical-semantic and phonological information are implicated in the top-down influence from the left IFG to left vOT. These results add to our understanding of the nature of high-level feedback effects during the early stages of visual word recognition.

Interpreting the amplitude of auditory signals through visual cues to sound source distance

Mr Sol Libesman, PhD student
University of New South Wales

Dr Thomas Whitford, *University of New South Wales*
Dr Damien Mannion, *University of New South Wales*

Many studies in auditory cognitive neuroscience examine the consequences of variations in the properties of sound waves reaching the ear. However, few studies relate such properties to the physical environment. Here, we consider the implications of the dependence between the amplitude of the signal reaching the ear and the distance between the sound source and the listener. The theory of loudness constancy proposes that the loudness (perceived intensity) of a sound at the ear demonstrates some invariance to this attenuation of sound amplitude over distance. Here, we investigated whether loudness constancy could be generated solely through the presence of visual cues to the distance of the sound source. In a series of three experiments, participants performed a psychophysics task in which they judged the relative loudness of two consecutively-presented pure tones. Delivery of each tone was accompanied by the visual presentation of a computer-generated scene with a frontally-presented loudspeaker at a particular distance (7.5m, 15m, or 30m). Distance was conveyed via various monocular cues. We find that the prediction from loudness constancy, that the point of subjective loudness equality would correspond to different amplitudes for tones perceived as being emitted from sources at different distances, was not supported. Instead, the point of subjective loudness equality was consistent with the amplitude at the ear. Future research is required to clarify the situational factors that control the expression of loudness constancy. Such knowledge is vital to the interpretation of auditory research, particularly in cases where variations in amplitude responses are associated with clinical conditions.

Are cognitive processes facilitated by motor demands?

Mr Magnus Liebherr, PhD - Student
Hochschule Fresenius / University of Duisburg-Essen

Dr Hanna Weiland-Breckle, *University of Cologne*
Prof Tanja Grewe, *University of Applied Sciences*
Prof Petra B. *Schumacher, University of Cologne*

We often walk around when we have to think about something, but suddenly stop when we are confronted with a highly demanding cognitive task, such as calculating 1540*24. While previous neurophysiological research, investigated cognitive (Klimesch, 1999) and motor (Huang et al., 2016) performance separately, findings of combining both are rare. To get a deeper understanding of the influence of motor demands as well as the difficulty of a simultaneously performed cognitive task, we investigated 20 healthy individuals (mean age 24.1 years). Participants had to perform two cognitive tasks with different levels of difficulty (simple: letter-number distinction, complex: vowel/consonant and even/odd number) while sitting and standing on one leg. In addition to behavioral data, we recorded the electroencephalogram from 26Ag/AgCI scalp electrodes. The critical time-windows, predefined by visual inspection, yielded an early (200-300ms, P2) and a later positivity (350-500ms P3). Statistical analysis of the early time window registered a motor x cognition interaction [$F(1,19)=5.83$, $p<0.027$]. Resolution of this interaction revealed an effect of the cognitive task in the one-legged stance motor condition [$F(1,19)=4.32$, $p<0.051$], with a more pronounced positivity for the simple task. No significant differences emerged for the simple motor condition [$F<0.6$]. Analysing the time-window between 350 and 500ms, no interaction was found between motor and cognitive tasks but main effects of the motor task [$F(1,19)=27.09$, $p<0.001$] and a marginal effect of the cognitive task [$F(1,19)=4.12$, $p<0.057$]. While the influence of cognitive task-difficulty (in the P3) is in accordance with previous studies (Kok, 2001), the motor task effect is specific to one-legged stance (cf. no effects for running, Gramann et al., 2010). The motor-cognitive interaction found in P2, leads to the suggestion that the more complex motor task (one-legged stance) facilitates cognitive task performance.

Walking reduces spatial neglect: An eye tracking study

Dr Tobias Loetscher, Senior Lecturer
University of South Australia

A/Prof Andrew Lee, *Flinders University*
Dr Owen Churches, *Flinders University*
A/Prof Celia Chen, *Flinders University*

Background: Spatial neglect is a common consequence of stroke. Neglect behaviour is typically exacerbated by increased task demands. It was thus anticipated that the addition of a secondary task requiring general attention (walking) would worsen performance on tests of spatial neglect. Here, however, we report a patient in whom neglect was considerably reduced when performing a visual search task while walking.
Method: SMI Eye Tracking Glasses were employed to track the eye movements of a 55-year old stroke patient with right brain damage. The patient, who displayed marked signs of left-sided neglect in paper-and-pencil measures, performed a visual search task on a computer screen (single-task) and while walking (dual-task). In the dual-task, the patient was required to detect targets placed along the ward corridors while walking a circular course. In order to assess neglect behaviour, an exploratory quotient was calculated by dividing the number of saccades into the right visual field by the number of saccades into the left visual field. Values > 1 indicate more saccades towards the right side, whereas values of 1 suggest a symmetric exploration of the left and right sides of space.
Results: The exploratory quotients for the computer and walking visual search tasks were 123.4 and 2.1, respectively. The walking quotient was thus more than 60 times smaller than the computer quotient. The much smaller quotient indicates a substantial increase of saccades to the left and, consequently, a significant reduction of neglect behaviour in the dual-task relative to the stationary visual search task.
Conclusions: Contrary to expectations, walking reduced symptoms of spatial neglect. Several explanations for why a presumably more taxing task ameliorated neglect will be discussed. For example, this patient may have suffered from left spatial neglect for near but not far space.

Goal-directed and habit-like modulations of stimulus processing during reinforcement learning

Dr David Luque, Postdoctoral research associate
UNSW Australia

Dr Tom Beesley, *University of New South Wales*
Dr Richard Morris, *University of New South Wales*
Dr Bradley Jack, *University of New South Wales*
Dr Oren Griffiths, *University of New South Wales*
Dr Thomas Whitford, *University of New South Wales*
Dr Mike Le Pelley, *University of New South Wales*

Animals and humans rapidly learn how to act in order to obtain rewards. Such reinforcement learning is supported by two different systems: A goal-directed system which represents outcomes and their values separately, and a habit system which caches the value of the stimulus-response association (S-R). This latter S-R representation leads to fast (but inflexible) responses given detection of the relevant stimulus. Recently, it has been shown that perceptual processing of stimuli predicting reward is automatically prioritized once they are associated with high value rewards, even when rewards are no longer available. It has been proposed that such reward-related modulation of stimulus salience is conceptually similar to an 'attentional habit'. Recording event-related potentials in humans during a reinforcement learning task, we show strong evidence in favor of this hypothesis. Resistance to outcome devaluation (the defining feature of a habit) was shown by the stimulus-locked P1 component (from 130 to 200ms), reflecting activity in the extrastriate visual cortex. Analysis at longer latencies revealed a positive component (corresponding to the P3b, from 550 to 700ms) sensitive to outcome devaluations. Thus, distinct spatio-temporal patterns of brain activity were observed corresponding to goal-directed and habitual values. These results demonstrate that cortical responses to both cached and current reward value occur in the same learning episode, suggesting that reinforcement learning engages both attentional habits and goal-directed processes in parallel.

Motivation enhances suppression of irrelevant emotional distractors.

Ms Amy Maddock, PhD Candidate
Victoria University of Wellington

Prof David Harper, *University of Wellington*
Dr David Carmel, *University of Edinburgh*
Dr Gina Grimshaw, *University of Wellington*

Our attention is biased towards emotional stimuli, which are often useful for survival and reproduction. But sometimes we must ignore emotional things when they are not relevant to current goals. Using effective cognitive control to ignore distractors is cognitively taxing, so we will only exert the extra effort if it seems 'worth it', for example if distractors are frequent and expected, or if we are sufficiently motivated to do so. Motivation reduces distraction from neutral and negative images. However, it is unknown whether motivation can encourage suppression of positive distractors, which are themselves rewarding. To determine how motivation influences suppression of positive, negative and neutral distractors, we had participants complete a simple perceptual task while attempting to ignore centrally-presented, task-irrelevant images, which could be intact or scrambled. Intact images were either positive (erotic scenes), negative (mutilations) or neutral (scenes of people). To elicit motivation, one group received a monetary reward for fast and accurate task performance, while a control group received no performance-based incentive. Overall, both negative and positive images were more distracting than neutral images, as reflected by greater slowing of responses on trials with intact relative to scrambled distractors. Crucially, the greater distraction from emotional images was attenuated in the reward condition – reward reduced distraction from both negative and positive images equally. Despite the rewarding nature of positive images, motivation can help us to ignore positive distractions.

An ERP study investigating memory-theory and predictive-coding of visual mismatch negativity (vMMN)

Ms Alie Male, PhD Candidate
Murdoch University

Dr Urte Roeber, *Murdoch University*
Prof Robert O'Shea, *Murdoch University*

The visual mismatch negativity (vMMN) is a brain signature of pre-attentive change processing usually tested with an oddball task. In the oddball task, there is a regular series of stimuli—standards—and occasionally an irregular stimulus—a deviant. By recording the electroencephalogram (EEG), we typically see greater negativity in response to deviants compared to the standards from about 150 to 400 ms after onset – the vMMN. There are two prominent theories about the vMMN's origin: one is that the series of standards establishes a memory trace and the deviant is different from the memory trace, requiring extra processing. Another is that the series of standards generates a prediction and the deviant yields prediction error, requiring extra processing. To discriminate between these two theories, we presented a series of static Gabor patches (120 ms, ISI: 680 ms), with each new Gabor rotated by 30 degrees from the previous. This continued until interrupted by a deviant rotated by 10, 20, 40, or 50 degrees (i.e., 10 or 20 degrees different from predicted, either less or more). According to memory theory, no vMMN would be expected from this task, because standards change on every trial. According to predictive-coding, a vMMN would be expected from this task, because standards change according to a rule to allow predictions. Preliminary analysis suggests that opposite to our prediction from memory theory we found that deviants less than the predicted orientation yielded different voltages from deviants more than the predicted orientation. We conclude that predictive coding gives a better account of our results than memory theory.

Cognitive remediation improves executive functions, self-regulation and quality of life in residents of a substance use disorder therapeutic community

Ms Ely Marceau, Doctor of Philosophy Candidate (Clinical Psychology)
University of Wollongong

Dr Jamie Berry, *Advanced Neuropsychological Treatment Services*
Ms Joanne Lunn, *We Help Ourselves*
Dr Peter Kelly, *University of Wollongong*
A/Prof Nadia Solowij, *University of Wollongong*

Deficits in executive functions (EFs) are common in substance use disorder (SUD) populations and hinder treatment. Recent research has trialled neuropsychological interventions to remediate EFs. We previously found that 50% of residents in SUD therapeutic communities had been hospitalised for head injuries and this was a significant determinant of cognitive impairment. The current study aimed to establish whether cognitive remediation improves EFs and self-regulation in an ecologically valid sample of residents attending SUD therapeutic community treatment, including those with past head injuries and psychiatric comorbidities. Controlled sequential groups design with all residents (N = 33, all female) receiving treatment as usual (TAU). The first group (n = 16) completed four weeks of cognitive remediation (CR) and the second, TAU only (n = 17). Outcome measures assessed post-intervention included performance-based EFs, Behavior Rating Inventory of Executive Function - Adult Version (BRIEFA), self-regulation and quality of life. CR relative to TAU significantly improved inhibition (Color-Word Interference Test; $F = 4.29$, $p = 0.047$), inventory-based assessment of EFs (BRIEFA Global Executive Composite; $F = 6.38$, $p = 0.017$), impulsivity (Barratt Impulsiveness Scale; $F = 4.61$, $p = 0.040$), self-control (Brief Self-Control Scale; $F = 5.53$, $p = 0.026$) and quality of life (Quality of Life Enjoyment and Satisfaction Questionnaire - Short Form; $F = 7.68$, $p = 0.010$). These findings suggest that CR improves EFs in a heterogeneous sample of residents in therapeutic community SUD treatment. Future research may explore the possibility of tailoring CR interventions for various SUD subgroups.
Funding source: University of Wollongong Faculty of Social Sciences Partnership Grant including contribution by industry partner, We Help Ourselves

How does knowledge affect attentional capture vs. dwelling and awareness? Evidence from EEG and eye movements.

Ms Aimee Martin, PhD student
The University of Queensland

Dr Stefanie Becker, *The University of Queensland*

Attention can be guided by the inherent salience of an object (bottom-up saliency) or the goals of the observer (top-down knowledge). Contrary to the prevalent view that attention is top-down biased to specific feature values (e.g., large, red; feature similarity view), recent studies have shown attention can be biased to relative features of a target in a context-dependent manner (relational tuning). However, previous studies focused mainly on implicit measures of attention (e.g., RTs, eye movements). The aim of the present study is to examine the effects of top-down (relational) tuning on overt (eye movements) and covert attention (N2pc in EEG), as well as awareness. In a visual search task, participants had to find a pre-defined colour target among several non-target items, and ignore an irrelevant distractor. To distinguish feature-specific from relational tuning, the colour of the distractor systematically varied such that it matched either the exact target colour (e.g., bluish green) or its relative colour (e.g., bluest). In two different experiments, attentional capture by the distractor was assessed by eye movements to the distractor or the N2pc in the EEG. To index awareness of the distractor, participants were asked to report its location on a small portion of trials. The eye movement results revealed that target-dissimilar distractors that matched the relative colour of the target (e.g., blue) captured attention and the eyes most strongly, whereas target-similar distractors held attention for longer. The N2pc component mimicked these findings, reflecting more capture by relatively matching distractors, but elongated dwelling on target-similar distractors. Awareness depended both on the initial capture of attention and dwelling on the distractor. This study highlights the importance of the context in determining top-down tuning of attention, which in turn influences orienting of attention, distraction, and our awareness of stimuli in the environment.

Reduced willingness to expend effort for reward in obesity: Link to weight loss outcomes

Ms Fernanda Mata, PhD student
Monash University

Prof Michael Treadway, *Monash University*
Mr Alastair Kwok, *Monash University*
Prof Murat Yucel, *Monash University*
Prof Helen Truby, *Monash University*
Prof Julie Stout, *Monash University*
Prof Antonio Verdejo-Garcia, *Monash University*

Objective: (1) To compare willingness to expend effort for rewards between healthy-weight, overweight and obese young adults; and (2) To examine how individual differences in willingness to expend effort for rewards predict adherence to weight loss treatment. Methods: 73 participants completed the Effort Expenditure for Rewards Task (EEfRT). Of those 73 participants, 42 excess weight young adults took part in a 3-month weight loss treatment after completing the EEfRT. Generalized Estimating Equations (GEE) models were used to compare the healthy-weight, overweight and obese groups in the EEfRT. Logistic regression models, including the proportion of hard-task choices for each reward probability condition as predictors (12, 50 and 88%), were conducted to longitudinally predict attrition inthe treatment. Results: Obese young adults were significantly less willing to expend effort for high magnitude rewards compared to overweight participants ($p=0.05$). Willingness to expend effort for uncertain rewards (50% probability) distinguished between completers and dropouts in the weight loss treatment ($p< 0.02$). Conclusion: Obese young adults, compared to their overweight counterparts, have diminished motivation to expend effort for obtaining high magnitude rewards. Less willingness to expend effort for the most uncertain rewards predicts poor adherence to weight loss treatment.

Necessity tamed: metacognition in the near absence of attention

Mr Julian Matthews, PhD candidate
Monash University

Ms Pia Schröder, *Maastricht University*
Dr Lisandro Kaunitz, *University Of Tokyo*
A/Prof Jeroen van Boxtel, *Monash University*
A/Prof Naotsugu Tsuchiya, *Monash University*

Whether conscious perception requires attention remains a topic of intense debate. Directing the focus of top-down spatial attention to a demanding central task, the dual-task literature has repeatedly demonstrated that the discrimination of certain complex stimuli can be achieved in the near absence of attention while perceptually simpler items are severely impaired. However, it remains unclear whether accurate discrimination of these unattended, complex stimuli is accessible to consciousness or just a product of unconscious processing as in blindsight. We addressed this issue by developing a novel, dual-task paradigm incorporating confidence ratings and an adaptive staircase procedure. With minimal training, subjects achieved equivalent task performance for face-gender discriminations performed under single-task or dual-task conditions. Further to this, gender-discrimination accuracy correlated with trial-by-trial confidence ratings, an indication of above-chance metacognitive accuracy, confirming conscious awareness of gender despite little or no top-down spatial attention. In contrast, the discrimination of simple coloured disks was significantly impaired with metacognitive accuracy dropping to chance even in a partial-report condition. Our findings demonstrate the first evidence that discrimination of face-gender in the near absence of attention is consciously accessible.

Dynamic causal modelling reveals a rapid subcortical route to the amygdala in visual and auditory processing.

Dr Jessica McFayden,
Centre of Advanced Imaging, Brisbane

Background: Since the discovery of a rapid, subcortical pathway from the thalamus to the amygdala in rodents, it has been theorised that a visual equivalent might exist in the human brain. This proposition has been met with much controversy but computational modelling has begun to shed light on the existence and potential functional role of such a pathway. Methods: I will present a series of magnetoencephalography (MEG) studies that employed dynamic causal modelling to investigate how visual (McFadyen et al., in prep, Garvert et al., 2014) and auditory (Garrido et al., 2012) are transmitted along subcortical and cortical pathways to the amygdala. In these studies, participants made gender judgements on emotional and non-emotional faces. In the auditory study, participants also heard expected and unexpected tones. Results: Collectively, these experiments demonstrate the likelihood that a functional subcortical pathway to the amygdala exists in the human brain for both visual and auditory stimuli. Interestingly, the results suggest that this pathway is extremely rapid but does not filter information for specific features such as emotional content, spatial frequency, or expectancy. Conclusion: In summary, this evidence suggests that the subcortical pathway likely plays a generalised role in providing the amygdala with sensory input as early as possible. This pathway also likely operates in conjunction with multiple parallel cortical pathways for processing biologically-relevant stimuli.

Rapid adjustments of frontoparietal networks underpin proactive cognitive control

Ms Montana McKewen, PhD Student
University of Newcastle

Mr Patrick S. Cooper, *University of Newcastle*
Dr Aaron S. W. Wong, *University of Newcastle*
Dr W. Ross Fulham, *University of Newcastle*
Prof Patricia T. Michie, *University of Newcastle*
A/Prof Frini Karayanidis, *University of Newcastle*

Cognitive control refers to a number of processes that facilitate goal-directed adjustments of behaviour such as overriding automatic responses, set-shifting, and updating working memory. These processes rely on a frontoparietal network. Oscillatory activity in the theta band (4-8Hz) in particular has been observed in the frontoparietal network and been reported to be critical for cognitive control. However, studies investigating theta oscillations in cognitive control typically use paradigms which rely on moment-to-moment (reactive) adjustments of the control system as opposed to tasks which allow for preparation (proactive). If theta is associated with cognitive control more generally, then we expect it should also be present in proactive control. Participants (N=211) completed a cued-trials task-switching paradigm where EEG was recorded. This paradigm allowed for the distinction between proactive and reactive control. EEG analyses involved computing power as well as inter-site phase clustering (ISPC), a measure of functional connectivity between electrodes across trials. Power analyses revealed two clusters of theta activity; centroparietal and midfrontal. ISPC analyses indicated that both clusters had strong connectivity to the parietal region. The ISPC for the centroparietal cluster showed an increase with task difficulty. For the midfrontal cluster, ISPC did not differ between different types of switch trials or between non-switch trials. However, ISPC was stronger for switch vs. non-switch trials. Therefore, the midfrontal-parietal ISPC results suggest the presence of a preparatory, frontoparietal switch-specific network. We found novel evidence of midfrontal theta activity in the cue period, despite it typically being reported after target. Interestingly, the midfrontal ISPC results show a switch-specific frontoparietal network. As such, midfrontal theta may be involved in more than just moment-to-moment conflict adjustment and warrants further investigation

Action disposition influences response selection towards aversive images of humans

Miss Rosemaree Miller, PhD Student
The University of Newcastle

A/Prof Frances Martin, *University of Newcastle*

Images that show injured, dead or mutilated humans commonly feature as negative stimuli in picture processing research. The aim of the present EEG study was to determine whether the emotional salience of these unpleasant images depends on the action disposition of the human in the scene. Forty participants (20 male) completed a modified Flanker task in which images of severe injury or humans armed with hand-guns were employed as stimuli. Activity for the early posterior negativity (EPN) and the late positive potential (LPP) indexed the emotional salience of congruent and incongruent Flanker arrays. Images of humans armed with hand-guns evoked larger amplitude EPN and LPP than congruent injury images. However, when these unpleasant images were mismatched, an armed hand-gun shown with injury distractors led to more negative EPN amplitudes than an injury target paired with armed hand-gun distractors, an effect not observed in LPP modulation. This result indicates that responses towards unpleasant images are mediated by the action disposition of a human in the scene. The specific perceptual factors that drive the emotional salience of severely injured humans requires further investigation.

Monoamine alterations in the dorsal striatum and behavioural flexibility in persistent neuropathic pain and acute stress

Dr David Mor, Lecturer
Sydney Medical School, Univeristy of Sydney

Mrs Gizem Gemikonakli, *The University of Sydney*
Mr james kang, *The University of Sydney*
Mr Mike Kendig, *The University of Sydney*
Mrs Veronica Cottam, *The University of Sydney*
Dr Corbit Laura, *The University of Sydney*
Dr David Mor, *The University of Sydney*

Chronic pain often leads to impaired cognition and reduced behavioural flexibility. The dorsomedial (DMS) and dorsolateral (DLS) striatum, mediate the expression of goal-directed and habitual behaviours respectively. This study investigated (1) if persistent neuropathic pain, with or without an additional acute psychological stress, alters behavioural flexibility as measured by sensitivity to devaluation; and (2) if changes in monoamine levels in the DMS and DLS reflect any behavioural differences.
Neuropathic pain was induced by a chronic constriction injury (CCI) of the sciatic nerve. CCI (n=35), sham-injury (n=20) or, naïve (n=32) rats were trained to press two levers for two rewards. In outcome devaluation tests, one of the rewards was devalued by pre-feeding it to satiety, immediately prior to an extinction test measuring responding on the two levers. To test the impact of the acute stress, rats were subjected to 15 minutes restraint following pre-feeding and prior to the devaluation test. Noradrenaline, serotonin, dopamine and associated metabolites were measured bilaterally from the DLS and DMS using HPLC.
Neither CCI alone, nor an acute stress alone altered sensitivity to devaluation, but a combination of the two significantly reduced sensitivity (3-way ANOVA, $P<0.01$). CCI increased DOPAC, HVA and 5-HIAA in the right DLS and reduced NE levels in the left DMS. Only in CCI rats with no acute stress, DA, DOPAC and HVA levels in the left DMS were positively correlated with lever pressing rates during training and sensitivity to devaluation. DA, DOPAC and HVA levels in the right DLS were negatively correlated with sensitivity to devaluation.
Interaction between injury and stress suggests an additive effect on behavioural flexibility. This data suggests that CCI leads to opposite changes in monoamine concentrations in the DMS and DLS, a process that may confer a higher vulnerability to future insult upon which behavioural flexibility deficits are observed.

High-intensity training enhances executive function in children

Dr David Moreau, Research Associate
University of Auckland

A/Prof Karen Waldie, *University of Auckland*

Physical exercise has shown to elicit improvements in several measures of cognition. Traditionally, this effect has been observed following aerobic exercise interventions; that is, sessions of moderate-intensity exercise maintained over time. Here, we present evidence demonstrating that an intervention based on high-intensity training (HIT) can induce cognitive improvements in children. Specifically, our novel 6-week HIT regimen resulted in robust improvements on measures of cognitive control and working memory. This effect was moderated by BDNF genotype, with met66 carriers showing larger gains post-exercise. In addition, our results indicate that HIT helps downregulate elevated resting heart rate, and thus benefited individuals who need it most. These findings complement previous literature linking physical exercise to cognitive enhancement, and provide a more detailed account of the mediating factors. Overall, this line of research suggests promising alternatives to enhance cognition, via short, potent exercise regimens.

The effect of red diffuse light on early ERPs in individuals with low and high autistic tendency

Ms Eveline Mu, Honours student
Swinburne University of Technology

Ms Laila Hugrass, *Swinburne University of Technology*
Prof David Crewther, *Swinburne University of Technology*

The ability to rapidly identify threat related signals, such as fearful faces, is crucial for survival. This rapid extraction, which occurs as early as 100ms, has been suggested to reflect processing of low spatial frequency (LSF) information via the magnocellularly driven subcortical route. However, individuals with autism spectrum disorder struggle to promptly extract such visual information. In investigating the magnocellular pathway, previous studies have demonstrated that retinal exposure to red diffuse light suppresses magnocellular responses - a method that lacks human physiological evidence. We measured early event related potential (ERP) components to LSF fearful and high spatial frequency (HSF) fearful faces, with red or green surrounds, in neurotypical individuals with low and high autistic traits, as measured with the Autistic Spectrum Quotient (AQ). Contrary to expectations, we found an increased P1 amplitude and latency for HSF fearful expressions in the Low AQ group, while the High AQ group showed increased P1 amplitude for LSF fearful ex-

pressions. In the presence of red diffuse light, we only found the light to suppress LSF fearful faces in the N170 component for the Low AQ. Interestingly, however, we found red light to affect the HSF information for High AQ individuals. Our results thus provide support for the emerging view that the subcortical pathway is not crucial for rapid fear detection. Moreover, we provide the first human electrophysiological insight into the effect of red diffuse light, with evidence suggesting that the red light does not completely suppress processing in the magnocellular pathway, but perhaps might suppress parvocellular pathway, or a combination of the two pathways.

Local/global influences on attention orienting across the subclinical autism spectrum

Dr Melanie Murphy, Associate Lecturer
La Trobe University

Ms Annie Agnus, *La Trobe University*
Ms Grace Christou, *La Trobe University*
Ms Gokce Erkocu, *La Trobe University*
Mr Saxon Goold, *La Trobe University*
Mr Simon John, *La Trobe University*
Ms Claudia Nguyen, *La Trobe University*
Ms Jessica Schepis, *La Trobe University*
Ms Penny Trueman, *La Trobe University*
Ms Clare Wilson, *La Trobe University*
Prof Sheila Crewther, *La Trobe University*
Dr Robin Laycock, *RMIT University*

Individuals with Autism Spectrum Disorder as well as subclinical populations with higher autism-like traits (AT) are reported to demonstrate a local bias in visual processing. Assessment of such processing typically requires explicit attention to global and/or local information. We used a sub-clinical adult population with higher or lower autism-like traits to first detect anomalies in explicit local/global processing using Navon letter stimuli, and secondly to determine whether involuntary reflexive processing of local/global compound arrow stimuli would differentially orient spatial attention.
The Navon task required participants to detect whether a target letter was present or absent from congruent or incongruent stimuli. Targets were present at either local, global, or both levels. The Arrow Cueing Task used congruent and incongruent hierarchical arrow stimuli pointing left or right. A Posner cueing paradigm was utilised with participants responding to a simple target appearing left or right of a previously presented cueing arrow after 250ms or 750ms SOA. Participants were informed that cue validity was uninformative.
The Navon Task revealed greater local to global interference in the High- compared with the Low-AT group, whereas there were no group differences in global to local interference. For the Arrow Cueing task a cueing effect for congruent arrow cues for the 750ms SOA was observed, with the High AT group remaining susceptible to reflexive arrow cueing effects in this condition. No group differences were observed for incongruent arrow cueing.
Although higher autistic traits were associated with a greater local bias during explicit global target identification, this did not transfer to reflexive local/global processing differences in the cueing task. Instead, the larger cueing effect for congruent arrows at 750ms SOA for the High-AT group may indicate a slower capacity to override exogenous attention processes with top-down control.

Biases in perceiving gaze vergence

Miss Alysha Nguyen, Student
University of New South Wales

Dr Colin Palmer, *University of New South Wales*
A/Prof Yumiko Otsuka, *Ehime University, Matsuyama, Japan*
Prof Colin Clifford, *University of New South Wales*

The perception of another's gaze is an important cue in social interactions, wherein the focus of their gaze can indicate an object of interest or potential danger in the environment. The vergence of the two eyes (i.e., their convergence or divergence) provides information about the distance of this object of fixation from the person. In the present study, participants viewed synthetic faces with varying degrees of eye vergence. Our first experiment examined whether observers had a bias for perceiving a particular vergence of gaze, and whether this was influenced by gaze direction. A second experiment further investigated this bias by manipulating stimulus uncertainty, realised by adding dark glasses over the eyes of the face stimuli. Results showed a significant bias for perceiving other individuals as having convergent gaze and fixating at closer distances, especially when their gaze was directed downwards and under conditions of uncertainty. The overall bias to perceive gaze as convergent may reflect the predominance of convergent over divergent gaze in everyday social interaction. That downwards gaze is most likely to be perceived as convergent might reflect the implicit knowledge that when someone's gaze is averted downwards there is a higher probability of fixating on an object close to themselves. These findings have significant implications for our understanding of social vision and how our visual system operates when faced with perceptual uncertainty.

Partial inhibition reveals age-related change during response inhibition in mid-to-late adolescents

Mr An Nguyen, PhD Student
University of Western Australia

Dr Jonson Moyle, *Princess Margaret Hospital*
Dr Allison Fox, *University of Western Australia*

Evidence from neuroimaging supports the protracted development of brain regions involved response inhibition. However, few studies have examined the development of response inhibition during the transition from adolescence to adulthood. In this study we used an error-sensitive go/nogo task that allowed us to detect when participants initiated, but did not complete, their response to nogo trials (partial inhibitions). We compared task performance and the N2 and P3 elicited during successful and partial inhibitions between mid-to-late adolescents (N = 26, M = 15.57, SD = 0.90) and adults (N = 24; M = 21.17, SD = 3.52). The results showed that adolescents made more errors on nogo trials compared to adults, and within the adolescent group, the proportion of errors on nogo trials decreased with age. In the ERPs, we observed significant group differences in the latency and distribution of the N2: The N2 peaked later adolescents and showed a broader scalp distribution. Furthermore, N2 peak latency on successful inhibitions was significantly associated with the proportion of errors on nogo trials and age in adolescents. No significant group differences in the overall amplitude or magnitude of the N2 and P3 effects were observed, and both groups showed a similar response during partial inhibitions. The ERP data suggests that the observed performance differences were due to an increase in the speed and efficiency of conflict monitoring processes as opposed to improvements in response inhibition.

Distinct cerebellar contributions to cognitive-perceptual dynamics during natural viewing

Dr Vinh Nguyen, Research Scientist
QIMR Berghofer

Mr Saurabh Sonkusare, *QIMR Berghofer*
A/Prof Jane Stadler, *University of Queensland*
A/Prof Xintao Hu, *Northwestern Polytechnical University*
Prof Michael Breakspear, *QIMR Berghofer*
Dr Christine Guo, *QIMR Berghofer*

Introduction: The contribution of the cerebellum to motor learning and coordination is very well known. In recent years, increasing evidence from clinical and cognitive neuroscience research has supported an emerging view of the cerebellar involvement in cognitive and affective processes. The exact nature of this involvement, however, is far less understood than the motor function of the cerebellum. In particular, putative functional subdivisions and specific cognitive functions are not known.
Methods: Twenty right-handed participants underwent a resting-state fMRI session, followed by a naturalistic fMRI session - freely viewing a short drama in its entirety. We used both data-driven and hypothesis-driven methods to identify cerebellar regions that are consistently engaged during the naturalistic condition. We then examined functional role of these identified

cerebellar regions during this dynamic perceptual and affective process and characterised their connectivity with the cerebral cortex.
Results: We found that distinct clusters at the posterior and inferior cerebellum are reliably engaged in this dynamic perceptual and affective process. These cerebellar regions show significant relevance to visual salience and unexpected turning points of the movie - an intriguing parallel to the cerebellar motor function in signalling predictive error in motor behaviour. We further demonstrated robust and dynamic functional connectivity of these distinct cerebellar regions to prefrontal and posterior parietal cortices.
Conclusions: Our results demonstrate that distinct functional subdivisions of cerebellum are robustly engaged in real-life cognitive processes, playing specific roles through a dynamic interaction with higher order regions in the cerebral cortex.

A systematic review of the effects of transient ischaemic attack on resting-state and task-based electroencephalography

Miss Korinne Nicolas, PhD Candidate
University of Newcastle

A/Prof Frini Karayanidis, *University of Newcastle*
Mr Patrick Cooper, *University of Newcastle*
Prof Patricia Michie, *University of Newcastle*

Cerebrovascular events involve a disruption of blood supply to the brain and are a leading cause of disability and death globally. In 20-40% of cases, a minor non-disabling cerebrovascular event known as a transient ischemic attack (TIA) occurs before a major disabling stroke. Furthermore, 10 to 15% of patients diagnosed with a TIA have a stroke within 3 months, with half occurring in the first 48 hours. Studies have found cognitive impairment post TIA, however, findings are variable. Although present data suggests there are cognitive deficits post-TIA, the inconsistencies in methodology, patients' characteristics and findings makes the precise nature of the relationship elusive. The current review of the literature will inform the direction of a future longitudinal study which will investigate the occurrence of post-TIA deficits. We expect to inform development of a new protocol to investigate neural, affective, cardiovascular and demographic factors that are associated with different cognitive profiles and cognitive pathways in older adults who have experienced a TIA.

Tracing the neural transforms of rhythm in the human auditory system

Dr Sylvie Nozaradan, Post-doctoral researcher
Western Sydney University

Prof Marc Schonwiesner, *Leipzig University*
Prof Peter Keller, *Western Sydney University*
Dr Alexandre Lehmann, *McGill University*

Neurons in the auditory system synchronize their responses to rhythmic sound inputs. This coupling or entrainment is thought to facilitate rhythmic movement, which is often timed with respect to a regular pulse-like beat and higher-order metric structure, as in music. How the human brain performs the transformation from continuous changes in acoustic features into perceptual metric units remains unknown. Here, we recorded neuroelectric activity generated at both cortical and brainstem levels of the human auditory pathway elicited by rhythms of different metric complexity. One rhythm had a regular beat marked by periodically occurring sound onsets (physically salient beats), while the other was a relatively complex and syncopated rhythm in which some beats were marked by silence instead of sounds (physically less salient beats). The simple rhythm was additionally played four times faster, thus at the upper limit for beat and meter perception, to test the effect of tempo on the neural transforms. We found that the difference between brainstem and cortical representations of the rhythms depended on the complexity of the rhythm. There was a significant difference for the complex rhythm, characterized by increased amplitude at meter-related frequencies in the cortical responses as compared to the brainstem responses, while no difference was observed between brainstem and cortical representation for the simple rhythm. Moreover, the cortical encoding was restricted to a frequency range corresponding to the musical tempo (<5Hz), while the brainstem encoding did not exhibit such a lowpass function. Our findings demonstrate a critical transformation in the neural encoding of rhythms between auditory brainstem and cortical structures, providing new insights on the emergence of high-level perceptual representations of rhythms and of rhythmic movement entrainment in humans.

Statistical Learning of Irrelevant Visual Information is Disrupted by Electrical Stimulation of Frontoparietal Cortex

Ms Abbey Nydam, PhD Candidate
University of Queensland

A/Prof Paul Dux, *University of Queensland*
Dr David Sewell, *University of Queensland*

The ability to learn novel and complex behaviours has a long been linked with functions of the prefrontal cortex (PFC). In recent years, work using non-invasive brain stimulation has provided evidence that the PFC contributes causally to learning, decision-making, and the effects of training on performance (Filmer, Mattingley, & Dux, 2013; Filmer, Mattingley, Marois, & Dux, 2013). This work has predominantly focused on explicit forms of learning that involve goal directed behaviour or instructed training. Yet, much of what we come to know about our environment is acquired incidentally and without instruction, by way of implicit statistical learning. For example, individuals can learn to predict a target location based on the visual context in which it is most likely to appear - a phenomenon known as contextual cueing (Chun & Jiang, 1998). Implicit statistical learning has been conceptualized as an automatic process that relies on neural substrates that are distinct from those involved in acquiring explicit knowledge, such as medial temporal lobe structures. However, neuroimaging studies have suggested areas in PFC and posterior parietal cortex (PPC) may play a role in implicit statistical learning for visual information. Here, we delivered anodal (excitatory), cathodal (inhibitory), or sham transcranial direct current stimulation (tDCS) to the left PFC and left PPC online, while participants undertook a contextual cueing task. Cathodal stimulation of both PFC and PPC disrupted the learning of contextual information, relative to the sham condition. These findings causally implicate frontoparietal regions in implicit statistical learning of visual context information, suggesting that these regions are involved in both implicit and explicit forms of learning.

Towards the development of psychosis biomarkers: Functional and structural brain networks in the continuum of psychosis

Dr Lena Oestreich, Postdoctoral Research Fellow
University of Queensland

Dr Marta Garrido, *University of Queensland*

The mismatch negativity (MMN) is an event-related potential component, which is evoked in response to surprising or unpredictable events. The auditory MMN is consistently reduced in patients with schizophrenia and healthy individuals at high-risk for psychosis who transition to clinical psychosis. The first aim of this study was to investigate whether the reduced MMN is also present in healthy individuals with varying degrees of psychotic experiences. The second aim was to explore the relationship between the functional and structural brain networks involved in the manifestation of the auditory MMN. Electroencephalography (EEG) and diffusion magnetic resonance data were collected from 100 healthy individuals with varying degrees of psychotic experiences. An EEG was recorded while participants listened to sounds sampled from a Gaussian distribution and simultaneously performed an incidental working memory task. MMN was extracted by comparing responses to outliers and means. Individuals with a high quantity of psychotic experiences exhibited significantly reduced MMN response compared to individuals with a low quantity of psychotic experiences. The functional brain networks activated during the auditory MMN, revealed by source reconstruction, are structurally connected via auditory white matter pathways, namely the arcuate fasciculus, the inferior occipito-frontal fasciculus and the aslant, all of which have been reported to be disrupted in schizophrenia. These results suggest that the auditory MMN might be a promising biomarker for identifying individuals at risk for developing psychosis who might benefit from prophylactic treatments. Additionally, the findings from this study indicate that functionally connected brain networks that are active during the generation of the auditory MMN are structurally connected via white matter pathways.

Neural processing of visible orientations

Prof Robert P. O'Shea, Senior Research Fellow
Murdoch University

Dr Urte Roeber, *Murdoch University*
Mr Tom Sanderson, *Southern Cross University*
Ms Emily Prowse, *Southern Cross University*
Dr Bradley N. *Jack, University of New South Wales*

One key feature of what we see is orientation. For example, a set of vertical lines looks very different from a set of horizontal lines. Moreover, when we present such sets of oriented lines to each eye, three qualitatively different experiences ensue: For identical orientations in each eye, we see one set of lines despite two sets being delivered to the eyes—binocular fusion. For small orientation differences between the two eyes, we see one set of lines that are tilted towards us in depth—stereopsis. For large orientation differences between the two eyes, we see one of the component set of lines for a second or so, then we see the other, then we see the first, then the second, and so on, for as long as we care to look—binocular rivalry. What early brain processing is associated with such experiences? We measured the electrical activity of the brain to 200-ms presentations of two sets of lines, either one to each eye (dichoptic) or both to each eye (dioptic), with a range of orientation differences, from 0 deg to 90 deg in 18-deg steps. Event-related potentials yielded two components from electrodes over the occipital cortex:

- A positive deflection 100 ms after the onset of the lines (the P100) whose amplitude decreased with dichoptic orientation difference but whose amplitude was constant with dioptic orientation differences.
- A negative deflection 170 ms after the onset of the lines (the N170) whose amplitude increased with dichoptic orientation difference but whose amplitude was constant with dioptic orientation differences.

We conclude that these two components reflect processing specific to binocular vision, the first assessing the suitability of the viewed orientations for fusion and stereopsis, the second preparing for the experience of binocular rivalry.

More than just a face: Expectations about person identity modulate the face-sensitive N170

Ms Anne Overell, PhD candidate
Queensland University of Technology

Dr Jordy Kaufman, *Swinburne University of Technology*
Mr Jonathan Robinson, *Queensland University of Technology*
Dr Andrew Young, *University of York*
Dr Patrick Johnston, *Queensland University of Technology*

The N170 ERP is considered to index structural encoding of faces (stimulus driven, bottom-up processing), prior to identity recognition, which is influenced by higher order cognitive factors. The face N170 is not generally seen as an index of identity recognition or considered to be cognitively penetrable. Here, we sought to test this conception of the N170, building on studies using contextual manipulation. By manipulating a patterned sequence of different, ambient images of familiar facial identities, we created an expectancy about identity—this expectancy was breached by infrequently presenting a different identity. There were three levels of the visual stimulus condition: Frequent Regular, Infrequent Regular and Infrequent Random. Brain activity was recorded with EEG over occipitotemporal areas. Participants (N=19) were healthy adult volunteers. It was predicted: (1) that in a pattern based on facial identity, an identity shown Infrequently and Regularly would elicit a larger N170 than one shown Frequently and Regularly; and (2) that a facial identity shown Infrequently but Randomly would elicit a larger N170 than both Frequent Regular and Infrequent Regular identities. Hypothesis 1 was supported: N170 response to Infrequent Regular stimuli was larger than to Frequent Regular, $F(1,19)=7.96$, $p=.011$. Hypothesis 2 was partly supported: N170 to both Infrequent Regular and Infrequent Random was larger than to Frequent Regular, Mdiff=1.23μV, 95% CI [0.41, 2.05]; Mdiff=1.24μV, 95%CI [0.56, 1.91], but there was no difference between Infrequent Regular and Infrequent Random, suggesting periodicity was not a factor driving the response. This is important because it supports an inference, contrary to the orthodox view, that in the N170 time interval, the brain is processing information sufficient to distinguish identity (recruiting top-down processes) not just encode facial form (bottom-up processing).

Functional mechanisms encoding others' direction of gaze in the human nervous system

Dr Colin Palmer, Postdoctoral Research Associate
UNSW Australia

Prof Colin Clifford, *Professor of School of Psychology, UNSW Australia*

The direction of others' gaze is a strong social signal to their intentions and future behaviour. Pioneering electrophysiological research identified cell populations in the primate brain that are tuned to specific directions of observed gaze, but the functional architecture of this system is yet to be precisely specified. Here, we develop a computational model of how others' gaze direction is flexibly encoded across a population of sensory channels. We incorporate the divisive normalisation of sensory responses - a computational mechanism that is thought to be widespread in sensory systems but has not previously been discovered in the context of social vision. We demonstrate that the operation of divisive normalisation in the gaze system predicts a surprising and distinctive pattern of perceptual changes following sensory adaptation to gaze stimuli, and find that these predictions closely match the psychophysical effects of adaptation in human observers. These results reveal the functional principles that govern the neural encoding of gaze direction, and support the notion that divisive normalisation is a canonical feature of nervous system function. Moreover, this research provides a strong foundation for testing recent computational theories of neuropsychiatric conditions in which gaze processing is compromised, such as autism and schizophrenia.

Resting state functional coupling between the ascending synchronising system, limbic system and the default mode network

Dr Bryan Paton, 1
The University of Newcastle

Default mode network (DMN) function has been implicated in perceptual, learning and memory function. Understanding the causal role of the DMN in these processes will provide insight into healthy function and the dysfunctions seen in dementia and psychiatric illnesses. In the case of both episodic and autobiographical memory processes, electrophysiology in animals suggests theta band oscillations are the intrinsic mechanism for their orchestration. Theta oscillations are primarily controlled by the ascending synchronising system, a set of sub-cortical nuclei found in the pontine tegmentum and basal forebrain. We show, using rapid fMRI resting state data, for the first time, a causal link between the ascending synchronising system and the DMN. Nodes of the DMN, including the hippocampus and parahippocampal gyrus are linked at the network level with the sub-cortical structures responsible for fundamental memory processes. Our cross-validated approach, using ICA decomposition, seed based connectivity and dynamic causal modelling provides critical support for the role of theta oscillations in memory function and coordination.

From hallucinations to the imagination: Seeing what's not there and measuring it

A/Prof Joel Pearson,
University of New South Wales

Cases of visual awareness without a corresponding stimulus occur in special conditions, such as pathological hallucinations, dreaming, mental imagery, synaesthesia and some illusions. Hallucinations can also be perceived as sweeping waves of visibility that occur when exposed to full field luminance flicker. However, a primary problem with such percepts is the inability to objectively measure the 'hallucinated' content. Here, I will talk about new methods to objectively measure two different types of visual phantom perception: mental imagery and flicker induced hallucinations. Using perceptual methods, we have shown that visual phantoms or non-retinal vision can be local in visual space, undergo adaptation and priming, are linked to visual cortex anatomy, and can even be bistable. These new methods provide novel tools to investigate the constructive nature of visual awareness in function and dysfunction.

Structure-from-motion and lightness perception: understanding the interaction between lightness and high-level motion

Miss Lindsay Peterson, Honours student
UNSW Australia

Dr Damien Mannion, *University of New South Wales*

The visual system's ability to estimate surface lightness (perceived reflectance) is a multi-stage process which is thought to involve cortical areas associated with the ventral visual pathway. The perception of 3-D shape information is critical for such lightness estimation, with previous studies demonstrating that multiple cues to 3-D shape can inform lightness judgements. Our study investigated whether human observers were able to use 3-D shape information from a high-level motion cue to inform judgements of surface lightness. Participants (N = 44) completed a visual psychophysics procedure consisting of a brightness matching task in which they adjusted the brightness of a patch in one region of the stimulus until it was perceived to match the brightness of a different patch. The results from our experiment demonstrated that participants were susceptible to a brightness illusion regardless of the availability of 3-D shape information provided by a high-level motion cue. This result has implications for our current understanding of lightness perception, suggesting that high-level motion cues are not integrated during lightness processing. Additionally, these results raise the question of whether visual pathways have the potential to interact to facilitate lightness perception.

Using low-cost portable neuroimaging to detect receptive language ability in children

Miss Selene Petit, Master student
Grenoble Institute of Technology

Dr Nicholas Badcock, *Macquarie University*
Ms Nadene Dermody, *Macquarie University*
Dr Shu Yau, *Marie Curie Postdoctoral Fellow of Aston Brain Centre*
Dr Elaine Schmidt, *Macquarie University*
A/Prof Anina Rich, *Macquarie University*
Dr Jon Brock, *Macquarie University*
Prof Lyndsey Nickels, *Macquarie University*
Dr Alexandra Woolgar, *Macquarie University*

Can some children understand more than they can demonstrate? Mounting anecdotal evidence suggests that some minimally-verbal (i.e. non-speaking) children with autism have preserved language comprehension that is not apparent using conventional tests. We aimed to develop a non-invasive neural test of spoken language comprehension in individual children using a portable EEG device. We developed two child-friendly paradigms that manipulated the semantic congruency of spoken language. The first paradigm used sentences with meaningful versus anomalous completion (e.g. "She wore a necklace around her neck" versus "She wore a necklace around her milk"). The second paradigm consisted of forward-associated or unassociated word pairs (e.g. "row-boat" versus "row-pen"). In groups of participants a larger N400 event-related potential is evoked by anomalous sentence completions relative to correct completions, and by unassociated word pairs relative to associated word pairs. For a screening task, the N400 needs to be reliably detected at an individual level. We therefore tested for the N400 in 31 children aged 6 to 12 years (N=16 for the first paradigm and N=15 for the second paradigm). We recorded simultaneously from a traditional research-grade EEG system, and from a portable low-cost EEG system (Emotiv EPOC+©), consisting of a wireless, easy-to-setup headset. The results from the two EEG systems were similar. At the group level, for both paradigms, we replicated the typical N400 findings in the literature. At the individual level, we detected a statistically significant N400 effect in up to 43% of the children. Although this is a relatively low rate, and the absence of an N400 effect would not necessarily mean an absence of comprehension, if a child did show a significant N400, we could infer hidden language comprehension, making this a promising start. This study was funded by the CCD Neural Markers Training scheme.

Spontaneous blink rate in anorexia nervosa: implications for dopaminergic activity in anorexia nervosa

Dr Andrea Phillipou, Research Coordinator
St Vincent's Hospital

Dr William Woods, *Swinburne University of Technology*
A/Prof Larry Abel, *University of Melbourne*
Prof Susan Rossell, *Swinburne University of Technology*
Dr Matthew Hughes, *Swinburne University of Technology*
Prof David Castle, *University of Melbourne*
Dr Caroline Gurvich, *Monash Alfred Psychiatry Research Centre*

A number of neurobiological mechanisms have been proposed to contribute to anorexia nervosa (AN), including dopaminergic function. The dopaminergic system plays an important role in eating behaviours, motivation, cognitive flexibility and reward; behaviours which are also disturbed in AN. The aim of this study was to utilise spontaneous blink rate (SBR) as a non-invasive measure of central dopaminergic activity in AN, and to examine the effects of cognitive load on this measure. 24 females with AN and 21 healthy individuals undertook two tasks: a fixation task and a prosaccade/antisaccade/no-go saccade task. AN participants demonstrated lower SBR than controls over both tasks. Further, both groups had significantly lower SBR during the saccade task than the fixation task. The findings suggest reduced central dopaminergic activity in AN, particularly striatal D2 activity, which may be related to the disturbed behaviours present in this group. Further, the findings suggest that dopamine agonists, which increase dopaminergic activity, may be beneficial in the treatment of AN rather than dopamine antagonists which are often advocated for the illness.

Differences in neural oscillations for optimal movements and goal attainment when observing others actions

Dr Simmy Poonian,
Macquarie University

Dr Pierre Jacquet, *Ecole Normale Supérieure, Paris, France*
Dr Florian Waszak, *Université Paris Descartes, Paris, France*

When we observe others' behaviour it is thought our brain makes predictions about their actions and intended goals. It currently remains unclear which aspects of the action sequence, i.e. the goals, grip type or optimal interactions between the two, are indexed by changes in neural activity through alpha and beta oscillations. In this study, we investigated the temporal profile of the oscillatory response to others' actions, in relation to grip type, goals and optimality. In an EEG study participants were presented with videos of an actor interacting with an object (a box), where the type of grip (power/precision) was varied with the intended goal (open/light), to create observations where goal attainment was reached using optimal or sub-optimal grip types. Cluster-based permutations revealed early differences in the action sequence for occipital beta in electrodes contralateral to the observed movement, with activity differences beginning soon after movement initiation. Differences in grip type were also found in ipsilateral occipital alpha after the grip was clearly observed and the actor was interacting with the box. Activity related to optimality revealed differences in contralateral frontal electrodes for beta (230ms to 330ms after goal onset) and middle frontal electrodes for alpha (400ms to 645ms after goal onset). Finally, activity for goals showed two significant clusters late in the action sequence, with differences in alpha in contralateral parieto-occipital electrodes (550ms to 900ms after goal onset), and differences in beta in fronto-central electrodes beginning over 1 second after goal onset. Our findings indicate the temporal profile when observing others involve processing of movement information early in occipital areas; with optimal interactions between goals and grip types being indexed in sensorimotor areas soon after goal onset, and activity related to goals occurring late in the action sequence.

Modelling Distraction

Dr Alexander Provost, Post-doctoral researcher
University of Newcastle

Ms Karlye Damaso, *University of Newcastle*
Prof Andrew Heathcote, *University of Tasmania*
Prof Ulrich Schall, *University of Newcastle*

Prof Patricia Michie, *University of Newcastle*
Prof Scott Brown, *University of Newcastle*
Prof Erich Schröger, *University of Leipzig*
A/Prof Juanita Todd, *University of Newcastle*

The healthy aged and persons with schizophrenia often exhibit deficits in attention control possibly linked to an inability to monitor the environment and filter out irrelevant stimuli. Relevance filtering can be assessed using the mismatch negativity (MMN) component of the auditory event related potential as an index of proficiency. MMN occurs when an unexpected change in sound patterning is detected. Larger MMN has been linked to attention switches that result in poorer and/or slower responses on trials associated with MMN elicitation. Consequently, it has been proposed poor relevance filtering inferred from smaller MMN in healthy aged and in persons with schizophrenia could be indexed on such tasks. Participants made tone length discriminations, either short (100ms) or long (250ms) while the tone pitch randomly varied between standard (700Hz - 75%), low pitch deviant (613 -12.5%) or high pitch deviant (1560 - 12.5%). In both young (n=23, < 35yr old) and older (n=19, 60+yrs) groups of participants we collected EEG whilst participants completed this distraction experiment in addition to a neuropsychological battery (e.g. CPT-IP, WAIS subtests, MOCA). Preliminary analysis confirms slower and more error prone performance on deviant trials compared to standard, demonstrating the distraction effect. Data also confirm slower and more error-prone performance in older adults and more pronounced distraction by deviants despite significantly smaller MMN amplitude. Additionally, the data was fit using a behavioural evidence accumulation model, the linear ballistic accumulator that enable extraction of latent variables relevant to decision making processes. Parameters of this model will be reported and ultimately formally linked with features of the neural data. Results confirm that MMN amplitude links to distraction effects may be confined to young healthy adults. The model fitting results provide a baseline to compare to the expected patient group results.

The challenge of heterogeneity in Autism Spectrum Disorders (ASD): Characterizing differences in monozygotic twins concordant or discordant for ASD

Mr Emmanuel Peng Kiat Pua, PhD Candidate
University of Melbourne

Prof Stephen Bowden, *University of Melbourne*
Dr Marc Seal, *Murdoch Childrens Research Institute*

Autism Spectrum Disorders (ASD) are neurodevelopmental conditions associated with deficits in social communication, social interaction, and restricted and repetitive behaviours. To date, the search for definitive neurobiomarkers remains challenging and obscured by inconsistent or incompatible findings. Although brain abnormalities have been identified in ASD, there is much disagreement on the regions implicated or direction of alterations. Monozygotic twin study designs are a powerful solution to investigate heterogeneous conditions such as ASD through the implicit control of genetic and shared environmental factors. The present study investigates brain structure and function in a Victorian cohort of monozygotic twin pairs between the ages of 5 to 18, discordant or concordant for ASD. We use Magnetic Resonance Imaging (MRI) to measure within-twin-pair differences in brain structural morphometry, structural connectivity and resting-state intrinsic functional connectivity. To ensure replication and generalizability of findings, the Autism Brain Imaging Database Exchange (ABIDE-II) with MRI and phenotype datasets from 557 ASD singletons and 587 typical controls will be used to validate results. Analysis of resting-state functional MRI data using the Network-Based Statistic approach found a single subnetwork associated with nonverbal intelligence (size=940, p-FWE=0.0044) in singleton males with ASD (n=26, ages 8 to 13 years) that was not present in matched typical controls (n=24). Preliminary findings suggest that nonverbal intelligence in males with ASD may be associated with an atypical intrinsic connectivity subnetwork despite intact cognitive test performance. This highlights the need to account for effects of heterogeneity that could explain between-group differences unrelated to symptom severity. We propose the co-twin control design as an effective method to control for variation in the analyses of brain-behaviour relationships in atypical populations.

Measuring the effects of attention to single fingertips using ultra-high field (7T) fMRI

Dr Alexander Puckett, Post-doctoral researcher
University of Queensland

Mrs Saskia Bollmann, *University of Queensland*
A/Prof Markus Barth, *University of Queensland*
Prof Ross Cunnington, *University of Queensland*

Attention is able to modulate the neuronal processing of sensory information. For example, visuospatial attention acts by modulating responses at retinotopically appropriate regions of visual cortex. Much less, however, is known about the processing associated with attending to other modalities of sensory information. One reason for this is that visual cortex is relatively large and hence easier to access non-invasively using fMRI. With high-resolution fMRI, however, it is now possible to access smaller areas such as primary somatosensory cortex, S1. Here, we combined a novel experimental design and high-resolution fMRI to measure the effects of attention to tactile stimulation in S1.
Data were acquired on a Siemens MAGNETOM 7T scanner. Anatomical images were collected using an MP2RAGE sequence with 0.5mm resolution. Functional data were collected using a 3D-EPI sequence with 0.8mm resolution. Tactile stimulation was delivered via a piezoelectric stimulator. There were two main experimental conditions: sensory and attention. During the sensory condition, four fingertips on the right hand were stimulated sequentially to map the somatotopic organization of the fingertip representations. During the attention condition, attention was swept across the fingertips under constant sensory stimulation of all four fingertips.
The attention condition elicited phase-encoded responses along the postcentral gyrus that were strikingly similar to those elicited by the sensory condition indicating that attention modulates S1 in a somatotopically appropriate fashion. Importantly, this modulation was measured at the level of the cortical representation of individual fingertips, and our results provide clear evidence of fingertip-specific attentional modulation. The ability to make such detailed measurements provides an unprecedented opportunity to examine the neural mechanisms underlying somatosensory attention and how these processes influence human somatosensation.

Electrophysiological response to duration deviants in Schizotypy

Ms Roshini Randeniya, Student
Queensland Brain Institute

Dr Lena Oestreich, *Queensland Brain Institute*
Dr Marta Garrido, *Queensland Brain Institute*

Auditory mismatch negativity (MMN) has been indicated as a potential biomarker for psychosis proneness given its consistent reduction in patients with schizophrenia and individuals at high-risk for psychosis, compared to healthy controls. Schizotypy is a term, which describes healthy individuals with psychotic-like experiences who possess an underlying vulnerability for schizophrenia. The current study aimed to identify if there are differences in the electrophysiological response elicited by auditory oddball paradigms between individuals who score high on a measure of schizotypal traits compared to individuals who scored low. 50 participants were recruited and grouped into High Schizotypal (n=24) and Low Schizotypal groups (n=26) based on their score on the Prodromal Questionnaire (Loewy et al., 2007). Participant's EEG was recorded while they underwent an auditory oddball paradigm with a concurrent visual task. Spatiotemporal analysis of whole data using an analysis of covariance (ANCOVA) revealed main effects of surprise and deviant type, and a significant group*deviant type interaction. There was neither a significant main effect of group nor an interaction group*surprise, that is no differences in the MMN between Low Schizotypy and High Schizotypy groups. However, our findings suggest that auditory oddball paradigms with longer duration deviants have the potential to be further explored with larger schizotypy samples to identify biomarkers for psychosis proneness.

A novel approach to characterising (relatively) complex decision-making using electroencephalography

Dr Dragan Rangelov, Postdoctoral Research Fellow
University of Queensland

Prof Jason Mattingley, *University of Queensland*

Quantitative models of decision-making permit accurate prediction of human behaviour. Recent electroencephalography (EEG) studies have linked two components – the CPP and the N2b – to decision processes as modelled by the diffusion model of decision-making. Thus, previously described EEG indices permit tracking of decision-making dynamics. Much current research focuses primarily on simple decisions such as motion direction discrimination. By contrast, relatively little is known about the dynamics of more complex decisions. Here we aimed to characterise (relatively) complex decisions using EEG indices of decision-making (the CPP and the N2b). Further, we tested whether cognitive load affects complex decision-making. Finally, we measured participants' response precision, that is, how similar the observed and the correct responses were, instead of response speed and accuracy. Participants (N = 36) monitored a stream of moving dots that changed colours every 2s, and memorized the motion direction of the target-coloured dots. Twice per trial, the dots had a target colour, and participants reported the average direction of the two target motions. To vary cognitive load, either one colour or two colours served as targets in different trial blocks. Behavioural analyses revealed that responses were a better match to the second target motion than the first. The response precision was similar for one and two target colours, suggesting that participants were able to concurrently maintain attentional sets for two colours. We observed strong N2b and CPP components both to the first and the second target which, consistent with behaviour, did not vary with cognitive load. Taken together, our results reveal that individual components of complex decisions closely resemble simple decisions. Importantly, our findings also suggest that complex decisions exhibit unique dynamics – here in the form of a recency bias – which would not be captured by simpler decision-making paradigms.

Decoding voluntary decisions: perception of freedom is dependent on keeping your options open

Miss Natalie Rens, PhD student
Queensland Brain Institute

Prof Ross Cunnington, *Queensland Brain Institute*
Dr Stefan Bode, *University of Melbourne*

It has been proposed that the perception of freedom of choice is driven by the opportunity to choose alternative plans of action. This study investigated how the perceived freedom of choice and the underlying neural correlates change depending on the ongoing maintenance of a choice and the availability of options.
In this fMRI experiment, participants freely chose between left or right doors in a virtual environment. After advancing up a corridor, cues at the halfway point indicated whether one or both doors remained open. When both doors were open, participants were free to either keep or change the initial decision (alternative action available), while a closed door forced participants to select a particular door (no alternative action available), which either matched their choice or required a change of decision.
We found that trials in which both actions remained available were rated as significantly freer than forced choice trials, and congruent choices were rated as freer than changes of decision. Multi-voxel pattern analysis revealed that upcoming choices could initially be decoded from visual cortices, followed by motor cortex at the halfway point. In the free choice conditions, additional clusters in the precuneus were predictive of choice. For congruent choice trials, the availability of the other door could be predicted from right dorsolateral prefrontal cortex, the frontopolar cortex and right inferior frontal gyrus.
These results suggest that regions related to self-referential processing, uncertainty and option selection were recruited to maintain flexible action plans for free choices, while forced conditions resulted in a fast translation of choices into specific motor plans. The subjective feeling of freedom appears to depend not only on making an unconstrained initial choice, but moreover, on the ongoing opportunity to change one's mind. Overall, this suggests that the perception of freedom is strongly related to keeping our options open.

Are two brains better than one? Evidence of neural synchrony across co-actors in a visually guided movement task

Miss Angela I. Renton, Research Technician
Science of Learning Research Centre

Dr David R. Painter, *Science of Learning Research Centre*
Mr Jeffrey J. Kim, *University of Queensland*
Prof Jason B. Mattingley, *University of Queensland*

In everyday life, it is often necessary for individuals to coordinate their actions with others to achieve common goals. Relatively little is known about the neural processes underlying such joint actions. Here we tested whether joint actions might involve coupling, or synchronisation, of brain states between co-actors. Pairs of participants used joysticks to manoeuvre a computer cursor to one of eight visual targets while we recorded neural activity using electroencephalography. In separate, randomly interleaved trials, participants were cued to perform the movement task either individually or jointly. Critically, throughout the experiment, participants were physically separated and thus not able to observe one another's movements directly. The cursor and visual targets flickered at unique frequencies, thus evoking unique steady-state visual evoked potentials. To test for evidence of neural synchrony, we employed a combination of time-frequency analyses, cross-correlations and deep neural network machine learning techniques. Cursor movements were faster and more direct under joint control than individual control. Additionally, joystick displacements were more highly correlated during joint control than individual control, indicating behavioural coupling. Moreover, neural activity between participants within each pair was more correlated under joint control than individual control conditions, consistent with neural synchronization. For the joint control condition, neural coupling was stronger for movements that successfully hit the target than for those that missed. Remarkably, neural coupling under joint control was even present before movement onset, suggesting synchronization was initiated during the early stages of motor planning.

Pushing attention to one side: Force field adaptation alters attentional processing in the healthy brain.

Dr Eva-Maria Reuter, Postdoctoral Reserach Fellow
University of Queensland

Prof Jason B. Mattingley, *University of Queensland*
Prof Ross Cunnington, *University of Queensland*
Prof Stephan Riek, *University of Queensland*
A/Prof Timothy Carroll, *University of Queensland*

Unilateral spatial neglect is a major cause of disability after stroke, and is characterised by an impaired capacity to attend to one side of space. Sensorimotor adaptation to optical wedge prisms is a promising treatment for neglect, but it remains unclear precisely how prism adaptation improves attention in neglect patients. For example, it is unknown whether prism effects rely on the experience and correction of visual errors, or upon subsequent adjustments of the motor plan. Here we asked whether changes in spatial attention can be induced by a remapping between intended movement direction and motor commands in the absence of a visual mismatch. We used event-related potentials (ERPs) recorded using electroencephalography to determine whether visual spatial attention is affected in healthy adults by adaptation to force fields that push movements to one side.
Thirty-eight healthy subjects performed a Posner spatial cueing task before and after they made 300 reaching movements to a target aligned with the body midline. A velocity-dependent force-field pushed the hand either leftward (n=19) or rightward (n=19) during each reach. Critically, the field was introduced gradually, so that participants implicitly learned to apply time-varying compensatory forces to one side of space without experiencing substantial deviations in movement trajectory.
Adaptation boosted attentional orienting responses (N1 ERP component, time-locked to the cue) toward the side of compensatory hand forces, and impeded attentional disengagement (P1 ERP component, time-locked to the target) from that side. The results indicate that remapping between motor commands and intended movement direction is sufficient to shift attention, despite the fact

that neither the hand nor the visual feedback were ever displaced from the body midline. These data from healthy adults provide new insight into the potential mechanisms of prism therapy, and open avenues for new treatment approaches for neglect.

Brain oscillations and connectivity in ASD: insights from atypical sensory and perceptual processing?

Prof Gina Rippon, Chair of Cognitive NeuroImaging
Aston University

Mr Robert Seymour, *Aston University*

Prof Klaus Kessler, *Aston University*

Based on the application of new techniques using contemporary measures of brain synchronisation and invoking the coupling of both high and low frequency bands, we have proposed a new model of atypical cortical connectivity in ASD. This model has developed from the observation that both hyper- and hypo-sensory and perceptual processing characterise the ASD profile. This would impact on both feedforward and feedback cortical pathways and affect normal predictive coding mechanisms, the downstream consequences of which could manifest as "the world changing too fast for a miswired brain".
We have tested this model using a simple sensory processing paradigm. Data were collected from N=7 ASD participants and N=10 controls, using a 306-channel Elekta Neuromag Magnetoencephalography (MEG) system. Phase-amplitude coupling (PAC) between high-frequency gamma-band and low-frequency alpha-band activity was calculated as a measure of local dysregulation. Feedforward/feedback connectivity profiles were calculated using Granger causality techniques.
Separate measures of alpha and gamma band activity showed no differences between ASD and controls, but there were marked differences in PAC, with a much more variable profile for the ASD group. This was associated with an atypical feedforward/feedback profile in the ASD group, dominated by increased feedforward connectivity in the gamma band and reduced feedback connectivity in the alpha band.
These early findings indicate that such measures offer a promising way of characterising connectivity profiles in the ASD brain which could be consistent with emerging neurocognitive models and with the extremely heterogeneous symptom profiles typical of the condition.
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Bayesian-like Processing in Visual Perception: An Index of Prediction Errors.

Mr Jonathan Robinson, PhD Student
Queensland University of Technology

Prof Michael Breakspear, *Queensland Institute of Medical Research*

Prof Andy Young, *University of York*

A/Prof Patrick Johnston, *Queensland University of Technology*

A recently established index of prediction errors in visual perception offers a means to investigate the processes underlying the formation of perceptual predictions. In two EEG experiments, we investigated the potential Bayesian-like parameters determining the reassessment of predictions. We manipulated the visual stimuli, both in terms of accumulated prior evidence, and disparity between present data and prior evidence. To achieve this, we present a rapid sequence of highly controlled images that form rigid rotation trajectories. Each sequence has a final image transition that is either predictable (conforms to sequence trajectory) or unpredictable (violates sequence trajectory). To investigate prior confidence, we adjusted the number of images (3/5 images) in a sequence prior to the unpredictable image. To investigate the changes of disparity between data and priors, we adjust the extent to which the final image violates the context trajectory (small violation: change in the size of final transition; large violation: reversed trajectory). To ensure that difference between conditions could only be attributed to the context created by the sequence and not merely low-level difference between images, trials were organised such that identical final image transitions occur in each condition and no single stimulus is repeated within a sequence. As with previous work, we found significantly large N170 amplitudes for all unpredicted final stimuli. Additionally, we find a greater N170: 1) based on the number of priors; a greater error signal to greater accumulated evidence; 2) depending on the size of violations, a greater error signal for larger violations that are contrary to the established trajectory. Further, a sequential decrease in the N170 occurs with each image presentation. We conclude support for a Bayesian-like function of signaling prediction errors, which serves as a means of efficiently refining the accuracy of predictions in visual perception.

When stochastic rules are not deterministic enough: An MMN study

Dr Urte Roeber, Senior Lecturer
Murdoch University

Prof Erich Schröger, *University of Leipzig*

One of the pre-requisites for flexible and adaptive behaviour is our brain's ability to encode regularities in the stimulation and to detect events that violate them. From hundreds of studies we know we can test this ability with sounds that violate a rule inherent in the recent auditory stimulation, because we typically find the mismatch negativity (MMN) component of event-related potentials (ERP) elicited by such sounds, even when they are not attended. Apparently, the system underlying MMN is of remarkable intelligence, because it not only detects simple rules such as stimulus repetitions but also complex abstract rules such as contingent, serial relationships between the stimuli. However, all previous reports of MMN are from violations of sequentially deterministic regularities. Here, we show that the predictive power of the MMN-system vanishes when sequential determinism is destroyed, that is, when the regularity does not obey a constant relation between consecutive sounds even though the overall rule is quite simple. We used two frequent but randomly presented standard tones (900 and 1100 Hz, p = .45 each) and one infrequent deviant tone (1000 Hz, p = .10) in the critical condition and compared our results with several, structurally equivalent but sequentially deterministic control conditions. According to traditional MMN results and theory one would expect that the MMN system could easily handle two different standards. However, we found reliable MMN only in the sequentially deterministic conditions, whereas there was no sign of MMN in the critical, sequentially stochastic condition. These results uncover a serious constraint on the MMN system's intelligence. But the results also demonstrate how important sequential dependencies are in our auditory environment and that the MMN system might be fine-tuned to deal with those.

Evidence of an abnormal state in non-clinical hallucinations

Mr Sebastian Rogers, PhD candidate
The University of New South Wales

A/Prof Joel Pearson, *University of New South Wales*

Are hallucinatory experiences dependent on an abnormal neural or perceptual state, like sleep, drug effects, or neurological changes such as in Parkinsons disease? Various models including abnormal states have been proposed to underlie clinical hallucinations. Here we sought evidence of an induced abnormal state in the normal population using simple geometric flicker-induced hallucinations. We presented subjects with an annulus flickering at 10 Hz that reliably induces hallucinatory grey blobs that move around the annulus. Hallucination onset latency was measured by keypress when subjects saw the blobs, and was taken as evidence of being in this state. Onset latency in a 10 Hz flickering test annulus was reduced by a prior 50 Hz flickering annulus (that does not cause hallucinations) relative to a control annulus, suggesting that it expedited the induction of the hallucinatory state. Onset latency also increased with increasing temporal durations between a prior 10 Hz annulus and an identical test annulus, indicating that the state survives short breaks in stimulation in a time dependent manner. This prestimulus priming effect was local in visual space, suggesting a local state effect in visual cortex and a contingency on retinotopic neural processes. Next we tested the frequency specificity of this state-like priming effect. We presented the prior and test stimuli at the same or different frequencies. The data did not support frequency specificity, suggesting a state that is invariant to the particular frequency of neural oscillations. Together the data suggest that luminance flicker might induce a kind of non-ordinary state in visual processing. Mechanisms underlying this state and how it relates to other types of hallucination in clinical and normal populations remain unknown. Future research will attempt to determine whether the hallucinatory state generalizes to other forms of hallucination and will endeavour to uncover the associated neural mechanisms.

Domain specific processing or visual expertise? Exploring the neural mechanisms underlying face processing using electroencephalography.

Ms Manuela Russo, PhD student
Queensland University of Technology

A/Prof Patrick Johnston, *Queensland University of Technology*
Dr Jordy Kaufman, *Swinburne University of Technology*

The N170 is a well-established electrophysiological brain index of higher-level vision. Research shows that the N170 has a greater amplitude to faces than to other stimulus categories and its peak is later and sometimes larger for inverted faces than for upright faces. Such findings led to the Face Specificity Hypothesis (FSH), suggesting the existence of specialized face processing mechanisms, and of orientation sensitive representations that are specific to face stimuli. An alternative is the Expertise Hypothesis (EH), which suggests the existence of a system for 'visual expertise' that allows people to develop a high level of subtle discriminative capacity in any class of visual stimuli, if sufficiently interesting/important to them. Thus, we develop a high level of expertise in discriminating faces since they are important to us, but the mechanisms supporting such expertise are domain general. However, the EH has been difficult to demonstrate. Our work builds on the findings of Johnston et al. (2014), that showed behavioral inversion effects are most likely to be observed when the stimulus set meets two criteria:1) members are defined by standard configuration of features; 2) members share a canonical view, such as Cartographic contours (e.g. maps). In the current study we investigated whether the N170 elicited by familiar maps might show inversion effects similar to those typically seen in response to faces. Australian participants were asked to perform a simple vigilance task, and were exposed to visual stimuli (i.e. four different line drawings of countries). Stimuli were presented to participants in both upright and inverted orientations (i.e. north-top-south-bottom). We found that N170 amplitudes were greater to Australia than to other countries. N170 peak latencies to Australia Upright were significantly faster than those to Australia Inverted, Other Upright and Other Inverted. Our results offered support for the Visual EH in preference to the FSH.

Neuroinformatics tools for simulating realistic brain activity

Dr Paula Sanz-Leon,
University of Sydney

Mesoscopic-scale models known as neural masses and neural fields are widely used to study spatiotemporal dynamics of neural tissue. When analytic methods become intractable, the use of numerical simulations is essential to get a deeper understanding of brain activity. In this talk, I will begin by briefly explaining the motivations behind building a brain simulator. This will be followed by a description of current tools available to simulate from one single area (or tissue), to a few interconnected areas to the whole brain. I will also discuss their similarities, advantages and limitations. Lastly, I will show you that getting started with brain simulations is just a few clicks away.

More than meets the eye: effects of task instruction on direct gaze biases in schizophrenia.

Dr Kiley Seymour, Senior Research Associate
Macquarie University

Prof Gillian Rhodes, *University of Western Australia*
Dr Jonathan McGuire, *Macquarie University*
Mr Nikolas Williams, *Macquarie University*
Dr Linda Jeffery, *University of Western Australia*
A/Prof Robyn Langdon, *Macquarie University*

Research on poor interpersonal functioning in schizophrenia focuses on impairments of emotion recognition and mental-state reasoning; but little is known of more fundamental perceptual abilities such as those needed to process eye gaze. Healthy perception of gaze is sustained by dedicated neural substrates and is critical for social interaction, providing vital information about another person's focus of attention and state of mind. People with schizophrenia misjudge averted gaze as directed towards them. However, current tasks do not dissociate an early perceptual bias from a high-level top-down effect. Studies that report a "direct gaze bias" in schizophrenia typically present faces with different gaze deviations and ask: "Are the eyes looking at you?" These tasks require a self-referential judgment and prompt inferences of the other person's intent. Thus, tasks of this type may tap into top-down effects of a theory-of-mind impairment or abnormal beliefs about being watched that might bias a patient's response. Our study measured perceptual sensitivity to gaze deviations ("cone of direct gaze") in schizophrenia by simply asking participants to judge whether eyes were directed left, right, or straight ahead. Such a judgement eliminates potential higher-order effects associated with self-referential processing or theory of mind impairments. Our results revealed that patients' cone of direct gaze width was similar to controls. Thus, our findings suggest that, while patients may suffer from deficits associated with interpreting another person's gaze, the early perceptual encoding of eye gaze direction is intact in schizophrenia. Tendencies to misjudge gaze direction in this group are therefore more likely to reflect effects of task instructions that prompt judgments of others' intent and cue self-referential biases.
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Coping Through Crying

Miss Leah Sharman, PhD Candidate
University of Queensland

Dr Eric Vanman, *University of Queensland*

It has often been suggested that one of the main functions of crying may be to facilitate recovery after having been in distress. That is, crying could serve to sedate, reduce pain, and restore the homeostatic balance. Attempts to explore this topic have previously used retrospective studies, with none experimentally testing this functional explanation. This experiment investigated the intrapersonal functional explanation of crying by evaluating if crying before a stressor will facilitate coping and recovery. Participants were first year undergraduate female students at the University of Queensland asked to watch several short videos lasting 20 minutes. Participants were randomly assigned to either the sad or neutral (interesting) video sequence. Videos chosen in the 'sad' condition were chosen for their extreme emotion elicitation, i.e., sad crying responses. Performance on a stressor (cold pressor task) was then timed. Throughout the experiment participants heart rate, respiration, and facial expressions were recorded through iMotions using FACET software. Saliva samples were also taken at 4 separate time points to measure changes in cortisol over the hour for baseline, video response, reaction to stressor, and a final time point. It is predicted that compared to controls participants who have cried will (a) be able to withstand a stressful task for longer; (b) show lower levels of cortisol following the stressor; and (c) have faster physiological recovery to baseline following the stress task measured using heart rate, respiration, and salivary cortisol. Preliminary results and implications will be discussed.

Examining the symptomology network of ADHD: A new way to view ADHD symptoms.

Dr Tim Silk, Senior Research Officer
Murdoch Childrens Research Institute

Dr Charles Malpas, *Murdoch Childrens Research Institute*
Dr Richard Beare, *Murdoch Childrens Research Institute*
Prof Vicki Anderson, *RCH Mental Health of Royal Children's Hospital*
Dr Daryl Efron, *Royal Children's Hospital*
Prof Philip Hazell, *University of Sydney*
Prof Jan Nicholson, *La Trobe University*
Dr Emma Sciberras, *Deakin University*

Categorical and dimensional approaches to assess ADHD symptoms are widely used, however rely on binary symptom count of equal weighting, with little attention to the individual make up of symptoms. By only assessing symptom count we might lose important information about the possible contribution of individual symptoms. Rather than as a list of separately summed symptoms, it can be viewed as a network of interacting symptoms.
Using a novel network model approach, this study explores the symptomology network consisting of the 18 DSM symptom criteria for ADHD in order to understand the complexity of the relationship between symptoms. Data was derived from the

Children's Attention Project, a community cohort study of 146 medication naïve children with confirmed ADHD and 209 confirmed non-ADHD controls (6-8 years). The presence of absence of each DSM-IV symptom criteria for ADHD were recorded from a parent face-to-face structured diagnostic interview. Analyses find that not all symptoms are equal, having different frequencies of endorsement, and different configurations of symptoms, with certain symptoms playing a more important role within the ADHD symptom network. There are 116,220 combinations of symptoms within a diagnosis of ADHD, with 91.8% the sample demonstrating a unique configuration of symptoms. Symptom association networks revealed the dissociation between inattentive and hyperactive symptoms, however highlights the importance of the hyperactive symptoms in the symptom network. In particular the 'motoric'-type symptoms and interrupts may be the most clinically significant. This study provides a unique approach in examining the network structure of ADHD symptoms. Moving beyond classical categorical and dimensional approaches, conceptualizing the symptoms as a network of interacting features has the potential to reveal symptoms of clinical importance. The finding may help to explain the heterogeneity in the clinical, cognitive and behavioural ADHD phenotype

Trigger failure in the stop-signal task triggers re-interpretations of electrophysiological relationships with inhibitory ability

Mr Patrick Skippen, PhD Candidate
University of Newcastle

Dr Ross Fulham, *University Newcastle*
Dr Dora Matzke, *Universiteit van Amsterdam*
Prof Andrew Heathcote, *University of Tasmania*
Prof Patricia Michie, *University of Newcastle*
A/Prof Frini Karayanidis, *University of Newcastle*

The latency of an individual's inhibitory process, Stop-Signal Reaction Time (SSRT), can be estimated a number of ways. However, traditional SSRT estimation is fraught with numerous difficulties, such as the inability to predict the occurrence of and to control for trials on which the inhibitory process fails to trigger (Trigger Failure; TF). While numerous studies have investigated electrophysiological correlates of SSRT, none have investigated such relationships while taking TF into account. We use hierarchical modelling to derive posterior distributions of SSRT, while simultaneously estimating TF. Participants derived from a large healthy community sample (n=124; 56% female; mean age 21) completed the stop-signal task with concurrent EEG recording. Population inference of the relationships between ERPs locked to the stop-signal and the model parameters was completed using plausible values analysis. Our results show that SSRT was substantially inflated (~100ms) without the inclusion of TF in the estimation. The inclusion of TF substantially reduced relationships between SSRT and both the N1 and P3 components. Conversely, a relationship between SSRT and the N2 component was not found with standard estimation methods but was apparent with the inclusion of TF. These results have important implications for the inhibition literature. Previously reported groups differences in SSRT may not be replicable with the inclusion of TF. In sum, the inclusion of TF reduces both the estimation and variance of SSRT, while also altering commonly reported relationships with ERPs.

Patterns of sedentary behaviour are associated with cognitive performance and cardiovascular disease risk in mid to late life

Dr Ashleigh Smith, Research Fellow
University of South Australia

Miss Danielle Greaves, *University of South Australia*
Miss Emma Tregoweth, *University of South Australia*
Dr Hannah Keage, *University of South Australia*

Emerging evidence indicates that engaging in extended periods of sedentary behaviour is associated with adverse health outcomes (including cognitive impairment) which remain independent of physical activity. In addition to total time engaged in sedentary activities, the way in which this time is accumulated is also important, with long sedentary bouts associated with poorer health outcomes compared to shorter bouts. Therefore, the purpose of this study was to compare sedentary metrics including those representing total time and fragmentation of behaviour with performance on the Addenbrooke Cognitive Exam-III (ACEI-II) and self-reported cardiovascular disease risk. As a part of a larger study, 7-days of objectively measured PA were captured using a GENEActiv wrist worn tri-axial accelerometer in 90 adults (mean age 65.5 □ 7.52, range 50-80 years, 52 females). Raw accelerations were reduced into 60 second epochs and time spent in sedentary behaviour compared to predefined cut-points using a custom built software (COBRA, UniSA). To explore patterns of sedentary behaviour, sedentary bouts were defined as at least 30 continuous minutes where accelerations were 100% below the light intensity threshold. Mixed effects models demonstrated sedentary time spent in bouts, but not total sedentary time per day, were associated with lower ACE scores. Independent of ACE-III score, both total sedentary time and time spent in bouts were associated with increased cardiovascular disease risk. These findings provide initial evidence for the importance of breaking up long bouts of sedentary behaviour for both cognitive performance and cardiovascular disease risk.

The quality of visual information modulates response inhibition in the modified stop-signal paradigm

Ms Maria Soloveva, PhD student
Monash University

Dr Sharna Jamadar, *Monash University*
Dr Govinda Poudel, *Monash University*
Dr Matthew Hughes, *Swinburne University*
Prof Nellie Georgiou-Karistianis, *Monash University*

Stop-signal response inhibition is a hallmark of executive function and can be explained by the outcome of a race between independent 'go' and 'stop' processes operationalised in a go and a stop signal task. Therein, inhibition is successful if the stop process finishes before the 'go' process and if the 'go' process finishes before the 'stop' process, response inhibition is unsuccessful. In this experiment, we assessed how parametrically manipulating the quality of visual information of the 'go' stimuli affects inhibition, as measured by probability of inhibition (Pi) and stop-signal reaction times (SSRTs). Fourteen healthy individuals (7 female and 7 male) (M = 31.36; SD = 8.90) underwent a modified 16-minute stop-signal task, where 'go' stimuli were the letters 'Y' and 'V' with low, intermediate-1, intermediate-2, and high levels of perceptual clarity (levels of Gaussian blur). On 33% of trials, the stop-signal (50 ms audio tone) followed the 'go' stimuli after a brief interval (the stop-signal delay, SSD), which was individually adjusted based on participant's response to intermediate-2 level of visual difficulty. We found that reaction times to the 'go' stimuli increased with increased visual difficulty, $F(3, 39) = 13.47$, $p < .001$, and that the probability of inhibition (Pi) also increased as a function of visual difficulty, $F(3, 39) = 11.60$, $p < .001$. Notably, however, SSRTs did not vary across conditions. Our results indicate that manipulating the go task difficulty affects the P(i) but does not affect SSRT and further support a well-established assumption that mechanisms responsible for choosing responses or inhibitions are independent.

Attention shifting performance in regular cannabis users following prolonged treatment with cannabidiol (CBD)

A/Prof Nadia Solowij,
University of Wollongong

Dr Samantha Broyd, *University of Wollongong*
Ms Camilla Beale, *University of Wollongong*
Dr Chao Suo, *Monash University*
Dr Peter Galettis, *University of Newcastle*
Prof Nagesh Pai, *University of Wollongong*
Prof Rodney Croft, *University of Wollongong*
Prof Murat Yücel, *Monash University*

Patients with schizophrenia and chronic cannabis users show impaired attentional processing. Cannabidiol (CBD) has been shown to have antipsychotic properties and to ameliorate cognitive, symptomatic and brain harm in cannabis users. We investi-

gated whether prolonged CBD administration to ongoing regular cannabis users may improve attention shifting performance and whether this may be related to changes in hippocampal glutamate levels and improvement in psychological symptoms. Twenty cannabis users participated in a 10-week open-label trial in which they received 200mg oral CBD daily whilst continuing to use cannabis. The CANTAB Attention Shifting Task (AST) and clinical measures were administered at baseline and post-treatment. Magnetic resonance spectroscopy was performed at each time point to quantify hippocampal glutamate. At baseline, poorer AST performance was associated with higher hippocampal glutamate levels (switching cost: p=.004) and a younger age of onset of cannabis use (greater errors, and switching and congruency costs: p=.05-.001). After 10 weeks of CBD treatment, AST performance improved in terms of latency to respond in switching blocks (p=.008) and congruency cost (p=.009). Better post-treatment AST performance correlated with higher CBD plasma levels (latency: p=.012; switching cost: p=.006; switch errors: p=.034). AST performance was associated with improved memory performance, but not strongly with improvements in depressive and psychotic-like symptoms. Prolonged treatment with CBD may improve attention shifting performance in regular cannabis users who continue to smoke cannabis. Improvements in verbal learning and memory, depressive and psychotic-like symptoms were also observed with some modulation of hippocampal glutamate levels. CBD holds promise for further potential therapeutic efficacy in cannabis dependence and a range of neuropsychiatric disorders. This study was enabled by an Australian Research Council Future Fellowship.

Universal preferences and individual differences in aesthetics: An exploratory comparison between vision and touch

A/Prof Branka Spehar,
University of New South Wales

Miss Catherine Viengkham, *University of New South Wales*
Miss Zoey Isherwood, *University of New South Wales*
A/Prof Branka Spehar, *University of New South Wales*

Background: Empirical aesthetics is the second oldest area of experimental psychology, but for the much of its history, the progress has been limited by vacillating between the opposing views that focus exclusively on either the universal aspects or the culturally or individually specific differences in aesthetic preference. There has also been a significant neglect of aesthetic considerations in sensory systems other than the visual (and perhaps auditory) modality. Indeed, it has been argued that creating a comparable aesthetic experience from vision to other senses was unachievable, simply because our sensory modalities are all so overtly different.
Methods: To address these limitations, we use fractal dimension to parametrically manipulate in the same way the complexity of abstract images/surfaces across the visual and tactile domains. In the first experiment we compare visual only, tactile only and visuotactile preferences for real 3D surfaces varying in fractal scaling properties. In the second experiment we investigate the stability and consistency of individual preference patterns across vision and touch for both static and dynamic visual and tactile stimuli, and both between and within individuals.
Results: We use k-means clustering and Q-mode factor analysis to determine dimensional structure of interindividual variations in aesthetic preference within and across different sensory domains. We found consistent and dimensionally similar clusters of individual differences in both tactile and visual preferences.
Discussion: We demonstrate that fractal dimension is an effective means of quantifying visual complexity even in stimuli that are superficially different in appearance and that these parameters are sensitive to both population and individual preferences. We show that both average preference and dimensional structure of interindividual variations were remarkably similar across different presentation modalities and quite stable within individuals.

Investigation of auditory processing differences with synchronous vs. asynchronous bimodal stimulation

Mrs Maria Viktoria Stuckenberg, PhD Student
University of Leipzig

Mr Andreas Widmann, *University of Leipzig*
Prof Erich Schröger, *University of Leipzig*

In our daily life, we are continuously exposed to a variety of information from all senses. The simultaneous processing thereof is essential for building a coherent percept of our environment. In order to investigate auditory processing in the context of audio-visual stimulation, we tested two different conditions: The visual and the auditory information occurred either simultaneously or the visual information preceded the auditory information. In the former, the two modalities were expected to interact mutually with each other, whereas in the later, the visual information was expected to predict the forthcoming sound (i.e., to generate an expectation of the upcoming auditory stimulus). In the synchronous condition, a white square was presented either above or below the fixation cross and simultaneously with a complex tone with either high or low pitch. The participants task was to indicate whether the tone was congruent with the square (e.g., high tone and square above fixation cross). In the asynchronous condition, the white square preceded the presentation of the tone by 600 ms, whereas the participants task remained the same. In both conditions the tones with their pitch being incongruent with the location of the squares elicited enhanced negativities, which started considerably earlier in the asynchronous condition (~150 ms) than in the synchronous condition (~200 ms).

Schizotypy and form perception through pooling: an application of the oblique superiority effect

Ms Jamesha Subachandran, Honours student
University of New South Wales

Dr Damien Mannion, *University of New South Wales*

The oblique superiority effect refers to a perceptual phenomenon in which cardinal (horizontal and vertical) dot patterns are harder to detect than oblique dot patterns. Motivated by the critical role of spatial pooling in the proposed neural mechanisms underlying this phenomenon, we applied the oblique superiority effect to the investigation of psychometrically-defined schizotypy. Based on previous studies reporting spatial pooling impairments in schizophrenia, it was hypothesised that ranked oblique superiority effect scores would decrease with increasing ranked scores on two schizotypy subscales: Unusual Experiences and Cognitive Disorganisation. Participants (N = 120, undergraduate psychology students) completed a computer-based task measuring the ability to discriminate cardinal (horizontal) and oblique target dot patterns from noise, and a paper-based questionnaire measuring schizotypy (O-LIFE). While the results supported the existence of the oblique superiority effect, there was no evidence for an association of the oblique superiority effect with schizotypy. These results are consistent with the ability to spatially pool visual information being unrelated to the level of psychometrically-defined schizotypy. This finding may reflect a difference between schizophrenia and high schizotypy, and further research into the oblique superiority effect may provide insight into the neural circuitry of those with schizophrenia.

Semantic priming and self-reported thought disorder

Mr Philip Sumner, PhD Student
Swinburne University of Technology

Dr Matthew Hughes, *Swinburne University of Technology*
Mr Sean Carruthers, *Swinburne University of Technology*
Prof Susan Rossell, *Monash Alfred Psychiatry Research Centre*

Semantic memory deficits in schizophrenia have been investigated for decades. These seem particularly sensitive and exacerbated in those with thought disorder (TD). Semantic priming has been common among the tasks used to index these deficits. However, difficulty has been encountered in the definition and measurement of TD, where typical assessments have relied on measures with a limited number of endorsed items that exhibit positive skewed. In this study, a long-SOA semantic priming task (lexical decision) was administered to 26 individuals with either schizophrenia or schizoaffective disorder, as well as to 26 healthy controls. Participants also completed a 29-item self-report questionnaire in terms of the frequency with which they had experienced various symptoms of TD. Although evidence of semantic priming was found using a 2 (semantic relatedness) x 2 (diagnostic group) mixed-design ANOVA, this priming did not differ significantly between those with schizophrenia and controls (i.e. there was no interaction between semantic relatedness and diagnostic group on lexical decision reaction times). Nevertheless, there was a trend-level (p=0.096) group effect on semantic priming when individuals with schizophrenia were subgrouped into those who had higher and lower levels of self-reported

TD. Moreover, there was a weak positive association between total self-reported TD and the priming effect (r=0.25, p=0.046). These results are consistent with abnormal semantic function and hyperpriming in those with TD and demonstrate the continuum of its severity across diagnostic groups. Further work is being conducted to investigate the functional neuroimaging underpinnings of these semantic deficits.

Neurocognition and formal thought disorder in schizophrenia: do impairment profiles differ between symptoms?

Dr Eric Tan, Postdoctoral Research Fellow
Swinburne University

Prof Susan Rossell, *Swinburne University*

Neurocognitive deficits are regularly associated with formal thought disorder (FTD), with semantic and executive dysfunction being the most consistently linked to the symptom, with attention and working memory less so. The classic approach to FTD research has tended to employ group comparisons (FTD versus non-FTD) and a composite FTD severity score. However, FTD is a heterogeneous symptom with 18 recognised sub-symptoms that present differently. It follows then that the underlying neurocognitive profile may differ between these. This study sought to address this by examining the relationship between individual FTD symptoms, a global FTD score and eight neurocognitive domains on a comprehensive battery: Speed of Processing (SP), Attention/Vigilance (ATT), Working Memory (WM), Verbal Learning (VerL), Visual Learning (VisL), Reasoning and Problem Solving (RPS), Social Cognition (SOC) and Inhibition/Executive Function (INHB). 59 schizophrenia/schizoaffective disorder (M=43.46,SD=10.67) completed the MATRICS battery and the D-KEFS Colour-Word Interference Test. FTD was assessed using the Thought, Language and Communication Scale (TLC). Spearman's correlations were conducted, p-values corrected to <.007. Pressure of speech was negatively correlated with INHB scores. Derailment was significantly negatively correlated with VisL. Loss of goal was significantly correlated with ATT and VerL. There were also a number of correlations that showed nonsignificant trend towards association: poverty of speech with SOC scores; tangentiality with WM and VerL, loss of goal with WM and RPS; and global FTD scores with VerL and INHB scores only. The findings strengthen existing evidence relating neurocognition and FTD; and confirm a differential pattern of associations between individual FTD symptoms and neurocognitive variables. Heterogeneity in FTD presentation appears to be associated with underlying neurocognitive heterogeneity. The mechanistic implications of these are discussed.

Do repetition suppression and expectation have different effects on the fidelity of sensory representations?

Dr Matthew Tang, Post-doctoral research fellow
University of Queensland

Prof Jason Mattingley, *University of Queensland*

Repetition suppression - a reduction in neural activity when a stimulus is repeated - has been widely used to examine neural coding of sensory information. Traditionally, the reduced response to the repeated stimulus has been attributed to neural adaptation. Recently, however, an alternative account has suggested that the reduction in neural activity to a repeated stimulus reflects a fulfilled sensory prediction. Consistent with this account, when a repeated stimulus is presented unexpectedly, the neural response is not reduced relative to the initial presentation of the same event. A possible resolution of the debate between the adaptation and predictive coding accounts is that prediction causes sharpening of tuning curves to relevant stimulus properties while adaptation decreases the amplitude of neuronal responses. Here we tested this hypothesis using a forward encoding analysis approach to electroencephalography (EEG) recorded at the scalp, which allows for the reconstruction of orientation-selective visual responses. To do this, participants were presented with sequential pairs of Gabor stimuli while recording EEG. The critical variable was the match in orientation between the first and second Gabor, manipulated across two conditions. In one condition the two Gabors had the same orientation on 80% of trials and one of 8 other orientations on 20% of trials, and in the other condition these probabilities were reversed. This manipulation allowed us to separate effects of expectation and adaptation on repetition suppression, as the orientation change was either expected or unexpected. We used forward encoding modelling to reconstruct the orientation-selective responses to the stimuli from EEG signals across the different expectation conditions. We found that expectation and adaptation have distinct effects on the neural representation of orientation information, suggesting that these two processes make different contributions to the repetition suppression effect.

Habitual physical activity levels, the p300 and the significance of alpha power

Miss Nicole Taylor, Master Student
The University of Auckland

A/Prof Paul Corballis, *The University of Auckland*
Dr David Moreau, *The University of Auckland*

Age-related declines in cognitive function are a major cause for concern in public health. Accordingly, there is considerable interest in developing lifestyle or exercise interventions that can prevent or delay the onset of cognitive decline. The relationship between the P300 component of the event-related potential (ERP) and levels of habitual physical activity has been well established, and offers a potential marker for cognitive function. However, there are still large underlying questions that remain about the nature of this relationship. This study aims to determine the links between levels of psychophysiological measures such as central blood pressure, heart rate, executive function and resting EEG, in order to reveal how habitual physical activity levels affect the P300. Electrophysiological effects of physical activity were investigated in a cross-section study comparing two groups of people who vary in habitual levels of physical activity. The International Physical Activity Questionnaire was used to classify participants into two groups high-active or inactive, based on overall levels of activity. Central blood pressure and heart rate were also measured to establish a link between self-reported physical activity levels and physiological function. ERPs were recorded during the AX-Continuous Performance Task in order to extract P300 responses to stimuli requiring cognitive control. Preliminary data suggest that P300 amplitude and latency were both affected by physical activity. Furthermore, the variation in P300 between groups was modulated by differences in resting EEG alpha power between groups. While preliminary, these findings imply that cognitive control may be influenced by physical activity, and suggest an additional approach for researchers to consider when investigating how exercise interventions can influence brain health and cognitive function.

Decoding dice and digits with Magnetoencephalography: How long does it take to access magnitude?

Ms Lina Teichmann, PhD Student
Macquarie University

Dr Thomas Carlson, *Syndey University*
A/Prof Anina Rich, *Macquarie University*

Numerical format describes the way quantities are conveyed, for example as digits ('3') or Roman Numerals ('III'). There is an ongoing debate about whether numerical representation in the brain is abstract and independent of format or format-dependent. The answer to this question has consequences for our understanding of how mathematical skill develops, and is taught. Magnetoencephalography (MEG) offers an opportunity to monitor brain activity with millisecond accuracy. Representational similarity analysis (RSA) applied to MEG data allow us to decode what type of information the brain processes at what time. Here, we use these methods to examine the time course of magnitude processing. We presented participants with a series of digits and dice patterns corresponding to the magnitudes of 1 to 6. We use MEG decoding and RSA to determine the time point at which information about magnitude is represented. Our results show that we can successfully decode digits and dice as early as 100ms after stimulus onset, but that abstract magnitude is represented at a later time. Thus, with our methods we can differentiate format-specific from abstract magnitude representation, as well as distinguishing processing of purely visual from higher-level magnitude information.

Sustained attention as a predictor of antisaccade performance in schizophrenia

Mrs Elizabeth Thomas, PhD candidate
Monash Alfred Psychiatry Research Centre, Alfred Hospital and Monash Central Clinical School

Mrs Jessica Myles, *Alfred Hospital and Monash Central Clinical School*
Mr Sean Carruthers, *Alfred Hospital and Monash Central Clinical School*
Mr Phil Sumner, *Alfred Hospital and Monash Central Clinical School*
Dr Erica Neill, *Swinburne University*
Dr Tamsyn Van Rheenen, *Swinburne University*
Ms Stephanie Louise, *Alfred Hospital and Monash Central Clinical Schooll*
Dr Eric Tan, *Alfred Hospital and Monash Central Clinical Schooll*
Prof Susan Rossell, *Alfred Hospital and Monash Central Clinical School*
Dr Caroline Gurvich, *Alfred Hospital and Monash Central Clinical School*

Antisaccade (AS) performance is regarded as one of the most promising intermediate phenotypes for schizophrenia. The AS task requires individuals to suppress the automatic response of looking at a target and instead look at the mirror (opposite) location. Successful AS performance is thought to rely on cognitive abilities including inhibition, attention and speed of processing. It has been suggested that the poorer AS performance in schizophrenia reflects a generalised neuropsychological deficit. Few studies have directly investigated the relationship between eye movements and neuropsychological functioning in schizophrenia. This study investigated potential neuropsychological predictors of AS performance. 141 adults (64 patients with schizophrenia/schizoaffective disorder and 87 healthy controls) were assessed for AS performance using an EyeLink II head-mounted eye tracker. Continuous Performance Task (CPT), Stroop and the Symbol-coding task were administered to assess cognitive processes likely to be engaged in the AS task. AS performance was unrelated to any neuropsychological measure in the control group. In patients, the model explained 17.2% of the total variance in AS error (percentage of saccades towards the peripheral target) performance, $F(3,36)=3.71$, $p=0.020$. CPT performance made a significant unique contribution of 15.4% ($beta=0.431$, $p=0.011$). The model also explained 18.4% of the total variance in AS latency (time from target onset to saccade onset) performance, $F(4,38)=3.37$, $p=0.019$. None of the measures were significant unique contributors, though CPT performance contributed at a trend level ($beta=-0.310$, $p=0.067$). The results suggest that AS performance is not a reflection of broad neuropsychological performance as previously thought, but is an extension of attentional deficits in schizophrenia.

Cognitive improvement during stroke rehabilitation: Spontaneous recovery or practice effects?

Mrs Christine Torrance, Undergraduate Student
University of Newcastle

Dr Helen Andrews, *University of Newcastle*
Dr Heidi Janssen, *University of Newcastle*
Dr Neil Spratt, *University of Newcastle*
Mr Michael Pollock, *University of Newcastle*
Dr Ruby Hooke, *University of Newcastle*
Dr Nicolas Buckley, *University of Newcastle*
Dr Karen Drysdale, *University of Newcastle*
A/Prof Frini Karayanidis, *University of Newcastle*

Cognitive functioning is significantly impaired after stroke and improves in the short to medium post-stroke period. However, the majority of studies do not differentiate between spontaneous recovery and practice effects arising from repeated testing. Strategies such as prebaseline massed practice and use of alternate forms decrease, but do not eliminate practice effects. Healthy controls (N=15) were assessed on tests of memory, attention and executive functioning on two separate occasions (average 19 days) using a neuropsychological test battery which consisted of: Logical Memory, Visual Reproduction, Digit Span, Symbol Search, Pattern Recognition Memory, Simple Reaction Time, Choice Reaction Time and Intra-Extra Dimensional Shift (IED) task. Stroke patients (N=30) were assessed on admission to and discharge from a rehabilitative ward (average 16.3 days). At baseline, assessments included the Functional Independence Measure (FIM), current global level of cognitive functioning (MoCA), premorbid functioning (WTAR) and the neuropsychological test battery. At retest only the FIM and neuropsychological tests were administered. The data were analysed using a two-way ANOVA with Session (baseline, retest) as a repeated measures factor and Group (stroke, health controls) as a second factor. Practice effects are represented by a main effect of Session, whereas spontaneous recovery is represented by a Group x Session interaction. Stroke patients performed poorly on all neuropsychological tests compared to healthy controls, however both groups showed improved performance at re-test. The rate of improvement did not differ between groups on any tests except for IED. Stroke patients improved more than healthy controls on IED with a rate of recovery above that of task practice, indicating spontaneous recovery.

Empirical testing of integrated information theory of consciousness

A/Prof Naotsugu Tsuchiya,
Monash University

A significant problem in neuroscience concerns the distinction between neural processing that is correlated with conscious percepts from processing that is not. Integrated information theory proposes that conscious percepts arise from a hierarchical structure of causal interactions between neuronal populations, i.e. a pattern of integrated information. We tested this proposal by computing integrated information patterns from intracranial electrocorticography from 6 neurosurgical patients with electrodes implanted over lateral and ventral cortices. During recording, subjects viewed continuous flash suppression and backward masking stimuli intended to dissociate conscious percept from stimulus, and unmasked suprathreshold stimuli. Object-sensitive areas revealed correspondence between conscious percepts and integrated information patterns. We quantified this correspondence using unsupervised classification methods that revealed clustering of visual experiences with integrated information, but not with broader information measures including mutual information and entropy. Our findings point to a significant role of locally integrated information for understanding the neural substrate of conscious experience.

Speech normalisation in EEG: an optimal paradigm?

Dr Alba Tuninetti, Postdoctoral Fellow
Western Sydney University

Dr Varghese Peter, *Western Sydney University*
A/Prof Paola Escudero, *Western Sydney University*

In recording the mismatch negativity (MMN) to sound stimuli in EEG/ERP, the standard oddball paradigm has been the cornerstone in eliciting reliable waveforms to acoustic and categorical differences (see Näätänen, 2001, for a review). Changes to the oddball paradigm, such as a multi-deviant paradigm where, for a particular deviant stimulus, other deviants act as standards, have also elicited reliable MMN responses to acoustic changes, suggesting that the human auditory system can still construct a reliable memory trace of the deviants as standards to index the change (Näätänen et al., 2004). We applied this method to natural speech tokens to compare the MMN in a standard oddball paradigm and a multi-deviant oddball paradigm. Two groups of participants with no knowledge of Dutch were presented with isolated Dutch vowels: a standard vowel and four deviants, a vowel change, a sex change, a speaker change, and an accent change. One group received a blocked presentation, wherein each deviant was presented in a separate block with the same standard in all blocks. The other group received a mixed presentation, where the standard and all deviants were presented in a single block. The MMN response was measured for each deviant. Preliminary results suggest that the standard presentation group ($n = 8$) shows a larger MMN response to the vowel and sex deviants. However, the mixed presentation group ($n = 13$) shows a larger MMN response to the accent and sex deviants. There is a marginal interaction ($p = .11$) between deviant type and condition that suggests qualitative differences between the mixed and the standard oddball paradigm. Because previous work only focused on acoustic differences in intensity, duration, location, and frequency, we sug-

gest that natural speech tokens may be perceived differently at pre-attentive levels depending on the memory traces formed during standard presentation.

Multivariate pattern analysis of event-related potentials predicts the general desirability of objects

Mr William Turner, Honours Student
University of Melbourne

Mr Phillip Johnston, *University of Melbourne*
Ms Kathleen de *Boer, University of Melbourne*
Dr Carmen Morawetz, *Freie Universitaet Berlin*
Dr Stefan Bode, *University of Melbourne*

Visual stimuli have been proposed to undergo immediate semantic processing during which information relevant to decision-making is extracted. Critically, previous research has not determined whether information directly predictive of decisions regarding everyday objects is automatically extracted during passive stimulus exposure. The current study investigated whether information regarding the general desirability of a stimulus (termed 'wanting') was rapidly and automatically processed. Participants completed a foreground attention task while their brain activity was recorded using electroencephalography (EEG). On each trial, a task-irrelevant image was presented in the background. After the experiment, participants rated the images with regards to wanting, as well as the potentially related stimulus attributes of relevance, familiarity and aesthetic pleasantness. Multivariate support vector machine classification was used to test whether these subsequent ratings could be predicted from spatio-temporal patterns of participants' EEG data. Prediction of wanting ratings was possible from brain activity at 70 and 110ms following stimulus presentation. Prediction of relevance ratings was possible between 90-120ms following stimulus presentation. Familiarity and aesthetic pleasantness ratings could not be predicted. Additional analyses revealed that wanting and relevance ratings were highly correlated and displayed similar feature weight maps. These ratings were also highly correlated with normative ratings for stimulus valence, arousal and approach/avoidance. The current results indicate that information related to the desirability of everyday objects is rapidly and automatically processed for a wide range of visual stimuli. Furthermore, they suggest that wanting judgements may result, in part, from the integration of information regarding stimulus relevance, valence, arousal, and approach/avoidance. Funding: ARC DECRA (DE140100350); UoM FBE/MDHS seed funding grant 2016.

Connectivity between the supplementary motor area and the primary motor cortex declines with age.

Dr Ann-Maree Vallence,
Murdoch University

Mrs Peta Green, *Murdoch University*
Ms Avalon Young, *Murdoch University*
Prof Keith Hill, *Curtin University*
A/Prof John Semmler, *University of Adelaide*
Prof Michael Ridding, *University of Adelaide*

Aging is associated with decline in voluntary motor control and decline in the quantity and quality of white matter, which results in impaired functional connectivity. The supplementary motor area (SMA) is densely connected with the primary motor cortex (M1) and, together, these two regions are important for selection, updating, execution of appropriate motor plans. Transcranial magnetic stimulation (TMS) protocols can be used to measure functionally relevant excitatory connections between SMA—M1: when a conditioning TMS pulse to SMA precedes a test TMS pulse to M1 at appropriate intervals, the MEP elicited by the test TMS pulse is facilitated due to activation of excitatory networks acting between SMA and M1. We aimed to determine whether SMA-M1 connectivity is reduced in older adults compared to younger adults. Purdue Pegboard was used to measure manual dexterity, the four square step test was used to measure dynamic balance, and dual-coil TMS was used to measure the excitability of connectivity between SMA—M1 in the hand motor region (and preSMA-M1 as a control). Younger adults performed better on the motor tasks than older adults. In younger adults, the interaction between SMA—M1 (but not PreSMA—M1) was facilitatory, replicating previous research; here, we extend this finding to show SMA—M1 facilitation is reduced in older compared to younger adults. Furthermore, a significant positive correlation was found between SMA—M1 facilitation and performance on the Purdue Pegboard task: greater SMA—M1 facilitation is associated with greater number of pegs placed. Together, these findings suggest that SMA—M1 connectivity is functionally relevant, contributing to manual dexterity performance, and that SMA—M1 connectivity is decreased with age. These data provide a neurophysiological basis on which to test whether strengthening SMA—M1 connectivity can improve voluntary motor control in older adults. Funding NHMRC (1088295), Western Australian Department of Health.

Dynamical entrainment of corticospinal excitability to observed rhythmic movement

Dr Manuel Varlet, Research Lecturer
Western Sydney University

Dr Giacomo Novembre, *University College London, United Kingdom*
Prof Peter Keller, *Western Sydney University*

Spontaneous modulations of corticospinal excitability during action observation have been interpreted as evidence for the activation of internal motor representations equivalent to the observed action. Alternatively or complementary to this perspective, growing evidence shows that motor activity during observation of rhythmic movements can be modulated by direct visuomotor couplings and dynamical entrainment. In-phase and anti-phase entrainment spontaneously occur, characterized by cyclic movements proceeding simultaneously in the same (in-phase) or opposite (anti-phase) direction. Here we investigate corticospinal excitability during the observation of vertical oscillations of an index finger using Transcranial Magnetic Stimulation (TMS). Motor-evoked potentials (MEPs) were recorded from participants' flexor and extensor muscles of the right index finger, placed in either a maximal steady flexion or extension position, with stimulations delivered at maximal flexion, maximal extension or mid-trajectory of the observed finger oscillations. Increased and decreased responses facilitating both in-phase and anti-phase relations but not unstable 90° phase relation were found in participants' flexors, supporting the occurrence of dynamical motor entrainment. Anti-phase motor facilitation contrasts with the activation of internal motor representation as it involves activity in the motor system opposite from activity required for the execution of the observed movement. These findings demonstrate the relevance of dynamical entrainment theories and methods for understanding spontaneous motor activity in the brain during action observation and the mechanisms underpinning coordinated movements during social interaction.

The effect of competiton and adaptation on the amplitude of the event-related potential n170

Miss Sreekari Vogeti, PhD Student
University of Auckland

Mr Oliver Saltmarsh, *University of Auckland*
A/Prof Paul Corballis, *University of Auckland*

When two or more faces are presented at the same time, they appear to 'compete' for representation in the visual system (Desimone & Duncan, 1995). Evidence for this comes from several studies investigating the modulation of the N170 component of the event-related potential (ERP) when a stimulus is presented (e.g., Jacques & Rossion, 2006). The N170 evoked by the presentation of a target face is attenuated in amplitude when the face is flanked by other faces compared to when it is flanked by other objects or by phase-scrambled faces. Similarly, the N170 evoked by a target face is reduced in amplitude when another face is presented prior to it. This is referred to as adaptation, or repetition suppression (Grill-Spector, Henson, Martin, 2006). It has recently been suggested that both competition and adaptation may reflect a stage of the same underlying process (Kovacs, Zimmer, Volverg, Lavric, & Rossion, 2013). In the present experiment, we aim to examine the temporal development of competition and adaptation by examining the amplitude of the N170 evoked for target stimuli using the both paradigms with the same participants. Here we presented i) a single target ii) a target and two peripheral flankers simultaneously, iii) two peripheral flankers followed by a target (as in competition paradigms), and iv) a central image followed by the target (as in adaptation paradigms). We found

a greater reduction in N170 amplitude for target faces versus phase scrambled controls. This occurred later in adaptation than in competition. In contrast, there was no stimulus specific attenuation of N170 when stimuli were presented simultaneously. These results suggest that competition and adaptation may not reflect the same neural mechanisms.

The association between Internet use and cognition: A pilot study

Grace Y. Wang,
Auckland University of Technology, New Zealand

Aleisha Chhokar, *Auckland University of Technology, New Zealand*
Apoorva Sheka, *Auckland University of Technology, New Zealand*

Background: Given the vast development of technological progress and enhanced accessibility to information technologies over the last two decades, issues surrounding its excessive use and abuse have become an increasingly important topic for research. It is argued that excessive Internet users suffer from a loss of control over their Internet use, resulting in various negative consequences. Although only Internet gaming disorder has been included in the DSM-5, evidence suggests that the harmful effects associated with addictive use of the Internet need to be addressed. The present research aimed to investigate the relationship between Internet use and cognitive function.
Method: Cognitive function of Internet users was evaluated using a battery of self-administered computerized neuropsychological test (IntegNeuroTM, Brain Resource Company, Australia), measuring seven cognitive domains, including memory, speed of processing and motor function, attention, executive function, verbal function, emotion identification and social cognition. The intensity of non-work/study-related Internet use was measured using Young's Internet Addiction Test.
Results: There was a significant positive correlation between intensity of Internet use and errors in the tasks measuring verbal memory (r=0.45, p=0.04) and working memory(r=0.85, p=0.001). Increased Internet use also led to greater negativity bias (r=0.58, p=0.05).
Discussion: Excessive Internet use may adversely affect cognition. Further study is required to examine the neurophysiological change associated with Internet use.

The role of infant and maternal factors on the early development of infant cognition

Ms Olivia Whalen, PhD candidate
University of Newcastle

A/Prof Frini Karayanidis, *University of Newcastle*
A/Prof Alison Lane, *University of Newcastle*
Dr Linda Campbell, *University of Newcastle*

Improved cognitive control is associated with greater coordination of cognition and affect, which in turn permits individuals to better monitor social and emotional arousal with deliberate reasoning, rational decision making and goal directed behaviour. A longitudinal study conducted by Moffitt et al., (2011) confirmed a causal relationship between early cognitive control ability and adaptive/maladaptive outcomes, whereby individual levels of self-control in childhood were highly predictive of real-world outcomes in adulthood, including physical health, substance abuse, wealth and criminal behaviour. The foundations for cognitive control develop through the preschool years and remain stable across the rest of life. Thus it is critical to understand how the precursors to cognitive control develop in childhood, and even in infancy. Individual differences in attentional control in infancy have been shown to be predictive of cognitive control in childhood, however the majority of research on infant attention has been purely descriptive with a perceptual focus.
The present study uses a comprehensive assessment of early cognitive ability and attention measures in infants aged 6mths and 12mths. Eye tracking tasks will be used to assess infant attention, and include smooth pursuit, habituation, joint attention and visual expectation paradigms. We are looking at how individual variability in performance on these measures relate to child development (as measured by the Bayley Scales), mother-child attachment and social interaction, infant temperament and sensory abilities, as well as parent health, mental health and executive functioning. 164 mother-infant dyads have been assessed in the present study to-date, and with the eye tracking currently being piloted, pilot data from the tasks will be reported. Understanding the early environmental influences on infant cognition has the potential to inform interventions that assist in the healthy development of children.

A spotlight on attention and prediction in the dragonfly.

Dr Steven Wiederman,
University of Adelaide

Whether a human catching a ball, a dog leaping at a Frisbee or a dragonfly pursuing one prey amidst a swarm, brains both large and small have evolved a relatively simple and efficient solution to a task that challenges the most sophisticated robotic vision systems - the detection, selection and pursuit of moving targets in cluttered environments. With behavioural and physiological recordings from flying insects, we examine the mechanisms underlying target selectivity, predictive coding of trajectory, selective attention and roles for active-vision strategies. We record from target-detecting neurons that are exquisitely tuned to moving targets irrespective of the cluttered surround and nearby distracters. We develop computational models of this neuronal processing, simulating closed-loop pursuits in virtual reality environments. We translate these bio-inspired models onto our autonomous ground vehicle, and test the robot's ability to pursue moving targets within unstructured environments.

Examining the auditory mismatch negativity in adults with and without developmental coordination disorder (DCD): a pilot study

Dr (Charles) Adam Wigley, Research Fellow
University of Notre Dame Australia

Prof Beth Hands, *University of Notre Dame Australia*

The aetiology of DCD is unclear but evidence suggests that the forward (predictive) modelling of motor actions may be a core problem. The mismatch negativity (MMN) electroencephalogram (EEG) response has been implicated in predictive error detection (e.g., forward modelling) and updating internal representations (e.g., motor learning). Deficits in both these areas have been associated with DCD. We will compare auditory MMN's in an initial sample of five adults with and five without DCD. Dynamic casual modelling (DCM) of the data will be used to investigate effective connectivity associated with the MMN response in both groups.
Data will be collected during the tasks from a Biosemi™ 64 channel EEG system. Blocks of stimuli are presented using a roving-standard paradigm. Stimuli are 1000Hz and 2000Hz sinusoid tones, 70msec duration, 5msec rise/fall times and ISI's of 500msec. Randomised alternating sequence of 8-12 repetitions are presented. Participants are asked to press a button every time they hear a randomly inserted (8 occurrences) spoken phoneme.
Data is pre-processed and analysed using SPM 12. SPM's of the averages from 8th (standards) and 1st stimuli occurrences (deviants) will be compared across groups. DCM group analysis will be undertaken based on networks established in previous literature.
Preliminary analysis indicates a significant MMN at 180msec in the frontal electrodes for the TD group supporting previous research. We anticipate the DCD group will show significantly attenuated MMN responses compared to the TD group. The DCM analysis will examine top down and bottom up influence in the MMN networks for both groups.
The ability to detect and attend to violations of expectation is central to error correction and task learning. As yet, no one has investigated auditory MMN in this population using DCM tools. This research has the potential to refine our understanding of the role early automatic neural responses play in the aetiology of DCD.

EEG Theta/Beta ratio, pro-environmental attitudes, and self-reported pro-environmental behaviour

Mr Royce Willis, Student
Southern Cross University

Dr Stephen Provost, *Southern Cross University*
Prof Leslie Christidis, *Southern Cross University*

The unpleasant feelings associated with environmental issues may lead some individuals to avoid thinking about them; 'The problem is just too big and what can I do?' Despite the overwhelming nature of environmental issues, some people confront them and adapt their behaviour to reduce their negative impact on the natural environment. The EEG Theta/Beta ratio has been found to positively correlate with trait approach motivation, while negatively correlating with anxiety. For this reason, it was hypothesized that the Theta/Beta ratio may correlate with pro-environmental attitudes and behaviour by allowing individuals to regulate anxiety and confront environmental issues. After completing the EEG stage of the study, participants (n=34) completed a number of self-report measures of environmental attitudes and behaviour, as well as measures of motivation tendencies. Right frontal Theta/Beta was found to support previous literature, positively correlating with a Behavioral Approach System ($r = .361$, $p = .036$). However, right frontal Theta/Beta also positively correlated with an Egoistic Value orientation ($r = .479$, $p = .004$), and negatively with environmental attitude ($r = -.404$, $p = .018$) and value ($r = -.453$, $p = .007$) measures, and self-reported pro-environmental behaviour ($r = -.415$, $p = .015$). This is preliminary evidence that the Theta/Beta ratio is positively related to self-rewarding approach behaviour, but inversely related to behaviour with benefits external to the self, such as pro-environmental behaviour.

Consciousness in dreaming & dreamless sleep: Questions & challenges for future research

Dr Jennifer Windt, Lecturer
Monash University

Consciousness is often defined contrastively by pointing to the difference between dreaming and dreamless sleep, where dreamless sleep is thought to be characterized by a loss of consciousness. This assumption is central to philosophical work on consciousness, but also informs research methodology in cognitive neuroscience. In this talk, I propose that the definition of dreamless sleep as a uniform state of unconsciousness is oversimplified. Sleep supports a range of different types of cognitive activity, including memory consolidation and emotional processing, as well as complex behavior, and different lines of research suggest that some of these are associated with kinds of conscious experience distinct from dreaming. This means that standard theoretical approaches to dreamless sleep, as well as the research methodologies they inspire, are oversimplified. I suggest that progress can be made by refining the taxonomy for describing conscious experience during sleep and the criteria for sleep-stage scoring in concert. This approach can inform research on memory consolidation in sleep, but also on the diagnosis and treatment of sleep disorders.

Replication and effects of practice using cued task-switching paradigm through evidence accumulation model: Robust EZ diffusion

Dr Aaron Wong, Post-doctoral Researcher
University Of Newcastle

Mr Patrick Cooper, *University Of Newcastle*
Dr Ross W. Fulham, *University Of Newcastle*
Prof Scott Brown, *University Of Newcastle*
A/Prof Frini Karayanidis, *University Of Newcastle*

Previous work has suggested that slower switch performance during task-switching is actually a consequence of higher cautious response setting, and a slower rate of evidence accumulation, Karayanidis et al. 2009. We present a replication of Karayanidis et al. 2009, with a larger sample that consists of 191 participants (108 females), with a mean age of 21.30 ± 4.85 years old. These participants successfully completed three sessions (two practice, one testing) of the Cued Task-Switching Paradigm as part of the larger AGE-ility project. We also present effects of practice from these three sessions.

The criterion (caution), drift rate (rate of evidence accumulation), and non-decision time (processing unrelated to decision making) parameters were individually modelled from RT data using Robust EZ Diffusion, Wagenmakers et al. 2008. All significant findings in Karayanidis et al. 2009 were replicated for criterion, drift rate and non-decision time for all three sessions, with the exception of non-informative switch, and switch to in first practice session due to the low trials number by design.
Repeated measures ANOVA was conducted to see the influence of practice on Robust EZ parameters. There were significant effects of Trial Type, Session, and Trial Type by Session on all Robust EZ parameters. With practice, non-decision time reduced for all trial types. A significant reduction in criterion was seen between first and second practice sessions for all trial types but does not continue for testing sessions. Drift rate increased with practice and was particularly evident in prepared repeat trials, but was not seen in non-informative repeat and switch to trials.
A replication of Karayanidis et al. 2009 using a larger cohort, further re-enforces that slower switch performance during task-switching is a result of higher cautious response and a slower rate of evidence accumulation. In addition, we have shown that these modelling parameters are malleable with practice.

The association of infant temperament and maternal pitch contours

Ms Alix Woolard, PhD Candidate
University of Newcastle

Dr Titia Benders, *Macquarie University*
Dr Linda Campbell, *University of Newcastle*
Prof Joerg Mattes, *University of Newcastle*
Dr Vanessa Murphy, *University of Newcastle*
A/Prof Frini Karayanidis, *University of Newcastle*
A/Prof Alison Lane, *University of Newcastle*

Infant temperament is defined as the pattern of reactivity and regulation displayed by an infant, and is suggested to influence the mother-infant interaction. One component of the interaction is the mother's infant-directed speech (IDS). Adaptations to pitch contours during IDS involve acoustic exaggeration, and they are used to regulate infant affect and attention. Rising and bell-shaped contours attain and maintain infant attention and communicate affect, whereas slowly-falling contours soothe infants and rapidly-falling contours prohibit unwanted behaviour. The aim of the study was to investigate whether these pitch contours were associated with infant temperament. Eight six-month-old infants and their mothers were recruited through the Breathing for Life Infant Development study. Mother-infant dyads participated in a 15-minute recorded play interaction, and mothers' pitch contours were extracted and classified. Infant temperament was assessed using the observer rated Temperamental Adjective Triad Assessment and the maternal rated Carey Temperament Scales. Infant temperament scores were correlated with the mothers' proportion of each pitch contour used during the interaction. Significant correlations were found between all contours and at least one temperamental dimension. Mothers used more rising and bell-shaped contours when infants were more approaching and more rising contours when infants were more persistent. Fewer rising and more slowly-falling and rapidly-falling contours were used when infants displayed a negative mood. Finally, more rising and rapidly-falling contours were associated with higher infant activity. The current study provides evidence of a relationship between infant temperament and maternal pitch contours. The results implicate the infant as an active participant in the mother-infant interaction. Further work is needed on this area, as understanding this interaction is integral to infant social, language, and cognitive development.

Don't judge a book by its cover - case of a minimally-verbal Autistic child with excellent receptive and productive language

Dr Alexandra Woolgar, Research Fellow
Macquarie

Ms Selene Petit, *Macquarie University*
Dr Nicholas Badcock, *Macquarie University*
A/Prof Anina Rich, *Macquarie University*
Dr Jon Brock, *Macquarie University*
Prof Lyndsey Nickles, *Macquarie University*

Very little is known about the cognitive abilities of Autistic children and adults who are minimally-verbal (i.e. with no or unreliable speech). Anecdotal evidence suggests that some of these individuals may have intact spoken language comprehension and can demonstrate intact language production through non-speech modalities. Traditionally however, this population has been very difficult to test. We present a case of a minimally-verbal autistic child with intact spoken language comprehension and written language production. This 9-year-old girl has a profile of autism as clinically assessed and as measured on the Autism Diagnostic Observation Schedule (ADOS) and parental report (Social Communication Questionnaire and Vineland Adaptive Behavioural Scales), and little productive spoken language. She has learnt to communicate by pointing to letters on a letter board (using Rapid PromptingTM Method). By adapting behavioural tests to enable her to respond using this communication method, we show that she has normal-range IQ and receptive vocabulary scores. Using a low-cost portable brain imaging (electroencephalography) device, we also show that her neural responses distinguish between spoken sentences with meaningful versus anomalous completion (e.g. "The hungry baby wanted to drink milk" versus "She wore a necklace around her milk"), and between forward-associated or unassociated spoken word pairs (e.g. "arm-leg" versus "nap-leg"). This brain imaging approach provides objective evidence for semantic processing of spoken words and sentences. It may have utility for detecting hidden language abilities in other children who are minimally-verbal and have not yet found a method to demonstrate how much they understand. This study was funded by the ARC CCD Neural Markers Training Scheme.

Individual differences in binocular rivalry across autistic personality traits

Ms Katie Wykes, Honours Student
Swinburne University

Ms Laila Hugrass, *Swinburne University*
Prof David Crewther, *Swinburne University*

Numerous visual processing differences for autism spectrum disorder extend to the neurotypical population, for groups with high vs. low levels of autistic personality traits. There is some controversy as to whether binocular rivalry is different across the autistic spectrum. Studies using complex, object images as rival stimuli found that switching rates are slower in autism and durations of mixed percept are longer; however, there is mixed evidence as to whether rivalry between simple grating stimuli differs for autistic and control groups. Here we investigate differences in binocular rivalry across a neurotypical sample with high and low autism quotient (AQ) scores. We also investigated differences in rivalry across a 'social disorganisation' factor that is shared across AQ and schizotypal personality scales. The rival stimuli were pairs of simple gratings or complex object images, presented at fixation or in the periphery. When the rival stimuli were presented at fixation, individuals with high AQ showed higher proportions of mixed perception, and lower switching rates for both simple and complex rival pairs. Contrary to previous studies, complex stimuli were found to produce higher proportions of mixed perceptions than simple stimuli across all groups. When the stimuli were presented peripherally, there were no between-groups differences in switch rate or mixed percept durations for the complex rival pair, yet the high AQ group showed higher proportions of mixed rivalry for the simple stimuli. When participant groups were split by social disorganisation, rather than AQ, we observed the same differences, with slightly higher effect sizes. These findings suggest that low-level visual processing differences in across autistic and schizotypal personality spectra may account for differences in binocular rivalry dynamics.

Top-down modulation of onset capture by feature relationships, within and between feature dimensions.

Ms Ashley York, MPhil Student
university of queensland

Dr Stefanie Becker, *University of Queensland*

Current models of attention propose that we can tune attention in a top-down controlled manner to a specific feature value (e.g. shape, colour) to find specific items. However, recent studies have shown that attention is often tuned in a context-dependent manner to the relative features of a sought-after target item, that is, the features that the target has relative to other surrounding non-target items (e.g. bluer, faster). However, the previous evidence is limited in that it is unclear whether tuning to relative features can modulate very early processes such as attentional capture by irrelevant, salient items. Moreover, it is currently unclear whether we can tune attention to multiple different feature relationships simultaneously (e.g., to larger and bluer). To investigate these questions, we randomly varied the target in visual search (e.g., target was either faster-rotating or bluer than the non-targets). In a second study, we tested whether attention can be tuned to two different relative features within the same stimulus dimension of colour (i.e., by randomly varying the target between being bluer or greener than the non-targets). As we were interested in top-down modulation of the earliest visual processing steps, we centrally assessed the participant's first eye movement on each trial. The results showed that the relationally congruent distractor (e.g., bluest, fastest) captured attention and the gaze most often, beyond maximally salient or feature-specific (e.g., target-matching) distractors. These results demonstrate that attention can be simultaneously tuned to different feature relationships, both within and across different feature dimensions (i.e. relative colour and relative motion; and two relative colours). Taken together, these results indicate that the relational account can potentially be extended to explain how we allocate attention in natural environments, which often require tuning to multiple features.

Time-resolved connectomics

Dr Andrew Zalesky,
University of Melbourne

Functional neuroimaging can be used to map the effects of non-invasive brain stimulation on functional brain systems. In this talk, I will introduce attendees to the language of networks and graphs, as applied in neuroscience, and demonstrate how network science can be used in a time-resolved manner to understand dynamic changes in functional connectivity and functional brain networks. I will highlight key methodological and statistical challenges inherent to analysing time-resolved functional brain networks, particularly the choice of sliding window length, the need for appropriate network null models to discern true neural fluctuations from spurious ones, and the pros and cons of regularised (partial) versus full correlation as measures of network connectivity. Another key challenge that I will address is defining networks nodes in a dynamic manner so that their boundaries can change, or they can merge and divide, as a function of time. Finally, I will present various examples where functional neuroimaging has been combined with network science to map dynamic changes in functional connectivity in neuroscience and clinical applications.

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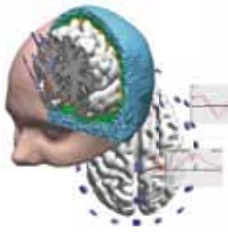

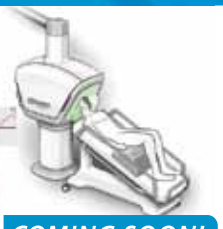

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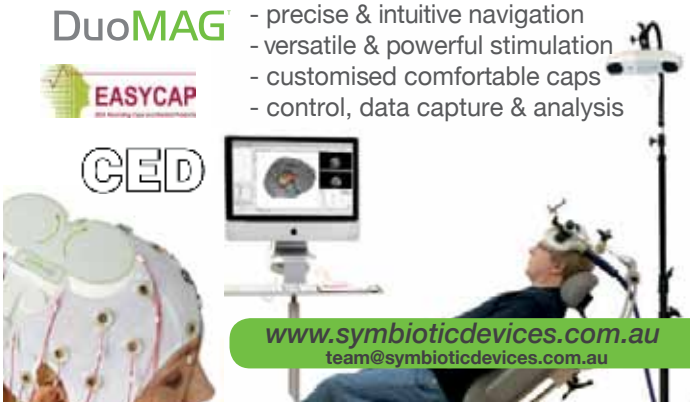

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Agenda at a Glance

Thursday 24 November		
9:00	**Early Career Research** Workshop	Sea & Star Room
10:30	**Morning Tea**	
11:00	**ECR Q&A Session**	Sea & Star Room
12:30	**Registration Desk Opens**	
13:00	**Mid-Career Research Workshop**	Sea & Star Room
14:30	**Afternoon Tea**	
17:00	**Conference Opening**	WhiteSands Ballroom
17:30	**Keynote 1: Dr David Strayer**	WhiteSands Ballroom
18:30	**Welcome Reception**	Promenade & Sandyfoot
20:30	**ECR Social Drinks**	Port Stephens Country Club
Friday 25 November		
9:00	**Keynote 2: Dr Rosalyn Moran**	WhiteSands Ballroom
10:00	**Morning Tea**	
10:30	**Open Talks A1** (Sun Room), B1 (Sea & Star Room)	
12:30	**Lunch (Promenade)**	
13:30	**Symposia A1** (Sun Room), B1 (Sea & Star Room)	
15:00	**Afternoon Tea**	
15:30	**Fast talks A1** (Sun Room), B1 (Sea & Star Room)	
18:30	**Poster Gala Session**	WhiteSands Ballroom
Saturday 26 November		
9:00	**Keynote 3: Dr Sara Festini and Michelle Farrell**	WhiteSands Ballroom
10:00	**Morning Tea**	
10:30	**Open Talks A2** (Sun Room), B2 (Sea & Star Room)	
12:30	**ACNS Equity Policy** Launch & Lunch	Promenade
12:30	**Other Lunch**	WhiteSands Reception
14:00	**Symposia A2** (Sun Room), B2 (Sea & Star Room)	
15:30	**Afternoon Tea**	
16:00	**Fast talks A2** (Sun Room), B2 (Sea & Star Room)	
18:30	**Conference Dinner**	Broughtons at the Bay
Sunday 27 November		
9:30	**2016 ACNS Young Investigaror Award: Dr Paul Dux**	WhiteSands Ballroom
10:00	**Morning Tea**	
10:30	**Open Talks A3** (Sun Room), B3 (Sea & Star Room)	
12:30	**Working Lunch**	Promenade
13:00	**Annual General Meeting**	Promenade