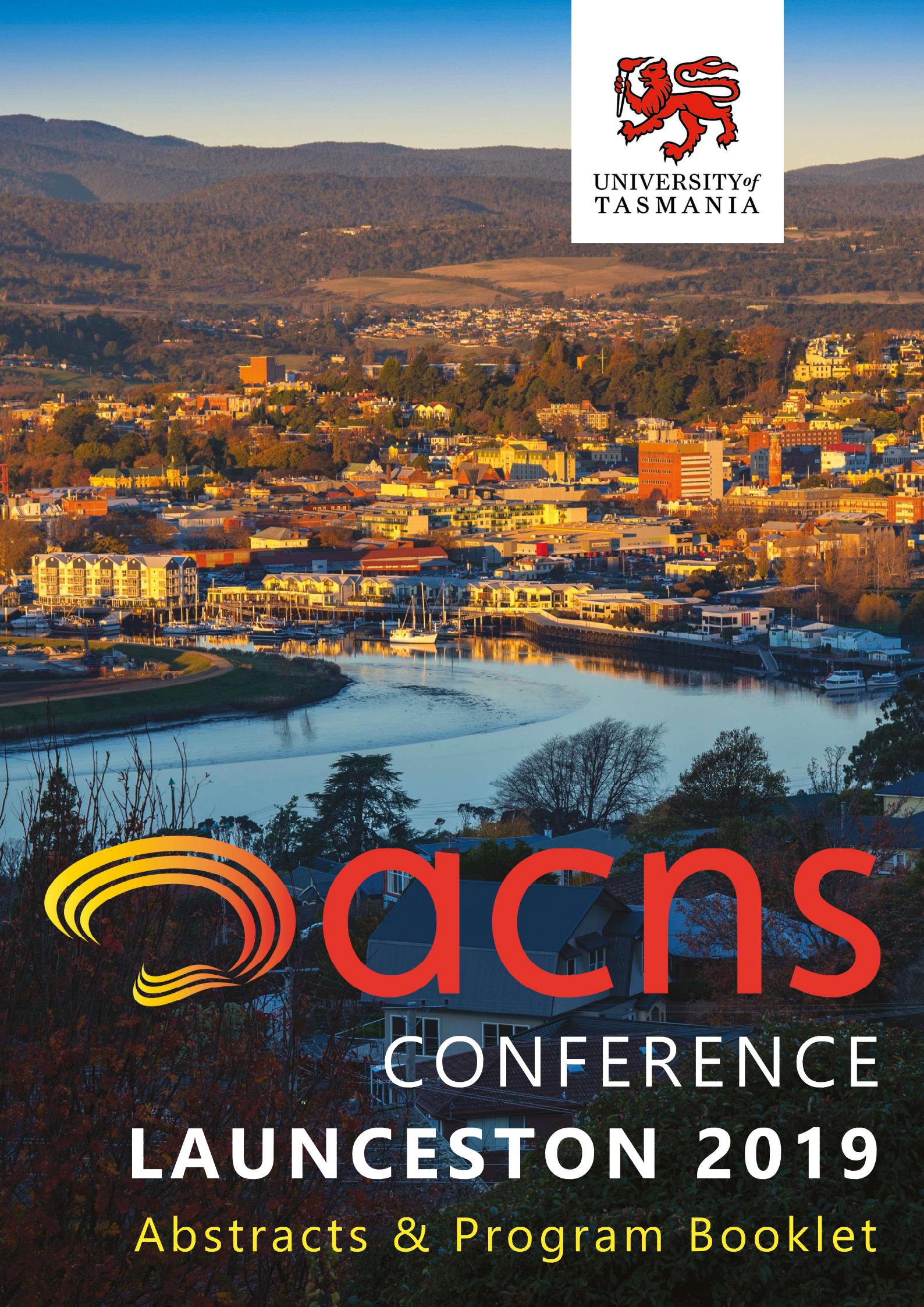
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Keynote Addresses

Professor Nici Wenderoth

Neural Control of Movement Lab, ETH Zurich

Nicole Wenderoth has been a Professor for Neural Control of Movement in the Department of Health Sciences and Technology at ETH Zurich, since 2012. Using task-related and resting-state fMRI, non-invasive brain stimulation, and a novel muscle-computer interface, her lab has investigated how new memories are encoded, consolidated and subsequently reconsolidated, with a focus on applying this knowledge to enhance rehabilitation protocols. They also investigate how learning and decisions are influenced by motivation and reward, for example how the relationship between stimuli and outcomes is encoded in the brain, how we can use rewards to motivate non-preferred actions (i.e. effort from a non-dominant effector), and how a deficit in reward processing could manifest into clinical disorders such as Autism. Another line of investigation has been brain connectivity in normal and pathological conditions, for example for better understanding and treatment of Autism (ASD) or stratification of therapy in Cerebral Palsy based on connectivity biomarkers.

Assistant Professor Xiaosi Gu

Icahn School of Medicine at Mount Sinai

Dr Gu is one of the foremost researchers in the area of computational psychiatry. Her research examines the neural and computational mechanisms underlying human beliefs, emotions, decision making, and social interaction in both health and disease, through a synthesis of neuroscience, cognitive science, and behavioural economics. After receiving a dual degree in Psychology and Economics from Peking University in Beijing, Dr. Gu moved to New York City to pursue a Ph.D. in Neuroscience at the Icahn School of Medicine at Mount Sinai. Dr. Gu then completed her postdoctoral training in computational psychiatry at Virginia Tech and the Wellcome Trust Centre for Neuroimaging, University College London (UCL). During her time in London, she also set up and has since been directing the world's first computational psychiatry course at UCL. Before joining Sinai, Dr. Gu previously held faculty positions at the University of Texas, Dallas and UT Southwestern Medical Center.

Associate Professor Juan (Helen) Zhou

Multimodal Neuroimaging Lab, Duke-NUS Singapore

Dr. Juan (Helen) Zhou is an Associate Professor and Principal Investigator of the Multimodal Neuroimaging in Neuropsychiatric Disorders Laboratory, Centre for Cognitive Neuroscience, Neuroscience and Behavioral Disorders Program at Duke-National University of Singapore Medical School , Singapore. She is also a principal investigator at Clinical Imaging Research Center, A*STAR and National University of Singapore. Her research focuses on the network-based vulnerability hypothesis in disease. Her lab studies the human neural bases of cognitive functions and the associated vulnerability patterns in aging and neuropsychiatric disorders using multimodal neuroimaging methods and psychophysical techniques.

Professor James Vickers

Director, Wicking Dementia Research and Education Centre, University of Tasmania

The University of Tasmania Faculty of Health is now the biggest provider of dementia education in the world, reaching thousands of students in over 100 countries; indeed Dementia MOOCs have reached over 50,000 people worldwide. Professor of Pathology, James Vickers' research has focused on ways to maintain or improve plasticity of the brain. A world first study, The Tasmanian Healthy Brain Project is exploring education as an intervention to alleviate cognitive decline in later life. Subjects undertake study at university and have regular psychological assessments to test higher brain functions such as processing speed, reasoning and memory.

ACNS Young Investigator Award

Associate Professor
Stefan Bode

University of Melbourne

Stefan studied psychology at the University of Göttingen, Germany, and the University of Zurich, Switzerland, and in 2010 he received his PhD from the Max Planck Institute for Human Cognitive and Brain Sciences & University of Leipzig, Germany. He is currently the Head of the Decision Neuroscience Laboratory and the Director of the Decision Science Hub at the Melbourne School of Psychological Sciences at the University of Melbourne. His research focuses on the cognitive and neural mechanisms underlying perceptual, health-related, and voluntary decision-making, as well as decision errors and preference formation in humans.

ACNS Emerging Researcher Awards 2019

Dr Rebecca Keogh

University of New South Wales

Rebecca completed her PhD at the University of New South Wales, where she is currently a Post-Doctoral Researcher at the Future Minds Lab. Her research uses a combination of psychophysics, non-invasive brain stimulation and neuroimaging to investigate visual cognition (e.g. visual memory, visual imagery, visual attention) and abnormal vision (e.g. visual hallucinations), and how variations in neural structure and function influence these cognitions.

Dr Tijl Grootswagers

The University of Sydney

Tijl received his PhD from Macquarie University and is currently a Postdoctoral Research Fellow in the Computational Cognitive Neuroscience Laboratory at the University of Sydney. In his research, he uses neuroimaging and computational tools such as multivariate pattern analysis to understand information processing in the human brain.

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Workshops

Wednesday 20th November

10.30-17.00	Advanced EEG Signal Processing: A hands-on introduction to Fourier and Wavelet-based analysis - Supported by Symbiotic Devices	Tram Room 28

Presenters:

Daniel Feuerriegel	University of Melbourne
Evelien Lageweg	Symbiotic Devices
Agnieszka Iwasiw	Symbiotic Devices
Eduardo Bellomo	Brain Products

Thursday 21st November

10.30-15.00	Early Career Researcher Day: "Networking"	Tram Room 28
10.30-11.00	**Keynote Presentation** Nicole Wenderoth **International networking and collaboration**	
11.00-12.00	**Networking Activity**	
12.00-13.00	Lunch - Supported by Symbiotic Devices	Tram Room 28
13.00-14.00	Award winners' talks and presentation by Cedric Tremblay (Monash University)	Tram Room 28
14.00-15.00	**Panel Q&A Session**	

Conference Schedule

Day 1 | Thursday 21st November

15.30-16.00	**Welcome and Acknowledgement of Country** **Conference Opening and Award Announcements**	Auditorium
16.00-17.00	**Keynote Lecture I** - Supported by UTAS School of Medicine Nicole Wenderoth **Volitional regulation of cortical excitability: Modifying cortical networks and brain oscillations with neurofeedback**	
17.00-19.00	**Welcome Reception** - Supported by UTAS School of Medicine	University of Tasmania School of Creative Arts Gallery Inveresk Campus

Day 2 | Friday 22nd November

08.30-09.00	**Young Investigator Award Talk** Stefan Bode **The neurocognitive mechanisms of changing one's mind**	Auditorium

	Auditorium		Tram Room 28	
09.00-10.15	**Symposia I:** **Cortical plasticity and motor function in ageing and neurodegenerative disease** (Chair: James Coxon)		**Symposia II:** **Using network neuroscience to understand typical and atypical development** (Chair: Nandita Vijayakumar)	
	Ann-Maree Vallence	**Is the excitation – inhibition balance important for fine motor control in older adults?**	Nandita Vijayakumar	**Maturational covariance of cortical development during puberty**
	George Opie	**Primed to learn: investigating the use of transcranial magnetic stimulation for promoting motor function in older adults**	Gareth Ball	**The development of structural connectivity subnetworks and specific alterations in autism spectrum disorder**
	Hayley Teasdale	**Combining physical exercise and transcranial direct current stimulation to address sensorimotor impairment in Parkinson's disease**	Sarah Whittle	**Coupling of resting state networks in adolescent problematic substance use and depression**
	Sophie Andrews	**Effects of acute exercise and transcranial magnetic stimulation on motor cortex plasticity and motor skill learning in Huntington's disease**	Karen Caeyenberghs	**Mapping brain networks in young patients with traumatic brain injury: What can graph metrics tell us?**

10.15-10.45	Morning Tea - Supported by UTAS School of Medicine	Tram Room 29
10.45-11.45	**Keynote Lecture II** Helen Zhou **Network-sensitive brain imaging in preclinical and prodromal dementia: a longitudinal perspective**	Auditorium

	Auditorium		Tram Room 28	
	Regular Talks			
11.45-12.45	**Cognition I**		**Social**	
	Montana McKewen	**Theta Frontoparietal Networks Underlying Switch and Mixing Costs During Task-Switching**	Ian Evans	**The effect of familiarity on neural correlates of emotion perception in 15 week old infants**
	Avinash Kumar Singh	**Cognitive Conflict in Virtual Reality Based Object Selection Task : An EEG study**	Sarah Krivan	**I'll cry instead: Mu suppression responses to tearful expressions**
	Shane Ehrhardt	**Transcranial direct current stimulation of prefrontal cortex augments multi-session single/dual-task training and induces near transfer: A dosage study**	Patrick Cooper	**Frontocentral signatures of curiosity: Evidence for subjective valuation of non-instrumental information**
	Frini Karayanidis	**Modelling practice and adult lifespan effects on task-switching performance in a large scale data set**	Aisling Mulvihill	**Use your Words: The relationship between private speech content and task performance in preschool children**

12.45-13.45	Lunch - Supported by Symbiotic Devices	Tram Room 29
Lunchtime:	**Equity and Diversity Open Discussion Forum** - Supported by Symbiotic Devices **Please bring your lunch and join us for an open discussion regarding equity and diversity within our Society and Neuroscience more broadly.**	Auditorium

13.45-15.30	**Visual System I**		**Clinical I**	
	Rebecca Keogh	**Using pupillometry to measure individual differences in visual imagery strength (Award Talk)**	Claire O'Callaghan	**Noradrenergic contributions to neuropsychiatric and cognitive symptoms in Parkinson's disease – ultra-high field imaging of locus coeruleus and effects of atomoxetine**

Regular Talks continued			
Tijl Grootswagers	**Using rapid stimulus presentation and multivariate decoding to study information processing in the human brain (Award Talk)**	Siddharth Ramanan	**A role for a parieto-hippocampal network in autobiographical memory retrieval - evidence from neurodegenerative disorders**
Alexei Dawes	**Memories of a blind mind: The impact of visual imagery absence on episodic memory in Aphantasia**	Trevor Chong	**Dissociable motivational deficits in pre-manifest Huntington's disease**
Daniel Feuerriegel	**Visual mismatch responses are a product of surprise, but not fulfilled expectations**	David Foxe	**Neural basis of visuospatial short-term and working memory in the primary progressive aphasias**
Tom Johnstone	**Probing the neural processing of personal and emotional relevance using EEG and fMRI**	Jeroen van Boxtel	**Sensory noise does not correlated with the autism quotient, but decision noise does**
Claire Bradley	**Dynamic changes in brain networks for spatial attention revealed by transcranial magnetic stimulation evoked potentials**	Talitha Ford	**Superior temporal glutamate/GABA ratios drive the relationship between of mismatch negativity latency and psychosocial difficulties**
		Muireann Irish	**Exploring the neural substrates of mind wandering in semantic dementia**

15.30-16.00	Afternoon Tea	Tram Room 29
15.30-17.30	**Poster Session I**	
18.00-21.00	**Early Career Researcher Mixer** Open to ACNS Early Career Researchers ONLY	James Boags Brewery Function Centre (Ground Floor and Beer Garden)

Day 3 | Saturday 23rd November

09.00-10.00	**Keynote Lecture III** Xiaosi Gu **The social brain: norms, beliefs, and model-based influence**	Auditorium

	Auditorium		Tram Room 28
	Fast Talks		
10.00-11.00	**Brain Stimulation and Imaging in Cognitive Neuroscience**	**Clinical II**	
	Pamela Barhoun — **The role of the primary motor cortex in motor imagery: a theta burst stimulation study**	Cherie Strikwerda-Brown	**Try to see it my way: Distinct neural correlates of different forms of perspective taking in frontotemporal dementia**
	Jaishree Jalewa — **Are rat mismatch responses sensitive to the primacy bias?**	Jessica Peters	**Fruit Ninja to improve reading: An action video game treatment for Dyslexia**
	Giana Patel — **Using long-wear electroencephalography to explore lempel-ziv complexity during conscious wakefulness**	Phoebe Thomson	**The influence of age and ADHD status on the development of sustained attention, three-wave longitudinal study through childhood and adolescence**
	Dominic MD Tran — **Transcranial magnetic stimulation and Prediction: Self-generated or signalled TMS excites the motor system less effectively than unsignalled stimulation**	Sidhant Chopra	**Differentiating the Effect of Medication and Illness on Grey Matter Volume in First-Episode Psychosis: A Longitudinal, Randomised, Triple-blind, Placebo-controlled MRI Study**
	Ashley York — **Investigating bottom-up versus top-down effects across cortical depth in human somatosensory cortex using 7T fMRI**	Karen Caeyenberghs	**Brain changes associated with multimodal training in patients with traumatic brain injury: A case study**

	Fast Talks continued			
	Eileen Luders	**From Baby Brain to Mommy Brain: Widespread Gray Matter Gain After Giving Birth**	Evelyn Deutscher	**Towards Personalised Profiles of Pathology in Traumatic Brain Injury Patients using Anatomical MRI Scans: A proof-of-concept study**
	Elektra Schubert	**Distributed patterns of event-related potentials during anticipation of emotion regulation predict success for reappraisal but not distraction**	Eric Tan	**Speech analysis for assessing schizophrenia spectrum disorders: what machine learning techniques say**
11.00-11.30	Morning Tea - Supported by UTAS School of Medicine			Tram Room 29
11.30-12.45	**Symposia III:** **Inhibitory control in healthy and clinical populations** (Chair: Mark Hinder)		**Symposia IV:** **Advancing our understanding of cognition** (Chairs: Emma Burrows and Katherine Johnson)	
	Rohan Puri	**Role of expectancy in selective stopping: a behavioural and neural perspective**	Shuting (Tina) Li	**A novel Posner-style cueing task to assess attention orienting in mouse models of autism**
	Jane Tan	**In-phase tACS does not improve response inhibition for older adults, but potentially reduces response conflict in their younger counterparts**	Jess Nithianantharajah	**Of mice and mental disorders: deconstructing motivation and decision-making to advance translational research in psychiatry**
	Dinisha Parmar	**Inhibitory control in neurodevelopmental disorders**	Farshad Mansouri	**The neural architecture of cognitive flexibility and control**
	Nahian Chowdhury	**Reduced motor cortex inhibition in problem gamblers**	Bernard Balleine	**Human and rodent homologies in the circuits mediating action control: Implications for obsessive compulsive disorder**
12.45-13.45	Lunch - Supported by Symbiotic Devices			Tram Room 29
13.45-14.45	**Keynote Lecture IV** James Vickers **Individual and public health interventions to boost cognitive reserve and resilience to dementia**			Auditorium
14.45-15.15	Afternoon Tea			Tram Room 29
14.45-16.30	**Poster Session II**			
16.30-17.30	**AGM**			Auditorium
19.00- Late	**Conference Dinner** with entertainment from The Geale Brothers - Supported by Compumedics			Penny Royal Restaurant 1 Bridge Road

Day 4 | Sunday 24th November

		Auditorium		Tram Room 28
	Fast Talks			
09.00-09.45	**Visual System II**		**Cognition II**	
	Philippa Johnson	**The visual system compensates for neural delays to represent moving objects in their physical position in real time**	Sally Richmond	**Individual differences in gamified attention training: Training curves in typically developing children**
	Regan Gallagher	**The Massive Report Paradigm: Assessing the richness of conscious experience**	Alice Stephenson	**The effect of prior perceptual load on visuomotor neural oscillatory mechanisms and task performance**
	Fernanda L. Ribeiro	**Predicting brain function from anatomy using deep learning**	Hamid Karimi-Rouzbahani	**Neural correlates of vigilance decrements: can we use brain decoding to pre-empt behavioural errors?**
	Abbey Nydam	**Speed of Processing Configural Regularities in Contextual Cuing**	Elizabeth Bowman	**The effects of dopaminergic psychostimulants on complex problem solving**

	Fast Talks continued			
	Imogen Stead	**Modelling of spatial representations across eye movements reveals rapid post-saccadic updating**	Julian Matthews	**Non-instrumental information is devalued in decision-making under risk and uncertainty**
09.45-10.30	**Visual System III**		**Sleep, Wakefulness and Arousal; Social**	
	Sidney Davies	**Dissociable effects of perceived position and perceived motion in the high-phi illusion**	Charmaine Diep	**Acoustic slow wave sleep stimulation improves daytime sleepiness and sustained attention in chronically sleep-deprived adults**
	Annabelle Pontvianne	**Do water views restore sustained attention?**	Chase Sherwell	**Measuring physiological synchrony and arousal with wearable devices: comparing approaches using the SoChro toolbox**
	Lena Zou-Williams	**Cultural influences on attention: evidence from eye-movements and EEG during emotional scene viewing**	Matthew Hendrickx	**Quite powerful: The EEG of memory consolidation during quiet wakefulness**
	Melanie J Murphy	**Eye Movement Patterns as a Measure of Problem-Solving Strategy in Primary School Aged Children**	Nikki-Anne Wilson	**Reduced Social Perception is Associated with Social Scene Construction Deficits in Frontotemporal Dementia**
	Alexander M. Puckett	**Manipulating the structure of natural images using wavelets to probe the human visual hierarchy**	Megan E. J. Campbell	**Automatic imitation of actions for unpredictable, but not predictable stimulus-response pairings**
10.30-11.00	Morning Tea - Supported by UTAS School of Medicine			Tram Room 29
		Auditorium		Tram Room 28
	Regular Talks			
11.00-12.30	**Understanding Cognitive Control of Action using EEG and fNIRS**		**Decision Making**	
	James Coxon	**Effect of pharmacological manipulation of dopamine D2 receptors on response inhibition**	Denise Moerel	**Disentangling the effects of attention and decision-making in space and time**
	Rebecca J. St George	**Functional near-infrared Spectroscopy shows age-related cortical compensation during standing**	Raina Angdias	**The Effect of Motor Costs on Decision Confidence**
	Daniel Hochstrasser	**The Role of Contextual Uncertainty on the Neural Interaction of Predicted and Attended Tones**	Yiu Hong Ko	**The effects of absolute and relative evidence strength on decision confidence**
	Elise Rowe	**Detecting (un)seen change: the neural underpinnings of (un)conscious prediction errors**	Tess Nikitenko	**Investigating the neural correlates of decision-making using transcranial magnetic stimulation**
	Dragan Rangelov	**Neurocognitive consequences of prediction violation across auditory and visual modalities**	Christina A. Van Heer	**Local versus global optimisation of error in probabilistic learning**
			Kelly Garner	**Cognitive capacity limits are remediated by practice-induced plasticity between the Putamen and Pre-Supplementary Motor Area**
12.30-13.00	Award Presentation and Final Remarks			Auditorium

Posters

Session I | Friday 22nd November 15.30-17.30

1	Predictive coding in the visual cortex of awake and anaesthetized non-human primates	Ekaterina Levichkina
2	Multimodal Neuroimaging in Paediatric Moderate/Severe Traumatic Brain Injury: Towards Understanding the Functional-Structural Relationship	Nicholas Parsons
3	How variability affects mismatch negativity elicitation	Mattsen Yeark
4	Searching for the sweet spot: Balancing tDCS intensity for cortical excitability modulation with double blinding integrity	Hannah Bereznicki
5	Effects of screen use on behavioural and cognitive attention and sleep in school-aged children	Karen Chiu
6	The role of individual alpha frequency in predicting susceptibility to false memories	Julia Romeo
7	The conditions under which inhibition of return is represented in object-based coordinates	Cameron T. Mace
8	The effects of Mindfulness Meditation with Neurofeedback on ERP Measures of Attention	James Brady
9	Alpha Neurofeedback Training For Mental Resilience	Graham Jamieson
10	Motion extrapolation in the flash-lag effect depends on perceived, rather than physical speed	Lysha Lee
11	Social anxiety and visual working memory differentiate typically developing children from those with additional learning needs, irrespective of diagnosis	Hayley E. Pickering
12	Differential patterns for true and false memories across sleep: An event-related potential (ERP) investigation	Sophie Jano
13	The role of the pre-frontal cortex in step initiation and the effects of age	Danielle Pretty
14	Gravity and Predictive Coding	Blake W. Saurels
15	Investigating the roles of the orexin system in goal-directed decision making	Jeremy Metha
16	A Freudian Blip – Examining the Neural Bases of Female Difference in Sexual Arousal	Ian D. Evans
17	Individual differences in threat detection measured using ensemble encoding	Daniel A. Madden
18	A common neural substrate for retrospective and prospective memory disturbances across dementia syndromes	Lulu Liu
19	The relationship between the human mirroring system and subtle mimicry of arm movements.	Emma J. Kornfeld
20	Dissociable effects of tDCS polarity on latent decision processes are associated with individual differences in neurochemical concentrations and cortical morphology	Hannah Filmer
21	A biomarker for anorexia nervosa	Andrea Phillipou
22	Transcranial direct current stimulation (tDCS) for the treatment of anorexia nervosa: Protocol	Andrea Phillipou
23	Exploring the NUCOG: the Cattell-Horn-Carroll model improves cognitive construct validity	Dave Mussoff
24	Multifocal visual evoked potentials to emotional faces	Eveline Mu
25	FMRI adaptation to stimulus form, orientation, and size in different subdivisions of the lateral occipital complex	Hayden Peel
26	Peak alpha frequency and statistical learning ability independently affect artificial language learning	Benjamin Troup
27	Standard and Inter-Regional Continuous Theta Burst Priming of the Primary Motor Cortex Modulates Transcranial Magnetic Stimulation- and Sensory-Evoked Potentials	Michael Do
28	Switching Between Selective and Divided Attention - Insights from behavioral as well as physiological data	Magnus Liebherr
29	Examining cerebellum-primary motor cortex connectivity using a novel transcranial magnetic stimulation protocol: Application in tremor-dominant Parkinson's disease	Brittany Rurak
30	Combined cognitive training and transcranial Direct Current Stimulation in older adults	Kristina Horne
31	A model of V1 complex cells challenges the role of corticothalamic feedback in figure-ground segmentation	William J Harrison
32	Memory complaints in healthy middle-aged adults are not associated with memory or sustained attention	Yi-En Quek
33	Attentional bias in trauma survivors	Selma Music
34	Seeing with your eyes closed: Spatially localised adaptation-induced changes to the 'intrinsic' occipital alpha rhythm	Wiremu Hohaia
35	Changes in the rate of force applied when lifting an object do not produce related changes in its perceived weight	Elizabeth J Saccone
36	The Ever-Changing Ideal: The Body You Want Depends On Who Else You're Looking At	Ellie Aniulis
37	Spatial ICA reveals distinct facial thermal components showing dynamic and synchronized temperature changes during naturalistic emotional experience	Saurabh Sonkusare
38	Tracking the time course of sensory dampening following response errors	Alexandra Konski
39	Lightness constancy in gaze perception	Colin J. Palmer
40	Computational cognitive requirements of random decision problems	Pablo Franco
41	Examining the neural correlates of error awareness in a large (n = 451) fMRI study	Gezelle Dali
42	Where do you look when you don't want to reach? Factors associated with visuomotor direction and inhibition	Gemma Lamp
43	Association between Schizotypy and Antisaccade Performance: New Data from a Large Sample and Meta-analysis	Elizabeth Thomas
44	Tracing the time course of memory consolidation with RSA	Alex Chatburn
45	Organised toe maps in extreme foot users	Harriet Dempsey-Jones
46	The effects of light level on the task-evoked pupil response during effortful listening	Jennifer Baldock
47	A Validation of Emotiv Flex for ERP Research	Nik Williams
48	The laughing mind and its dissociation of the self	Sam Hatfield
49	Neural activity during response inhibition predicts treatment outcomes in PTSD.	Thomas Williamson
50	Perturbs and Observes the Frontotemporal Network in Automatic/Pre-attentive Abstract Change Detection with Transcranial Magnetic Stimulation and Event-related Optical Signal	Chun-Yu Tse

Posters

Session II | Saturday 23rd November 14.45-16.30

1	Cognitive Predictors of Complex Task Performance: On the Influence of Attention Control, Working Memory and Situation-Specific Task Models	Angela D. Bender
2	A dynamic noise background reveals perceptual motion extrapolation	Ryohei Nakayama
3	Effort exertion modulates learning from choice outcomes	Huw Jarvis
4	The Contribution of Spatial Frequencies in Perceptual Rescaling Mechanisms	Gizem Yildiz
5	Association between hippocampal integrity and relational memory performance in older adults with subjective cognitive decline	David White
6	Sleep restriction reduces motivation to exert cognitive effort	Mindaugas Jurgelis
7	Examining the spatial dynamics of the center-of-gravity effects in inhibition of return and sensory adaptation	Nicholas R. Wilson
8	A rose coloured view of emotional processing in autism	David Crewther
9	Causal evidence of right temporal parietal junction involvement in implicit Theory of Mind processing	Amaya Fox
10	Functional connectivity in allelic variations of APOE and BDNF polymorphisms in adults: the Tasmanian Healthy Brain Project (THBP)	Manuela Pietzuch
11	High-intensity interval exercise as a modifier of neocortical plasticity in the visual cortex	Claire J. Cadwallader
12	The belief of being watched facilitates the rapid awareness of eye gaze	Kiley Seymour
13	Risky business: impulsivity and decision-making in younger-onset dementia	Stephanie Wong
14	Magnetoencephalography (MEG) reveals the timing of neural responses during real and pantomimed visually guided actions	Laila Hugrass
15	Sleep deprivation and circadian timing differentially impact prosaccade reaction times depending on cognitive demands	Jinny Collet
16	The relationship between negative symptoms and cognitive function in schizophrenia	Caitlin Yolland
17	Handedness modulates spatial attentional shifts in a monotonous simulated driving task	Dilushi Chandrakumar
18	Investigating the effects of iTBS and cTBS on working memory in healthy younger and older adults.	Catherine Offer
19	How Perceptions of Trustworthiness are Influenced by (Arbitrary) Group Memberships: A Facial EMG and fMRI Investigation	Eric Vanman
20	Investigating distractor interference by cognitive load using pupillary luminance responses in the anti-saccade paradigm	Chin-An Josh Wang
21	Functional connectivity and the neuroprotective effects of motherhood on the ageing human maternal brain.	Winnie Orchard
22	Internally-generated responses in parkinsonian disorders: A neuropsychological study of verbal and non-verbal fluency	Gail Robinson
23	Dynamic Within-Subject Metabolic Connectivity Using High Temporal-Resolution Simultaneous BOLD-fMRI FDG-PET	Sharna Jamadar
24	Diamonds are forever – priming effects from visual imagery on perceptual rivalry	Katie Wykes
25	Causality perception and temporal sensitivity at the Blind-spot	Neha Dhupia
26	Does the brain see what the eyes miss? A steady-state visual evoked potential (SSVEP) study of inattentional blindness.	Oren Griffiths
27	Towards a More Accurate Assessment of Cognitive Processing in Aging & Post-Stroke: Insights from Healthy Aging	Deena Ebaid
28	Neurophysiology of perceptual decision formation in the ageing brain.	Méadhbh B. Brosnan
29	Modelling spelling as a process of Bayesian decision-making	Helen Mason
30	Fractals in Motion: The visual system's reliance on the fractal structure of natural scenes across spatial and temporal domains.	Michelle Roberts
31	Neural Implications of Emotional Imagery	Kajal Patel
32	Limited physiological adaptation over time for individuals with Intellectual Disability with and without Autism: A Pilot Study	Nahal Goharpey
33	Implicit vs explicit learning: Does the method of encoding affect delayed memory performance?	Bradley Skinner
34	Effect of obsessive-compulsive traits on decision-making is mediated by exploration-related strategies	Shinsuke Suzuki
35	Developing a robust analysis pipeline for paediatric magnetoencephalographic (MEG) data	Robert Seymour
36	Right and left hemisphere contributions to emotion induced blindness	Ella Moeck
37	Eye movements are related to error checking during enumeration and arithmetic	Jason Forte
38	Attention & Personality as Predictors of Creative Cognition & Achievement	Ciara Grossmann
39	Why Phonological Intervention Alone is not sufficient for remediation of Reading Fluency	Zena Elhassan
40	Autonomy support enhances movement efficiency	Reza Abdollahipour
41	Stimulating prefrontal cortex enhances performance gains from sensory-motor training in older adults	Si Jing Tan (SJ)
42	Rules are made to be broken! - Cognitive and neural mechanisms underlying conditional rule-breaking	Leidy Yurani Cubillos-Pinilla
43	Omission and commission errors on a predictable Go/No-Go task differentially predict early and higher-order literacy and numeracy in 5-7-year-old children.	Frances C Lewis
44	Association between SLF, SLF I, II, III and complex motor planning in children with Developmental Coordination Disorder: Preliminary findings	Ranila Bhoyroo
45	Ideal or Real? Issues in Assessing Ideal Body Size	Nicole Thomas
46	Unsupervised Analysis of Sleep Data Detects Periods of Lucid Dreaming	Jasmine Walter
47	Response inhibition dysfunction in complex post-traumatic stress disorder	Jenny Tran
48	Muscle Strength to Mental Strength: Exercise Engagement and Age-Related Cognitive Decline	Rhianna Lovegrove
49	Divided attention in the tactile modality	Sharon Daniel
50	Motor neuron disease features are useful for predicting frontotemporal lobar degeneration subtypes	Zhe (Jill) Long
51	The Critical Role of the Inferior Frontal Cortex in Establishing a Prediction Model for Automatic/Pre-attentive Change Detection: A TMS-EEG Study	Troby Ka-Yan LUI

Social Events

Thursday 21st November

17.00-19.00	**Welcome Reception** - Supported by UTAS School of Medicine	University of Tasmania School of Creative Arts Gallery Inveresk Campus

Friday 22nd November

18.00-21.00	**Early Career Researcher Mixer** Open to ACNS Early Career Researchers ONLY.	James Boags Brewery Function Centre (Ground Floor and Beer Garden)

Saturday 23rd November

19.00- Late	**Conference Dinner** with entertainment from The Geale Brothers - Supported by Compumedics	Penny Royal Restaurant 1 Bridge Road

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Abstracts

Keynotes

Volitional regulation of cortical excitability: Modifying cortical networks and brain oscillations with neurofeedback

Nici Wenderoth

ETH Zurich

Operant conditioning based on neurofeedback is increasingly used in both basic research and neurorehabilitation. Electroencephalography (EEG) is likely the most popular non-invasive modality for neurofeedback in humans, but applications are challenged by a low signal-to-noise ratio and poor anatomical and functional specificity. Here I will present an alternative approach where we apply transcranial magnetic stimulation (TMS) in a non-invasive neurofeedback context. I will show (i) that healthy participants can learn to volitionally up- or down-regulate the state of their motor system and elucidate which neurophysiological mechanisms mediate this effect; (ii) how this approach can be extended to decoding intended finger and hand movements; and (iii) that TMS neurofeedback training is feasible in stroke patients.

Network-sensitive brain imaging in preclinical and prodromal dementia: a longitudinal perspective

Juan (Helen) Zhou

Duke-National University of Singapore

The spatial patterning of each neurodegenerative disease relates closely to a distinct structural and functional network in the human brain. This talk will mainly describe how brain network-sensitive neuroimaging methods such as resting-state fMRI and diffusion MRI can shed light on network dysfunction associated with pathology from preclinical to clinical dementia. I will first present our findings from two independent datasets on how amyloid and cerebrovascular pathology influence brain functional networks cross-sectionally and longitudinally in individuals with mild cognitive impairment and dementia. Evidence on longitudinal functional network organizational changes in healthy older adults and the influence of APOE genotype will be presented. In the second part of my talk, I will describe our work from diffusion MRI examining how cortical cerebral microinfarct, a novel cerebrovascular marker, influence brain structural network topology and cognition. Our recent findings on how brain white matter abnormalities such as extracellular water increases and axonal damage relate to amyloid burden and age of disease onset across disease spectrum will be briefly described. If time allows, I will touch on some new ways to characterize brain functional network dynamics at rest and task for the aging and developing brain. These findings underscore the importance of longitudinal design and push beyond region-specific differences to connect brain network changes with decline in cognitive performance. Further developed with machine learning approaches, multimodal network-specific imaging signatures will help reveal disease mechanisms and facilitate early detection, prognosis and treatment search of neuropsychiatric disorders.

The social brain: norms, beliefs, and model-based influence

Xiaosi Gu

Icahn School of Medicine at Mount Sinai

To maintain the normal functioning of a society, individuals are generally expected to adapt to social norms, which are the shared beliefs about how individuals should behave in a given situation. However, an individual might also be able to change other people's beliefs and consequently, influence their choices. In this talk, I will present our recent neurocomputational work that attempts to model both 1) how humans adapt their internal expectations when others' behaviors are not changeable and 2) how individuals can exert control over others through model-based forward thinking. Taken together, these findings reveal the dynamic and proactive nature of human interactions.

Individual and public health interventions to boost cognitive reserve and resilience to dementia

James Vickers

Wicking Dementia Research and Education Centre, University of Tasmania

With the ageing of the global population, the health, social and conomic impact of dementia will be immense. While there is yet to be an effective therapeutic agent to modify the disease course of the major conditions that underlie dementia, there is increasing interest in the potential to modify individual and population risk for significant cognitive decline. The current state of epidemiological evidence indicates that there are potentially modifiable risk factors for dementia. There is also increasing interest in the concept of 'cognitive reserve' with respect to relative resilience to dementia. The risk factors for dementia are broadly not well understood by clinicians or the general public. This presentation will describe initiatives of the Wicking Dementia Centre to increase public understanding of dementia risk globally through a Massive Open Online Course (MOOC), and how we are using longitudinal intervention studies in Tasmania to explore how we can increase cognitive reserve and reduce risk of dementia.

Award Talks

The neurocognitive mechanisms of changing one's mind

Stefan Bode
University of Melbourne

Humans change their decisions all the time, in particular when new information becomes available, which can suddenly alter what we believe to be correct or even desirable. The neural and cognitive mechanisms of these processes are surprisingly poorly understood. In this talk, I will present recent findings from our lab from a series of behavioural, EEG and fMRI experiments. These results illustrate how sensory and value information is integrated when decision-makers change their mind. I will further show how decision preference can be dynamically updated depending on the decision-maker's previous choices, their engagement in related cognitive processes such as emotion regulation, or their exposure to environmental cues such as health message primes.

Using pupillometry to measure individual differences in visual imagery strength

Rebecca Keogh
University of New South Wales

Lachlan Kay
Joel Pearson

Visual imagery is our ability to 'see with the mind's eye' and the vividness with which people report being able to imagine varies substantially. A recently identified group (aphantasia) report not experiencing any visual imagery at all. Previous work using pupillometry has demonstrated that when we imagine bright images our pupils constrict, whereas when we imagine dark images they dilate, similarly to what occurs when we perceive these images. Here we investigated whether we can use pupillometry as an objective measure of an individual's imagery strength in a general population as well as a group of aphantasic individuals. In this study we had participants imagine light or dark images and measured their pupil diameter as they imagined these stimuli. We also had participants rate the vividness of their imagery during the task, in addition to completing the binocular rivalry imagery paradigm, which measures the sensory strength of visual imagery through its effect on binocular rivalry (specifically looking at the percent of binocular rivalry trials primed by imagery). We found that, in the general population, pupils dilated during darker imagery, but constricted with lighter imagery. In the aphantasic group we found this effect was less pronounced. In the general population the degree to which their pupils dilated in relation to brightness (difference between dark and bright imagery conditions) correlated positively with their imagery strength (percent of binocular rivalry trials primed). These results suggest that pupillometry may be a tool for objectively measuring individual differences in imagery ability.

Using rapid stimulus presentation and multivariate decoding to study information processing in the human brain

Tijl Grootswagers
University of Sydney

The increasing popularity of multivariate pattern classification (i.e., decoding) for time-series (i.e., MEG or EEG) data has led to the creation of several toolboxes for time-series pattern classification. These toolboxes generally include a wide range of built-in classifiers, feature-selection, scaling, and dimensionality-reduction methods. While this provides the user with a flexible number of options, it also creates a large number of free parameters in the choice of analysis, which can have issues for the replicability and reproducibility of results. Several explorations have been performed to test the effect of parameter choices for pattern classification, in fMRI, MEG, and EEG. However, the effects of analysis choices are generally compared on a single dataset, while varying a single parameter at the time. To provide general recommendations for time-series pattern classification, the effects of different parameters (and their interactions) should be evaluated using different modalities (e.g., MEG and EEG) and different paradigms (e.g., visual perception; working memory; decision making). In this study, we used multiple publicly available MEG and EEG datasets covering different experimental paradigms. We then used the popular CoSMoMVPA toolbox to systematically compare the effects of a comprehensive range of analyses options and their interactions on pattern classification results. The results provide a set of broadly applicable guidelines for time-series pattern classification that are straightforward to implement in future decoding studies.

Symposia

Cortical plasticity and motor function in ageing and neurodegenerative disease

Chair: James Coxon

Monash University

Motor function is critical for maintaining independence, but deteriorates as we age, and even more so with neurodegenerative disease. However, the human brain has a remarkable capacity to reorganise itself via synaptic plasticity when exposed to new experiences. This symposium will bring together early-mid career researchers utilising non-invasive brain stimulation techniques (e.g. TMS, tDCS) to better understand cortical neurophysiology and synaptic plasticity. The symposium will showcase novel approaches intended to enhance motor functioning to counteract the ageing process as well as neurodegeneration due to Parkinson's disease and Huntington's disease.

Is the excitation – inhibition balance important for fine motor control in older adults?

Ann-Maree Vallence

College of Science, Health, Engineering and Education, Murdoch University

Brittany K Rurak

Geoff Hammond

Hakuei Fujiyama

Functional changes in the primary motor cortex (M1) likely play a role in age-related decline in motor control. Both intracortical inhibitory and facilitatory processes acting within M1 are important for fine motor control, but we do not know how age affects the balance between these processes, or whether the excitation – inhibition balance is associated with motor function. We used transcranial magnetic stimulation (TMS) to measure the balance between the excitability of GABAergic inhibitory circuits and facilitatory circuits that generate I-waves. Results show that the shift from net inhibition to net facilitation differs between younger and older adults, suggesting altered efficacy of short-interval intracortical inhibition in older adults. Results also show that an excitation – inhibition balance favouring inhibition was associated with better fine motor control and an excitation – inhibition balance favouring facilitation was associated with poorer fine motor control. These findings contribute to our understanding of age-related differences in intracortical inhibitory and facilitatory processes and their potential role in age related decline in manual dexterity.

Primed to learn: investigating the use of transcranial magnetic stimulation for promoting motor function in older adults

George Opie

Discipline of Physiology, Adelaide Medical School, University of Adelaide

Brodie Hand

James Coxon

Ulf Ziemann

John Semmler

While the factors contributing to age-related declines in motor function are multi-factorial, changes in the brain's neuroplastic capacity are likely important. Interventions that modulate neuroplasticity may therefore be an effective means of influencing the way in which older adults learn new motor skills. Our group is therefore attempting to improve motor learning in older adults by using transcranial magnetic stimulation to modify brain excitability prior to motor training. This talk will present findings from our recent studies, in which paired-associative stimulation was applied in conjunction with visuomotor training in young and older adults.

Combining physical exercise and transcranial direct current stimulation to address sensorimotor impairment in Parkinson's disease

Hayley Teasdale

Faculty of Health - University of Canberra, Australia

Parkinson's disease (PD) patients have sensorimotor impairments that compromise postural stability and balance. In this talk I will present the results of a series of studies investigating the effect of non-invasive technologies, including transcranial direct current stimulation (tDCS) and a novel therapeutic vibrotactile ball, on aspects of motor function in Parkinson's disease. This will include preliminary results from a randomised cross-over trial of four weeks of combined physical exercises and high definition tDCS in PD patients. Participants completed 4 weeks of experimental intervention (combining active HD-tDCS with exercises), and 4 weeks of control intervention (combining sham tDCS and cognitive training). Measurements were taken of ankle proprioception in inversion and plantarflexion, balance, symptom severity, and fear of falling by a blinded physiotherapist at baseline, 2 weeks, and 4 weeks. Results indicate that participants show a significant and clinically important improvement in balance during the experimental condition. Future directions for research utilising this promising intervention will be discussed.

Effects of acute exercise and transcranial magnetic stimulation on motor cortex plasticity and motor skill learning in Huntington's disease

Sophie Andrews

Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash University, and Neuroscience Research Australia and School of Psychology

Andrews, S.C.

Curtin, D.

Kampf, L.

Coxon, J.P.

Stout, J.C.

Huntington's disease (HD) is a genetic neurodegenerative disease that results in progressive motor dysfunction, as well as cognitive impairment and psychiatric symptoms. Onset is typically during midlife, but there is evidence that both neurodegeneration and neural compensation processes occur up to two decades prior to diagnosis. During this crucial period, interventions such as aerobic exercise and non-invasive brain stimulation may have the potential to enhance neuroplasticity and slow functional decline. In this talk, I will present a series of studies examining the effects of acute exercise and intermittent theta burst stimulation on motor cortex plasticity and visuomotor skill learning in people who are gene-positive for HD (pre-symptomatic and early symptomatic), as well as healthy adults without the HD-gene.

Using network neuroscience to understand typical and atypical development

Nandita Vijayakumar

School of Psychology, Deakin University

The brain is undergoing significant maturation during childhood and adolescence. Network neuroscience informs us about the changing relationship between brain regions during development, with the potential to reveal more about cognitive processes characterised by distributed neural activity. This symposium brings together research on structural and functional connectivity using multiple approaches to identify network components and model their dynamics. We will discuss normative maturational changes in the brain, as well as aberrations in neurodevelopmental disorders, psychopathology, and acquired brain injuries. We highlight the value of network neuroscience for typical and atypical populations, including its relevance for cognition and behaviour.

Maturational covariance of cortical development during puberty

Nandita Vijayakumar

School of Psychology, Deakin University

Emma Sciberras

Vicki Anderson

Daryl Efron

Philip Hazell

Jan M. Nicholson

Timothy J. Silk

Introduction: Structural covariance conceptualises how morphological properties, such as cortical thickness, of different brain regions relate to each other. We extend this model to study the network properties of longitudinal cortical development, to better understand the coordinated maturation of brain regions during puberty.
Method: We used structural MRI data from a longitudinal study of typically developing children and adolescents (N = 78, aged 9 to 14 years) sampled up to three times over three years (n scans = 206). The sample was split into "advanced" and "delayed" pubertal groups based on within-subject changes in pubertal stage. For each pubertal group, we estimated standardised linear rate of change (per participant) for 148 regions, and correlated change across regions to construct a "maturation" matrix for each group. Network metrics were used to compare global, regional, and modular properties (involving decomposition of networks into functional modules) of the "advanced" and "delayed" pubertal matrices. Results: While global network properties did not differ between pubertal groups, the precuneus and posterior cingulate exhibited greater maturational covariance with other regions (based on number and strength of correlations) in the "advanced" pubertal group. The "advanced" pubertal group exhibited greater within-network covariance in the default mode network, as well as stronger covariance between this network and the dorsal attention and ventral attention networks, compared to the "delayed" pubertal group. Discussion: Findings highlight coordinated maturation of regions and modules that support social and higher-order cognitive processes during puberty, in line with the normative functional changes occurring during this developmental period.

The development of structural connectivity subnetworks and specific alterations in autism spectrum disorder

Gareth Ball

Developmental Imaging, Murdoch Children's Research Institute, Melbourne

Richard Beare

Marc L Seal

Diffusion-weighted MRI allows the delineation of macroscale areal brain connectivity, changes to which reflect the ongoing maturation of white matter tracts. These developmental changes vary in timing and are likely disturbed in common neurodevelopmental disorders. At a millimetre-scale, the structural connections between brain regions can be conceptualized as a complex network. In this work, we use a data-driven approach, non-negative matrix factorisation (NMF), to model complex networks derived from whole-brain tractography as a set of components, or subnetworks, that vary together across the population. We demonstrate that network components can be robustly and reliably identified in a large developmental cohort [1,2]. We then model component strength across childhood, defining specific developmental trajectories for subnetwork connectivity and highlighting associations between changes in white matter connectivity patterns and local changes in cortical thickness [1]. Finally, in a group of adolescents with high-functioning ASD and age-matched, typically developing controls, we find a specific cortical subnetwork with significantly increased connection strength in ASD [2]. Neuroimaging data provides a natural setting for NMF analysis due to the inherent nonnegativity common to many imaging-derived metrics (e.g., tissue volume, fiber count). We show that NMF results in an interpretable decomposition of complex imaging data, capturing biological relevant subnetworks that vary in strength with age. This work highlights possible long-term implications of alterations to the developmental trajectories of specific cortical subnetworks. References [1] Ball, Beare & Seal. 2019. Charting shared developmental trajectories of cortical thickness and structural connectivity in childhood and adolescence. Human Brain Mapping in press [2] Ball, Beare & Seal. 2017. Network component analysis reveals developmental trajectories of structural connectivity and specific

Coupling of resting state networks in adolescent problematic substance use and depression

Sarah Whittle

Melbourne Neuropsychiatry Centre, Department of Psychiatry, The University of Melbourne and Melbourne Health, Australia

Divyangana Rakesh

Jinglei Lv

Background: Emotion regulation (ER) deficits are apparent in both depression and substance use problems, both of which are prevalent during adolescence. Alterations in ER neural circuitry (specifically, altered connectivity between subcortical [e.g., amygdala] and frontal regions) have been implicated in both depression and substance use problems, and there is suggestion that they represent a common neurobiological marker. However, no research has investigated both types of mental health problems in the same study using network approaches to investigate functional connectivity. Methods: We used resting-state functional magnetic resonance imaging (fMRI) and independent component analysis (ICA)

to delineate cortical and subcortical functional networks in 108 adolescents (mean age = 17.59 years, SD = 1.22 years, 58 females) from the community. We examined the relationship between coupling of frontal and subcortical networks and both depression (major depressive disorder [MDD] diagnosis) and problematic substance use (based on the youth risk behaviour survey [YRBS]). Results: We found problematic substance use to be associated with coupling of the executive control network (ECN) and the subcortical network. Problematic substance users showed decreased (more negative) coupling compared to non-problematic/non-users. We did not find MDD-related alterations in the coupling of these networks. However, exploratory analyses revealed alterations in coupling of the ECN and default mode network (DMN) in adolescents with MDD. Conclusion: An altered relationship between the subcortical and prefrontal cortical systems may underlie ER deficits in adolescent problematic substance use.

Mapping brain networks in young patients with traumatic brain injury: What can graph metrics tell us?

Karen Caeyenberghs

Institute for Health Research, Australian Catholic University, Melbourne, Victoria, Australia

Mary MacKillop

Introduction: Sustaining traumatic brain injury (TBI) during childhood- a 'critical period' of white matter development - interrupts white matter maturation (Lebel and Deoni, 2018). Previous research using diffusion MRI reported widespread white matter alterations in young patients with TBI (Roberts, Mathias, Rose, 2014). These disruptions in white matter organization leads to a wide array of deficits of higher order functions (such as executive functioning, postural control) that reside on the integration of widespread brain areas (Caeyenberghs et al., 2012, 2014). Methods: The objective of this paper is to review our studies that have examined TBI-related alterations in different properties of the functional and structural brain network, including global integration, segregation, centrality and resilience. We will focus on diffusion and functional MRI data in young patients with TBI of different severity and recovery phase, and we will examine robust patterns of change in graph metrics across studies. Also, we will explore whether alterations in graph metrics are implicated in motor symptoms and neurocognitive dysfunction after TBI. Finally, we will outline several methodological challenges associated with the examination of brain networks in young patients with TBI, including the sample size, parcellation scheme used, node definition and subgroup analyses. Conclusions: Graph theory is a unique and powerful tool for exploring structural and functional connectivity in young TBI patients. One limitation is that its results do not provide specific measures about the biophysical mechanism underlying TBI. Continued hypothesis-driven work in this field will hopefully see graph metrics used as diagnostic and prognostic biomarkers to provide more accurate diagnosis and help guide treatment at the individual patient level.

Inhibitory control in healthy and clinical populations

Chair: Mark Hinder

Sensorimotor Neuroscience and Ageing Laboratory, School of Medicine (Division of Psychology), College of Health and Medicine, University of Tasmania.

Inhibitory control is a critical aspect of human behaviour. Cancellation of planned actions has been studied in the laboratory for many years using paradigms such as the stop signal task. Inhibitory control is often compromised in clinical populations as well as in neurological and neurodevelopmental disorders, possibly influenced by both connectivity within the brain's stopping network and one's ability to use cognitive cues to plan actions. Here we present a series of talks by early career researchers that combine behavioural paradigms with state-of the-art brain stimulation techniques to more fully understand the neural mechanisms underpinning cancellation of planned motor responses.

Role of expectancy in selective stopping: a behavioural and neural perspective

Rohan Puri

Sensorimotor Neuroscience and Ageing Laboratory, School of Medicine (Division of Psychology), College of Health and Medicine, University of Tasmania.

Mark R. Hinder

Many everyday tasks require 'selective stopping', involving the rapid cancellation of one component of an action, while continuing to execute other action components, albeit in a delayed manner ('selective stop cost': SSC). However, little is known of the underlying neural mechanisms as well as the role of expectancy on selective stopping. Twenty-eight healthy right-handed adults (19 – 41 years) responded to a 'Go' stimulus, via a simultaneous button press, with their left and right index fingers. To assess selective stopping, the go stimulus was followed by a 'Stop' stimulus on 1/3rd of the trials, requiring the cancellation of either the left or right response. Furthermore, to assess the role of expectancy, participants were provided, at the start of each trial, either an uninformative or informative cue in regards to which hand may be required to stop. Dual-site transcranial magnetic stimulation was utilized to investigate corticospinal excitability (CSE) and interhemispheric inhibitory (IHI) pathways between the two primary motor cortices (M1). Informative, compared to uninformative, cues reduced the SSC by ~ 20% (21 ms; $p < 0.001$) and was associated with significant underlying neural changes. During the preparation and execution phase (i.e., prior to the stop stimulus), CSE was lower for the informative, relative to uninformative, cued condition but only for the dominant right hand ($p = 0.009$). During the stopping phase (i.e., 150 ms after the stop stimulus), significant changes were only observed when the non-dominant left hand was required to stop. Specifically, CSE was lower in the left, compared to right, hand ($p = 0.019$) and was associated with greater IHI mediated by direct pathways onto the left, compared to right, hand ($p = 0.031$). Overall, these results suggest that expectancy influences selective stopping with associated M1 changes during the preparation and stopping phase possibly depending on hand dominance.

Reduced motor cortex inhibition in problem gamblers

Nahian Chowdhury

School of Psychology, University of Sydney

Evan Livesey

Alex Blaszczynski

Justin Harris

Impairments in response inhibition have been implicated in gambling psychopathology. This behavioural impairment may suggest that the neural mechanisms involved in response inhibition, such as GABAA activity in the primary motor cortex

(M1), are also impaired. The present study obtained paired-pulse Transcranial Magnetic Stimulation (TMS) markers of GABAA and glutamate from the left M1 of three groups: problem gamblers, at-risk gamblers and controls, with each group matched for alcohol use, substance use and ADHD symptomology. Response inhibition was measured using the stop signal task. Results showed that problem gamblers exhibited weaker M1 GABAA relative to controls and elevated M1 glutamate relative to at-risk gamblers and controls. Though there were no differences in response inhibition between the groups, poorer response inhibition was correlated with weaker M1 GABAA across all groups. These findings are the first to show that problem gambling is associated with impaired M1 GABAA and glutamate neurotransmission, and that these M1 GABAA impairments are implicated in response inhibition.

Inhibitory control in neurodevelopmental disorders

Dinisha Parmar

School of Psychology, Deakin University

Natalia Albein-Urios
Jason He
James Coxon
Ian Fuelscher
Pam Barhoun
Christian Hyde
Peter G. Enticott

Neurodevelopmental disorders, including autism spectrum disorder (ASD) and developmental coordination disorder (DCD), are characterised by impairments in motor control. A significant portion of motor control research in these conditions has examined inhibitory control, typically via the stop signal task in combination with neuroimaging and electrophysiology. We conducted a series of studies assessing stop task inhibition in young adults diagnosed with ASD or DCD, along with age-matched neurotypical (NT) controls. Results demonstrated that individuals with DCD were less efficient than NT peers at stop task inhibition, with reduced action restraint efficiency index scores and longer stop signal reaction times. This seems to indicate difficulties with engaging inhibitory mechanisms during motor behaviour. We have also conducted clinical trials, with both NT and ASD samples, using high-definition transcranial direct current stimulation (HD-tDCS), to investigate the likely role of the right inferior frontal gyrus (rIFG) on stop task inhibition. We present an overview of these studies and discuss the potential use of non-invasive brain stimulation for therapeutic intervention in neurodevelopmental disorders.

In-phase tACS does not improve response inhibition for older adults, but potentially reduces response conflict in their younger counterparts

Jane Tan

Discipline of Psychology, Exercise Science, Chiropractic and Counselling, Murdoch University

Hakuei Fujiyama

A growing body of research indicates that age-related changes in functional neural network connectivity underlie declines in cognitive functioning. In particular, deficits in response inhibition have been associated with reduced functional connectivity in the fronto-basal-ganglia network, which includes the right inferior frontal gyrus (rIFG) and the pre-supplementary motor area (pre-SMA). Here, we explored the effect of dual-site transcranial alternating current stimulation (tACS) on neural oscillatory phase relationships between the rIFG and the pre-SMA and stop-signal task (SST) performance in younger (n=19) and older adults (n=15). We hypothesised that the induction of a 0° phase angle (in-phase) difference in beta band activity between these regions using tACS would facilitate functional connectivity between the rIFG and preSMA, and lead to improvements in response inhibition. Conversely, the induction of a 180° phase angle difference (anti-phase) was posited to adversely affect inhibitory performance. We found that neither in-phase nor anti-phase tACS resulted in significant changes in response inhibition performance for older participants. Changes in the stopping ability of younger individuals approached significance ($p = .040$, FDR-corrected alpha = .025), with shorter stopping times following in-phase tACS. The analysis of sensor- and source-level electroencephalographic (EEG) activity also found no significant changes in beta band phase coherence and phase lag between the rIFG and the pre-SMA following both tACS conditions. However, changes in gamma band coherence resulting from in-phase tACS were significantly associated with improved/lower declines in response inhibition for older adults. In addition, event-related potential (ERP) analysis revealed that in-phase tACS significantly decreased stop-N2 amplitudes for younger adults, indicating that response conflict was reduced. The presence of age-related differences in the effects of dual-site tACS on neural activity highlights the importance and need for more research on older populations to elucidate the neural underpinnings of inhibitory deficits in the ageing brain.

Advancing our understanding of cognition

Chairs: Emma Burrows & Katherine Johnson

Psychological Sciences, The University of Melbourne

Despite highly promising preclinical data, the majority of compounds developed to treat cognitive brain disorders fail to progress to end stage clinical trials. A major hurdle in improving translation is that cognitive correlates in preclinical animal models have been, to date, approximate and do not reflect methods used in clinical populations. This symposium features emerging and established researchers approaching this problem using sophisticated technologies and methodology, with a focus on direct translation to the clinic. These speakers will provide novel insight into neural mechanisms underlying cognitive dysfunction through the combined use of preclinical animal models and patient groups being assessed on similar cognitive tasks.

A novel Posner-style cueing task to assess attention orienting in mouse models of autism

Shuting (Tina) Li

Psychological Sciences. The University of Melbourne

K Johnson
EL Burrows

A deficit in attention orienting may be one of the earliest features in people with Autism Spectrum Disorder (ASD). Attention orienting is comprised of two components - exogenous and endogenous orienting. Exogenous orienting of attention is a stimulus-driven process in which one's attention is drawn automatically to salient external stimuli. Endogenous orienting of attention represents a goal-directed process in which expectations and/or knowledge of an individual determine where and when one's attention is given. To date,

the neural mechanisms underlying the atypical attention orienting in autism remain unclear. Genetic mouse models are useful tools to investigate the neurobiology of cognition, but a well-established assessment of attention orienting in mice is missing. The Posner cueing task is a widely used visual-spatial orienting task in humans. It has been adapted in studies of rats and fish, but rarely used in mice. It is important to develop a mouse version of the Posner cueing task before investigating the association between attention orienting and ASD-associated genetic mutations. Our objective was to adapt the human Posner cueing task for use in mice using recently developed touchscreen technology, with a subsequent aim to use this paradigm in a mouse model of ASD.
Thirty-two C57BL/6 mice were trained and tested in automated touchscreen chambers. Mice were trained to sustain their nose-poke to a central dim square until the display of a peripheral target (a bright square). They were rewarded with strawberry milkshake for nose-poking the target. The targets were either validly or invalidly cued. In the exogenous tasks (n =16), the cue was a flash of light in the peripheral square. In the endogenous tasks (n=16), the cue was a centrally-presented spatially-predictive grating – 145 degree gratings predicted the target on the left, while 45 degree gratings predicted the target on the right. The validity of cues were 50% in the exogenous tasks, and above 80% in the endogenous tasks.
In both the exogenous and endogenous tasks, mice showed higher accuracy and shorter response times in the validly cued trials, compared to invalidly cued trials. This effect is consistent with results in the human Posner task. While mice were able to maintain their nose-poke at centre, this was negatively correlated with increased stimulus-onset asynchrony (SOA). In this study, we have successfully adapted the human Posner task to mice. Mice responded faster to validly cued stimuli, in line with results in humans. This mouse Posner task can be used to assess attention orienting in mice containing ASD-associated genetic mutations and also following pharmacological manipulations to enable a greater understanding of neural mechanisms underlying deficits of manipulations to enable a greater understanding of neural mechanisms underlying deficits of attention orienting in ASD.

Of mice and mental disorders: deconstructing motivation and decision-making to advance translational research in psychiatry

Jess Nithianantharajah
Florey Institute of Neuroscience and Mental Health

Luo Jiaqi
Tan Jessica
Lee Clara
Nikila Woodland

A major challenge in delineating the neurobiological basis of mental disorders such as depression lies in their complex symptomology, heterogeneity and comorbidity. Animal models provide crucial tools to dissect these complex brain disorders into discrete components that allow us to examine underlying neural circuitry, molecular and cellular pathways that may be critical in the pathogenesis of mental disorders. I will discuss our recent work dissecting distinct cognitive components in mouse models of synapse gene mutations of importance to neurodevelopmental and neuropsychiatric disorders. Combining the development of novel rodent touchscreen assays to dissociate behaviours driven by reward, effort, motivation and decision-making, our team is developing the approaches necessary to enhance how we model and measure complex behaviours in rodents to inform translational avenues for mental disorders.

The neural architecture of cognitive flexibility and control

Farshad Mansouri
Monash University

Buckley MJ
Tanaka K.

In a complex and changing environment, the validity of rules or goals might change in terms of their associated reward and cost, and we often face the necessity to make a strategic decision to adaptively shift between these behavioural rules or goals. Such a decision entails assessment of the value (cost and benefit) of current and alternative rules or reward resources for the individual, and also for the group, in socially advanced species. A distributed neural network involving prefrontal and medial frontal cortices regulates the use of cognitive resources to optimize exploitation of current reward resources, while minimizing the associated cost. This is referred to as executive control of goal directed behaviour. Recent studies suggest that dorsolateral prefrontal, orbitofrontal and anterior cingulate cortices are involved in optimizing the exploitation of the current reward sources however, the most rostral part of the prefrontal cortex (frontopolar cortex) plays a crucial role in adjusting the tendency for exploitation, versus exploration of other alternative resources, by assessing the value of alternative tasks/goals and re-distribution of our cognitive resources.

Human and rodent homologies in the circuits mediating action control: Implications for obsessive compulsive disorder

Bernard Balleine
UNSW Sydney

Prior clinical observations derived from the treatment of obsessive compulsive disorder have implicated a loop-like circuit involving the mediodorsal thalamus, orbitofrontal cortices, ventral striatum and feedback to the thalamus via the ventral pallidum in the compulsive actions associated with this disorder. Interestingly, in a previously unrelated set of findings in rodents, this same circuit has been heavily implicated in the way predictive cues affect action selection and execution in tests of Pavlovian-instrumental transfer. This suggests a homologous circuit may mediate both the normal and abnormal control of actions in humans and rodents. We have recently investigated areas of the medial and lateral orbital cortex in rodents and found a stimulus control process in the lateral orbital influences output for actions selection via the medial orbital cortices through this circuit. Furthermore, using a human analogue of the Pavlovian instrumental transfer test together with fMRI, we found activity in this circuit associated with transfer in healthy subjects whereas those with OCD showed evidence of occlusion of the transfer effect associated with abnormal activity in the medial orbital cortex and its connections with the striatum.

Regular Talks

The Effect of Motor Costs on Decision Confidence

Raina Angdias

Melbourne School of Psychological Sciences, The University of Melbourne

William Turner, Melbourne School of Psychological Sciences, The University of Melbourne

Daniel Feuerriegel, Melbourne School of Psychological Sciences, The University of Melbourne

Trevor T-J Chong, Monash Institute of Cognitive & Clinical Neuroscience, Monash University

Robert Hester, Melbourne School of Psychological Sciences, The University of Melbourne

Stefan Bode, Melbourne School of Psychological Sciences, The University of Melbourne

An integral aspect of decision-making is the ability to revise our confidence in a decision - that is, to change our minds, especially in response to new evidence or after making an error. An emerging view within the metacognition literature suggests that confidence judgments integrate multiple sources of information, and it has recently been hypothesised that action-related information can positively bias decision confidence. Here, we tested this hypothesis directly and investigated whether expended effort, or the sunk motor costs of a decision, biases perceptual confidence. Forty-four participants performed a difficult luminance discrimination task that involved identifying which of two dynamic stimuli (flickering grayscale squares) was brighter. Participants reported their choice by squeezing hand-held force-sensitive dynamometers. We varied the effort required to report a decision across three levels (low, medium, high). Importantly, the required effort level was only revealed after participants had initiated their response. Participants then rated their confidence in their choice, ranging from 0% (Certainly incorrect) to 100% (Certainly correct). Overall, participants were more confident in decisions that required greater effort to report, and this effect remained after controlling for accuracy and response times. These findings suggest that confidence judgments are sensitive to the motor costs of an already executed response. Our findings are consistent with contemporary models of metacognition, which posit that motor outputs can inform post-decision confidence.

Dynamic changes in brain networks for spatial attention revealed by transcranial magnetic stimulation evoked potentials

Claire Bradley

Queensland Brain Institute, The University of Queensland

Claire Bradley, Queensland Brain Institute, The University of Queensland

Emily McCann, Queensland Brain Institute, The University of Queensland

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A frontoparietal cortical network underpins visual attention. Activity in this network is captured by brain imaging methods such as electroencephalography (EEG), but imaging alone is not well-suited to providing an ongoing readout of the network's neurophysiological state and its causal involvement in psychological operations. Here we combined EEG and transcranial magnetic stimulation (TMS) to provide such a readout. We had three aims: (i) to probe a parietal node of the attentional network using TMS at differing levels of attentional engagement; (ii) to use EEG to record TMS-evoked potentials (TEPs) during task performance; and (iii) to assess whether TEPs are modulated by attentional state. Forty-four right-handed participants received single-pulse TMS over the left intra-parietal sulcus (IPS), defined anatomically in each individual, while we recorded EEG. Attention side (contralateral or ipsilateral to TMS) was manipulated by having participants discriminate motion direction of infrequent targets embedded in random-dot kinematograms positioned in the left and right hemifields. Dot coherence (low, high) was varied across blocks to manipulate task difficulty. Spatial attention significantly modulated TEP amplitude at early to mid-latencies (~30-50ms), with larger amplitudes when attention was directed contralaterally. Task difficulty modulated TEP amplitude at later latencies (~100-160ms), with larger amplitudes during low coherence blocks. Whole-scalp global-mean-field-potential and time-frequency analyses provided concordant results. Taken together, the findings provide a detailed picture of the spatial and temporal dynamics of visual attention networks following non-invasive stimulation of the inferior parietal cortex. [This study was pre-registered on the Open Science Framework (https://osf.io/uk86r)]

Dissociable motivational deficits in pre-manifest Huntington's disease

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Apathy is a common and disabling symptom in Huntington's disease (HD), a neurodegenerative disease characterised by early striatal cell loss. A long-standing view is that apathy comprises cognitive and physical subtypes, but an outstanding question is whether these subtypes are served by separate neuroanatomical substrates. Here, we asked whether individuals in the pre-manifest stages of HD display dissociable patterns of cognitive and physical apathy. We recruited 20 individuals with pre-manifest HD, and 20 matched controls. Notably, neither group were clinically apathetic when assessed on standard clinical scales. Participants were first trained on separate cognitively or physically effortful tasks, which were similar in their temporal features and demand characteristics. In a subsequent choice phase, participants made separate decisions about how much cognitive or physical effort they were willing to invest for a given reward. Our central finding was that cognitive and physical motivation were differentially affected in HD. The pre-manifest group were significantly less motivated than controls to engage in cognitively effortful behaviour, but the effects of HD on physical motivation were subtler, and only evident as distinct patterns of effort discounting on computational models of subjective value. Importantly, these differences were detectable despite both groups being matched in their apathy ratings on standard rating scales. This suggests that subclinical

deficits in motivation are present in pre-manifest HD, and detectable with sufficiently sensitive tasks. Our results provide important empirical support for prominent frameworks of apathy, by providing the first human evidence that separable neuroanatomical substrates underlie distinct subtypes of motivational impairment.

Frontocentral signatures of curiosity: Evidence for subjective valuation of non-instrumental information

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Humans are curious creatures, with the desire to know about the unexpected being a powerful motivator of behaviour. Recent work has shown that people will incur significant costs to obtain information about potential future rewards regardless of whether this information actually assists in obtaining the reward. This motivational aspect suggests that information in and of itself may have subjective value. In this study, we aimed to determine if information valuation was neurally encoded in a similar fashion to other reward signals. We recorded EEG while participants passively viewed a pre-determined lottery in which non-instrumental information about potential win/loss states were progressively revealed during the trial. This information could lead to early knowledge of a win or loss without affecting the actual lottery's outcome. Additionally, we included random information (i.e. non-informative stimuli), which simply displayed a random state unrelated to the current lottery's chance of success. N2 amplitudes were increased for non-informative sources of information, while P3a amplitudes were enhanced for potential loss signals. Moment-by-moment shifts in expectations of wins/losses were also associated with larger frontocentral ERP amplitudes than no shift in expectation. Critically, we found that non-informative stimuli, which had no relationship to the current lottery, nevertheless had a similar ERP profile to real expectancy updates. Taken together, we provide novel evidence that non-instrumental information is automatically processed as if it had instrumental value, with neural signatures similar to reward processing.

Effect of pharmacological manipulation of dopamine D2 receptors on response inhibition.

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Cortico-basal ganglia loops and the neurotransmitter dopamine are critical for motor control, including response inhibition. In stop-signal tasks, response inhibition can be engaged proactively using advance information, or reactively, to 'slam on the brakes' following a stop-cue. Dopamine D2 receptors and the indirect cortico-basal ganglia pathway could feasibly contribute to both forms of inhibition. The aim of this study was to investigate the effect of the dopamine D2 antagonist Sulpiride on behavioural and electrophysiological signatures of proactive and reactive inhibition. In a double-blind randomised crossover study (Sulpiride/Placebo), participants (N=24) completed an anticipated response stop-signal task while electroencephalography was recorded. On each trial, advance information indicated the likelihood of a 'Stop' trial (Stop 0%, Stop 25%, Stop 33%). We hypothesised that Sulpiride would increase 'Go trial response times as a function of stop-cue expectancy, and may also prolong stop-signal reaction time. There was a main effect of stop-cue expectancy ($p = .037$), but no effects that involved drug ($p > .24$). Sulpiride increased 'Go' response variability ($p = .01$) and tended to prolong stop-signal reaction time ($p = .06$). A significant distinction between stop-success and stop-fail was evident in the event-related potential (P1 amplitude, $p < .001$). Drug interacted with stop-cue probability ($p = .01$), with Sulpiride decreasing P3 amplitude when stop-cues were more likely to occur (Stop 33% vs Stop 25%). Although Sulpiride had subtle effects on behaviour, the electrophysiological data support a role for dopamine D2 receptors in proactive inhibition.

Memories of a blind mind: The impact of visual imagery absence on episodic memory in Aphantasia

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Cognitive processes such as episodic memory, future event prospection, dreaming, spatial navigation and emotional regulation are all thought to depend on visual imagery. Some individuals, however, lack the ability to voluntarily generate visual imagery altogether - a condition termed 'aphantasia'. Recent findings using objective measures of imagery strength suggest that aphantasia is a condition defined by the veritable absence of visual imagery, rather than a lack of metacognitive awareness of imagery. We asked whether visual imagery absence in aphantasia might be associated with weaker episodic memory and future prospection abilities. We demonstrate that compared to participants with normal visual imagery ability, individuals with aphantasia report less vivid and phenomenologically rich episodic memories and imagined future events, and also appear to be less likely to report vivid memory intrusions of the kind consistent with the re-experiencing of past traumatic events. On more robust measures of episodic memory (such as an adapted version of the Autobiographical Interview), patterns of group differences between control participants and individuals with aphantasia are more nuanced, and suggest a complex relationship between visual imagery ability and the metacognitive vividness of constructed autobiographical events. It is argued that individual differences in visual imagery ability must be accounted for when investigating episodic memory performance. Overall, our data suggest that visual imagery may act as a normative but perhaps non-essential representational format for remembering the past and imagining the future.

Transcranial direct current stimulation of prefrontal cortex augments multi-session single/ dual-task training and induces near transfer: A dosage study

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Transcranial direct current stimulation (tDCS) has been shown to improve single- and dual-task performance in healthy participants and enhance transferable training gains following multiple sessions of combined stimulation and task-practice. However, it has yet to be determined what the optimal stimulation dose is for facilitating such training outcomes. We aimed to test the effects of different tDCS intensities with a commonly used electrode montage on performance outcomes in a multisession single/dual-task training and transfer paradigm. In a pre-registered study, 123 participants, who were pseudorandomised across four groups, each completed six sessions (pre- and post-training sessions and four combined tDCS and training sessions) and received 20 minutes of prefrontal anodal tDCS at 0.7 mA, 1.0 mA, or 2.0 mA, or 15-second sham stimulation. Response time and accuracy were assessed in trained and untrained tasks. We observed significant improvements in the single and dual-task reaction times and dual-task accuracy for 1.0 mA when compared to sham performance. The 1.0 mA group also showed near transfer to an untrained single/dual-task. In contrast, 0.7 mA and 2.0 mA protocols improved single-task response times relative to sham, with no effects on dual-task performance or transfer. Our study highlights that training performance gains are augmented by tDCS, but their magnitude and nature are dependent on the stimulation intensity. Specifically, only a mid-intensity stimulation condition (1.0 mA) led to both improvements in performance (both reaction time and accuracy) and near transfer to an untrained task.

The effect of familiarity on neural correlates of emotion perception in 15 week old infants

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Emotion perception is considered a crucial component of human functioning due to its valuable role in the process of communication. The development of emotion perception during infancy has been associated with important developmental constructs such as attachment, emotion regulation and approach/avoidant behaviours. Event related potential (ERP) studies investigating the perception of fearful facial expressions in infancy have found that sometime between five and seven months of age infants are able to distinguish fearful faces from other emotion expressions. Concurrently, ERP studies investigating the discrimination between familiar and non-familiar faces/stimuli have found evidence of discrimination in infants as young as 12 weeks of age. The current study sought to investigate whether familiarity modulates emotion perception prior to five months of age. Twenty-two 15 week old infants (12 male) were tested on an ERP paradigm which consisted of four emotional facial stimuli consisting of happy versus fearful / mother versus stranger images. Partial least squares (PLS) analysis coupled with source localisation software were used to analyse the data. The face of a fearful stranger elicited significantly greater neural activation than the fearful face of the infant's mother between 376 - 458 milliseconds (ms) post-stimulus onset in the left Brodmann's Area (BA) 18 and 19 (mid-occipital gyrus, occipital cuneus respectively), while the infant mother's happy face elicited significantly greater neural activation than the stranger's happy face between 712 - 842ms post-stimulus onset in BA 7 (postcentral gyrus). These findings suggest that familiarity modulates infants' emotion perception at 15 weeks.

Visual mismatch responses are a product of surprise, but not fulfilled expectations

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We are constantly forming expectations about our sensory environments. These expectations facilitate our decision-making and allow us to detect unusual events. Accordingly, studies using visual oddball designs have reported enhanced neural responses to surprising, compared to expected, images. Influential predictive processing models posit that these mismatch effects arise from both suppression of responses to expected stimuli and enhanced responses to surprising stimuli. Existing studies have confirmed the role of surprise, but have confounded effects of fulfilled expectations with those of stimulus repetition, which mimic hypothesised expectation effects. We isolated and quantified effects of fulfilled expectations and surprise using a novel oddball design based on Fast Periodic Visual Stimulation (FPVS). This design controls for stimulus repetition effects while entraining participants expectations toward seeing specific images. We presented stimulation sequences consisting of the same face image presented at a rate of 6 Hz while recording EEG. Every 7th face was replaced by one of two different face identities, here termed the oddball stimulus. The probability of a particular face image being the oddball ranged between 10% and 90% across sequences, in steps of 10%, including an expectation neutral condition whereby Face A and B were each presented as 50% of oddball stimuli. Oddball-evoked ERPs were more negative between 200-300ms following surprising (10-40% probability) oddballs, compared to expected (60-90%) oddballs. However, expected oddball-evoked ERPs did not differ from neutral (50%) oddballs. Our findings indicate that visual mismatch responses reflect the detection of unusual events, but not the suppression of responses to expected inputs.

Superior temporal glutamate/GABA ratios drive the relationship between of mismatch negativity latency and psychosocial difficulties

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Several lines of evidence demonstrate aberrant excitatory-inhibitory neural processes across autism and schizophrenia spectrum disorders, particularly within the psychosocial domain. Such neural processes include disrupted mismatch negativity (MMN), and increased excitatory glutamate and reduced inhibitory GABA neurotransmission. MMN latency has been associated with glutamate concentrations; thus an excitation-inhibition imbalance might drive the relationship between disrupted MMN and psychosocial difficulties. Thirty-eight adults (18 male, 18-40 years) completed the Schizotypal Personality Questionnaire (SPQ) and Autism-Spectrum Quotient (AQ). Glutamate and GABA neurotransmitter concentrations in bilateral superior temporal cortex (STC) voxels were quantified using Magnetic Resonance Spectroscopy, while the auditory duration MMN was measured with Magnetoencephalography. Spearman correlations probed the relationships between bilateral STC glutamate/GABA ratios, MMN latency, and AQ and SPQ dimensions. Mediation effects of glutamate/GABA ratios were investigated using causal mediation analysis (bootstrap=10,000). Only SPQ-Interpersonal and AQ-Communication were significantly correlated with right hemisphere glutamate/GABA ratios and MMN latency ($p<.05$), which were in turn significantly correlated ($p=.035$); thus two mediation models were investigated. When controlling for glutamate/GABA ratios, MMN latency no longer predicted SPQ-Interpersonal scores (ß=153.85, $p=.047$; ß=78.0, $p=.310$), suggesting that increased glutamate/GABA ratios drive the relationship between MMN latency and SPQ-Interpersonal scores. In contrast, MMN latency remained a significant, albeit weaker, predictor of AQ-Communication, suggesting partial mediation (ß=74.12, $p=.004$; ß=57.18, $p=.029$). In using a multimodal approach, these findings support the growing body of literature pointing toward an excitation-inhibition imbalance that is central to psychosocial functioning across the autism and schizophrenia spectra, and provides a neurochemical indicators of processes that underlie psychosocial difficulties.

Neural basis of visuospatial short-term and working memory in the primary progressive aphasias

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Primary progressive aphasias (PPA) comprise three main variants: logopenic (lv-PPA), non-fluent (nfv-PPA) and semantic (sv-PPA). Differentiating the language profiles of the PPA variants remains challenging, especially for lv-PPA and nfv-PPA. Accordingly, there are advantages to using clinical tools that circumvent language. Here, we investigated the visuospatial short-term and working memory profiles in PPA variants and typical Alzheimers disease (AD). We hypothesised the lv-PPA and AD groups would have the most difficulty on these tasks and that this would relate to the integrity of posterior temporal and parietal brain regions. Thirty-three lv-PPA, 26 nfv-PPA, 31 sv-PPA and 58 AD patients, and 45 healthy controls were recruited. All participants completed the WMS-III Spatial and Digit Span tasks and underwent a structural brain MRI for voxel-based morphometry analyses. Spatial Span Forward (SSF) performance was impaired in lv-PPA and AD but not in nfv-PPA or sv-PPA, relative to Controls. In contrast, Digit Span Forward (DSF) performance was impaired in lv-PPA, nfv-PPA and AD, and preserved in sv-PPA. As expected, backward span scores were significantly lower for all groups. Neuroimaging analyses revealed that SSF and SSB performance in all patients combined correlated predominantly with grey matter loss in temporo-parieto-occipital brain regions. Post-hoc group comparisons of these regions showed that grey matter loss was more extensive in the lv-PPA and AD groups than the nfv-PPA and sv-PPA groups. The findings suggest that the visuospatial short-term and working memory profile of lv-PPA are separable from nfv-PPA and sv-PPA and likely reflect their distinct patterns of brain atrophy.

Cognitive capacity limits are remediated by practice-induced plasticity between the Putamen and Pre-Supplementary Motor Area

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Humans show striking limitations in information processing when multitasking, yet can modify these limits with practice. Such limitations have been linked to a frontal-parietal network, but recent models of decision-making implicate a striatal-cortical network. We adjudicated these accounts by investigating the circuitry underpinning multitasking in 100 individuals and the plasticity caused by practice. Applying Dynamic Causal Modelling to fMRI data, we observed that multitasking costs, and their practice induced remediation, are best explained by modulations in information transfer between the striatum and the cortical areas that represent stimulus-response mappings. Specifically, our results support the view that multitasking increases coupling from the putamen to the intraparietal sulcus and pre-supplementary motor area (pre-SMA). Furthermore, we propose that slower information transfer from putamen to pre-SMA leads to practice-induced improvements in multitasking.

The Role of Contextual Uncertainty on the Neural Interaction of Predicted and Attended Tones

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Auditory Event-Related Potentials provide a simple index of attention and prediction that play important roles in developing internal models of the perceptual environment.

In hierarchical inference models (e.g., predictive coding) attention acts as a data gathering mechanism that helps resolve prediction errors in an uncertain context. Typically, the auditory N1 is larger to an attended than an unattended stimulus, whereas a smaller N1 occurs to a predicted than an unpredicted stimulus. The current study investigated whether uncertainty modulates these effects of attention and prediction by examining N1 under two different contexts of uncertainty. Tones that alternated between each ear were presented. Participants were asked to attend to stimuli presented either to the left or right ear and make a response when a softer tone occurred in the attended ear (10%). The pitch of tones presented in the left ear was randomised; in the right ear the pitch of the first tone in the sequence was random (unpredicted) and the following tone one note higher (predicted). In the Certain context, pairs of tones in the right ear followed this pattern 90% of the time, for the rest, an unexpected random tone was presented; in the Uncertain context, this pattern 60% of the time, with a random second tone presented 40%. For the Certain context, N1 amplitude was larger for both predicted and attended stimuli; for the Uncertain context there was no effect on N1 for either attended or predicted stimuli. These results will be discussed within a predictive coding framework.

Exploring the neural substrates of mind wandering in semantic dementia

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Mind-wandering, a form of spontaneous cognition, refers to the quintessentially human capacity to perceptually decouple from the immediate surroundings to consider perspectives distinct from the here and now. Changes in the frequency and content of mind-wandering may constitute an important neurocognitive endophenotype across clinical disorders, reflecting alterations in the default and frontoparietal brain networks. Here, we explored the capacity for mind-wandering in semantic dementia, a neurodegenerative disorder characterised by progressive deterioration of the conceptual knowledge base due to anterior temporal lobe degeneration. Thirteen SD patients were contrasted with 28 healthy older Controls on the Shape Expectations task, a minimally demanding cognitive task which reliably promotes mind-wandering. Despite marked semantic deficits, SD patients displayed significantly higher levels of mind-wandering relative to Controls ($p < .001$), when controlling for global cognitive dysfunction. Voxel-based morphometry analyses revealed that grey matter intensity in the left angular gyrus correlated positively with mind-wandering performance. Resting-state functional connectivity analyses further revealed decreased functional connectivity between the left angular gyrus and the hippocampus, bilaterally in SD relative to Controls. This study is the first, to our knowledge, to document elevated mind-wandering in a population characterised by marked cognitive decline and significant neural insult. Although preliminary, our results suggest that perceptually-based mind-wandering reflects a disconnection between posterior and medial temporal regions of the default network, which may allow intact episodic representations to be summoned by the SD patient in a relatively unconstrained manner. Funded by an ARC Future Fellowship to M.Irish (FT160100096)

Probing the neural processing of personal and emotional relevance using EEG and fMRI

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The ability to adaptively respond to cues in the environment that signal benefit or harm is vital for mental health and well-being. Most theories of emotion see the personal relevance of harmful or beneficial stimuli as the major driver of emotional responses. The majority of brain imaging studies of emotion, however, have used stimuli of little or no personal relevance to participants. The faces of loved ones are perhaps the most personally and emotionally relevant things that we see, making their timely perception a priority. Yet the time course and neural circuitry involved in perceiving personally relevant faces remain unknown. We applied representational similarity analyses and simultaneous EEG-fMRI to examine neural responses to emotional faces of participants' romantic partners, friends, and a stranger. EEG-fMRI representations of personal relevance started prior to structural encoding at 100ms in visual cortex, but also in prefrontal and midline regions involved in value representation, and social cognition regions important for monitoring and recalling self-relevant information. Representations specifically related to romantic love emerged after 400ms. Our research provides compelling reasons for research in the social and affective neurosciences to study responses to individualised social stimuli. Such studies might yield valuable insights into how the brain engages circuitry beyond that typically considered in models of sensory perception, in order to prioritise processing of genuinely personally relevant stimuli.

Modelling practice and adult lifespan effects on task-switching performance in a large scale data set

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Higher order cognitive processes rely on the ability to flexibly and efficiently adapt behaviour in response to continuously changing contextual demands. Experimental task-switching paradigms tap into processes that support cognitive flexibility and have been modelled using decision diffusion models. The Ebb and Flow game of the online cognitive-training platform, Lumosity, is based on components of the task-switching paradigm. We leveraged a large-scale dataset from Lumosity users to investigate how cognitive processes involved in cued switching between tasks are affected by level of task practice across the adult lifespan. We developed a computational account of task switching that specifies the temporal dynamics of activating task-relevant representations and inhibiting task-irrelevant representations and how they vary with extended task practice across a number of age

groups. Practice modulated the level of activation of the task-relevant representation and improved the rate at which this information becomes available, but had little effect on the task-irrelevant representation. While long term practice improved performance across all age groups, it had a greater effect on older adults. Indeed, extensive task practice made older individuals functionally similar to less practiced younger individuals, especially for cognitive measures that focus on the rate at which task-relevant information becomes available. Implications for cognitive training and models of task-switching will be discussed. The research was supported by Australian Research Council Discovery Project Grants (DP170100756, DP180103613).

The effects of absolute and relative evidence strength on decision confidence

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Making a decision comes with a sense of confidence, or a subjective belief regarding the likelihood of one's decision being correct. Decision confidence is often studied using perceptual tasks in which participants make choices between two discrete options and subsequently report their confidence in their decision. Reported confidence increases in proportion to the magnitude of the perceptual difference between two stimuli, i.e. the relative evidence. For example, when judging which of two squares is brighter, larger differences in brightness lead to higher confidence ratings. However, recent studies have hinted that confidence ratings also increase with higher absolute evidence (e.g., the combined brightness levels of the two squares). We tested how these two types of evidence might interact in driving choices as well as confidence reports. We implemented a speeded two-alternative, forced-choice luminance judgment task, with evidence strength defined by the brightness levels of the stimuli. Participants were presented with two flickering, grayscale squares, and they were required to choose the square that appeared brighter on average. After this, they reported their confidence in their decision using a 7-point scale ranging from surely incorrect to surely correct with guessing as the mid-point. Consistent with previous findings, accuracy and confidence levels were higher when relative evidence was higher. High absolute evidence, however, led to reduced decision accuracy but at the same time to increased confidence. Our findings therefore demonstrate that increasing absolute evidence reduces accuracy while impairing our ability to detect errors, leading to an unfounded sense of confidence.

I'll cry instead: Mu suppression responses to tearful expressions

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Tears are a facial expression of emotion that readily elicit empathic responses from observers. It is currently unknown whether these empathic responses to tears are influenced by specific neural substrates. The EEG mu rhythm is one method of investigating the human mirror neuron system, purported to underlie the sharing of affective states and a facilitator of social cognition. The purpose of this research was to explore the mu response to tearful expressions of emotion. Fifty-eight participants viewed happy and sad faces, both with and without tears, in addition to a neutral control condition. Participants first completed a gender discrimination task, and then an imitation condition where they were required to mimic the displayed expression. Mu enhancement was found in response to the discrimination task, whilst suppression was demonstrated in response to the imitation condition. Examination of the difference scores revealed that greater suppression was observed in response to happy-tear and sad face conditions. A planned contrast exploring suppression in neutral faces revealed no significant differences between emotional and neutral conditions. The mu response to neutral expressions resembled that of the happy-tear and the sad conditions, lending support to the idea that ambiguous emotional expressions require greater sensorimotor engagement. This study provides important evidence for the role of the mirror neuron system in discerning tearful expressions of emotion in the absence of context.

Theta Frontoparietal Networks Underlying Switch and Mixing Costs During Task-Switching

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In task-switching paradigms, behavioural performance is poorer when participants are required to switch tasks, compared to repeating the same task, and for repeat trials that are intermixed with other trials (mixed-repeat), compared to repeat trials in a single task block (all-repeat). Using both event-related potentials (ERPs) and time-frequency power, effects of switching and mixing tasks have been observed at frontal and parietal sites. Some studies have also shown that these frontal and parietal effects are part of frontoparietal networks, typically observed in the theta band (~4-8 Hz). However, we do not yet know how these networks relate to behaviour. Based on previous research, this study predicted that the frontoparietal theta networks would be increased for switch vs. repeat, and repeat vs. all-repeat trials. This study also predicted that increased connectivity would be associated with faster RT. Participants (N=197) completed a cued-trials task-switching paradigm where EEG was recorded. Inter-site phase clustering, a measure of functional connectivity between sites, was computed from the EEG. Frontal sites were shown to connect most strongly to bilateral posterior sites. These bilateral posterior sites were also strongly connected to each other. Theta ISPC strength was typically increased for switch compared to repeat, and repeat compared to all-repeat trials. The networks appears similar for the mixing and switch costs. Furthermore, for some frontoparietal connections, increased connectivity was associated with faster RT. Thus, the present study shows that frontoparietal theta networks are associated

with both switch and mixing costs and that these networks are related to behaviour.

Use your Words: The relationship between private speech content and task performance in preschool children

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Emerging in the preschool years, private speech provides a regulatory tool to overcome cognitive, motivational and emotional obstacles and consequently support task performance outcomes. Here, I investigate the association between private speech content and task performance in 3- to 5-year old children. A sample of 101 preschool children completed a Duplo construction task at two difficulty levels. Spontaneous intelligible private speech was coded according to task relevance and across three task regulatory phases - forethought, performance and self-reflection. Children's use of private speech content subtypes was consistent across age levels, with performance type content being most prevalent, capturing self-instructional, observational and strategy-oriented utterances. Forethought type content, characterised by planning, task analysis and motivational statements, had a positive impact on Duplo construction performance during optimal levels of task demand. Task irrelevant content was negatively associated with performance during high task demand and positively associated with performance during low task demand. The findings of this research have implications for both parenting and educational practice. Firstly, adults may profile the private speech content elicited during a task to provide a formative assessment of self-regulatory engagement. Additionally, adult interactions are known to shape the use and effectiveness of children's private speech. Specifically, adults engaging in collaborative instructional activities with young children are encouraged to model the use of quality forethought type verbal content.

Investigating the neural correlates of decision-making using transcranial magnetic stimulation

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Our ability to make fast and accurate decisions is affected by prior knowledge about likelihood of possible responses, the quality of sensory evidence and efficiency of motor preparation and execution. Fifty-one healthy adults (range: 18-47 years) responded with their left or right index fingers to rapidly decide whether a bi-colour flashing grid was comprised of more blue or orange cells. A cue indicated which response was more likely ('70% blue', '70% orange', or 50% - neutral); difficulty was manipulated with the dominant colour constituting 52% or 54% of the cells. Cues varied on a trial-trial basis (Exp 1; n=33) or were held constant across 160 trials (Exp 2; n=18). TMS assessed corticospinal excitability (CSE) during the cueing and decision-making period (Exp 1). Reaction times were significantly shorter in easy v. hard trials (<.01) but, surprisingly, only varied between trials in which the stimulus was congruent v. incongruent to the cue in Exp 2 ($p<.01$). These results suggest that flexible cue utilisation is limited when presented with multiple concurrent alternatives. Response accuracy was lower in hard v. easy trials, but only when stimuli were incongruent with the cue (Exp 1: congruency x difficulty interaction; $p <.001$).CSE following the cue was affected by congruency; specifically, MEPs in the hand corresponding to orange responses were elevated when an orange response was likely, compared to when a blue response was likely, indicating that motor pathways are mediated in expectation of a particular response. However, no further CSE modulation was apparent during decision-making.

Noradrenergic contributions to neuropsychiatric and cognitive symptoms in Parkinson's disease – ultra-high field imaging of locus coeruleus and effects of atomoxetine

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In Parkinson's disease (PD), there is neuronal loss in the noradrenergic locus coeruleus (LC) and dysregulation of forebrain noradrenaline projections, which is thought to contribute to cognitive and neuropsychiatric symptoms. Using ultra-high field neuromelanin imaging of the LC and resting state, and an atomoxetine manipulation, we characterised this brain system and revealed benefits of boosting noradrenaline on neurocognitive functions. Twenty-five individuals with PD and 26 controls were scanned at 7T using a 3D Magnetisation transfer sequence. Whole brain resting state was also acquired. Nineteen patients also underwent a double-blind randomised placebo-controlled crossover design, receiving 40 mg oral atomoxetine/placebo. These sessions involved a number of assessments to characterise clinical and neuropsychiatric features. Participants also underwent a reinforcement learning task in combination with pupillometry. We used hierarchical Bayesian models to establish learning rate, exploration-exploitation, and lapse rate parameters. In the patients we showed signal loss in the LC and changes in resting state connectivity patterns across the brain when the LC was used

as a seed. Confirming a role for noradrenergic function in reward-related processing, under atomoxetine we found a significant improvement in learning. Of the computational parameters, the effect of atomoxetine was most prominent in the exploration-exploitation parameter, consistent with increased levels of prefrontal noradrenaline facilitating a more exploitative strategy. Our findings reveal noradrenergic contributions to reinforcement learning in PD - suggesting a potential neurocognitive mechanism that might underpin the noradrenergic role in depression and apathy. Our findings also have relevance for normative models of noradrenergic function centred on exploration-exploitation behaviour.

A role for a parieto-hippocampal network in autobiographical memory retrieval - evidence from neurodegenerative disorders

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Autobiographical memory permits the vivid recollection of personally experienced events, and hinges on interactions between the hippocampus and fronto-parietal cortices. Parietal regions, in particular, are consistently implicated in functional imaging investigations of autobiographical retrieval, yet their exact contributions remain unclear. Here, we investigated a causal role for parietal cortices in autobiographical recall, using neurodegenerative disorders as lesion models. Ten patients with Logopenic Progressive Aphasia (LPA) a rare neurodegenerative disorder characterised by early atrophy to the left inferior parietal cortex amidst relatively spared hippocampal integrity, were contrasted with 18 Alzheimers disease (AD) patients, demonstrating significant hippocampal and parietal atrophy, and 16 healthy Controls. Participants completed the Autobiographical Interview - a measure examining free and probed recall of autobiographical memories from four life epochs, and underwent structural brain imaging. Relative to Controls, the LPA group displayed marked deficits in free recall, but not probed recall, of autobiographical memories across all epochs. The AD group, by contrast, displayed global impairments across free and probed recall, relative to Controls. Voxel-based morphometry analyses of structural MRI data implicated a parieto-hippocampal network involving bilateral inferior and medial parietal cortices and the right hippocampus in autobiographical free recall impairments in LPA. By contrast, in AD, free and probed recall performance deficits correlated with widespread atrophy of frontotemporal and parietal regions. Our findings suggest the importance of regions beyond the hippocampus in modulating autobiographical memory retrieval, highlighting the need to consider parietal contributions in current theoretical frameworks of autobiographical memory.

Neurocognitive consequences of prediction violation across auditory and visual modalities

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The nervous system responds strongly to unexpected, oddball events relative the expected events. Predictive coding theory posits that, through learning, the nervous system develops an internal model of the likelihood of events in environment, which serves to generate predictions about current sensory inputs. On this view, oddball responses reflect a mismatch between the model and the current input, and these trigger updating mechanisms which minimize future prediction errors. Intriguingly, no previous study has asked whether mismatch responses, and the updating processes they engender, affect the encoding of spatially and temporally coincident stimuli across distinct sensory modalities. Here we investigated this question using EEG to determine whether auditory oddballs alter the encoding of an elementary feature of coincident but irrelevant visual stimuli. Participants heard sequences of sounds containing rare and unpredictable oddballs, while monitoring a central stream of gratings with random orientations. We first verified robust differences between oddball and standard sounds, consistent with the classic mismatch negativity response. We then applied multivariate forward encoding analyses to the EEG data, time-locked to the onsets of the visual events, to decode orientation-specific information associated with the central gratings. We observed reliable decoding of visual orientation information, but critically the magnitude of the decoded response was equivalent during epochs containing expected and unexpected sounds. The findings suggest that neural mechanisms responsible for updating sensory representations in one modality do not necessarily impact on feature-encoding of coincident events in another modality.

Detecting (un)seen change: the neural underpinnings of (un)conscious prediction errors

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Detecting changes in the environment is fundamental for survival, as these may indicate potential rewards or threats. According to predictive coding theory, detecting these irregularities relies on both incoming sensory information and our prior beliefs; with incongruity between the two manifest as a prediction error (PE) response. Many changes occurring in our environment do not pose any threat and may go unnoticed. Such subtle changes can nevertheless be detected

by the brain without ever emerging into consciousness. What remains unclear is how such sensory changes are processed in the brain at the network-level. Here, we developed a visual oddball paradigm, where participants engaged in a central letter task during electroencephalographic (EEG) recordings while presented with task-irrelevant (and unreported) high- or low- coherence background random dot motion. Critically, once in a while, the direction of the dots changed . After the EEG session, we behaviourally confirmed that changes in motion direction at high- and low-coherence were visible and invisible, respectively. ERP analyses revealed that changes in motion direction elicited PE regardless of visibility of such changes but with distinct spatiotemporal patterns. To better understand these responses at the network-level, we applied Dynamic Causal Modelling (DCM). Winning DCM's showed that both visible and invisible PE relied on a release from adaptation (or repetition suppression) within sensory areas of V1 and MT. Future network analysis will reveal the connectivity underpinnings for differences in PE generation for visible and invisible changes.

Cognitive Conflict in Virtual Reality Based Object Selection Task : An EEG study

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Cognitive conflict is an essential part of everyday interaction with the environment and is often characterized as a brain monitoring and control system that activates when prediction based on previous experience acquired from the environment does not match with derived knowledge from sensory inputs from cognitive processing. Although cognitive conflict can be seen as an essential part of learning about the environment, it requires the brain to assign a higher number of cognitive resources such as attention, memory, and engagement compared to non-conflicting conditions. In this work, cognitive conflict has been evaluated in a three-dimensional (3D) object selection task in a virtual reality environment by assessing, evaluating, and understanding the factors of visual appearance, task completion time, movement velocity during interaction and its implications for a sense of agency, and presence in a virtual reality (VR) environment. An electroencephalogram (EEG)-based approach along with behavioral information is used. The results show that the amplitude of negative event-related potential (50-150 ms), defined as prediction error negativity (PEN), correlates with the realism of the rendering style of virtual hands during the interaction. It was also found that PEN amplitudes are significantly more pronounced in slow trials than fast trials. These findings suggest that a realistic representation of the users hand, compatible task completion time are essential components for the better integration of information from both visual and proprioceptive systems during the interaction to avoid cognitive conflict due to a mismatch between action and expected feedback.

Functional near-infrared Spectroscopy shows age-related cortical compensation during standing

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Standing balance is largely controlled by subcortical process, however when balance is challenged, additional processing power may be provided by the Pre-Frontal Cortex (PFC). Older people typically have compromised balance as they have age-related declines in both sensorimotor function and cortical processing resources. The purpose of this study was to investigate how ageing influences PFC processes during standing balance. PFC activity of 24 young (mean=20.8 years), and 25 older (mean=70.6 years) adults was measured using functional near infrared spectroscopy (fNIRS) while postural sway was measured via centre of pressure changes on a force-plate. Balance was performed under varying sensorimotor challenges, specifically removing vision, reducing the base of support and reducing proprioceptive feedback. Within each balance condition, PFC activity was compared with, and without a dual cognitive task (counting back by 3s). This comparison revealed how cortical processing was modulated as balance difficulty increased, while controlling for individual differences in sensorimotor function. Older individuals exhibited increased postural sway magnitude across all conditions and elevated PFC activation in the easier balance tasks, compared to young subjects. However, in the more challenging balance tasks, cortical activity decreased for older subjects but progressively increased for young subjects. This pattern of activation supports a neural compensation hypothesis of aging whereby cortical activity is upregulated to compensate for reduced sensorimotor input. Older subjects were unable to compensate effectively in the most challenging sensorimotor conditions and balance suffered accordingly.

Sensory noise does not correlated with the autism quotient, but decision noise does.

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Individual differences in internal noise have been proposed to explain differences in perception between individuals with and without autism spectrum disorder (ASD). This hypothesis has also been extended to the general population to explain individual differences in perception more generally. Often, the equivalent noise paradigm is used to measure internal noise. However, the equivalent noise paradigm only provides a single measure of noise, capturing behavioural variability that is due to a range of factors, including different kinds of sensory noise, and decision noise. Here, we present an in-depth analysis of the double-pass paradigm (Burgess & Colburn, 1988) an alternative to the equivalent noise paradigm and show, with modelling, that it can divide internal noise into additive noise, multiplicative noise, and (stimulus-) induced noise. We then estimate these types of noise in two motion-direction-discrimination-in-noise experiments: one with small stimulus angles (n = 37), and one with large stimulus angles (n=55). Stimulus noise was varied to separate multiplicative noise from induced noise. Autism quotients (AQs) were also obtained for each participant. We find that additive noise and multiplicative noise do not depend on AQ, but induced noise does. Based on theoretical considerations, we equate induced noise to noise in criterion settings, which is a type of decision noise. Therefore, individuals with higher AQ show no differences in, presumably, sensory noise, but they do in decision noise. Since decision noise is often not controlled in experiments, this provides a

potential explanation for the equivocality of the perception literature in ASD.

Local versus global optimisation of error in probabilistic learning

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The role of subjective confidence in decision making has received much attention, but substantially less work has investigated how confidence influences decisions which operate over time; in other words, the learning process. Humans may require some representation of how certain or confident they are in information in probabilistic environments, where they cannot perfectly predict outcomes, for example, in forecasting. This is particularly imperative when the environment may suddenly change over time, and observers have to update their knowledge about the world. We conducted 4 experiments where we asked observers to make predictions about the future when the environment was stationary versus when it changed over time. Surprisingly, we found that observers behaved in remarkably consistent ways, by optimising their local (very recent) predictions, at the expense of being accurate globally (overall), and that subjective confidence did not appear to play a large role in this process. We show that the patterns we observe can be captured by a simple additive learning model, and demonstrate how cognitive modelling can help arbitrate between competing accounts of learning. Our model is able to characterise behaviour remarkably well across participants, and changes in experimental task, and challenges more complex accounts which have typically been used to explain the type of behaviour we observe.

Fast Talks

The role of the primary motor cortex in motor imagery: A theta burst stimulation study

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Soukayna Bekkali, Deakin University
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Dwayne Meaney, Deakin University
Peter Enticott, Deakin University
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Motor imagery (MI), the ability to mentally simulate a given movement, is thought to play an important role in cognitive processes that subserve efficient motor control, planning and development. Accordingly, evidence suggests MI activates similar neural pathways and cortical regions involved in that of actual movement. It has been proposed that MI therapies may hold potential benefits for neurorehabilitation. However, the underpinning neural constructs of MI, particularly the role of the primary motor cortex (PMC), remains debated. This study is examining the function of the PMC during MI in young adults with typical motor ability using continuous theta burst stimulation (cTBS). Adults with typical motor ability aged 18-30 years old are currently being recruited for three sessions. During two separate sessions, participants complete the hand rotation task (HRT), a well validated measure of MI, after receiving cTBS to the PMC and the supplementary motor area (SMA). The SMA is being examined to see if the observed effects on MI are due to the PMC itself, or spill over activity arising from the SMA that is also thought to be important for movement. During a third session, participants complete the HRT following sham cTBS to either the PMC or SMA, forming the control condition. Data is currently being collected and results will be discussed. We anticipate that applying cTBS to the PMC in young adults with typical motor ability will reduce their MI efficiency relative to the sham condition. The implications of these results will be discussed.

The effects of dopaminergic psychostimulants on complex problem solving

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Dopaminergic systems in decision-making have been of increasing research interest. Medications that target these systems are used in disorders of attention and cognition and are sometimes diverted to non-medical uses by healthy people hoping to enhance cognitive performance. However, research to date reveals mixed cognitive effects of those medications in the healthy, and little research into performance of complex tasks has been undertaken. We completed a repeated-measures, double-blinded, placebo-controlled single dose trial (PECO:ACTRN12617001544369,U1111-1204-3404) to examine three indirect dopamine agonists in complex problem-solving performance of healthy adults. 40 participants received 15mg dextroamphetamine, 30mg methylphenidate, 200mg modafinil, or placebo, counterbalanced across 4 testing sessions at least one week apart. In each session, participants completed the Knapsack Task (a NP-hard combinatorial optimisation task), and the CANTAB Simple and Five-choice Reaction Time, Spatial Working Memory, Stockings of Cambridge, and Stop Signal Tasks. In general, participants explored the solution space more actively, and initially more randomly, in the drug conditions. Participants who performed least well under placebo were then more likely to improve their performance in the drug conditions, whereas those who had performed well with placebo were more likely to show a decrease in performance. Performance in the Knapsack Task correlated strongly with the CANTAB Spatial Working Memory Task strategy score. This suggests that dopaminergic stimulants may increase healthy adults' motivation to spend more time and explore more combinations in pursuit of the solution to a computationally complex problem. However, this does not always result in enhanced performance because exploration becomes more random.

Brain changes associated with multimodal training in patients with traumatic brain injury: A case study

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Deficits in manual dexterity and cognition are frequently reported in patients with Traumatic Brain Injury (TBI). The purpose of this case series was to pilot a novel home-based multimodal training (CogMo). Participant 1 was a male TBI patient, four years post-injury with moderate impairments in fine motor skills and attention. Participant 2 sustained a TBI 30 years earlier, with severe memory impairments. Participants trained for 30min/day, 5 days/week for 8-weeks. Pre- and post-training, planning was examined using a computerised Tower of London (TOL) test, and bimanual dexterity was assessed with a subtest of the McCarron Assessment of Neuromuscular Development (MAND). T1-weighted MRI scans were administered and cortical thickness from two ROIs (primary somatosensory cortex and superior frontal cortex) were extracted using FreeSurfer. Performance on the MAND subtest improved in both participants after CogMo training, revealing decreases in completion time from pre- to post-training (-22% and -6% respectively). Participant 2 showed a moderate increase in cortical thickness of S1 (left hemisphere (LH) 2.15%, right hemisphere (RH) 21.65%), while morphology was unchanged in participant 1 (LH -1.41%, RH -0.74%). Participant 2 showed improvements in planning (9% decrease in total moves), and morphological analyses revealed increases in cortical thickness in the superior-frontal gyri (LH 3.74%, RH 3.09%). However, participant 1 showed no measurable changes in planning and cortical thickness (LH 0.14%, RH 2.53%). Participating in multimodal training was feasible for both participants in the chronic phase of TBI. Future analyses to determine changes in brain structure using diffusion MRI are underway.

Differentiating the Effect of Medication and Illness on Grey Matter Volume in First-Episode Psychosis: A Longitudinal, Randomised, Triple-blind, Placebo-controlled MRI Study.

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Background: First episode psychosis (FEP) has been consistently associated with altered grey matter volume (GMV). No prospective study to date has been able to distinguish the effect of antipsychotic medication from the natural progression of psychosis in driving these changes. Methods: We conducted a triple-blind randomised placebo-control trial where 62 people aged between 15 to 24 with FEP received either an atypical antipsychotic or a placebo pill over a treatment period of 6 months. Both FEP groups received intensive psychosocial therapy. A healthy control group (n=27) was also recruited. T1-w structural MRI scans were taken at baseline, 3-months and 12-months. Longitudinal Voxel-Based-Morphometry was used to identify grey matter areas where there was a significant group by time interaction. Results: Using robust non-parametric methods, and after controlling for baseline age, sex, total intracranial volume, we identified a significant group x time interaction within the right pallidum ($p < 0.05$; FWE-corrected). Across the study treatment period, there was a volumetric increase in the medication group, a decrease in the placebo group, while the healthy control group remained stable. In patients, a greater increase in pallidal GMV over 3 months was associated a greater reduction in symptom severity, indexed by the pre-registered trial outcome measure, BPRS Total score (-.418; $p = .017$) . Conclusion: Atypical antipsychotics have protective effects on the disease-related grey matter decline seen within the basal ganglia. Greater volumetric increase within the same area is associated with better symptomatic outcome, suggesting a key role for this region in mediating symptomatic recovery.

Dissociable effects of perceived position and perceived motion in the high-phi illusion.

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It has been proposed that the brain employs anticipatory mechanisms that allow us to compensate for the processing delays inherent in neural transmission. A range of motion-based visual illusions (such as the flash-lag effect) have been taken as evidence for predictive mechanisms in visual motion processing. A recent addition is the high-phi illusion, in which a moving texture is suddenly replaced by a new, uncorrelated texture. The observer perceives the transient replacement

as rapid motion even though no motion is presented. It has been shown that when the inducing motion duration is short, the illusory jump is perceived as forward, whereas when the inducing motion duration is long, the jump is perceived as backward. Here, we investigated whether this illusory motion is sufficient to cause motion-induced position shifts. Combining the high-phi illusion with the flash-grab effect, we explored the interaction between position and motion signals. Consistent with previous reports, the high-phi jump was perceived as forward for short inducer durations and backward for longer durations. Importantly, we also demonstrated that a static target flashed concurrently with the transient is mislocalised, indicating even illusory motion is sufficient to induce motion-induced position shifts. Interestingly, although the target was shifted forward for short inducer durations and backward for long inducer durations, the time-course of mislocalisation was found to have an earlier onset than perceived motion direction. This suggests predictive mechanisms in which motion signals influence perceived position are implemented very early in the visual hierarchy.

Towards Personalised Profiles of Pathology in Traumatic Brain Injury Patients using Anatomical MRI Scans: A proof-of-concept study

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Traumatic brain injury (TBI) often results in life-long disability as a result of significant neurobehavioural deficits associated with cognition. Reliable prognosis of cognitive outcome is extremely difficult due to immense heterogeneity in TBI patient outcomes. Accordingly, clinicians need better tools to understand individual patient's likely outcomes without the need for sophisticated MRI sequences. This proof-of-concept study will demonstrate the applicability of a novel workflow using only clinically available T1-weighted MRI scans to create Personalized Profiles of Pathology (PPP). Through the ENIGMA TBI working group, an international network of researchers have shared datasets focused on moderate-severe TBI (http://enigma.ini.usc.edu/ongoing/enigma-tbi/). A total of 189 participants including 80 TBI patients (mean age 22.22 years, SD 5.79) and 113 healthy controls (mean age 24.40 years, SD 5.97) were pooled across 5 sites. Performance on the Trail Making Test (TMT) will be used to dichotomise patient groups (patients with/without executive deficits). We have developed an in-house multi-step workflow for creating Personalised Profiles of Pathology: (1) Pre-processing including construction of age-binned templates and segmentation-normalisation (ANTs); (2) Automated lesion identification (ALI); (3) Manual editing of lesion maps; (4) Lesion Symptom Mapping (LSM); (5) Identifying white matter tract damage using white matter atlases (Tract-wise Statistical Analysis (TSA)) and normative tractography data (Disconnectome Symptom Mapping (DSM)), and; (6) Lesion network mapping (LNM) estimating disruption to functional networks using normative resting state fMRI data.The current study will inform future longitudinal imaging studies, potentially allowing early identification of patients at increased risk of poor cognitive outcomes who would benefit from rehabilitation interventions.

Acoustic slow wave sleep stimulation improves daytime sleepiness and sustained attention in chronically sleep-deprived adults

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Daytime sleepiness arising from chronic sleep restriction has been linked to occupational errors and poorer health outcomes. To determine whether sleep and subsequent performance can be enhanced without changing the sleep period, we examined whether acoustic enhancement of slow wave sleep (SWS) improved sleep and daytime sleepiness in a sleep-restricted population.Twenty-five healthy adults (16 female) provided data in a randomized, single-blind, cross-over study. Participants wore a closed-loop automated acoustic stimulation device for two consecutive nights. Acoustic tones were delivered during N3 (STIM), or at inaudible decibels during equivalent N3 periods (SHAM). Participants rated their fatigue and alertness following both Night 1 and Night 2, (Karolinska Sleepiness Scale; KSS, Samn-Perelli Fatigue Scale), and completed a series of subjective (KSS, Samn-Perelli Fatigue Scale) and objective measures of alertness (Multiple Sleep Latency Test; MSLT) and sustained attention (Psychomotor Vigilance Task, PVT) throughout the day following Night 2.Overall, the majority of participants had more SWS and higher slow wave activity (power in the 0.5-4Hz band) over two nights of STIM compared to SHAM. Following STIM, participants responded faster on the PVT and had fewer lapses. There were no changes in the MSLT. Participants reported feeling more alert and less fatigued on the KSS and Samn-Perelli Fatigue Scale following STIM compared to SHAM after both nights. We show that the use of an acoustic device to enhance SWS may alleviate some of the cognitive deficits associated with sleep-restriction. This work was supported by the Cooperative Research Centre for Alertness, Safety and Productivity.

The Massive Report Paradigm: Assessing the richness of conscious experience

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To most of us, our experience of the world seems extremely rich. However, some researchers claim this feeling of richness is an illusion (e.g., Cohen, Dennett, & Kanwisher, 2016), based on demonstrations of cognitive and perceptual capacity limitations

in tasks of working memory performance, peripheral vs foveal visual acuity, or inattentional and change blindness. We developed several tasks to estimate the richness of perceptual experiences based on information theory, in an approach we collectively call the 'Massive Report' paradigm. First, we simply showed participants (in lab N=10, in MTurk N>600) a brief glimpse (SOA=67, 133 or 267ms before being masked) of one natural scene picture (we used 580 images in total) and asked for 5 nouns/adjectives/verbs that describe the scene. Second, we compiled a large pool of descriptors for the set of images as potential 'alternatives' and performed classical discrimination tasks with confidence ratings. The novelty of the paradigm is that we interrogated the phenomenology associated with a single image with a 'massive' set of questions (between 80 and 640 questions per image). The results of these experiments suggest that subjects can discriminate a huge repertoire of scene characteristics; in information theoretic terms, the bandwidth of differentiation measures at > 1500 bits per second (compared to previous estimates of <40 bits per second). Our results suggest that a moment of experience is much richer than previously considered.

Quite powerful: The EEG of memory consolidation during quiet wakefulness

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Relatively little is known about the consolidation processes during wakefulness between initial encoding and recall events. This study compared the influence of these phenomena on both veridical (true) and generalised (false) memory performance. Participants (N=35, 13 males, age=22.7, SD = 4.6) committed eighteen DRM lists to memory, each with two unpresented associated theme words (lures), followed by an immediate recognition test including the unpresented lures, assessing false memory. EEG was then recorded whilst participants rested for 20 minutes with eyes closed (QW), followed by a delayed recognition task. Participants also performed two 10-minute cognitive tasks as an active wakefulness (AW), followed by a final recognition task. Furthermore, testing occurred in both auditory and visual modalities. A linear mixed effects model looking at the effects of memory type (true/false), modality (A/V), and period (QW/AW) on memory performance revealed significant differences in memory performance across QW, but not AW. The number of false memories increased following QW, only for the visual modality. EEG analyses suggest that relative global power within the theta, alpha, and sigma bands during QW predict increases in memory generalisation, with sigma also predicting a greater level of generalisation within the auditory modality compared to the visual modality. These findings suggest that quiet wakefulness leads to an increase in the generalisation of memory content, providing behavioural data commensurate with the idea that processes related to the generalisation of memory may also occur when resting with eyes closed. Further studies are needed to detect and describe these phenomena in wake.

Automatic imitation of actions for unpredictable, but not predictable stimulus-response pairings

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Interacting with another person successfully requires the flexible integration of motor and perceptual processes. By estimating the likelihood of another person's actions one can prepare an appropriate response in advance, allowing for smooth and dynamic interpersonal interactions. The predictability, or indeed unpredictability, of another person's movements and the relationship between this observed action and one's own motor preparation, may place the mirror system under the umbrella of predictive processing. Here automatic imitation behaviour, as an indicator of mirroring processes, was measured during a stimulus-response compatibility task where the probability, and hence predictability, of stimulus-response congruence was varied. Across hidden blocks the likelihood of matching versus mismatching stimulus-response pairs changed so that congruence was either predictable (90%, 70%, 30%, 10% matching trials) or unpredictable (50% matching). We show that outside of the unpredictable blocks the classic automatic imitation effect is reversed, and instead mismatch responses appear to be primed by predictable contexts.Using the Hierarchical Gaussian Filter (HGF) we modelled trial-wise precision weighted belief-updating about the likelihood of congruence and the stability of this belief (or environmental uncertainty), and found this better predicted reaction time data than a classic Rescorla-Wagner (fixed-rate) learning model. Indeed trail-wise pupil responses to stimuli reflected the precision-weighted belief updating captured by HGF parameters. This highlights that automatic mirroring, or the reaction-time benefit of an observed action matching with one's own action, is indeed modified by expectations about stimulus-response relationships.

Are rat mismatch responses sensitive to the primacy bias?

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Mismatch negativity (MMN), an auditory prediction error signal, is an enhanced response to unexpected (deviant) stimuli compared to expected (standard) stimuli. Many studies have found that it is reduced in schizophrenia, which has led to a strong interest in MMN as a potential clinical and pre-clinical biomarker. Previous studies have revealed that an order-driven bias exists for MMN, which results in larger MMN to deviants that are presented first. We investigate whether rat mismatch responses (MMRs) are sensitive to this primacy bias. MMRs were studied in awake, freely moving Wistar rats using wireless telemetry. Epidural electroencephalographic electrodes were surgically implanted and the rats were exposed to the sequences of standards and deviants that differed in frequency. All rats were presented with both high frequency deviant and low frequency deviant sequences, but half of the rats heard the low frequency tones as deviants first, and the other half heard the high frequency tones as deviants first. Order effects were found for rats who were first exposed to a low frequency deviant. The MMR amplitude was larger in response to the deviant sound heard first compared to that presented second. Such effects were not found for rats exposed to high frequency deviant first. Here, we have shown for the first time order-dependent bias for the MMR in rats, similar to found in human MMN, indicating that primacy bias is a modifier of auditory cortical responsiveness to sounds in rat MMRs similar to human MMN - at least for low frequency sounds.

The visual system compensates for neural delays to represent moving objects in their physical position in real time

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Due to the time required for neural transmission and processing, the brain only has access to outdated sensory information. This means that unless the brain is able to compensate for neural delays, moving objects would be represented in the brain behind their veridical location. One way this compensation could occur is through extrapolation based on the object's previous trajectory, as suggested by recent research. Here, we investigated how far the neural position representation of a moving object lags the true position of that object in the world. We presented a circular stimulus in a 37-position hexagonal grid, either briefly flashed in individual positions or moving through the array along one of 42 motion vectors. Electroencephalography (EEG) data was collected and analysed using multivariate pattern analysis. We trained classifiers to discriminate between positions on the grid based on EEG activity evoked by the flashed stimuli, and then tested those classifiers on the motion trajectories. This allows for deriving an index of when a specific neural representation is established in time. We observed that for moving objects, a neural position representation normally activated around 100-150ms after stimulus onset was in fact activated earlier than the moving object's arrival at that location. This finding suggests that the brain can compensate for its own delays by representing moving objects closer to their veridical position in real time.

Neural correlates of vigilance decrements: can we use brain decoding to pre-empt behavioural errors?

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When people monitor for rare events for long periods, their detection performance drops leading to errors. Understanding the neural underpinnings of these vigilance decrements is important as they can cause tragic consequences in real-life situations. Here, we built upon the extant vigilance literature in three ways. First, we generated a multiple object monitoring task modelled on railway network situations. Second, we compared the brain activations in two levels of target frequency, one where intervention was frequent, and the other where intervention was only rarely needed. Third, we used multivariate decoding to assess different aspects of task-relevant neural information coding. We collected magnetoencephalography (MEG) data from 20 participants while they monitored and responded to potential collisions of moving objects on the screen. We had attended/unattended dots (50% each) under Active and Monitoring conditions in which collisions happened to 50% and 3% of the dots, respectively. Our results showed significant improvement in neural information coding under attention. There was also a significant drop in coding of object position information over the course of the experiment, which was unique to the Monitoring condition. Our recently developed error analysis method showed that object position information was absent on trials where participants missed the target. This allowed us to discriminate, around ~1s before the collision time, if the subject was going to miss the event or not. These results provide new insights about how vigilance decrements impact information processing in the brain and provide an avenue for predicting behavioural errors using novel neuroimaging analysis techniques.

From Baby Brain to Mommy Brain: Widespread Gray Matter Gain After Giving Birth

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Introduction: Existing research suggests a possible brain rejuvenation after giving birth. An apparently younger brain might be explained by enhanced cerebral tissue in (aging-relevant) brain regions. Thus, the aim of our longitudinal study was to map the exact location of any gray matter changes presumably increases between two time points: within 1-2 days of childbirth (early postpartum) and at 4-6 weeks after childbirth (late postpartum). Methods: T1-weighted brain images of 14 healthy women were acquired at early and late postpartum on the same 3 Tesla scanner and analyzed using voxel-based morphometry (VBM). That is, images were bias-corrected, spatially aligned and tissue classified. Then, using the gray matter segments, one difference image per women was created (late-early) and spatially smoothed. Finally, a one-sample t-test was applied while correcting for multiple comparisons. Results: There was no evidence of any significant gray matter decrease between early and late postpartum. In contrast, significant effects indicating gray matter increase were widespread across the brain, involving cortical regions (pre-/postcentral gyrus, central and frontal operculum, inferior frontal gyrus, precuneus, and middle occipital gyrus) as well as subcortical regions (thalamus and caudate). Discussion: After giving birth, pregnancy-related hormones drop to almost non-measurable levels, but the full effect of these postpartum changes manifests only after a few days. The early postpartum scan is thus believed to capture an approximation of the pregnant brain, both hormonally and anatomically. The observed gray matter increase between early and late postpartum is intriguing and may suggest a reorganization of the brain after pregnancy.

Non-instrumental information is devalued in decision-making under risk and uncertainty

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It is theorised that humans are naturally curious and intrinsically value information. This preference motivates us to seek information that has no expected use, even when gaining such non-instrumental information is costly or effortful. In everyday life, however, the choice to satisfy curiosity involves the risk that information might point to negative outcomes, or fail to resolve uncertainty to the desired degree.This study investigated information value in the context of risk and uncertainty, operationalised using a five-window slot machine with fixed odds (50% win vs. loss). Young healthy adults chose to play after taking into consideration the stake and information that could predict (but not alter) the outcome of each gamble. Risk (amount at stake) and uncertainty (number of non-informative slots) were manipulated orthogonally, and the presentation of information was controlled to distinguish effects of information value on choice from the canonical preference for temporal resolution of uncertainty.Participants played most often when sufficient information was available to be certain of the outcome. This effect was found despite them knowing it had no bearing on outcomes, consistent with non-instrumental information preference. However, participants also demonstrated a small preference for no information over obtaining marginal information that would be insufficient to substantially resolve uncertainty. This effect was most prominent when stakes were high but, independent of uncertainty, participants exhibited a preference for lower rather than higher stakes, consistent with risk-aversion. Our findings suggest that curiosity and resolution of uncertainty might play distinguishable roles in non-instrumental information seeking in risky environments.

Eye Movement Patterns as a Measure of Problem-Solving Strategy in Primary School Aged Children

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The link between development of attention and cognitive strategies has seldom been explored from the perspective of eye-movement (EM) patterns in typical child development, despite evidence that EM patterns are related to problem-solving ability in adults and clinical populations. Therefore, we measured EMs in 54 typically developing grade 3-6 primary school students while they completed problem-solving items on the non-verbal Raven's Coloured Progressive Matrices (RCPM). We hypothesised that better RCPM performance would correspond with more efficient EMs, and that EM patterns would differ based on item difficulty category (i.e. Simple Pattern Completion, Discrete pattern Completion, Continuity and Reconstruction of Simple and Complex Structures, and Reasoning). A Gazepoint GP3HD 150Hz Eye Tracker was utilized to measure the frequency, duration and location of eye movements between the matrix and alternative answers of puzzle items and correlated with item accuracy on the RCPM across four item categories of difficulty.Significant differences in EM patterns were seen with increasing item difficulty. For more complex items, participants viewed the matrix for significantly longer time, and made more attention switches between matrix and answers for items. Our results suggest that efficiency of EMs, as defined by fixation duration and frequency of switching (between matrix and answers, and between each possible answer), are indicative of the degree of effort of top-down processing used by children and level of performance. This is evidenced by significantly longer fixation time and reduced frequency of switches between alternatives required for accurately answered item categories of progressively increasing difficulty.

Speed of Processing Configural Regularities in Contextual Cuing

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Repeated experience with structured visual information plays an important role in how attention and decision-making

processes operate. This is captured by the contextual cuing of visual search paradigm where invariant spatial configurations produce a faster and more accurate responded to targets in repeat compared to novel contexts (e.g., Chun & Jiang, 1998). We investigated how rapidly these contextual regularities are extracted to produce the implicit learning behaviour. Backward masking was used to limit visual processing to 300ms - enough time for only one fixation. At this short exposure duration, we observed intact cuing. However, this was only the case under conditions where there were 12 individual repeat configurations, but not for 30 contexts. Learning that number required longer inspection times of 2000ms, suggesting a context set-size capacity limit. To the best of our knowledge, this is the first study to show contextual cuing with masked displays. Our results highlighted a powerful statistical learning mechanism that can rapidly extract abstract information based on configural regularities, and then use this to guide ongoing cognition within the same timescale. These findings dovetail nicely with the observations of rapid high-capacity gist extraction in real-world scenes.

Using long-wear electroencephalography to explore lempel-ziv complexity during conscious wakefulness

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It has recently been claimed that measures of electroencephalographic (EEG) signal diversity, such as Lempel-Ziv Complexity (LZc), may provide an index of an individuals level of consciousness. These studies typically involve comparing conditions of reduced or altered consciousness, with periods of wakefulness, and claim that differences in LZc reflect the differences in consciousness. There is however, very little known about how LZc might fluctuate, either with or without a corresponding change in consciousness. The present study used portable long-wear EEG recordings to gain a unique perspective on LZc during conscious wakefulness. Multi-day continuous EEG data from two participants was collected and analysed using a LZc algorithm to assess signal diversity in space and time domains. A single LZc value was produced for non-overlapping 10-second segments of continuous EEG data. Results showed that LZc during Wake (14-hours during daytime, with multiple days per participant) is on average higher than during sleep (Stage N1, Stage N2, Slow-Wave-Sleep, and Rapid Eye Movement sleep). However, visualising the LZc data during Wake revealed a consistent but wide spread with a positive skew. Due to this variation, mean LZc found when only taking brief periods of EEG data, typically used in this area of research, are also highly variable. This will limit the practical utility and ultimately the understanding of this measure in research and for future clinical applications. This study for the first time describes the variability of LZc during conscious wakefulness and provides a framework for investigating other similar diversity-based measures of consciousness.

Fruit Ninja to improve reading: An action video game treatment for Dyslexia

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Our recent systematic review provides support for the use of visuo-attentional interventions to improve reading in dyslexic and neurotypical children. Of particular interest were the subset of studies that used a commercially available Action Video Game (AVG) as a reading intervention, given the accessibility, popularity, and intrinsic engagement of these games. These studies all used the same AVG 'Raymans Raving Rabbids' for a total of only 12 hours across 2 weeks, to produce significant gains in reading rate and fluency, despite not directly training reading skills. Thus, we aimed to extend upon these promising findings by investigating the efficacy of a different AVG (Fruit Ninja) provided for a shorter duration (10 x 30min sessions; 5 hours over 2 weeks) in a group of dyslexic children age 8 to 13 years (Grades 3 to 6). Seventy children participated in the randomised controlled trial in one of three treatment arms; a treatment as usual control group (participants continued to receive their school-based remediation); Standard Fruit Ninja Training (participants played with a computer mouse); and Eye-movement-controlled Fruit Ninja Training (participants played via eye tracking). The two Fruit Ninja treatment groups were chosen to delineate the importance of eye movements in attentional training. Preliminary findings showed that only participants in the two Fruit Ninja treatment groups improved in their text reading rate and comprehension after the intervention period, while no group showed improvements in text reading accuracy. This evidence highlights the clinical applicability of AVGs as fun, engaging interventions for reading.

Do water views restore sustained attention?

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Attention Restoration Theory proposes that exposure to certain types of natural stimuli restores directed attention. Empirical evidence is equivocal however, and the research is often limited to exposure to vegetation or an indiscriminate blend of water and vegetation. This study examined the differential effects of exposure to water and vegetation on sustained directed attention performance. Seventy-nine university students (27 males) were tested on the Sustained Attention to Response Task (SART), then quasi-randomly allocated to one of three conditions in which they were shown either a digital image of a meadow with trees, a beach, or a city, for 40 seconds. They then performed the SART again. Using an eye-tracker, the participant's pupil diameters were recorded during the SARTs, providing a measure of tonic arousal. Perceived restoration after viewing the image was also measured. It is anticipated that exposure to the water and vegetation natural scenes will have a beneficial effect on perceived restoration, and the number of errors made on the SART, but there will not be a physiological effect underpinning the psychological restoration.

Manipulating the structure of natural images using wavelets to probe the human visual hierarchy

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Experiments using naturalistic stimuli provide insights into cognitive function 'in the wild'. However, challenges exist for creating parametric manipulations of such stimuli with tight experimental control. Here, we demonstrate how to selectively degrade subtle statistical dependences in natural scenes using the wavelet transform. Importantly, these manipulations leave basic features (e.g., luminance and contrast) intact. To manipulate image structure using wavelets, the image is first decomposed using a family of wavelet basis functions sensitive to variance at specific spatial scales. We then randomly permute the decomposed data associated with one or more spatial scales - essentially destroying the structure at that scale. We conducted an fMRI experiment to demonstrate the application of these image manipulations for probing the functional architecture of the visual hierarchy. The overarching goal was to contrast levels of activity in different visual areas elicited by the presentation of intact vs. wavelet-degraded natural images. Our results reveal a few salient response differences across visual area and experimental condition. Notably, we find evidence supporting our core hypothesis that higher cortical areas are more sensitive to the more complex statistical features of natural scenes (i.e., cortical areas respond more strongly when natural image structure is present than when absent and this difference increases as one progresses up the hierarchy). This work demonstrates the utility of using wavelet-based image manipulations to probe the visual hierarchy - supporting the notion that perceptual systems in the brain are optimally tuned to the complex statistical properties of the natural world. A.M.P. acknowledges funding from the ARC (DE180100433).

Predicting brain function from anatomy using deep learning

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Most of the human visual cortex is organized retinotopically. Although the detailed organization of these cortical 'retinotopic maps' has been shown to be related to the underlying anatomy of the brain, conventional models fail to accurately predict the individual differences present in these functional maps. Recent advances in deep learning algorithms may offer a way forward, having shown immense potential in their ability to model complex associations amongst related features. It was our aim, therefore, to develop a neural network capable of learning the relationship between the functional organization and underlying anatomy of the visual cortex. Developing a deep learning model involved three main steps: (1) training the neural network, (2) hyperparameter tuning, and (3) testing the model. Prior to the training step, the 181 participants from the HCP retinotopy dataset were randomly separated into three independent datasets: training, development and test sets. During training, the network learned the correspondence between the retinotopic maps and the anatomical features by exposing the network to each example in the training set. Model hyperparameters were tuned by inspecting model performance using the development dataset. Finally, once the final model was selected, the network was tested by assessing the predicted maps for each subject in the test set. Our models were able to successfully produce retinotopic maps from anatomical properties alone. Importantly, our approach accurately predicted unique variations seen across individuals. More generally, this work demonstrates the potential of deep learning to provide models able to predict individual differences in brain function from anatomy.

Individual differences in gamified attention training: Training curves in typically developing children.

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Cognitive training interventions have provided inconsistent benefits in children. Despite growing evidence that individual differences may play a role in training outcomes, potential predictors and mechanisms of training have largely been left unexplored. In the current study, individual learning trajectories of an attention training task were investigated within a novel, adaptive, game-based attention intervention, TALI. From a randomised control trial of TALI only those participants who competed the training program were included (n = 38; M age = 6.82 years, SD = 1.09 years). Children completed one training session per day, five times a week for five weeks. Assessments, conducted at baseline and post-training, included the Test of Everyday Attention for Children (TEACh-2). Progress within TALI was recorded by the program.Latent growth curve models were applied to characterise individual trajectories of level progress from the TALI selective attention task. Residual slope terms were extracted, after adjusting for age and IQ, and were correlated with changes in selective attention (TEACh-2). Age (Estimate = 0.39; SE = 0.13; p = .006) but not IQ (Estimate = 0.03; SE = 0.12; p = .780) was a predictor of rate of progress in the TALI selective attention task; correlations were not significant (r = .01 to -.19; p > .05; BH corrected). Older children had a steeper rate of level progression through the selective attention task, but this steeper rate of level progression was not related to larger training gains. The results suggest that TALI may need to be tailored for older children.

Distributed patterns of event-related potentials during anticipation of emotion regulation predict success for reappraisal but not distraction

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The ability to control one's emotions, termed emotion regulation (ER), is vital for everyday functioning. It is important to understand the factors influencing ER success, including processes relating to the anticipation of ER strategy use (i.e. prior to active regulation) and implementation (i.e. during active regulation) of ER strategies. The present study investigated whether brain activity during the anticipation and implementation of two widely-studied ER strategies (distraction and reappraisal) is related to regulation success. Brain activity was recorded using electroencephalography while participants (N = 27) were presented with negative images. Preceding each trial, participants were cued either to passively view an image, or to use distraction or reappraisal to decrease their emotional responses to the images. ER success scores were calculated from subsequent self-report disgust and sadness ratings. Multivariate support vector regression was used to predict ER success scores from small time windows of spatiotemporal patterns of event-related potentials recorded during the anticipation stage (before image presentation) and implementation stage (during image presentation) for each ER strategy separately. During anticipation, ER success for reappraisal could be predicted from patterns of brain activity, while during implementation, ER success could be predicted for distraction. The results were highly similar for sadness and disgust. These findings suggest that anticipatory cognitive processes form a key determinant of reappraisal success but may not be similarly important for distraction. This may reflect the fact that reappraisal is a more cognitively demanding ER strategy than distraction, requiring enhanced preparation of mental resources.

Measuring physiological synchrony and arousal with wearable devices: comparing approaches using the SoChro toolbox

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Wearable biometric-recording devices have gained popularity in studies taking place in ecologically-valid environments, enabling the capture of large quantities of physiological data concurrently from multiple participants. This is particularly promising for investigating the association between socio-emotional phenomena and physiology with minimal intrusion. However, the current literature contains dozens of methods for feature extraction from physiological data, with varying degrees of suitability for continuous, in situ recordings. We developed an open-source GUI toolbox (SoChro) designed for flexible pre-processing and estimation of physiological synchrony (simultaneous fluctuations in sympathetic activity between interacting individuals) and arousal metrics for simultaneously recorded physiological data. Several time-domain and frequency-domain measures of arousal level and synchrony based on electrodermal (skin conductance) activity were compared. Performance of each measure was assessed in terms of their sensitivity to detect variation in participant behaviour, while parametric and non-parametric statistical techniques were assessed for false discovery rates. These methods were then applied to physiological data recorded in 10 secondary school classrooms across multiple lessons, using observed behaviour and self-report measures to contextualise the relationship between physiology and collaborative learning. Based on our results, we make recommendations for the appropriate analysis and statistical testing of simultaneous physiological recordings. Our findings contribute to the development of tailored approaches for detecting hidden psychophysiological states indicative of co-operative behaviour.

Modelling of spatial representations across eye movements reveals rapid post-saccadic updating

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We move our eyes several times a second to fixate, track and identify objects in the surrounding environment. This creates a challenge for the visual system, which must repeatedly update its representation of the external world based on the abruptly changing retinal 'snapshots' that occur with successive fixations. Several models have been proposed to explain changes in the allocation of spatial attention across saccadic eye movements, but previous investigations have not pitted them directly against one another. Both a 'pre-saccadic remapping model', and a competing 'spatial convergence model', predict large spatial shifts in the locus of visual attention prior to saccadic onset, but attribute these shifts to different underlying causes. Here we sought to characterise trans-saccadic updating with a full-field classification image design. Observers made consecutive saccades while concurrently attending covertly to a location in the periphery in order to report the polarity (black vs. white) of a briefly presented target bar. The display consisted of dynamic visual noise, upon which the target was added at a random time during each trial. We exploited the visual noise by fitting

template-matching models of trans-saccadic attentional allocation to the data to investigate how covert spatial attention is updated to track objects across saccades. Neither of the tested models was the best account of the data. Instead, the best fitting model was one in which visual attention is rapidly redeployed immediately post-saccade. Contrary to previous reports, these findings imply that the allocation of spatial attention is relatively unperturbed across saccades.

The effect of prior perceptual load on visuomotor neural oscillatory mechanisms and task performance

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The ability to switch tasks efficiently is a complex aspect of cognitive control. Neuroscientific research on the underlying mechanisms of task-switching suggests that successful execution of a new task requires the human brain to manage sensory input, update and reconfigure new task-related processes, and engage task-relevant areas. Updating new task-sets and engaging task-relevant areas has been related to theta synchronisation and alpha desynchronisation respectively. However, it is not clear how the perceptual and cognitive load of a former task affects performance and the underlying mechanisms of a new task. Given that task-switching is particularly important in rapidly changing environments, including for safety-oriented professions, understanding which factors impact new task activity is important.Therefore, this study investigated the oscillatory dynamics underlying a visuomotor task preceded by a visuospatial task of differing perceptual load. Forty healthy participants switched between a visual search and a tracking task. Perceptual load of the visual search task was altered between low and high. Electroencephalogram (EEG) and task performance was recorded.Frontal alpha desynchronisation was greater during visual search high load, and theta synchronisation was greater during low load. Tracking task reaction time was similar following both low and high load; however, participants' control of the cursor was significantly worse following high load, reflecting poorer accuracy. Evoked frontal theta power was greater during the tracking task following low load, and parieto-occipital alpha desynchronisation was greater following high perceptual load. These results suggest that prior perceptual load affected the neural mechanisms required for successful visuomotor performance.

Try to see it my way: Distinct neural correlates of different forms of perspective taking in frontotemporal dementia

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Shifting from our own viewpoint to adopt that of another is a fundamental human process that permits successful social interactions in daily life. Several different forms of perspective taking exist, including adopting anothers visual perspective to imagine what (Level 1), or how (Level 2) they see the world, and simulating anothers thoughts or feelings via theory of mind. Whether these discrete aspects of perspective taking represent distinct, or overlapping, neurocognitive processes, however, remains poorly understood. Here, we examined the neural correlates of different forms of perspective taking in the behavioural variant of frontotemporal dementia (bvFTD), a neurodegenerative disorder characterised by profound social dysfunction and frontotemporal atrophy. Fifteen bvFTD patients and 15 healthy Controls completed a comprehensive perspective taking battery, involving tasks of Level 1 and Level 2 visual perspective taking and theory of mind, and carer-rated questionnaires capturing perspective taking in daily life. Participants also underwent structural MRI, and the relationship between task performance and grey matter intensity in cortical regions-of-interest, including medial prefrontal cortex, temporoparietal junction, precuneus, and inferior frontal gyrus, was examined. Compared with Controls, bvFTD patients were significantly impaired on all measures of perspective taking. No significant correlations emerged, however, between performance on the different perspective taking measures in bvFTD. Neuroimaging analyses revealed both common and unique neural correlates for each form of perspective taking. These findings suggest partially distinct, yet overlapping, neural mechanisms underlie visual, cognitive, and affective perspective taking, and extend our understanding of the profile of sociocognitive dysfunction in bvFTD.

Speech analysis for assessing schizophrenia spectrum disorders: what machine learning techniques say

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Speech deficits are an established aspect of schizophrenia spectrum disorders (SSD), and speech analysis is a growing focus in the development of objective clinical tests in psychiatry. This study used two machine learning techniques to explore and identify the speech variables that best differentiated SSD patients and healthy controls (HC). 43 schizophrenia/schizoaffective disorder patients (M=41.67, SD=9.89) and 46 HCs (M=38.89, SD=14.30) were recorded in general conversation with the interviewer. Recordings were blindly transcribed and language analysis software was used to generate over 100 speech variables of interest (e.g. type-token ratio, number of omitted words, etc). Two machine learning techniques were used for classification: binary logistic regression and a random forest (RF) algorithm, with a 0.8/0.2 training and validation split for both. The results for logistic regression analysis achieved 72.73% (training) and 90% (validation) sensitivity and 86.11% (training) and 100% (validation) specificity respectively, with only number of utterances with omissions and part-word revisions significantly differentiating the groups. RF analysis confirmed the discriminating utility of these two speech variables and a number of other utterance variables (e.g. omitted words, word repetition), achieving 78.79% (training) and 80% (validation) sensitivity and 94.44% (training) and 90% (validation) specificity respectively. The findings successfully identified speech variables that best differentiated SSD patients and HCs. The relatively small sample size is augmented by the congruence between two separate analyses and support the utility of speech assessment for classification. Potential future uses include objective and rapid SSD speech screening tools, with promising implications for diagnosis and illness management.

The influence of age and ADHD status on the development of sustained attention, three-wave longitudinal study through childhood and adolescence

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Background: Sustained attention deficits are frequently reported in attention-deficit/hyperactivity disorder (ADHD). However even in neurotypical samples, longitudinal studies examining how sustained attention changes across development are lacking, and in ADHD samples are even more scarce. Method: The Sustained Attention to Response Task (SART) was conducted in ADHD (n=129) and control (n=123) individuals at up to three time points over ages 9-14 as part of the Neuroimaging of the Children's Attention Project (NICAP). Key SART variables of interest were standard deviation of response time (SDRT), omission errors and ex-Gaussian parameter tau. Trajectories of sustained attention development, indicated by changes in SART performance, were examined using generalised additive mixed modelling with age at assessment and ADHD status as potential predictors. Results: Main effects of age and ADHD group significantly predicted changes in SDRT, omission errors and tau (mean R²=.15). The relationship between age and these measures was negative and linear, with older children predicted to have greater sustained attention performance. There was no significant difference in attention performance between children with persistent ADHD and those who had remitted from ADHD since study commencement, and in both groups SDRT, omissions and tau were consistently higher than in control children across all time points. Discussion: Findings reveal that trajectories of sustained attention development over ages 9-14 are comparable between ADHD and control groups, however children with ADHD display consistently poorer sustained attention than controls. Results also reveal that ADHD-related attention deficits persist over time even in participants with ADHD in remission.

Transcranial magnetic stimulation and Prediction: Self-generated or signalled TMS excites the motor system less effectively than unsignalled stimulation.

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The brain's response to sensory input is modulated by prediction. For example, sounds that are produced by one's own actions or those that are strongly predicted by other environmental cues are perceived as being less salient and accompanied by an attenuated N1 component in auditory evoked event-related potentials. Here we examined whether the neural response to direct stimulation of the brain is attenuated by prediction in a similar manner. Transcranial magnetic stimulation (TMS) applied over primary motor cortex is often used to gauge the excitability of the motor system. Motor-evoked potentials (MEPs), elicited by TMS and measured in peripheral muscles, tend to be larger when actions are being prepared and smaller when actions are voluntarily suppressed. We tested whether the magnitude of MEPs was attenuated under circumstances where the TMS pulse can be reliably predicted, even though control of the relevant motor effector was not required. Self-initiation of the TMS pulse and reliable cuing of the TMS pulse both produced attenuated MEP magnitudes. These results suggest that predictive coding may be governed by domain-general mechanisms responsible for all forms predictive learning.

Reduced Social Perception is Associated with Social Scene Construction Deficits in Frontotemporal Dementia

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Increasing evidence suggests that the capacity to mentally simulate richly detailed social scenarios supports discrete aspects of social cognition. The behavioural-variant of frontotemporal dementia (bvFTD) is associated with profound deficits in theory of mind and social knowledge. Here, we investigate the relationship between explicit social norm violation detection and social simulation in this syndrome. Twenty bvFTD patients and 19 healthy controls completed a modified version of the Dewey stories test involving rating the appropriateness of various social behaviours. Deviation scores were calculated to represent the extent to which patient responses diverged from controls. Participants also completed a test of social scene construction involving describing an atemporal social scene (e.g., busy restaurant), and the Social Norms Questionnaire (SNQ) as an index of social knowledge. bvFTD ratings significantly diverged from control ratings on the Dewey task [p =.002]. Raw scores indicated bvFTD patients tended to rate scenes as less shocking than controls [bvFTD, M=25.25, SD=10.56; Controls, M=28.35, SD=4.71]. Â bvFTD patients also performed significantly worse than Controls on the social scene construction task [p =<.0001], and the SNQ [p =.025]. Pearson correlations in the bvFTD group revealed associations between reduced social perception on the Dewey task and poorer social scene construction [r = -.69, p =.002], and knowledge of social norms [r = -.51, p=.034]. This study reveals that an impaired capacity to identify explicit social norm violations is associated with difficulties in envisaging social scenes in bvFTD. These findings increase our understanding of the cognitive processes associated with social dysfunction in bvFTD.

Investigating bottom-up versus top-down effects across cortical depth in human somatosensory cortex using 7T fMRI

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One of the fundamental properties of human cerebral cortex is its layered organisation, whereby the grey matter is marked by multiple distinct bands comprised of different neuronal populations, serving different functions. Generally, the middle layers are associated with feed-forward (bottom-up) processes; conversely, cells in the superficial and deep portions are associated with feed-back (top-down) functions. Until recently the investigation of these different layers has been restricted to electrophysiology studies. By leveraging advances in imaging techniques, however, we can now probe these layer-dependent patterns of activation non-invasively in human cortex - here in primary somatosensory cortex, S1. High resolution anatomical (MP2RAGE; 0.5mm) and functional BOLD (3D-EPI; 0.8mm) imaging data were acquired on a Siemens Magnetom 7T scanner. Tactile stimulation was delivered to each fingertip independently using piezoelectric stimulators. There were two main experimental conditions: sensory and attention. During the sensory condition, four fingertips on the right hand were stimulated sequentially. During the attention condition, attention was swept across the fingertips under constant sensory stimulation of all four fingertips. A set of precise laminar surface models were then used to extract and examine data across cortical depths. Activation patterns were successfully extracted at multiple cortical depths for both sensory and attention conditions. Both conditions elicited significant activation across cortical depths, and early data suggest the depth-dependent patterns differed across conditions, potentially reflecting the underlying neuronal differences. The ability to make such detailed measurements provides an unprecedented opportunity to examine the neural mechanisms underlying both bottom-up and top-down processes and how these influence somatosensation.

Cultural influences on attention: evidence from eye-movements and EEG during emotional scene viewing

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Previous studies investigating whether attentional strategy differs by culture have yielded inconsistent results. One suggestion is that culture-shaped attention can be modulated by bottom-up, stimulus-driven attention. To further test this hypothesis, we manipulated the emotional properties of image stimuli and investigated whether salient features would mask culture-shaped attention strategies. Australian (n=26) and Chinese (n=26) participants viewed 120 composed images that varied in the emotional valence of the foreground object and/or background, followed by a surprise recognition test where objects and backgrounds were presented in isolation. Eye movements and EEG were recorded simultaneously during the tasks. We examined ratios of object-related fixations to background-related fixations, and Event Related Potentials (ERPs) known to be modulated by attention (C1,P2,P3). Linear Mixed Effects model (LMM) analysis of the fixation data did not show any significant interactions between culture and stimulus manipulations, potentially demonstrating culturally universal patterns in the orientation of attention (object versus background). In contrast, ERP data yielded significant interactions between culture and object manipulations: the magnitudes of the stimulus manipulation effect were smaller in Chinese participants. We interpret this as a lower sensitivity for local features in the Chinese group or a preference for extracting the global gist. Our study is the first to investigate cultural differences in attention at a neurocognitive level. We conclude that our stimulus manipulations differentially influenced two aspects of attentional strategies: the object-vs-background orientation of attention was susceptible to the stimulus-based constraints, while the cultural difference in the global-vs-local processing styles remained observable.

Posters

Autonomy support enhances movement efficiency

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An important motivational factor that influences motor performance and learning is performer autonomy (Wulf & Lewthwaite, 2016). Autonomy-supportive conditions that provide an opportunity for choice have been shown to increase movement effectiveness across various tasks, and populations. The effects of autonomy support on movement efficiency, or economy, were less clear. The purpose of our studies was to examine the effects of autonomy support on movement efficiency in force production tasks. One study (Iwatsuki, Abdollahipour, Psotta, Lewthwaite, & Wulf, 2017) used a maximum-force production task with a hand dynamometer. The findings showed that giving participants the opportunity to choose the order of hands resulted in sustained maximal forces across trials, whereas forces decreased in a control condition without choice. In another study (Iwatsuki, Shih, Abdollahipour, & Wulf, 2019), a task requiring force production via plantar flexion was used, with target torques corresponding to 80%, 50%, and 20% of maximum voluntary contractions. Allowing performers to choose the order of target torques reduced neuromuscular (EMG) activity compared with a control condition, even though the actual torques produced were similar for both groups. Overall, the findings demonstrate enhanced movement efficiency resulting from autonomy support. Funding: The study was supported by a grant from the Czech Science Foundation (GAČR 18-16130S).

The Ever-Changing Ideal: The Body You Want Depends On Who Else You're Looking At

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Through advertising and social media, women consistently view images of other women's bodies. These bodies frequently fit the 'thin ideal' and can warp perceptions of how one might desire their body to look. As such, we investigated how the presence of different sizes of bodies affects one's perception of how they want their body to look. We created arrays of 9 bodies. These arrays were comprised of four bodies that fit the societal thin ideal, and five additional bodies that ranged from moderately underweight to obese. Fifteen versions of six array levels were created, all including the four ideal bodies. Array one included the five thinnest flanker bodies, whereas array six including the five largest flanker bodies. Female participants selected the body in each array that they considered closest to their ideal body. State and trait body dissatisfaction and BMI were also measured. Results showed that average BMI of the selected ideal body increased significantly for each array level. Participants were also less likely to pick an underweight ideal body as array level increased. Average BMI chosen for each level, and overall, was correlated with current feelings of fatness and state body dissatisfaction. Importantly, a large proportion of our sample selected ideal bodies that were technically underweight, further highlighting the need for broader body representations. These results demonstrate the context-dependent nature of body perception, and the rapidity with which these perceptions can change.

The effects of light level on the task-evoked pupil response during effortful listening

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There is increasing interest in the measurement of cognitive effort during listening tasks, for both research and clinical purposes. Task-evoked pupil responses (TEPRs) can be used as proxy measures of cognitive effort, via autonomic nervous system activity. However, the effect of light conditions on TEPR amplitude during listening tasks is not clear. Thus, this research aimed to systematically examine the effects of four light levels on TEPR amplitude during effortful listening.
Thirty-six otologically normal adults completed a speech-in-noise task (correctly repeating target sentences presented in background babble noise). A 4 (light level) x 4 (signal-to-noise ratio [SNR]) repeated-measures design was used. Pupil diameter was continuously recorded. There were statistically significant main effects of light level ($p = <0.001$) and SNR ($p = <0.001$) on TEPR amplitude. There was also a significant interaction between light level and SNR in their effects on TEPR amplitude ($p = <0.001$) - TEPR amplitude was more sensitive to changes in SNR in dimmer light, and TEPR amplitude was more greatly affected by light level in poorer SNRs. These results provide the first empirical evidence that TEPR amplitudes are affected by light conditions in a speech-in-noise task. Combined with the results of previous research, these findings suggest that the relationship between TEPR amplitudes and light conditions might be dependent on the type of task being performed. Measurement of TEPRs may provide a unique opportunity to measure cognitive effort during listening. Further research is needed to examine the effects of light during different types of listening tasks.

Cognitive Predictors of Complex Task Performance: On the Influence of Attention Control, Working Memory and Situation-Specific Task Models

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It is widely accepted that successful performance of multiple concurrent goals in complex and dynamic settings (e.g., during military operations, operating a vehicle) is predicted by measures of attention control (AC) and working memory (WM). The primary goal of this study was to determine whether the capacities of AC and WM as predictors of individual differences in complex task performance are mediated by situation-specific task models (cognitive knowledge structures that have been posited as a special form of long-term working memory). To do so, we tested participants on a battery of well-established working memory (change detection, operation span, Corsi block tapping task) and attentional control (single vs. dual response selection task, psychological refractory period, attentional blink, Stroop) tasks. Situation-specific task models were assessed with experimenter-scheduled probes (Situation Present Assessment Method), while participants performed a complex air-traffic control (ATC) task. Based on latent variable modeling, we found that WM mediated fully the association between AC and complex task performance. Furthermore, individual differences in task models partially mediated the association between WM and complex task performance. The current results indicate that the ability to create and maintain task models is an important mechanism of successful performance in multitask settings and is one of the pathways through which WM variation influences higher order cognition. The Commonwealth of Australia supported this research through the Australian Army and a Defence Science Partnerships agreement of the Defence Science and Technology Group, as part of the Human Performance Research Network.

Searching for the sweet spot: Balancing tDCS intensity for cortical excitability modulation with double blinding integrity

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This research aimed to develop a clearer understanding of the range of transcranial direct current stimulation (tDCS) intensities researchers could rely upon to produce cortical modulation, without participants and researchers detecting a difference between active and sham conditions. Three separate studies investigated a range of anodal tDCS intensities (0.5, 0.8, 1.6, 1.8, and 2 mA) to investigate tDCS-induced cortical change and sensations. Cortical excitability was assessed using transcranial magnetic stimulation (TMS) to primary motor cortex (M1) up to 40 mins post-stimulation. Condition experience was assessed using sensation scores throughout stimulation, and double blinding was assessed via condition judgement and judgment confidence at 1.6 and 1.8 mA. This series of studies demonstrates a lack of tDCS-induced effects on cortical excitability compared to sham at a range of intensities (0.5, 0.8, 1.6, 1.8, and 2.0 mA), likely due to inter-individual response variability to tDCS and/or TMS. tDCS-induced sensations are perceived more strongly in the active condition compared to sham at 1.8 mA and 2.0 mA, but not the 1.6 mA, 0.8 mA, or 0.5 mA intensities. tDCS was effectively double blinded at 1.6 and 1.8 mA, despite stronger sensations being elicited in the active condition midway through stimulation at 1.8 mA compared to sham. Despite the mixed efficacy of tDCS blinding in the literature, follow-up reviews demonstrated that blinding assessment is still not rigorously or consistently assessed in transcranial electrical stimulation (tES) research. Recommendations for standard, best-practice blinding assessment and reporting procedures are provided.

Association between SLF, SLF I, II, III and complex motor planning in children with Developmental Coordination Disorder: Preliminary findings

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Children with Developmental Coordination Disorder (DCD) experience difficulties planning complex movement sequences relative to their peers. A white matter tract that is potentially sub-serving this difficulty is the superior longitudinal fasciculus (SLF), consisting of three main branches; SLF I, II and III, all of which are important for complex planning. Previous research has linked the SLF to poor motor skills in those with DCD. However, to-date, no study has investigated the contribution of the microstructural organisation of the SLF, and its independent branches SLF I, II, and III, in relation to complex motor planning in this population. The aim of the study is to investigate this association with complex motor planning, measured by end-state-comfort (ESC), in children with DCD. Behavioural and diffusion weighted imaging data were collected from 19 boys aged 8 - 12 years, 9 met the diagnostic criteria for DCD. Motor planning was tested using a complex grip selection task, and ESC was recorded. Participants underwent high angular MRI and the data were pre-processed using ExploreDTI V4.8.6. The SLF as well as its subsequent branches were delineated using CSD tractography. Finally, Apparent Fibre Density (AFD) was extracted for all tracts. Data are being analysed using STATA 15.0, to determine if there is a positive association between AFD of SLF, SLF I, II and III and ESC. Results may contribute to the search for the etiological underpinnings of DCD by identifying if microstructural abnormalities in the SLF or in individual tracts are associated with their complex motor planning difficulties.

The effects of Mindfulness Meditation with Neurofeedback on ERP Measures of Attention

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Mindfulness meditation, a practice which involves focusing attention on an intended object, such as the breath, while disregarding external and internal sources of distraction, has been associated with improvements in emotional regulation and attention. The present study aimed to investigate the effects modafinil MM (including neurofeedback) on behavioural and event-related potential (ERP) measures of attentional processing. Specifically, the study aimed to examine the effects of MM on alerting, orienting and executive control using an attentional network task (ANT). Participants with low mediation experience (n=30) were randomised to a one-week

intervention (at least 20 mins for 7 days) of either mindfulness-based meditation with neurofeedback (MUSE) or relaxation training with biofeedback (Pip). Participants completed the ANT at pre-training and post-training session while EEG activity was recorded using a NeuroScan system. Participants also completed measures of trait mindfulness, state anxiety and emotional regulation at pre and post-training. Behavioural (reaction time and accuracy) and electrophysiological (N1, N2 and P3) correlates of attention were examined using mixed models analyses. Results were interpreted in terms of the influence of mindfulness-based meditation on specific networks of attention and associated neural correlates.

Neurophysiology of perceptual decision formation in the ageing brain

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Visual processing speed is increasingly considered a biomarker of cognitive ageing, yet the neurobiology of age-related impairments in this capacity is unclear. We used a perceptual decision making electroencephelography (EEG) framework to investigate how discrete neurophysiological signals indexing processing speed differed in the older (N=26) relative to younger (N=30) adults. Ageing was associated with slower target selection, evidenced by a later peak latency of the N2c over occipito-parietal scalp regions. Moreover, older adults exhibited a reduced efficiency for perceptual decision formation, indexed by a later onset, shallower build-up rate, and lower amplitude of the centro-parietal positivity (CPP) marker of sensory evidence accumulation. These findings provide neurophysiological insights into processing speed deficits in ageing and highlight a useful framework for monitoring intervention efficacy and understanding the neurobiological substrates of processing speed deficits in age-related conditions such as stroke and Alzheimers Disease.

High-intensity interval exercise as a modifier of neocortical plasticity in the visual cortex

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Long-term potentiation (LTP) is a form of neuroplasticity commonly implicated in mechanistic models of learning and memory. Much like learning and memory, it is a brain-wide phenomenon. LTP manifests as a long-lasting increase in synaptic efficacy following repeated synaptic activation. High-intensity interval (HIIT) exercise has been previously shown to boost LTP magnitude in the motor cortex. Higher long-term physical activity levels have also been associated with a greater magnitude of LTP in the visual cortex; however, a causal effect is yet to be determined. This study aimed to investigate whether an acute bout of HIIT exercise could boost the magnitude of LTP expressed in the visual cortex. Young adults (N=14, mean age=24.23) engaged in either 20 minutes of HIIT exercise or 20 minutes of rest in two counterbalanced sessions. Following exercise/rest, LTP was induced in the visual cortex using high frequency presentations of either vertically or horizontally orientated sine gratings (counterbalanced); termed a 'visual tetanus'. Electroencephalography was used to measure the visual-evoked potential, specifically an established marker of visual LTP, the N1b. Measurements were taken from the visual cortex before and after the visual tetanus while participants viewed stimuli of both orientations presented at low frequency. Data analysis is ongoing. Our hypothesis will be supported if there is a more pronounced change in the N1b for HIIT relative to rest.

Handedness modulates spatial attentional shifts in a monotonous simulated driving task

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Current research suggests that spatial attention is modulated by alertness, with high and low levels of alertness associated with attentional shifts towards the left and right side, respectively. This study investigated suggestions that associations between alertness and spatial attention vary based on handedness, with left-handers showing the opposite effect to right-handers (i.e., a leftward bias with lowered alertness). Twenty left-handed and 22 right-handed participants (15 males, mean age=23.6y, SD=5.0y) were assessed on a monotonous simulated driving task (lasting approximately 60 minutes as alertness decreases with time-on-task) whilst EEG was recorded. The driving task involved responding to 96 grey circular stimuli appearing at three horizontal locations on each side of the screen, whilst driving in a 50km/h zone. Mixed model analyses with reaction time (RT) as the outcome, and participant ID on the intercept revealed a significant side by location by time-on-task interaction for right-handers (p=.002), with slower RTs to left-sided stimuli, stimuli further from the centre of the screen, and with prolonged task duration. This interaction was not significant for left-handers (p=.886). Findings show a reduction in the initial leftward bias with time-on-task only in right-handers. Power spectral analysis will be performed by computing fast fourier transform to calculate alpha and theta power in the parieto-occipital and frontal regions respectively to examine brain activity changes with task duration in left-handers and right-handers Behavioural results suggest left-handers may be more resilient to performance

decrements whilst engaging in monotonous tasks than right-handers, supporting handedness may influence the alertness and spatial attention relationship.

Tracing the time course of memory consolidation with RSA

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Sleep leads to several benefits for memory, including reduced forgetting of episodic content, resistance to interference and the generalisation of learned material. Here we have attempted to trace the time course of human memory by measuring the generalisation of learned inputs across six hours of learning, sleep, interference and recall. 22 subjects (Mage = 21 years; 17F) were fitted with a 64 channel EEG cap and learned the spatial locations, and temporal sequence of 20 images (grouped into four broad semantic categories) around a circular display. Following learning and immediate recall testing, subjects undertook a two-hour monitored nap opportunity. Following this, subjects learned an interference sequence (the same images in a different spatiotemporal sequence) and were tested on their recall of the original learned sequence. Representational Similarity Analysis (RSA) was used to track the time course of memory consolidation. In general, average RSA values increased across time, and reached asymptote after sleep, indicating the pattern completion of memory traces across sleep. Average RSA values were resistant to the effects of interference, despite behavioural responses being negatively impacted thereby. RSA analyses also revealed a pattern of changing similarity commensurate with Multiple Trace accounts of memory. Thus, we have been able to use RSA to track the time course of human memory, from initial encoding, through consolidation, interference and recall, demonstrating the important role of sleep in the memory consolidation process.

Effects of screen use on behavioural and cognitive attention and sleep in school-aged children

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With screen media use rapidly increasing in young children, there are growing concerns regarding its impact on sleep, attention control, and child development more broadly. Despite its prevalence, the consequences of screen use on child cognitive functioning has been relatively under-studied, and remains largely inconsistent. The aim of this study was to examine the relations between screen use, sleep, and attention. The sample consisted of 234 Grade 1 and Grade 2 children (139 males, 96 females) aged 6-8 years old. The Strengths and Weaknesses of ADHD Symptoms and Normal Behaviour Rating Scales was used to measure child inattentive and hyperactive behaviours, and the Fixed Sustained Attention to Response Task (SART) to measure sustained attention. Sleep problems and sleep duration were assessed using the Children's Sleep Habits Questionnaire-Abbreviated. Parents reported their child's daily screen use for televisions, tablets, smartphones, and video game consoles. Children with higher screen use, specifically television and tablet use, experienced higher total sleep problems and shorter sleep duration than children with low use. Furthermore, screen use was associated with cognitive but not behavioural attention. Children who played video games demonstrated significantly faster mean response times and less response time variability on the SART than children who never played. Sleep was not associated with behavioural or sustained attention. Essentially, screen use appears to impair sleep in children, while video game use may have selective benefits on aspects of sustained attention.

Sleep deprivation and circadian timing differentially impact prosaccade reaction times depending on cognitive demands

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The impacts of sleep deprivation and circadian timing on cognition appear to be task-dependent, although past studies compared performance between tasks employing diverse sensory-motor modalities. Here, we removed this potential confound with an oculomotor task battery that keeps both sensory cue (visual stimulus) and motor response (peripheral saccades) constant. Twenty-two participants (17 males; aged 20-45) completed four-hourly prosaccades throughout 40 hours of sleep deprivation under constant routine conditions. In the Block task, all trials required a saccade as fast as possible towards the peripheral stimulus (prosaccade). In the Interleaved task, prosaccade trials were pseudo-randomly interleaved with antisaccades (inhibit the automatic prosaccade and look mirror opposite instead), with the colour of the central fixation cross indicating upcoming trial type (pro- or anti-saccade). Compared to the relatively disinhibited state of the Block task (preparedness to respond as fast as possible on all trials), the Interleaved task required a more inhibited prefrontal state to be able to respond correctly on antisaccade trials. Block prosaccade reaction times changed significantly with sleep deprivation: $F(9,160)= 6.22$, $P < 0.001$, slowing down during the night, before recovering partially in the subsequent day at a more favourable circadian time when wake was being promoted. Interleaved prosaccade reaction times, however, did not change throughout the constant routine protocol: $F(9,153) = 1.16$, $P = 0.33$. We demonstrate differential impacts of sleep deprivation and circadian timing between trials requiring the same visuomotor response, but under different cognitive demands.

A rose coloured view of emotional processing in autism

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Autism shows consistent visual magnocellular abnormalities. Primate TypeIV magnocells are suppressed by red backgrounds, and project only from retina to LGNproviding

the opportunity for investigating network differences as a function of autistic tendency (Autism Spectrum Quotient - AQ). Thus, we recorded ERP responses to spatial frequency filtered emotional faces in HighAQ (n=22) and LowAQ (n=21) young adults, using red and green backgrounds of equal luminance. For the LowAQ group, red surrounds reduced the effect of fear on P100 amplitude. For the HighAQ group, red surrounds enhanced P100 amplitudes to low spatial frequency fearful faces. Factor analysis, focussed on the ERPs to low spatial frequency stimuli (plus AQ scores) showed 3 factors (explaining 77% variance) only one of which was AQ dependent. Splitting by AQ group, for Low AQ, Factor1 coded Fear across Red and Green backgrounds, while Factor2 coded Neutral expression across Red and Green backgrounds (with negative correlation between the amplitudes). For high AQ, Factor1 coded for Green backgrounds while Factor2 coded for Red backgrounds, across emotional states. The only suppressive effect of red light was observed in the Low AQ group, suggesting that the High AQ group may be less reliant on LGN input in processing emotional expression.

Rules are made to be broken! - Cognitive and neural mechanisms underlying conditional rule-breaking

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While rule-breaking - i.e. the action of violating external norms - can lead to both, negative, and positive consequences, it has mostly been defined as a rather global but, therefore, ambivalent concept. To describe rule-breaking more precisely, we investigate conditional rule-breaking, defined as the skill to carefully decide whether to follow or break a rule in a certain situation based on the subsequent consequence and the rule-breaker's internal goals. Therefore, to conditionally break a rule implies to break it only when the expected subsequent consequence is positive (i.e., leads to benefits) and when it is in concordance with the rule-breaker's internal goals. To validate the construct of conditional rule-breaking, we developed a controlled laboratory paradigm sensitive to inter-individual variability in conditional rule-breaking. In a sample of 133 participants, 38% unconditionally (i.e., always) followed the rule, 12% unconditionally broke the rule, and 50% conditionally broke the rule in accordance with anticipated benefits and internal goals. As expected, conditional rule-breakers obtained larger payoffs than unconditional rule followers and unconditional rule breakers. Moreover, conditional rule-breakers showed higher cognitive conflict than unconditional rule followers, as reflected in longer reaction times and larger as well as more complex movement trajectories. We furthermore analysed electrophysiologically (EEG P300 component amplitudes and latencies at the early stages of the decision-making process) and differential (i.e., personality traits) data to explain the inter-individual variability in rule-breaking behaviour. Our experiment emphasises the necessity to account for subforms of and inter-individual differences in rule-breaking behaviour.

Examining the neural correlates of error awareness in a large (n = 451) fMRI study

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The ability to detect an error in performance is critical to ongoing and future goal-directed behaviour. Diminished awareness of performance errors has been associated with a loss of insight and poor functional recovery in several clinical disorders (e.g., attention- deficit/hyperactivity disorder, schizophrenia, addiction). Accordingly, there is an increasing attempt in the literature to explore the neural activity underlying error awareness. Earlier neuroimaging studies have found no difference in dorsal anterior cingulate cortex (dACC) activity between errors made with and without awareness. More recent studies, however, have discerned greater dACC activity during aware errors. Contrary patterns of activation have been attributed to insufficient statistical power (Wessel, 2012). We therefore sought to clarify the neural correlates of error awareness in a large event-related functional magnetic resonance imaging (fMRI) study. Four hundred and fifty-one healthy participants undertook the error awareness task (Hester et al., 2005), a motor Go/No-Go response inhibition paradigm in which participants commit aware and unaware errors. Analysis of behavioural data revealed performance indices to be consistent with prior work. Participants correctly withheld 55% of their responses on No-Go trials, and were aware of 87% of commission errors. No association was found between awareness of errors and overall inhibition performance. The speed of responses was significantly related to the awareness of the error, such that reaction times were faster for aware errors than for either unaware errors or correct Go responses. The event-related functional analysis is currently ongoing and preliminary results regarding differential error awareness effects will be presented.

Divided attention in the tactile modality

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Most of our knowledge about the interplay between attention and consciousness comes from the visual domain, which suggests that some stimuli can be consciously perceived in the near absence of top-down attention, while other stimuli cannot. Here, we investigated whether tactile conscious discrimination remains intact in the near absence of attention. We used the well-established dual-task paradigm from the visual domain, in which participants are instructed to perform a central demanding task while performing a secondary task in parallel.

We compared the performance of a frequency discrimination task in N=16 participants in three conditions with different attentional requirements but identical input. Four fingers on one hand and 2 fingers on the other hand were stimulated with vibrators. In the single-task, participants focused on one finger pair, while in the dual-task condition, they focused on two finger pairs either on the same hand or across hands. Performance in the dual-task was worse than in the single task. In contrast to previous visual experiments reported improved performance when tasks were divided across hemifields compared to within a hemifield, we did not find comparable result in the tactile modality. Specifically, we found that in the dual-task conditions, performance was the same for same-hand and across-hands conditions. Our results suggest that simple haptic tasks, such as frequency discrimination, cannot be performed in the near absence of attention.

Organised toe maps in extreme foot users

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While the fine-grained features of topographic maps in somatosensory cortex can be shaped by everyday experience, it is unknown whether behaviour can support the expression of somatotopic maps where they do not typically occur. Unlike the fingers, represented in all primates, individuated toe maps have only been found in non-human primates. Using 1mm resolution fMRI we identify organised toe maps in two individuals born without either upper limb who use their feet to substitute missing hand function, and even support their profession as foot artists. We demonstrate the ordering and structure of the artists' toe representation mimics typical hand representation. We further reveal 'hand-like' features of activity patterns, not only in the foot area, but similarly in the missing hand area. We suggest humans may have an innate capacity for forming additional topographic maps that can be expressed with appropriate experience.

Causality perception and temporal sensitivity at the Blind-spot

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Visual objects that subtend across the blind-spot seem complete. The processes underlying this are not yet understood. We examined this by exploring temporal processing about the blind-spot. First, we examined causality perception. We found the human brain does not allow for the time an object should take to traverse the blind-spot in order to contact a static object on the far side, to launch it into motion. We further assessed temporal sensitivity about the blind-spot by having people distinguish elements that flickered on and off in tandem, from elements that flickered in counter-phase to create an apparent motion, while we recorded EEG. People had more difficulty distinguishing flicker from apparent motion about the blind-spot, relative to a control site matched for visual eccentricity, and to a mixed condition with one element adjacent to the blind-spot and another at the control site. With EEG, at the control site we found that more activity was entrained by flicker than by apparent motion, but this was not true about the blind-spot. Overall, our data suggest that elements on either side of the blind-spot are encoded, at least in part, by a common pool of neurons with overlapping receptive fields. This would make it harder to discern flicker from apparent motion about the blind-spot, and could contribute to the sense that an object is 'complete' when it subtends across the blind-spot. We argue against more complicated analyses, which construct representations that are in addition to retinal input.

Standard and Inter-Regional Continuous Theta Burst Priming of the Primary Motor Cortex Modulates Transcranial Magnetic Stimulation- and Sensory-Evoked Potentials

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Standard and priming continuous theta burst stimulation (cTBS) administered over the primary motor cortex (M1) can induce neuroplastic- and metaplastic-like effects. No studies have compared the neuro-modulatory effects of standard and priming cTBS protocols with transcranial magnetic stimulation-electroencephalography (TMS-EEG). We compared the neuroplastic effects of standard and inter-regional cTBS priming of M1 were measured with TMS-evoked potentials (TEPs) elicited from M1. Shoulder evoked-potentials (SEPs) elicited with TMS were included to control for multisensory M1 TEP contamination. Twenty participants received standard cTBS and inter-regional cTBS priming of M1 via the left-DLPFC (10 minute inter-train-interval) separated by a minimum of 7 days. M1 TEPs were measured at baseline (Time 1), after the first cTBS round (Time 2), and after the second cTBS round (Time 3). Short latency (< 60 ms) M1 TEP peaks were of larger amplitude compared to homologous SEPs. Long latency (> 60 ms) M1 TEP and SEP components were of comparable magnitude. Despite amplitude and topography differences, standard cTBS modulated the M1 N45 TEP and N45 SEP. No correlations in M1 N45 TEP and N45 SEP change values after cTBS administration were identified. Inter-regional cTBS M1 priming modulated the M1 N100 TEP, but not the N100 SEP. M1 TEPs comprise both target and non-target TMS-evoked neural activity. Modulation of the M1 N45 TEP and M1 N100 TEP partially reflects cTBS induced neuroplastic- and metaplastic-like effects, but also multisensory confounds. Incorporating active control conditions into TMS-EEG protocols can help isolate the target TMS-evoked neural response of interest.

Towards a More Accurate Assessment of Cognitive Processing in Aging & Post-Stroke: Insights from Healthy Aging

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Cognitive impairments are among the most common deficits observed in aging and post-stroke. Currently however, there is no rapid test-battery available to assess cognitive and visuomotor ability that may also serve as prognostic indicators of stroke recovery. Current gold standard assessments are paper-pencil tasks from the WAIS-IV including the Symbol Search (SS) and Coding (Cod) which consistently show decline with advancing age and post-stroke. Given their reliance on intact motor performance, this may confound the outcome measure of cognitive speed. Thus, study 1 aimed to investigate the utility of a psychophysical non-motor speed task i.e., the Inspection Time (IT) task in 107 healthy educated adults (67 young and 40 older adults), and to examine the contribution of motor speed to the IT, SS and Cod tasks. Study 2 aimed to investigate the utility of oculomotor patterns (saccades and visual fixations) as a biobehavioural measure of cognitive processing in the same population. Age-group differences were significant on the SS and Cod but not on the IT task. Motor speed was significantly correlated to SS and Cod performance but not IT performance. Older adults also demonstrated slower oculomotor patterns compared to young adults, which also correlated to performance on the IT. Findings caution against the use of paper-pencil tasks in aged or stroke populations where motor speed is almost always compromised. Findings also highlight the potential utility of the IT and eye-gaze patterns as objectively-derived markers of cognitive speed changes that may serve to inform information processing in healthy or stroke samples.

Why Phonological Intervention Alone Is Not Sufficient for Remediation of Reading Fluency

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Currently there is little intervention research aimed at improving reading rate and comprehension, which are known to be important in achieving reading fluency. In contrast, there are many training programs that target decoding skills and phonological awareness (PA) for the remediation of poor readers. Such PA training is reported to be successful in improving word reading accuracy ~60% of participants, but this alone does not lead to fluent reading. Thus, the current study investigated the importance of visual word recognition, as a measure of the orthographic lexicon, to reading rate and comprehension in a sample of 6- to 12-year olds (N = 182) from Grade 1 (n = 41), Grade 2 (n = 41), Grade 5 (n = 41), and Grade 6 (n = 41). Visual word recognition, rather than phonological skills, was found to be strongly correlated with reading rate and comprehension in both lower (n =82) and upper (n =82) primary school students. As expected, both phonological (i.e., PA and phonological decoding) and visual recognition (i.e., naming speed and visual word recognition) skills were found to improve with increasing grade levels, though skill levels appeared to plateau by fifth grade. Overall, the current study showed that visual word recognition is a critical factor in reading rate and reading comprehension, and a considerably more important predictor of these reading skills than PA or phonological decoding, raising questions about the potential clinical relevance of reading interventions that emphasize visual word recognition.

A Freudian Blip – Examining the Neural Bases of Female Difference in Sexual Arousal

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This study explores the unresolved question of why heterosexual women's behavioural and biophysical responses are often similar to both masculine and feminine visual sexual stimuli (VSS), known as the gender non-specific response. This response is more consistently found in early-stage responses, including the well-established N170 inflection to VSS as measured by the EEG. We investigated whether early non-specific responding could reflect a latent drive response to feminine stimuli developed in infancy towards the mother and later repressed in explicit processing, as posited by Freudian theory. Event-related potentials were recorded while participants viewed subliminally and supraliminally presented primes and feminine and masculine VSS targets. In the subliminal block, the experimental mother prime produced a significantly larger (more negative) peak N170 amplitude to feminine compared to masculine VSS, a gender specific response. In the corresponding supraliminal condition where the relationship between prime and target VSS was explicit, and when primed with a control image, no significant difference between feminine and masculine VSS was found, typical of the gender non-specific response. The study provides fundamental evidence that the early-stage gender non-specific response in females can be manipulated using priming techniques, together with a conclusion that androphilic female sexuality may partly be comprised of an underlying and pre-conscious drive to feminine stimuli developed in infancy.

Dissociable effects of tDCS polarity on latent decision processes are associated with individual differences in neurochemical concentrations and cortical morphology

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Applying a weak electrical current to the cortex has the potential to modulate neural functioning and behaviour. The most common stimulation technique, transcranial direct current stimulation (tDCS), has been used for causal investigations of brain and cognitive functioning, and to treat psychiatric conditions such as depression. However, the efficacy of tDCS in modulating behaviour varies across individuals. Moreover, despite being associated with different neural effects, the two polarities of electrical stimulation, anodal and cathodal, can result in similar behavioural outcomes. Here we employed a previously replicated behavioural paradigm that has been associated with polarity non-specific disruption of training

effects in a simple decision-making task and used the linear ballistic accumulator model to quantify latent components of the decision-making task. In addition, magnetic resonance imaging measures were acquired prior to tDCS sessions to quantify cortical morphology and local neurochemical concentration. Both anodal and cathodal stimulation disrupted learning-related task improvement relative to sham (placebo) stimulation, but the two polarities of stimulation had distinct effects on latent task components. Whereas anodal stimulation affected decision thresholds for the behavioural task, cathodal stimulation altered evidence accumulation rates. Moreover, performance variability with anodal stimulation was related to cortical thickness of the inferior frontal gyrus, whereas performance variability with cathodal stimulation was related to cortical thickness in the inferior precentral sulcus, as well as to prefrontal neurochemical excitability. Our findings demonstrate that both cortical morphology and local neurochemical balance are important determinants of individual differences in behavioural responses to electrical brain stimulation.

Eye movements are related to error checking during enumeration and arithmetic

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Dot enumeration speed is highly correlated with arithmetic speed when the enumeration dot stimuli are grouped at four locations (a quad dot display) and arithmetic stimuli are displayed as four Arabic numerals (add four display). Fixation frequency increases with enumeration and addition response times, but it is not known if the patterns of eye movements reflect task strategy or error checking. We recorded eye position and measured response times of 43 undergraduate students during add four and quad dot enumeration tasks with totals from 4 to 14. Results showed the expected correlation between enumeration speed, arithmetic speed and fixation frequency. Higher frequencies of eye movements were associated with increased fixations to previously counted dots. This pattern is consistent with error checking, rather than counting strategy. It remains to be seen whether error checking plays a role in explaining individual differences in arithmetic.

Causal evidence of right temporal parietal junction involvement in implicit Theory of Mind processing

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The ability to represent the internal thoughts, beliefs and desires of others, and recognise that these might be distinct from one's own, is crucial for adaptive social interaction. Such operations are thought to tap Theory of Mind (ToM), with its importance underscored by the link between ToM impairment and a range of neurodevelopmental disorders (e.g., Autism and Schizophrenia). Extensive investigations into the neural substrates of ToM, when individuals have to make overt/explicit judgments concerning others, have highlighted a link with a network of regions including the temporal parietal junction (TPJ), particularly in the right hemisphere. Recently, evidence has emerged that ToM can also operate implicitly and that this may be particularly impaired in Autism. However, very few studies have examined the neural basis of implicit ToM and none have employed methods allowing casual inferences to be made. Here, using brain stimulation, a Sally-Anne false-belief task, and eye-tracking we show that right TPJ is causally involved in ToM judgments that are made implicitly. These findings have implications for characterising the neural substrates of a key executive function, determining the extent to which implicit and explicit ToM draw on overlapping neural architecture and, potentially, better understanding of disorders tied to ToM impairment.

Computational cognitive requirements of random decision problems

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Real life instances of problems can be modelled as emerging from a random generating process. These are referred to as random instances. Previous studies have found that for electronic computers the computational requirements of solving an instance of a problem are related to a specific set of features of the problem. This mapping has been shown to apply to a multitude of problems and is referred to as Instance Complexity (IC). Overall, there is ample evidence suggesting that this theory is a general framework for electronic computers. Additionally, it has been shown that this pattern holds when humans solve the knapsack problem. However, it remains an open question whether IC is a generalisable measure, for humans, of the expected computational requirements of solving a problem. For this purpose, we ran a set of experiments in which human participants solved a set of instances of one of two, widely studied, computational problems (Traveling Salesperson and the Boolean Satisfiability). Instances varied in their IC. We found that, in line with our hypothesis, IC had a negative effect on human performance in both problems. In particular, on instances with high IC participants exerted more effort and had a lower accuracy rate. Our results suggest that IC is a general measure of expected difficulty of random instances. Since IC might be used as an approximation to the expected computational requirements of the task, IC could be a crucial component in the cognitive resource allocation process in the brain.

Limited physiological adaptation over time for individuals with Intellectual Disability with and without Autism: A Pilot Study

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Individuals with Intellectual Disability (ID) are more commonly diagnosed with an anxiety disorder than typically developing (TD) individuals, yet much of the past research on anxiety in developmental disorders has focused on Autism Spectrum

Disorder (ASD) with high functioning individuals. Using blood pressure and heart rate as biological surrogates for anxiety, the current longitudinal study compared anxiety levels of adolescents with Idiopathic ID, and adolescents with ASD and ID (ID+ASD) of similar chronological age (CA) and mental age, and a TD group of similar mental age. Completion of cognitive tasks were used to elicit situational anxiety, in order to determine whether the ID group was more consistently anxious than the TD group. Participants' blood pressure and heart rate were measured before and after the first and last of three experiment sessions, over 3 weeks. As BP changes with CA, BP of the ID groups were compared to TD adolescents of similar CA from a recently published BP screening table. All groups showed higher overall mean blood pressure measurement than the TD individuals of similar age from a recently published blood pressure screening table. The ID group showed increased DBP from week 1 to 3 of testing and ID+ASD showed a trend towards increased BP from week 1-3. The results, using objective, biological measures, show that adolescents with ID, especially those with ID+ASD show persistently higher anxiety, suggesting an association between higher anxiety and an ASD diagnosis. This relationship did not appear to be driven by information processing or motor ability.

Does the brain see what the eyes miss? A steady-state visual evoked potential (SSVEP) study of inattentional blindness.

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Spatial attention is fallible. When people are engaged in a demanding visual tracking task, they often completely fail to notice an unexpected, but otherwise salient object (e.g. a person in a gorilla suit). Interestingly, the likelihood of a person gazing at the unexpected object is a poor predictor of whether they will later report noticing it or not. Theorists have suggested that this form of transient overt attention is insufficient for the unexpected object to reach conscious awareness. We hypothesized that sustained neural entrainment produced by a flickering stimulus via the SSVEP response may be a better predictor of subsequent awareness. The present experiment separately investigated the contributions of overt attention (measured using an eyetracker) and covert attention (measured using SSVEP via electroencephalography) to people's awareness of the unexpected object. A standard inattentional blindness protocol was used, in which people track coloured shapes bouncing around the screen and a novel, unexpected shape is shown midway through the task. An inattentional blindness effect was obtained. The majority of participants did not notice the flickering, unexpected object, and there was no association between the likelihood of noticing the object and fixating upon it. People showed enhanced SSVEP response amplitude to the target stimuli, but there was no increase in the SSVEP response to the unexpected objects in the noticers as compared with the non-noticers. This work was funded by a HRPnet project grant awarded to the last two authors.

Attention & Personality as Predictors of Creative Cognition & Achievement

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Creative people fulfil some of society's most vital roles, such as providing inspiration and alleviating suffering. However, the definition and measurement of creativity is inconsistent across paradigms. Attention and personality have both been identified as predictors of creative cognition and achievement; however, the relationship of these three variables together has not been examined. Latent inhibition is the capacity to screen irrelevant stimuli from conscious awareness. Attenuated latent inhibition and trait openness are theorised to reduce screening capacity, thus increasing the probability of combining novel and meaning information to produce a creative outcome. We examined the relationship between creativity, global versus local attention, and the Big Five Personality traits. Analysis identified a link between openness and creative achievement; remaining personality traits were not related to creative achievement. Although we found that participants were more accurate on congruent trials on the Navon Figures task, we did not find the expected reaction time advantage on congruent trials, which we suspect is the result of online testing. Our data also suggest the presence of a floor effect on the remote associates test, such that participant performance was far poorer than anticipated. We suggest this floor effect impacted our null findings in relation to creativity and attention. Our findings highlight the challenges of undertaking creativity research and reiterate the importance of adequate construct operationalisation.

A model of V1 complex cells challenges the role of corticothalamic feedback in figure-ground segmentation

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The initial processing stages in the primary visual cortex are generally well understood, with some being modelled at the neuronal level. These processes are often assumed to drive the responses observed in many human neuro-imaging studies. I use multiple examples to show, however, that the implications of these assumptions are sometimes ignored in experimental design, leading to premature or possibly incorrect conclusions. In particular, evidence from a recent fMRI study suggests that the lateral geniculate nucleus (LGN) is involved in figure-ground segmentation via cortical feedback. Moreover, this study found that feedback activity was not influenced by observers' attentional allocation, leading the authors to conclude that the LGN plays a role in pre-attentive figure-ground segmentation. Without testing an explicit model, however, it is unclear what information was fed back to LGN, and to what extent this information should be influenced by attention, particularly because of the difficulty in knowing which stimulus information drove the fMRI signal. I estimated the early cortical representation of the stimuli used in this previous study using an uncontroversial model of V1 complex cells. My results reveal that a figure-ground segmentation mechanism is not necessary to explain the sensitivity of the LGN to apparent figure-ground arrangements, because the observed fMRI activity should be expected from simple first-order processes. I will discuss similar examples from other areas of cognitive neuroscience, including from the working memory literature. I argue that we can best advance theory by explicitly modelling the assumptions upon which neuro-imaging data are generated.

The laughing mind and its dissociation of the self

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Rhythmic vocalisations, contortions of the face, euphoric sensations—the strangeness of laughter is masked by its ubiquity. The leading account posits that laughter evolved to induce "playful affect" in others (via mirror neurons) in the context of non-serious incongruity. It does not, however, explicate how this causally generates the playful thought-actions that are asserted to be the advantageous adaptation. Freud (1905) proposed that laugher is implicated in processes that moderate ego functions of rational constraint to permit conscious expression of primary-process thinking. This is recontextualised within the free energy principle, whereby ego functions are characterized as instantiated by the default-mode network (DMN). Inspired by the entropic brain theory (Carhart-Harris et al., 2014), it was hypothesised that heard laughter (vs. control audio) would interact with seen irrational (vs. rational) action-object pairings to produce behavioural and neural effects consistent with so-called "entropic states". 62-channel EEG was recorded from 20 participants in a 2×2 event-related design, with the audio/visual stimuli followed by a response item. There were significant interactions in the behavioural data: irrational images were rated as more absurd/ dreamlike (and with lower RTs) when accompanied by laughter. Two a priori seed regions were selected within the DMN that encode related yet dissociable dimensions of the self: the ventral precuneus (vPC) and the ventromedial prefrontal cortex (vmPFC). Using lagged nonlinear connectivity as an index of functional integration, a 2-way contrast demonstrated significantly reduced connectivity between the vPC and vmPFC within the alpha (8–13Hz) band in the laughter (irrational minus rational) condition.

Seeing with your eyes closed: Spatially localised adaptation-induced changes to the 'intrinsic' occipital alpha rhythm

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One of the longest-standing observations from human electroencephalographic (EEG) is that alpha-band (~7 to 13Hz) oscillatory power is enhanced when people close their eyes. This has been taken as evidence for a default rhythm for activity in visual cortex, which is disrupted when people open their eyes. We have found this effect can be modulated via visual adaptation. After adapting to radial motion, or to localised dynamic white noise, when people close their eyes the increase in alpha is further enhanced. This effect is broadly tuned, peaking for motion adaptation of ~10Hz, but robust for a range of adapting frequencies about this value - ruling out a modulated frequency tag as a plausible explanation. Preliminary data suggest the alpha increase after adapting to localised dynamic white noise is, 1) contra-lateral to the retinal position of the adaptor, 2) is apparent when the eyes are open or closed, and 3) can be disrupted by a further visual event (even if the eyes are closed). Our data demonstrate that visual processes are ongoing, even when your eyes are closed. We believe that alpha power is inversely scaled with visual brain activity, so it is increased when the eyes are closed, but can be further increased by using adaptation to reduce the visual system's spontaneous noise levels below baseline. Our data reveal that alpha levels when the eyes are closed are not a default of the visual system, as they are subject to ongoing visual operations.

Combined cognitive training and transcranial Direct Current Stimulation in older adults

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Neurocognitive decline is one of the most debilitating age-related conditions, and is particularly concerning due to the rapidly ageing population. Consequently, much excitement has been generated about the use of non-invasive brain stimulation techniques in ameliorating this process. Existing studies suggest that anodal transcranial direct current stimulation (tDCS) can indeed enhance cognitive training effects. It remains unclear, however, whether such benefits transfer to other cognitive domains or persist over time. The current study is the largest to date, and the first Registered Report of its kind to investigate the effects of a combined decision-making training and tDCS protocol on executive functions in older adults. We recruited 131 participants aged between 60-75 and assigned them to one of four demographically-matched groups. Each group received one of the following protocols over five sessions conducted on consecutive days: training and tDCS over the left prefrontal cortex (PFC); training and sham tDCS (left PFC); training on a control task and tDCS over the left PFC; or training and tDCS over the visual cortex (control electrode location). Participants completed a comprehensive battery of executive function tasks at pre- and post-intervention, and one and three month follow-up time points. The study adhered to a Bayesian sampling approach, thus data was collected until a Bayes Factor >10 was achieved for three critical hypothesis tests, indicating strong support for the alternate or null hypothesis. To summarise the results, combined anodal tDCS and decision-making training did not produce generalizable or lasting executive function benefits in older adults.

Magnetoencephalography (MEG) reveals the timing of neural responses during real and pantomimed visually guided actions

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Visually guided actions involve distinct (yet interacting) neural processing within the dorsal 'vision for action' and ventral 'vision for perception' streams. fMRI studies have identified regions in the dorsal and ventral streams that are associated with real and pantomimed actions. However, little is known about the timing of these responses. We recorded magnetoencephalography (MEG) and hand kinematics from 12 right-handed young adults (M = 29.08, SD = 5.37 years). Lights cued the participants to release a button then reach towards one of two positions. Participants were instructed

to act as quickly and accurately as possible. For the grasp condition, participants grasped translucent rods. For the pantomime condition, participants mimicked a grasp, but there were no objects at either target position. Source-localised MEG analyses were time-locked to the light onset and to key kinematic events (button release, maximum velocity, maximum acceleration). For both the grasp and pantomime conditions, sources within the dorsal stream contributed more strongly to early components of the visual evoked response (M170), whereas object processing regions within the ventral stream (IT) contributed more strongly to later components of the response (M400). These results highlight the value of using MEG to study the timing and localisation of neural activity during the visual planning of motor actions.

Dynamic Within-Subject Metabolic Connectivity Using High Temporal-Resolution Simultaneous BOLD-fMRI FDG-PET

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Recent developments in acquisition protocols have made it possible to introduce a temporal dimension to FDG-PET acquisitions. In this study, we use these protocols to probe metabolic and haemodynamic connectivity. Twenty-seven healthy right-handed volunteers underwent a simultaneous MR-PET scan using a 3 Tesla Siemens Biograph. fMRI was acquired with 2.45 second volumes in 6 blocks of 10 minutes. A continuous infusion of PET tracer (FDG) was administered to allow dynamic modelling of the PET signal in 16 second frames. A gradient filter was applied to model the instantaneous change in the PET signal. Timeseries were extracted in brain regions and correlated to construct metabolic (FDG-PET) and haemodynamic (BOLD-fMRI) functional connectomes for each subject. Group average connectomes were compared. Within-subject functional connectomes were obtainable with FDG-PET with a temporal resolution of 16 seconds. The metabolic and haemodynamic connectomes were correlated (R=0.44) with strong similarities in some brain regions (frontal and parietal lobe) and divergence in others (occipital lobe). Strong metabolic connectomes were matched in the BOLD-fMRI connectome; however many highly correlated BOLD-fMRI regions did not appear to be metabolically correlated. In sum, metabolic and haemodynamic connectomes can be acquired simultaneously at a high temporal resolution. These complementary measures provide a new avenue for probing cerebral function in health and disease.

Alpha Neurofeedback Training for Mental Resilience

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Mental resilience is associated with the ability to adapt and cope with adversity, life stressors and traumatic events, and has been associated with cognitive flexibility. This experimental study investigated the feasibility of training alpha band electrical activity in the right anterior insula of the human brain in order to increase mental resilience.15 mentally healthy defence and emergency service personnel (age: M = 40.60, SD = 12.15), completed self-report measures on resilience and emotional intelligence and viewed strong negative and positive affective images prior to and post eight neurofeedback training (NFT) sessions using an alpha protocol applied to right (test) or left (control) anterior insula .Mixed ANOVA indicated an overall significant increase in affective functioning (emotional intelligence) with a large effect size across the sample, $F(1,10) = 5.66$, $p < .05$, partial eta squared = .36. eLORETA source analyses of EEG indicated a significant increase in alpha band (8 - 12 Hz) activity in the right anterior insula (RAI) post NFT, $F(1, 9) = 4.26$, $p < .001$, associated with the training condition and a significant increase in low beta (12.1 - 18 Hz) during the viewing of negative valence images, $F(1, 9) = 7.33$, $p < .001$.The study provides evidence that learning better self-regulation of alpha activity in RAI may enhance control of negative emotional responses while experiencing distressing or threatening stimuli. Similar NFT protocols may assist in optimising skilled performance in life and death situations, and remediating deterioration in self-regulation post exposure to traumatic events.

Differential patterns for true and false memories across sleep: An event-related potential (ERP) investigation

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Episodic memory is a reconstructive process and, as a result, is prone to the formation of false memories. Although false memories are posited to rely on associative networks, whether they can be distinguished from true (veridical) memories at an electrophysiological level is still under debate. The effects of sleep-based consolidation and encoding factors on false memory generation are also unknown, although such an investigation could provide insight into the underlying mechanisms of learning and memory. Therefore, the present study employed the Deese-Roediger-McDermott (DRM) paradigm and analysed ERPs, to determine whether semantic false memories can be differentiated from true memories. The research also aimed to examine the role of a daytime nap and EEG similarity at encoding in predicting false memory outcomes. Participants (N= 28, Mean age= 22.5, Females= 25) underwent the DRM learning phase, before being randomly assigned to either an experimental (daytime nap) group, or to a control (wake) group. Following a 2-hour daytime nap/wake period, participants completed the DRM delayed recognition phase. Larger positive amplitudes in the P300 component (200-350ms) in response to false memories were found to differentiate between the two types of memory ($p<0.01$). Additionally, slow wave sleep (SWS) was shown to modulate the relationship between EEG similarity and memory type ($\chi^2(50) = 4.66$, $p<0.05$). The present findings indicate that changes in ERP patterns can distinguish between true and false memories, whilst also suggesting that varying amounts of pattern separation or pattern completion at encoding results in differential consolidation trajectories for memories.

Effort exertion modulates learning from choice outcomes

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Humans routinely use the outcomes of previous decisions to update their behaviour. Striatal dopamine plays an important role in this process by encoding reward prediction errors. Striatal dopamine is also known to mediate effort exertion during goal-directed behaviour. Surprisingly, there is little research on whether these distinct roles interact. We addressed this by asking whether physical force could augment reward-based learning. We tested 108 healthy adults on a probabilistic reversal learning task in which participants made choices between two stimuli. Participants had to learn which stimulus was correct based on probabilistic feedback after each choice. Critically, in contrast to previous reversal learning paradigms, choices were registered by applying force to a pair of hand-held dynamometers. Participants also completed a separate control block in which decisions were registered with minimal force requirements. We found that, compared to the control block, overall accuracy in the task depended on the amount of effort exerted. In our previous work using a similar task, we modelled choice data computationally, finding that greater effort exertion across trials led to higher overall learning rates. Here, we investigated the effect of effort on a trial-by-trial basis. Our main finding was that higher peak amplitude of force on a given trial improved accuracy on the subsequent trial ($p = 0.02$). These results demonstrate that the amount of physical effort exerted when making a choice modulates learning from the choice outcome. This work lays the foundation for future neurophysiological studies to characterise the role of dopamine in this process.

Sleep restriction reduces motivation to exert cognitive effort

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Sleep deprivation often leads to impaired performance. One outstanding question is whether this is driven by a lower motivation to engage in cognitively or physically demanding behaviour. Here, we investigated the effects of sleep restriction on the motivation of individuals to invest cognitive or physical effort in return for reward. Twelve healthy young adults completed an effort-based decision-making task over two sessions - once while fully rested, and the other after three hours of sleep. In an initial conditioning phase, participants were trained to ceiling performance across six levels of effort on separate cognitively and physically demanding tasks. Then, in the critical decision-making phase, participants revealed their preference for how much effort they would be willing to invest for reward, by choosing between a baseline low-effort/low-reward option, and a variable high-effort/high-reward offer. By having participants make separate decisions for cognitive and physical effort, we could examine motivation within each domain independently. Our results showed that sleep restriction reduced the motivation to exert cognitive effort, but only when rewards were low. In contrast, the effects on physical motivation were less pronounced. Importantly, these effects were noted despite participants being equally capable of successfully completing all levels of both the physical and cognitive effort tasks in both sessions. These results suggest that the adverse effects of sleep deprivation on behaviour may be partly driven by the reduced motivation to exert cognitive effort. Specifically, sleep-deprived individuals may be less willing to exert the cognitive effort needed to successfully complete the task.

Tracking the time course of sensory dampening following response errors

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Each day we make countless perceptual judgements. When we make errors, a stereotypical cascade of processes occurs, which (usually) makes our subsequent decisions slower but more accurate. However, for decisions within ~300ms following an error, both our response speed and accuracy are impaired. Recent findings have indicated that this brief-duration impairment is due to a dampening of sensory responses to task-relevant information, yet a recent electroencephalography (EEG) study by Steinhauser and Andersen (2018) challenged this view and instead reported boosted sensory responses from the time of error commission. They tracked amplitudes of steady-state visual evoked potentials (SSVEPs) within a conflict task and found larger SSVEPs evoked by target stimuli following errors, implying enhanced attention. We aimed to resolve this contradiction and investigated whether these recent findings generalise to other error contexts. For this, we tracked sensory response modulations by recording SSVEPs in a conflict-free perceptual discrimination task. We presented target gratings consisting of leftward- and rightward-oriented stripes within a circular aperture which contrast-reversed at 20Hz. For 100ms, we increased the contrast of one set of stripes. Participants judged which stripes were higher in contrast. Before and after the brief target, a neutral stimulus was presented to track SSVEPs and index fluctuations in visual attention. We found that SSVEP amplitudes to task relevant stimuli were dampened between 300-400ms preceding response errors, and from 0-200ms following error commission. Our findings support the sensory dampening account, and suggest that effects in Steinhauser and Andersen are specific to conflict tasks or their experimental design.

The relationship between the human mirroring system and subtle mimicry of arm movements

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Mimicry is a form of motor resonance whereby one passively and unintentionally simulates the behaviours or expressions of others. The human mirroring system is suggested as the neural basis for mimicry, however this relationship is largely unexplored. The current study is the first to examine the relationship between simultaneous changes in muscle activation and mu rhythm suppression, a proxy measure of the mirroring system. 30 controls (15 females; Age: M= 20.33 years, SD = 3.84) completed two blocks of hand movements (Left, Right) in which they observed and imitated a grasping hand movement. EMG and EEG were recorded simultaneously. EMG was recorded from the left and right forearms. Both mu suppression (9 - 10 Hz) and changes in EMG were calculated for each condition (Imitate, Observe) for three 1 second epochs post stimulus onset. For EMG, Time interacted with Condition, such that the changes over Time were mainly reflected by changes in the Imitate Condition, while the Observe Condition produced relatively little to no change. For mu suppression, a topographic shift between conditions was found for Time, such that suppression was largest during the Second epoch at the central midline for the Imitate Condition and at the posterior hemispheres for Observe. Findings suggest that while mu suppression may encode actual movement during imitation, reflected by increased EMG, it may also reflect the inhibition of movement during observation as there was little to no change in EMG during observation.

Where do you look when you don't want to reach? Factors associated with visuomotor direction and inhibition

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Visual control of reaching and grasping for objects is essential for effective interaction of higher mammals with the environment. However, the associated factors crucial for completion of a fast and accurate, goal-directed reach and grasping movement are not yet fully understood, nor is how we inhibit reaching. In the current study, N=28 participants (12 female and 16 male), aged 19-40 (m=28.07, SD=5.64) completed a simple visuomotor reaching and grasping task compared to a motor inhibition (Go/No-Go) variant of the task. Kinematic data was collected with high speed biological motion capture cameras, while eye movements were also tracked. Task performance was correlated with results from an iPad eye-hand coordination task (Slurp), measures of non-verbal intelligence (Raven's Progressive Matrices) and self-report of autistic traits (AQ), depression, anxiety and stress (DASS-21), and attention levels (5-point Likert scale) while completing the task. While speed in eye-hand coordination was correlated with speed on the visuomotor task, no other factors predicted performance. However, the current kinematic data underlies the strategic importance of eye movement and attention strategies prior to visuomotor task completion. These results support the idea of a dynamic myriad of neural processes during both visuomotor directed and inhibition tasks.

Motion extrapolation in the flash-lag effect depends on perceived, rather than physical speed

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The flash-lag effect is a well-known paradigm used to investigate how object localization and motion encoding interact within the visual system. In this illusion, a flash that is physically aligned with a moving object appears to lag behind the object. Motion extrapolation is a popular account for this effect, in which motion information is used to predict and shift an object's perceived position forward along its trajectory. Here, we study the extrapolation account of the flash-lag effect by using the floating square illusion (in which the objects defined by dynamic noise are perceived to move faster than objects defined by static noise) to dissociate perceived and physical velocity. We hypothesized that manipulating perceived speed would also affect the degree to which the moving object is extrapolated in space, and as such the magnitude of the flash-lag illusion. Participants (N=28) viewed a circular version of the flash-lag effect, in which a rotating wedge was defined by one of several combinations of static and dynamic noise. As predicted, objects defined by dynamic noise on a static noise background yielded the largest flash-lag magnitudes. A follow-up control experiment (N=20) was conducted to verify that perceived velocity was in fact being manipulated by the stimuli. These findings suggest that the flash-lag effect depends on perceived, rather than physical speed, providing a better understanding of the specific mechanisms underlying spatial localization within the visual system, and by extension for how the brain enables effective interaction with dynamic environments.

Predictive coding in the visual cortex of awake and anaesthetized non-human primates

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Predictive coding theory suggests that higher-order cortical areas supply expectation signals based on prior experience to early sensory areas, e.g. primary visual cortex (V1). We tested the presence of such feedback by comparing neural activity

in awake and anaesthetized macaques. Each trial presented a pair of gratings of either the same orientation (match) or orthogonal ones (non-match), while the awake monkey performed a fixation task. The second grating in all trials had the same orientation, so any differences in response to the second stimulus are attributable to expectations based on past experience. We manipulated expectation by altering the probability of match and non-match trials, having blocks with 80% match and 20% non-match trials, or vice-versa. Local field potentials (LFPs) were recorded from 28 V1 intracortical sites in the awake animal and 16 sites in a macaque under anaesthesia. In the awake monkey, LFPs were simultaneously recorded also from the lateral intraparietal (LIP) and dorsolateral prefrontal (dlPFC) cortices, with unexpected grating pairs leading to a significant change of the LFP amplitude in 24 out of 28 V1 recordings in a 400 ms interval from the onset of second stimulus. However, under anaesthesia there were no significant expectation effects on LFP amplitude (0/16 recordings). The prominent effect in LIP reflected suppression of responses with common (80%) trials and in dlPFC, an amplification of the difference in response between common and rarer (20%) trials. Our results are consistent with frontoparietal signals underpinning feedback that may mediate predictive coding in V1.

Omission and commission errors on a predictable Go/No-Go task differentially predict early and higher-order literacy and numeracy in 5-7-year-old children.

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Attention control in the classroom underpins the development of literacy and numeracy skills. How well a child can maintain their attention to a task may be foundational for learning but how cognitive attention control differentially predicts literacy and numeracy is unknown, because past research is based mostly on measures of behavioural attention. Children (n=248, M=76 months) completed assessments of sustained attention control using the fixed-sequence Sustained Attention to Response Task (SART), early literacy, reading, early numeracy, and higher-order mathematics. Teachers rated children's inattentive and hyperactive/impulsive behaviours using the SWAN. Omission errors on the SART (not responding to Go stimuli) were predictive of poorer performance on non-symbolic magnitude judgement, phonemic awareness, and reading accuracy. Commission errors on the SART (responding to No-Go targets) were predictive of poorer performance on mathematical problem-solving and reading comprehension. Momentary fluctuations in response time variability (fast frequency variability from a Fast Fourier Transform of RT) reflect fluctuations in attention; greater fluctuations were predictive of poorer symbolic magnitude judgement, phonemic awareness, and reading comprehension. Children with greater attention lapses 'omission errors', have difficulty developing early numeracy and literacy skills. Children with poor top-down attention control, poor performance monitoring and inhibitory control 'commission errors', have difficulty making inferences from their knowledge of words and numbers. Higher behavioural inattention and hyperactivity/impulsivity was predictive of poorer performance on almost all academic measures. Behavioural questionnaires may detect children at risk for academic difficulties, but the SART provides more nuance on how sustained attention underpins literacy and numeracy.

A common neural substrate for retrospective and prospective memory disturbances across dementia syndromes

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Background: Retrospective and prospective memory deficits are well-established in dementia syndromes, however, the underlying neurocognitive mechanisms mediating these impairments remain unclear. This study aimed to compare the cognitive and neural profiles of retrospective and prospective memory performance across dementia syndromes. Methods: Twenty-nine Alzheimers Disease (AD), 57 behavioural-variant frontotemporal dementia (bvFTD), 13 semantic dementia (SD), 11 progressive non-fluent aphasia (PNFA), and 14 logopenic progressive aphasia (LPA) patients and their carers separately completed the self-report and carer-rating version of the Prospective and Retrospective Memory Questionnaire (PRM-Q) and were compared to 30 healthy controls. All participants underwent neuropsychological testing and whole-brain structural MRI. Results: Retrospective and prospective memory were disproportionately affected in AD and bvFTD patients relative to Controls. In contrast, SD, PNFA, and LPA patients did not show differences compared with Controls. While AD and bvFTD patients displayed comparable memory deficits, voxel-based morphometry revealed common and dissociable neural substrates in each group. Both RM and PM carer-rated deficits in AD were found to relate to grey matter intensity decrease in lateral and medial temporal regions including the hippocampus, as well as the orbitofrontal cortex. Similarly, RM and PM carer-rated deficits were associated with the bilateral orbitofrontal cortex for bvFTD. Conclusion: Our study confirms marked memory impairments in AD and bvFTD patients attributable to the degeneration of distinct neural substrates. The orbitofrontal cortex emerged as a common region commonly implicated in retrospective and prospective memory deficits in each patient group, suggesting it plays a critical role in memory function.

Motor neuron disease features are useful for predicting frontotemporal lobar degeneration subtypes

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Background: Clinical and pathological heterogeneity is common in patients with frontotemporal lobar degeneration (FTLD) pathology and FTLD-TAR DNA-binding protein (FTLD-TDP) and tau positive FTLD (FTLD-tau) are the main pathological subtypes. Pathological subtyping of FTLD-TDP has been established (Types A, B, C, D). This study aimed to identify clinical or imaging characteristics that differentiate either FTLD-TDP from FTLD-tau, or FTLD-TDP subtypes from each other. Methods: Clinical and neuropsychological characteristics at initial presentation were compared between pathologically defined FTLD-tau and FTLD-TDP groups. Voxel-based morphometry analysis explored differential patterns of neuroanatomical changes at disease early stage. Results: In total, 26 FTLD-TDP, 28 FTLD-tau and 78 controls were included in the study. At initial presentation, the most common clinical phenotype in FTLD-TDP was frontotemporal dementia-motor neuron disease (FTD-MND), while corticobasal syndrome (CBS) was the most common in FTLD-tau. MND features were only present in FTLD-TDP, yielding high. specificity (94.1-100%) and positive predictive value (80-100%), but low to moderate sensitivity (20-50%). Both FTLD-TDP and FTLD-tau had widespread atrophy compared to controls, but FTLD-TDP displayed greater atrophy of bilateral basal ganglia than FTLD-tau. Relative to TDP-43 Type B, Type A patients were more impaired on confrontational naming and semantic knowledge and revealed more basal ganglia atrophy. TDP-43 Type B had significantly shorter survival than TDP-43 Type A, while pseudobulbar palsy was highly specific (92.3%) for Type B. Discussion: The presence of MND features was highly specific for FTLD-TDP pathology among patients with FTLD. The presence of pseudobulbar palsy was highly specific for FTLD-TDP Type B.

Muscle Strength to Mental Strength: Exercise Engagement and Age-Related Cognitive Decline

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As the population replacement rate exceeds the birth rate, the median age of the population in Western countries increases. With increasing age there is an increase in population disease burden, particularly in mental health. As such, there is considerable interest in the identification of modifiable factors that may protect against cognitive ageing. In this study, 71 participants in three age-balanced groups (young, 18 – 21; middle-aged, 22 – 47 years; older adults, 48 +) were purposively recruited from the general Australian community to examine the effect of aerobic versus resistance exercise on executive functioning (EF). As hypothesised, older adults evidenced decline in self-reported executive functioning (EF) impairment, and some aspects of mental flexibility. Multivariate Analysis of Variance (MANOVA) revealed that moderate to high aerobic exercise engagement, and moderate resistance exercise engagement may be somewhat beneficial for reducing age-associated performance decrements in mental flexibility. A dissociation of mental flexibility from spatio-temporal tracking performance provided support for a modular decline model of cognitive ageing, indicating that geriatric decline typically emerges around middle-age and is asynchronous in nature. Further to this, the project has validated a new, clinically useful measure of age-associated executive functioning impairment and improved upon extant literature by developing a retrospective questionnaire that differentiates between types of exercise.

The Critical Role of the Inferior Frontal Cortex in Establishing a Prediction Model for Automatic/ Pre-attentive Change Detection: A TMS-EEG Study

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According to the prediction model hypothesis in automatic or pre-attentive change detection, the inferior frontal cortex (IFC) is involved in extracting and establishing the prediction model from the frequently presented standards, or re-instating the prediction model for detecting deviant. However, the concurring evidence to the IFC's contribution to the prediction model is inferred from Mismatch Negativity (MMN) studies focusing on deviance detection. The current study investigated the functional role of IFC in establishing the prediction model by disrupting the functioning of the IFC in processing a train of standard tones with Transcranial Magnetic Stimulation (TMS) and measuring the subsequent TMS effect on MMN responses to pitch deviants. Specifically, the MMN response preceded by a 3-standard train with TMS pulses applied to the IFC at the initial 2 standard positions was compared to that of a 6-standard train with IFC TMS at the initial 2 positions, a 6-standard train with IFC TMS at the initial 5 positions, and a 9-standard train with IFC TMS at the initial 5 positions. An abolishment of MMN response to deviant was only observed when TMS was delivered to the IFC at the initial 2 standards of the 3-standard train, while the MMN responses were preserved in other train length conditions with IFC TMS, or in all the train length conditions when TMS at the vertex or TMS pulse sound was presented. These results suggested a critical functional role of IFC during standard processing in pre-attentive change detection.

The conditions under which inhibition of return is represented in object-based coordinates

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In spatial cueing tasks, slowed responses to cued targets compared to uncued targets are known as inhibition of return (IOR). It has been proposed that IOR functions as a novelty seeking mechanism by placing inhibitory 'tags' at previously

attended areas, thus facilitating search to novel areas. Although it is clear IOR can been represented in retinotopic, spatiotopic, and/or object-based coordinates, it is unclear under what conditions object-based encoding takes place. The aim of the current study was therefore to examine the conditions under which IOR is represented in an object-based frame of reference by cueing an object and then rotating the object to a new location, before presenting a target that appears in the object location or in a different location. Cues were either ignored or fixated, and saccadic responses to targets were required. The preliminary results suggest an overall object-based IOR effect, regardless of whether cues were ignored or fixated. To ensure the validity of the experimental design, a control condition without object rotation was also conducted, producing, as expected, robust IOR effects in both conditions.

Individual differences in threat detection measured using ensemble encoding

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Bias toward threat can distinguish anxious from non-anxious persons and this bias has been implicated in the aetiology and maintenance of anxiety-related disorders. Individual differences in anxiety are hypothesized to disrupt the ability to voluntarily shift and focus attention, which produces a tendency to involuntarily focus on threat information. Current paradigms investigating attentional bias to threat focus on indices of threat based on eye movements, which do not show adequate reliability. Furthermore, depression, which shows high comorbidity with anxiety and relates to disorder specific cognitive deficits, has not been consistently measured. Derived from ensemble encoding, we created matrices with increasing ratios of threat-to-neutral stimuli and asked participants whether the proportion of threat to neutral was equal or not. Two additional conditions were included to distinguish between ability to focus (i.e., neutral cue) and shift (i.e., angry cue) attention. Participants completed measures of anxiety, depression, and attentional control. Equality judgements of the arrays were positively skewed in the baseline and angry-cue conditions, suggesting an overestimation of threat stimuli. Furthermore, performance on the baseline and neutral conditions was significantly correlated with focusing. This overestimation of threat information was not significantly correlated to anxiety when controlling for co-morbid depression. Reliability estimates for the angry and neutral cue conditions were sufficient. This method demonstrates appropriate reliability; however, validity was not sufficient to attribute overestimation of threat to anxiety directly. Future research should recruit from populations with lower base rates of psychological distress to allow for between participant comparisons of the task.

Modelling spelling as a process of Bayesian decision-making

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In English, spelling is more complex than word reading as the relationship between graphemes (i.e., letters) and phonemes (i.e., sounds) is not equally distributed. Despite this known complexity, models of spelling are largely descriptive and do not adequately explain how spelling information is learned and managed. Recently, Bayesian reading models have proliferated research and development. Given the complex relationship between reading and spelling, we developed a Bayesian computational model of spelling to address these limitations. The Bayesian spelling model was designed to behave like a human speller, based on current spelling knowledge. It simulates a dictation task, making spelling decisions based on 10 parameters that are analogous to human spelling decisions. The model was trained with Queensland spelling lists and tested with words from a computerised NAPLAN dictation task for grade 3, 5, 7, and 9 students. Accuracy and error data for students and all model parameters were calculated and transformed into density distributions to overcome identified data limitations. Independent-samples Bayesian t-tests compared the model distributions with the distributions of students for each testing grade. Results showed that responses of students aligned with responses from expected model parameters. These findings provide robust validation for our model as we effectively reproduced human spelling behaviour, and the progression through testing grades aligns with known learning processes. Future research with our model provides a feasible means of experimentally examining educational strategies and spelling disorders and could have implications for natural language processing.

Investigating the roles of the orexin system in goal-directed decision making

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Orexins are neuropeptides produced by several thousand neurons in the lateral hypothalamus. These neurons project widely through the central nervous system where they bind to regionally selective and largely non-overlapping G-protein coupled receptors: OxR1 and OxR2. Orexins are well known as regulators of the sleep/wake cycle with OxR2 and dual receptor antagonists showing potential as hypnotics. However, recent investigations into orexinergic modulation of feeding or drug seeking behavior suggest they also play a role in reward processing, in particular, through OxR1 receptors located in the VTA. To investigate the role of OxR1 in reward circuitry, Â 40 male C57/BL6 mice were dosed daily with an OxR1 selective antagonist (1-SORA-51, 45mg/kg) or vehicle (20% w/v TPGS) prior to performing an operant probabilistic reversal learning task consisting of 5 days of probabilistic discrimination learning, followed by 5 days of reversal learning, both on and off drug in a crossover design. Compared to TPGS control, animals took significantly longer to make decisions in the operant task on drug. We then characterized animal choices using reinforcement learning models consisting of

separate learning rates for positive/negative reward prediction errors (RPE) and a perseveration parameter. Animals dosed with 1-SORA-51 show a substantial decrease in positive RPE learning rate compared to TPGS control, with no differences in the negative RPE learning rate. This suggests that OxR1 antagonists do not suppress learning overall, but rather decrease the updating of reward values following positive RPEs selectively. As such, OxR1 antagonists may be of interest in models of abnormal reward processing.

Right and left hemisphere contributions to emotion induced blindness

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Emotion induced blindness (EIB) occurs when an emotional distractor impairs peoples ability to detect a subsequent neutral target in a rapidly presented image stream (100 ms per image). EIB relies on temporal and visuospatial attention. In most people, visuospatial attention is predominantly a right hemisphere function, leading us to pay slightly more attention to the left than the right visual field. But EIB also relies on the automatic processing of emotion, which although heavily debated is also predominantly a right hemisphere function. Given these specialisations, we wondered: does hemispheric processing influence EIB? We presented image pairs horizontally (right and left visual field) whilst participants maintained central fixation. The distractor (negative, neutral) and target (a neutral image rotated 90° left or right) appeared in the same, or the opposite, stream as one another. We found a reliable EIB effect: accuracy in detecting the neutral target was worse following negative than neutral distractors. Despite finding a left visual field advantage on baseline trials (trials without distractors), the size of EIB did not differ in each visual field. Contrary to vertical stream EIB experiments, we found EIB when the distractor and target appeared in both the same and the opposite streams. These results replicated in a second experiment. We conclude that horizontal streams may give rise to non-spatially localised EIB, which advances our understanding of the circumstances where graphic material (e.g., seeing a car crash) may decrease awareness of important, but neutral, material (e.g., noticing the car in front's brake lights).

Multifocal visual evoked potentials to emotional faces

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The magnocellular system has been implicated in rapidly processing facial emotions, such as fear, because it feeds into the collico-pulvinar route to the amygdala. A well-accepted technique in examining temporal processing in the magnocellular and parvocellular pathways can be inferred using non-linear visual evoked potentials. However, no study to date has utilised such method to examine whether emotional information reaches the primary visual cortex (V1) via either magnocellular or parvocellular inputs. Here we investigated the relationship between facial emotion processing and temporal analysis of the magnocellular (K2.1) and parvocellular (K2.2) contributions to achromatic non-linear multifocal visual evoked potential responses recorded from occipital scalp (OZ). Nonlinear VEP analysis was performed using pseudorandom brightening/darkening of fearful, happy, neutral faces (or no face) with surround patches decorrelated from the central face-bearing patch.Â Thus, the spatial contrast of the faces was 30% while the temporal contrast of the per-pixel brightening/ darkening was 10% or 70% temporal contrast. From 14 typically developing young adults, we found no significant interaction between emotion and contrast for magnocellular (K2.1) or parvocellular (K2.2) non-linearity components. As expected, however, we found a main effect of contrast on the K2.1 component, with greater amplitudes for high contrast stimuli. Taken together, our findings suggest that facial emotional information, though discernible in parietal EEG, may not be fed back to early V1 processing. However, given the novelty of the method and stimuli used in the current study and sample size, further investigation is required.

Attentional bias in trauma survivors

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Previous studies have documented an attentional bias for threat-related stimuli in posttraumatic stress disorder (PTSD) using eye-tracking technology, yet the nature of this bias has not been clearly delineated. Further, it is unclear if the findings to date can be generalised to a non-Westernised sample with chronic war-related PTSD. The first aim of this study was to explore which components of attention (facilitated threat, difficulty disengaging, attentional avoidance) are biased in a group of resettled refugees. The second aim was to examine if the bias was trauma-specific (e.g. war) or would broaden and include genera threat (e.g. car accidents). Method: Two groups with war-related psychopathology (PTSD+, PTSD) and a trauma-exposed healthy control group participated in the study. The participants simultaneously viewed four emotional images (one negative, positive, and neutral image, and either a general threat image or a trauma-relevant threat image) for 30s while eyetracking was performed. Results: Maintenance bias (difficulty disengaging) for trauma-relevant threat was observed for all participants, with the PTSD group broadening their attentional bias to general threat images. Conclusion: Maintaining attention on general and trauma-specific threat may reflect a cognitive vulnerability factor for PTSD. The theoretical and clinical implications of these attentional trajectories will be discussed.

A dynamic noise background reveals perceptual motion extrapolation

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The visual system has been suggested to extrapolate the trajectory of moving objects. However, the location of the disappearance of moving objects is typically perceived correctly. Some have suggested that the abrupt disappearance and associated luminance transient result in a correction or reset of extrapolation. In support of this possibility, we find that when the background comprises dynamic noise, the perceived position of the disappearance of a texture-defined moving object is shifted in the motion direction, whereas on a static background it is not. The magnitude of the perceptual

extrapolation in the dynamic noise case increased with object speed (4-16 dva/sec) but does not seem to increase with retinal eccentricity (1.5, 3, 6 dva; fovea, para-fovea, periphery), and was substantial even at the fovea. These preliminary results suggest the existence of motion extrapolation calculated at later cortical stages and corrected by transient signals at the time of the object's disappearance.

Investigating the effects of iTBS and cTBS on working memory in healthy younger and older adults

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Theta burst stimulation (TBS) has shown promising results in improving working memory (WM) in healthy older adults, although the role that aging plays on TBS response remains unclear. This study aimed to investigate whether aging modulates the effects of TBS applied to the left dorsolateral prefrontal cortex (dlPFC) on WM and the associated cortical haemodynamic response. Thirty participants, 15 younger (mean age 26.3, 7 females) and 15 older (mean age 65.2y, 8 females) healthy adults, received iTBS, cTBS or sham TBS to the left dlPFC in a randomised cross-over design. Computerised 1- and 2-back tasks were used to measure WM, and functional near-infrared spectroscopy (fNIRS) was used to measure changes in oxyhemoglobin (HbO2) in the left and right dlPFC. Linear mixed models were used to compare task performance (reaction time and accuracy) and HbO2 consumption of the left and right dlPFC between age groups. iTBS significantly decreased reaction time ($p = .013$) and increased accuracy score ($p = .001$) in older adults, compared to sham TBS. The 2-back task produced similar results following iTBS (decreased reaction time, $p = 0.001$; increased accuracy score, $p = 0.004$) in older adults, again compared to sham TBS. HbO2 values were significantly increased in older compared to younger adults in the left dlPFC following iTBS in both the 1-back ($p <. 001$) and 2-back ($p <.001$) tasks, however no significant increases were recorded for right dlPFC. iTBS to dlPFC appears to enhance WM and the associated haemodynamic response, but only for older adults.

Functional connectivity and the neuroprotective effects of motherhood on the ageing human maternal brain.

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The maternal brain undergoes structural and functional plasticity during pregnancy and the postpartum period. We have a growing understanding of the human maternal brain's response to infant stimuli. However, very little is known about functional plasticity outside of this infant-centric context, and whether they persist beyond the postpartum period, into late-life. Functional connectivity measures the temporal correlation in blood oxygenation level dependent signal between brain regions. Resting state functional connectivity (rs-FC) indicates the intrinsic connectivity of the brain when it is not engaged in a specific task. To examine the relationship between rs-FC and parity (number of children) in the ageing maternal brain, we correlated rs-FC of 82 brain regions with number of children (1-6 children) for 221 elderly women (73.8±3.52 years).Our results show widespread decreasing functional connectivity with increasing number of children. Regions with the highest degree (number of connections that correlated with number of children) include the prefrontal cortex, inferior parietal lobe, right temporal pole, and left thalamus. This network overlaps substantially with regions implicated in early motherhood, suggesting the functional adaptations of motherhood persist into older age, potentially permanently. Our results also show decreased connectivity between, but not within networks, and decreased connectivity from the prefrontal cortex. Both of these patterns are shown in the opposite direction in studies of age-related decline, suggesting motherhood confers a neuroprotective effect on the ageing brain.Our results suggest that the neural adaptation to motherhood is both long-lasting, and potentially beneficial for the function of the maternal brain in late-life.

Lightness constancy in gaze perception

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A key challenge to the visual system is to correctly interpret the light entering the eye in terms of its distal causes, which includes both the properties of the objects that we are looking at (reflectance) and the current lighting conditions in the environment (illumination). In the context of social perception, our sense of when we have eye contact with another person relies on the distribution of luminance across their eye region, reflecting the position of the darker iris within the lighter sclera of the human eye. This distribution of luminance can also be distorted by changes in the lighting conditions. Here we perform a set of psychophysics experiments in human observers to investigate how lighting conditions impact upon our perception of where other people are looking. First, we find that simple changes in illumination direction can produce systematic biases in our sense of when we have eye contact with another person. Second, we investigate how this effect is produced by changes in both shading patterns and specular highlights across the eyes. Third, we find that the visual system is able to use information about the lighting conditions to partially discount or explain away the effects of illumination on how other people appear to us, leading to a more robust sense of where those people are looking. Overall, this illustrates how visual mechanisms that help to control for the effects of illumination on retinal input can have direct consequences for our social experience of the world.

Multimodal Neuroimaging in Paediatric Moderate/Severe Traumatic Brain Injury: Towards Understanding the Functional-Structural Relationship

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The leading cause of disability in childhood and adolescence is traumatic brain injury (TBI). Young patients with TBI suffer from several symptoms including cognitive deficits and and motor disorders. The majority of neuroimaging studies in paediatric TBI have focused on one MRI modality only. In the present preliminary study, we propose a multimodal MRI coupling workflow to capture structural-functional coupling.20 children with TBI (mean age 13 years 11 months ±3 years 1 month) were compared with an age-matched control group of 21 children. Brain structure and function was assessed by performing a set of magnetic resonance imaging (MRI) scans, including a T1-weighted anatomical scan (1mm3 isotropic), diffusion-weighted MRI scan (max b-value = 1000, 64 directions), resting-state fMRI (TR = 3000ms, TE = 30ms, slice thickness = 2.8mm). fMRI data were processed using manual independent component analysis. The fixel-based analysis framework was applied on the diffusion MRI data. TBI patients showed reduced functional connectivity (p= .001, FDR corrected) between the medial prefrontal cortex (MPFC) and posterior cingulate cortex (PCC) within the default mode network relative to healthy controls. This was in line with our finding of reduced white matter fibre density connectivity in the superior longitudinal fasciculus (p= .05, FWE corrected) connecting these cortical regions. Our findings demonstrate reductions in both functional connectivity and related white matter structures in TBI. Our further analyses will utilize a novel multilayer network analysis to capture structural-functional relationship directly in order to sensitively monitor response to injury as well as neuro-rehabilitation.

Neural Implications of Emotional Imagery

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Requiring imagination, emotional mental imagery purely involves cognitive processes. As a vital element of communication, emotions require the integration of several cognitive functions such as, for example, reasoning, planning behaviour, and language. Inherently, these functions implicate the activation of the prefrontal, frontal and the parietal brain regions. Forty healthy young adults (20 males and 20 females) aged 24 years on average participated in the study. Based on a specific experimental paradigm, each participant was instructed to imagine, one by one, four different emotions, two positive (i.e. happy and laughter) and two negative (i.e. sad and angry) for five seconds separately. Their brain activity was collected via 32 EEG electrodes. Gamma oscillations (55-59 Hz) were considered within and between imagined positive and negative emotions with further investigation of the valence lateralisation model and Rolls' reinforcement model. Results revealed significant changes in brain activity for frontal and parietal but not for the prefrontal areas. A significant difference was evident within positive emotions specifically in the central regions but not between negative and positive emotions. Only lateralisation of positive emotions was found specifically in the left parietal region; an overall greater left hemisphere lateralisation relative to the right hemisphere for all emotions was found. Regardless of the discrepancies between previous studies and the present study, left hemisphere lateralisation of positive emotions was a consistent finding. Conclusively, these results ascertain that potential similarities exist between explicit emotional tasks and imagined emotional tasks.

FMRI adaptation to stimulus form, orientation, and size in different subdivisions of the lateral occipital complex

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During fMRI, fourteen participants indicated by button pressing whether two serially presented novel objects composed of Geons were the same or different along one of three dimensions (form, orientation, or size) while the other two dimensions were held constant. The presented pairs were the same object or not, had the same orientation or were 60° apart, or had the same size or differed by 0.56° (size could range between 2.72° and 5.54°). ROIs for the pFS, LO proper, LO1, and LO2 were defined with independent functional localisers. The retinotopic representation of the cortex was considered when defining the latter two. ANOVA on the beta-weights for each condition, followed by Bonferroni-corrected pairwise comparisons, revealed BOLD adaptation to form (unrepeated form & repeated form) in both LO proper (p = .003) and pFs (p = .001) but not in LO1 (p = .108) or LO2 (<p = .144), no differences in BOLD when orientation was unrepeated versus repeated in any ROI (all p > .594), and greater BOLD when size was repeated compared to when it was not (repeated size > unrepeated size) in all ROIs (all p< .024). We conclude that specific subdivisions of the lateral occipital complex process the form of stimuli while all subdivisions of this region seem to process size more strongly when it is repeated. The reasons for the latter are still unclear but we suspect it may arise from additional demands to scrutinise the size of objects that appear more similar.

A biomarker for anorexia nervosa

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Anorexia nervosa (AN), like other mental illnesses, is diagnosed based on a patients description of symptoms and a clinicians judgment. The subjective nature of making psychiatric diagnoses is further confounded by denial of illness symptoms and the secretive nature of AN. Thus, establishing a reliable and valid objective marker or biomarker for AN is critical. The aim of this study was to establish whether an atypical type of eye movement (square wave jerks) could be used as a biomarker for AN, and to gain a better understanding of the neural underpinnings of this potential biomarker.Participants currently with AN (c-AN), participants weight-restored from AN (wr-AN), sisters of individuals with AN (AN-sis) and healthy controls (HC) (n=20/group) were assessed for the presence of SWJs during a fixation task. Participants also underwent magnetic resonance spectroscopy to detect GABA levels in the superior colliculus (region involved in SWJs).An increased rate of SWJs were found in c-AN, wr-AN and AN-sis groups relative to HCs, and SWJ rate discriminated groups with high accuracy (p< .05). Differences in GABA levels between groups were also explored. SWJs were identified as a promising biomarker

for AN. Establishing a biomarker is critical to: 1- provide an objective diagnostic measure for identifying AN; 2- enable early identification of the illness; 3- identify those at risk of developing AN; and 4- provide insight into the underlying biological mechanisms underpinning AN. As eye movements utilise very specific neural circuitry, the presence of SWJs also provides potential targets for neurobiological treatments, including medications and brain stimulation.

Transcranial direct current stimulation (tDCS) for the treatment of anorexia nervosa: Protocol

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In our previous research, we uncovered very distinctive eye movement abnormalities in anorexia nervosa (AN) indicative of altered functioning of the superior colliculus (SC). The SC receives inputs from different regions, including the inferior parietal lobule (IPL) to initiate and inhibit eye movements. Our findings have also indicated reduced 'functional connectivity' between the SC and left IPL in AN. This is an important finding as these regions are not only involved in eye movement production, but also in multi-sensory integration and body image, key deficits, and arguably the driving-force behind AN behaviour. It is expected that stimulating the left IPL will project to the SC, and will: 1- increase the functional connectivity between these regions as determined by resting state functional magnetic resonance imaging (fMRI); 2- result in a reduction of SWJs; and 3- reduce AN symptomatology. Twenty individuals with AN will participate in a double-blinded pilot randomised controlled trial (10 stimulation, 10 sham). High definition anodal transcranial direct current stimulation (HD-tDCS) (or sham) will be administered to the left IPL daily for 10 days. Participants will complete a battery of neuropsychological assessments, an eyetracking task and an MRI scan pre- and post-tDCS. Two follow-up sessions will be completed at 4 and 12 weeks. This project will make a significant contribution to our understanding of the underlying mechanisms involved in AN, and treatment for the illness. Specifically, it will provide pilot data to determine on feasibility and acceptability of this treatment, as well as potential efficacy, to enable a full-scale randomised controlled trial.

Social anxiety and visual working memory differentiate typically developing children from those with additional learning needs, irrespective of diagnosis

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Anxiety is recognised as a common factor in many neurodevelopmental disorders. Recent research has also implicated anxiety as a potential biomarker for children with additional learning needs (ALN) who may not have a diagnosed neurodevelopmental disorder. We sought to further examine whether anxiety and/or select cognitive measures could differentiate ALN children with or without formal diagnoses from their typically-developing (TD) peers. Participants comprised of three groups: children with formally diagnosed neurodevelopmental disorders (NDD group), ALN children without a diagnosis (ALN group), and TD children of the same chronological age (TD group). Parents of all participants completed the Spence Children's Anxiety Scale as a measure of their child's anxiety. All participants also completed Raven's Colored Progressive Matrices (non-verbal intelligence), the Peabody Picture Vocabulary Test (receptive vocabulary), the Expressive Vocabulary Test (expressive vocabulary), and auditory and visual Digit Span (short-term and working memory). Results revealed that total anxiety scores were not significantly different between the NDD and ALN groups. The NDD group did, however, have significantly higher levels of anxiety compared to the TD group. Subscale analysis revealed that both the NDD and ALN groups had significantly higher social anxiety (Social Phobia Scale) compared to the TD group. Analysis of the cognitive data revealed that visual working memory (backward digit span) was significantly lower in both the NDD and ALN groups, compared to the TD group. These findings highlight the need to consider anxiety levels in children with additional learning needs, regardless of whether they have a formally diagnosed neurodevelopmental disorder.

Functional connectivity in allelic variations of APOE and BDNF polymorphisms in adults: the Tasmanian Healthy Brain Project (THBP)

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Resting-state fMRI has been used to measure pathological alterations in complex networks of the brain. Functional connectivity is reduced in overt Alzheimer's disease (AD) and could be a potential biomarker of early brain changes. The objective of this study was to identify group differences in functional connectivity between individuals with polymorphisms of the BDNF Val66Met gene and APOE genes in older adults without dementia. Three resting-state networks were of interest: default mode network, dorsal attention network, and salience network. We recruited and scanned 76 healthy older adults (mean age = 63.3 years, SD = 6.3) from the THBP. Independent components analysis and dual regression were performed to investigate group differences, adjusted for age, gender, and cognitive reserve. Functional connectivity revealed no significant changes between APOE $\varepsilon4$ carriers (n=35) compared to $\varepsilon3$ homozygotes (n=41), p = 0.07-0.94, and no significant differences in BDNF Met carriers (n=35) compared to Val homozygotes (n=41), p = 0.06-0.98. An interaction effect was found between Met/$\varepsilon3$ and Met/$\varepsilon4$ carriers in the task-positive network, p = 0.03, and between Met/$\varepsilon3$ and Val/$\varepsilon4$ in the dorsal-ventral stream, p = 0.02. Met/$\varepsilon3$ had significantly higher connectivity in the lateral occipital cortex (superior division) than Met/$\varepsilon4$. Met/$\varepsilon3$ showed stronger functional connectivity than Val/$\varepsilon3$ in the region of the occipital pole. Assumptions could be that amyloid-beta accumulated in APOE $\varepsilon4$ carriers and weakened the connectivity in Met carriers. It is important to investigate genetic interaction longitudinally

to identify a conclusive role of the BDNF Val66Met polymorphism in relation to functional connectivity.

The role of the pre-frontal cortex in step initiation and the effects of age

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Falls in the elderly frequently occur during the step initiation phase of gait. The ability to initiate fast, and accurate, stepping in response to environmental cues is thought to be critical to prevent trips and maintain balance. This skill involves attention, decision-making and inhibition of inappropriate responses. We therefore hypothesised that the pre-frontal cortex (PFC) is involved in step initiation - a region not commonly associated with locomotion. This study investigates the role of the PFC in step initiation and how this process is affected by age. Twenty young (mean=26.9 years) and twenty older (mean= 69.2 years) healthy subjects initiated steps to target as quickly as possible. Functional Near-Infrared Spectroscopy (fNIRS) measured PFC activation, while force-plates measured weight shifts and step time. Age-related sensorimotor decline makes stepping and balance inherently more challenging for older people, so in order to understand age-related changes to cortical processes we examined multiple levels of task difficulty. Conditions included combinations of simple stepping (SS), choice stepping (CS) and a dual-task (both forwards and backwards digital recall). The results indicated that PFC activation was higher during CS compared to SS. Older subjects took longer to step particularly during the most difficult dual task. In contrast, the young group maintained fast stepping and this was associated with enhanced PFC activation, not seen in the older group. Together the results suggest the PFC is an important region for step initiation and during competing demands young people are able to more flexibly engage PFC to maintain stepping performance.

Memory complaints in healthy middle-aged adults are not associated with memory or sustained attention

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Complaints about memory are common among otherwise healthy middle-aged adults, yet the significance of these complaints remains underexplored. These complaints have largely been studied in the context of memory processes. Many of these complaints, however, also appear to reflect complaints about attention. It has not been previously considered that attention processes, and in particular sustained attention, may underlie these complaints. The current study examined the associations between the number of memory complaints and the type of memory complaint with memory performance and sustained attention performance in healthy middle-aged adults. Sixty-six healthy individuals aged 35-64 years (mean age = 47.73 years) were administered the 7 Questions, Rey Auditory Verbal Learning Test, Sustained Attention to Response Task, and Depression Anxiety Stress Scales 21. Results showed that the number of memory complaints was not associated with memory or sustained attention performance but was associated with anxious symptoms. Likewise, the type of memory complaint was not associated with memory or sustained attention performance. The complaints of recently experiencing a change in memory and of trouble remembering things from one second to the next were associated with anxious symptoms. These results suggest that complaints about memory in otherwise healthy middle-aged adults do not reflect an underlying dysfunction in memory or sustained attention. Rather, these complaints likely indicate heightened, but subclinical, anxious symptoms. In a clinical setting, the interpretation of memory complaints by healthy middle-aged adults should consider an anxiety-related etiology.

Fractals in Motion: The visual system's reliance on the fractal structure of natural scenes across spatial and temporal domains

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Natural scenes exhibit consistent photometric and geometric regularities despite perceptual differences between environments (e.g. deserts, jungles, mountains). Photometric regularities concern the fine variations in natural scene luminance intensities, whereby plotting amplitude as a function of spatial and temporal frequency reveals a linear relationship quantified as the 1/f amplitude spectrum (alpha = 1). Natural scenes also contain geometric regularities, comprising similar densities of structure across spatial and temporal scales - a property classifying them as fractal. Recent research suggests that the visual system has preferential tuning toward natural geometry over photometry (Isherwood et al, 2017). However, these findings have so far been restricted to the spatial domain. Here we focus on measuring visual sensitivity to these properties in the temporal domain. For this, we used a psychophysics task (4AFC) to measure discrimination sensitivity (N = 90) to synthetic noise movies that varied across three movie types - greyscale, thresholded and edges. Each movie type shared the same geometric properties (measured by fractal D), but greatly differed in their photometric properties. We observed a characteristic dependency on geometry across movie types, where peak sensitivity was observed for natural geometry despite large differences in their photometric properties. These findings provide evidence that the visual system is preferentially tuned to the fractal structure of natural scenes both spatially and temporally - a property which may be preferential given the stability of structure across various illumination conditions (i.e. sunrise vs. sunset).

Internally-generated responses in parkinsonian disorders: A neuropsychological study of verbal and non-verbal fluency

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Internally-generation of responses is centrally affected in parkinsonian disorders, which implicate frontostriatal circuits. We investigated the cognitive component of response generation as reflected on verbal and non-verbal fluency tasks. Participants with parkinsonian disorders (N = 59: 29 Parkinson's disease [PD]; 22 corticobasal syndrome [CBS]; 8 progressive supranuclear palsy [PSP]) and 89 age-matched healthy controls completed eight fluency tasks in four domains: word, design, gesture, and ideational. The total number of correct responses generated, error rates (repetitions and rule breaks) and consistency of responding over time (energization rate) were analysed. CBS patients were significantly reduced in the number of responses generated on all eight fluency tasks with a high repetition rate for one design fluency task. By contrast, PD patients' response generation was significantly reduced on only three fluency tasks (phonemic word, meaningless gestures, conventional ideational) but they produced a high number of errors on four fluency tasks (rule-breaks: phonemic/semantic word; repetitions: semantic word, meaningless gestures). Consistent with previous research, the PSP patients' pattern of responding reflected an energization deficit as they failed to maintain response generation over time. Overall, the pattern of performance on fluency tasks differs between patient groups. Specifically, the quantity of responses generated is primarily and differentially affected in CBS and PSP patients, whereas the quality of responses generated is affected in PD patients. This has implications for both the differential diagnosis of parkinsonian disorders and the cognitive processes implicated in internally-guided response generation. This work was supported by an NHMRC Boosting Dementia Research Leadership Fellowship.

The role of individual alpha frequency in predicting susceptibility to false memories

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The current study aimed to explore whether individual differences in cognitive functioning can be used to predict outcomes related to memory. Individual Alpha Frequency (IAF) was used to predict false memories outcomes, potentially through predictive model updating, in line with free energy accounts of brain function. IAF was calculated by recording resting state activity using EEG, to determine the individual spectral peak frequency within the alpha band. Additionally, as the consolidation of memories during sleep arguably promotes the consolidation of memories, the role of sleep in either facilitating or inhibiting false memory formation was also explored. Thus, the current study examined the likelihood of adopting a false memory using the Misinformation Effect. Participants (N=28; 25 females, mean age=22.5, SD=3.82) underwent learning prior to either a 2-hour nap opportunity or equal wake interval. Placement of interference was manipulated (pre- and post-sleep) across two sleep conditions. Recognition entailed an old/new judgment task whereby participants were required to indicate whether the image presented was from the original event or interference phase. Linear mixed-effects modelling indicated that IAF alone could not be used to predict susceptibility to false memory outcomes ($\chi^2(27) = 0.14$, $p=0.71$). However, results revealed a significant interaction between IAF, interference and time spent in Stage 2 Sleep ($\chi^2(22) = 5.43$, $p<=0.04$). This interaction highlights the role of sleep as a protective factor against interference, depending on IAF, which provides preliminary evidence for the use of electrophysiological markers to predict differential trajectories for memories across sleep based on individual differences.

Examining cerebellum-primary motor cortex connectivity using a novel transcranial magnetic stimulation protocol: Application in tremor-dominant Parkinson's disease

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Parkinsons disease (PD) is a common neurodegenerative disease resulting in progressive motor dysfunctions, including tremor. The pathophysiology of tremor-dominant PD remains poorly understood. The current project has three objectives. First, to examine test re-test reliability of cerebellum-primary motor cortex (cerebellum-M1) connectivity measured using dual-coil transcranial magnetic stimulation (TMS) in younger and older adults. Second, to examine whether cerebellum-M1 connectivity is altered in people with tremor-dominant PD compared to age- and sex-matched controls. Third, to examine whether the strength of cerebellum-M1 connectivity is associated with tremor severity in people with PD. Cerebellum-M1 connectivity was measured using dual-coil TMS in younger and older adults without PD (N = 58) in two identical sessions separated by ~7 days. We have begun to investigate cerebellum-M1 connectivity and tremor severity in people with tremor-dominant PD. Test re-test reliability of cerebellum-M1 connectivity was moderate in younger and older adults without PD. Cerebellum-M1 connectivity was reduced in older compared to younger adults without PD. Based on preliminary results and evidence from neuroimaging studies, we hypothesise that people with tremor-dominant PD will show reduced cerebellum-M1 connectivity when compared to age- and sex-matched controls, and the strength of cerebellum-M1 connectivity will be positively associated with tremor severity in PD. The current findings suggest that cerebellum-M1 connectivity can be reliably measured using dual-coil TMS. This has important implications for the use of dual-coil TMS to investigate cerebellum-M1 connectivity in tremor-dominant PD, and for increasing our understanding of the pathophysiology of other movement disorders.

Changes in the rate of force applied when lifting an object do not produce related changes in its perceived weight

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Weight illusions demonstrate that our expectations of an object's weight affect how heavy it feels. According to the Sensorimotor Mismatch Theory, the sensory feedback from a lift that is easier or more difficult than expected makes the

object feel lighter or heavier, respectively. We tested this idea by having participants lift identical-looking light (126.6 g) and heavy (518.4 g) cubes. For each lift, we examined the effects of the preceding trial by comparing Switch (e.g., light-after-heavy) with No-switch (e.g., light-after-light) trials. We measured peak rates of grip (between thumb and forefinger) and load (vertical force) force for each lift. Because the cubes appeared identical, we hypothesised that the forces deployed for one lift would predict them for the next, creating differences for Switch compared to No-switch trials. Critically, we tested if there was also a corresponding, related change in post-lift perceptual weight estimates. For the light cube, there were greater rates of force (ps ≤. 03) and lower weight estimates ($p<.001$) for Switch (light-after-heavy) than No-switch trials (light-after-light). For the heavy cube, there were lower rates of force ($ps\leq.01$) and higher weight estimates ($p<.001$) for Switch (heavy-after-light) than No-switch trials (heavy-after-heavy). However, in opposition to the Sensorimotor Mismatch Theory, these differences in forces and perceptual estimates for Switch compared to No-switch trials did not correlate with each other ($rs\leq-.1$, $ps\geq.16$). In conclusion, weight expectations seem to influence motor and perceptual processes independently from one another.

Gravity and Predictive Coding

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The brain does not fully process all the sensory information available to it. Instead, information can be selected for detailed analysis (via attention), or filtered - excluded from detailed analysis. Filtering could be achieved, at least in part, via the predictive coding framework (Rao & Ballard, 1999, Nature Neuroscience). Forward signalling of encoded information is hypothetically curtailed when sensory predictions match input (Friston, 2018, Nature Neuroscience). Recent evidence has linked alpha-band (8-12 Hz) cortical oscillations to inhibitory feedback (driven by spatial attention, see van Kerkoerle et al., 2014, PNAS). We used the brain's intuitive understanding of physics (MacNeilage & Glasauer, 2018, Current Biology) to examine links between predictive success and neural oscillations. Participants viewed short basketball videos, presented upright or inverted, while their eye movements were monitored. Videos were terminated just after a jump shot had been taken. We found that people were less accurate at predicting if shots would be successful when footage was inverted. Gaze patterns were also less consistent for inverted input. Upright trials were associated with enhanced alpha-band activity clustered on occipital sensors. Moreover, a greater alpha increase for upright trials was associated with better performance on those trials. Enhanced alpha-band activity for upright presentations could not be causally attributed to different saccade numbers. Overall, our data suggest that when the brain is less able to predict outcomes, due to violations of Newtonian physics, information processing is less selective - resulting in reduced inhibitory interactions characterised by enhanced alpha-band oscillations in cortex.

The belief of being watched facilitates the rapid awareness of eye gaze

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The common experience of the feeling of being watched by another has been experimentally examined for over a century. Studies show that when participants believe they are watched, they tend to make more prosocial choices. A recent proposal suggests that the belief of being watched triggers a heightened awareness of stimuli in relation with the self. However, no direct empirical support is currently available. Here we examine how the belief of being watched modulates perceptual awareness of self-relevant information. Using a method known as continuous flash suppression, we rendered faces with direct and averted gaze initially invisible. Previous research using this method has shown that direct eye contact gains privileged access to conscious awareness. In the current study, when participants believed they were being watched on surveillance cameras from outside the room, they became aware of the stimuli much faster than a control group. This was evident as a main effect of group ($F(1, 44) = 15.66$, $p < 0.001$, $eta^2 = 0.263$). No interaction between group and gaze direction was observed. Our results suggest that the belief of being watched significantly modulates the earliest unconscious levels of perceptual processing, leading to the rapid detection of eye-gaze. The results have implications concerning the impacts of increasing levels of surveillance within our society and for understanding persecutory delusional experiences in psychosis.

Developing a robust analysis pipeline for paediatric magnetoencephalographic (MEG) data

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Building on our standardised procedure for collecting high-quality MEG recordings from children (Rapaport et al., 2019); we discuss a newly developed analysis pipeline for paediatric MEG data. First, we outline a custom source localisation procedure, which works as follows. MEG-MRI coregistration is achieved by matching participant's headshape with a database of paediatric MRI templates (Sanchez et al., 2012). From this, a singleshell headmodel and a source-reconstruction grid warped to MNI-space are created. Source localisation is performed using a linearly constrained minimum variance beamformer to localise event-related fields. Using data from 36 participants aged 3-8, we demonstrate the successful localisation of auditory N100 evoked fields, and mismatch field responses to primary auditory cortex. In addition, using data from a group of 20 participants aged 4-8, we demonstrate robust occipital alpha-band connectivity during a naturalistic viewing paradigm. Second, we have developed a new method for acquiring participant scalp surface data, using a Structure Sensor and Ipad. This allows a 3D scan to be obtained within 30-90 seconds, from which head-position indicator coils can be marked, using MATLAB. This replaces the commonly-used Polhemus digitiser, which takes approximately 5 minutes to acquire a full scan. Our new approach offers faster and higher quality headshape information from paediatric populations. We demonstrate the successful use of the Structure sensor on adult MEG data from 10 subjects; and paediatric MEG data from 3 subjects. Openly available scripts from our MEG pipeline are presented openly on Github: https://github.com/Macquarie-

Implicit vs explicit learning: Does the method of encoding affect delayed memory performance?

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Background: Numerous studies have examined the differences between implicit and explicit motor sequence learning, yet few have investigated whether these differences extend to delayed memory performance. Thus, using a novel task, we aimed to determine whether explicit or implicit encoding differentially affects delayed motor sequence memory. Method: Eighty-four undergraduate students (61 female; mean age = 20.94, SD=5.36) completed a modified serial reaction time task designed to assess both implicit and explicit motor sequence learning. Learning was measured via changes in target-sequence completion times over 15 trials. To assess delayed memory performance, target-sequence completion times were measured again following a 30-minute delay. To examine task-related practice effects, comparisons were made to randomly generated sequence completion times. Results: Participants demonstrated significant improvement across explicit ($t = 10.06$, $p < .001$) but not implicit ($t = -1.65$, $p = .31$) learning trials in comparison to randomly generated sequences. Following a 30-minute delay, participants performed significantly faster on both the implicitly ($t = -6.26$, $p < .001$) and explicitly ($t = -4.62$, $p < .001$) learned sequences in comparison to randomly generated sequences. No differences in delayed performance were observed between the implicitly and explicitly learned sequences. Discussion: Previous studies have differentially associated neural circuitry and regional activity with implicit and explicit motor sequence learning. Results from the present study suggest that while there are encoding dependent differences in motor sequence learning, early memory consolidation appears independent of encoding methods. Future work is required to examine the mechanisms underpinning implicit and explicit memory consolidation and to explore factors that enhance retention (e.g. sleep).

Spatial ICA reveals distinct facial thermal components showing dynamic and synchronized temperature changes during naturalistic emotional experience

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Thermal imaging [infra-red imaging (IRI)] is an innovative new tool for monitoring psychophysiological states. Current methods to quantify facial thermal responses are grounded on region of interest (ROI) based approaches focussing predominantly on nosetip, which has been found to be a sensitive region for capturing temperature changes. Such analyses, however, ignore the majority of facial thermal information. Data-driven approaches like spatial independent component analysis (sICA) allow extracting meaningful features from high dimensional data. However, its use to analyse facial IRI data has not been explored. We, here, applied sICA to facial IRI data of healthy subjects while they viewed a 20 minute emotional movie whilst concomitantly acquiring facial videos and conventional physiological measures [galvanic skin response (GSR) and heart rate (HR)]. Our results demonstrate that, when benchmarked against a prior ROI approach, the nose-tip is a consistent sICA-derived component along with cheeks and philtrum. Inter-subject correlation (ISC) analysis showed significant synchrony of physiological responses (thermal, GSR and HR metrics) between subjects. Furthermore, thermal responses were highly correlated with participants' facial emotional expressions and, by extension, the emotional content of the movie. In summary, this study validates a novel approach of sICA for investigating facial IRI data and also corroborating previous findings that the nose-tip is a sensitive region showing thermal variations.With developments of such data-driven methods, thermal imaging has the potential for widespread use. Being contact free, it also provides advantages over the traditional psychophysiological methods and promises to open up new avenues of research in affective neuroscience.

Effect of obsessive-compulsive traits on decision-making is mediated by exploration-related strategies

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Various psychiatric symptoms impair our decision-making. Recent studies in computational psychiatry have aimed to elucidate the neural and computational mechanisms underlying the psychiatric deficits of decision-making. However, given the high comorbidity of psychiatric disorders, little is known about which symptoms are specifically associated with the impairment. Also, it remains elusive what computations in decision-making are affected by the symptoms. To address these issues, we conducted a large-scale online experiment. In the experiment, 1200 healthy participants performed a reward-seeking decision-making task and then completed questionnaires about psychiatric symptoms. Factor analysis on the questionnaire data reveals that there exist at least two hidden dimensions underlying the psychiatric symptoms: the first one is mainly associated with obsessive-compulsive traits while the second one is associated with depression and anxiety. Furthermore, computational model-based analyses demonstrate that only the first psychiatric dimension, mainly associated with obsessive-compulsive traits, was negatively correlated with overall performance of the decision-making task; and that the negative correlation was mediated by a computational process that governs choice stochasticity (i.e., random exploration) and propensity to choose options previously unchosen. Given that the preference for previously unchosen options can be thought to reflect motivations to explore uncertain options (i.e., uncertainty-driven exploration), our findings highlight a key role of exploration-related strategies in psychiatric deficits of decision-making. Furthermore, together with the previous neuroimaging findings that random and uncertainty-driven exploration strategies recruit frontopolar cortex and lateral prefrontal cortex respectively, our results may suggest that distinct prefrontal regions are implicated in the impairment of decision-making by obsessive-compulsive traits.

Stimulating prefrontal cortex enhances performance gains from sensory-motor training in older adults

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The ability to process multiple sources of information

simultaneously has been shown to be particularly impaired with ageing (Verhaeghen et al., 2003). There is evidence to suggest that such impairments reflect limitation in basic response selection (RS) processes (Melis et al., 2002; Merian et al, 200; Woods et al., 2015). Previous neuroimaging studies of young adults have implicated the left prefrontal cortex (PFC) as a key neural substrate of RS (Sigman & Dehaene, 2008; Dux et al., 2006, 2009). Subsequent tDCS studies (Filmer et al., 2013, 2013, 2017) have provided causal evidence for the role of left PFC in RS. Filmer at al. (2013) demonstrated that RS training in young adults is disrupted via active transcranial direct current stimulation (tDCS; anodal and cathodal) of left (but not right) PFC. Here, we examined if this pattern is observed in older adults, testing if PFC remains a key response selection node with age. To date, there is no study examining the neural substrates of RS and RS training in older adults using tDCS. Borrowing from Filmer et al.'s approach, our study employed anodal, cathodal, and sham stimulation to the left and right pLPFC and measured performance as participants trained on low and high response load tasks. Both anodal and cathodal stimulation of the left PFC (but not right) for the high load condition enhanced performance relative to sham, suggesting that stimulation strengthens RS training effects. These results highlight age-related differences in PFC function and the neural substrates of RS associated with ageing.

Association between Schizotypy and Antisaccade Performance: New Data from a Large Sample and Meta-analysis

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Objective: Deficits in inhibitory control on antisaccade tasks have been reliably shown in schizophrenia. Less evidence is available on antisaccade performance in schizotypy, the subclinical expression of schizophrenia. We report an empirical study and meta-analyses of the association of schizotypy with antisaccade performance. As research has shown effects of learning and fatigue on antisaccade performance, we also observe investigate whether time on task effects are dependent on schizotypy. Methods: 526 healthy individuals from the general population aged 18 to 54 years completed the antisaccade task and the prosaccade control task. Variables measured were latency, gain (accuracy) and error rate. Participants completed the Schizotypal Personality Questionnaire (SPQ) as a measure of schizotypy. Cognitive-Perceptual, Interpersonal and Disorganised schizotypy factors were explored separately. Random-effects meta-analyses were performed on published data, including this study. Results: High schizotypy was selectively associated with increased antisaccade error rate, with the Disorganised dimension emerging as strongest predictor (β=0.106, p=0.019). We observed an increase of antisaccade direction errors over time on task (p=0.006) of comparable magnitude for low and high Disorganised schizotypy groups (p=0.748). Meta-analyses indicated significant associations of error rate with positive (g=0.37), negative (g=0.26), disorganised (g=0.36) and overall schizotypy (g=0.37) (all p≤003). Conclusion: There is a reliable association between antisaccade direction error rate and schizotypy. We also demonstrate that time on task effects are independent of level of schizotypy.

Ideal or Real? Issues in Assessing Ideal Body Size

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Ideal body size has changed over time. Blonde bombshell Marilyn Monroe was idolised in the 1950's, whereas the 1990's saw the idolisation of heroin chic. There has been a resurgence in curvaceous bodies in recent years, with the Brazilian butt becoming increasing desired among women. It is easily apparent that the media has played a significant role in defining current body ideals and that the sheer existence of an ideal body size promotes body dissatisfaction amongst women of all ages. However, does the way in which we assess ideal body size in psychological science also encourage women to report an ideal that is smaller than their true body size? We asked participants to complete a series of ideal body size scales, and collected body shape dissatisfaction, self-esteem, social media usage, height and weight data. On average, participants chose an ideal body that was significantly smaller than their reported actual body size. BMI was positively related to reported actual body size on each scale; however, participants systematically underestimated their true size when using the visual depictions. In contrast, ideal body size was unrelated to BMI. The majority of participants reported they did believe their actual body size was presented on any of the scales and that the wording of the questions made them feel obligated to have an ideal body that was smaller than their true size. We highlight the significant issues with examining ideal body size and provide suggestions for improving ideal body size measures in future research.

Peak alpha frequency and statistical learning ability independently affect artificial language learning

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Individual peak alpha frequency (PAF; 8-12 Hz) reflects the temporal receptive windows of sensory processing and is involved in attention and memory. While research has examined the relationship between PAF and episodic and working memory, little is known about the relationship between PAF and statistical learning ability (SLA; a mechanism that extracts environmental regularities) on memory. Here, we report an electroencephalogram study examining the effects of PAF and SLA on artificial language learning. 30 participants

(age range: 18-40; female=15) completed a statistical learning task requiring the learning of triplet shape patterns, followed by pattern recognition and completion (mean accuracy: 62.8%, range: 36-94%). The artificial language involved the learning and discrimination of grammatical and ungrammatical sentences across 6 test blocks (mean accuracy: 61.8%, range: 33-93%). To estimate PAF, pre and post experiment resting-state EEG was obtained (PAF range: 7-11.5 Hz). Linear mixed effects modelling revealed a significant SLA x PAF x Grammaticality interaction ($p<.001$): higher PAF and SLA resulted in higher performance for Ungrammatical sentences, while lower PAF and high SLA resulted in higher performance for Grammatical sentences. We argue that both high PAF and SLA are not optimal for processing environmental regularities. While SLA predicts the extraction of environmental regularities, PAF may be involved in internal model updating. From this perspective, SLA and PAF may reflect distinct but related neurobiological information-processing mechanisms.

Perturbs and Observes the Frontotemporal Network in Automatic/Pre-attentive Abstract Change Detection with Transcranial Magnetic Stimulation and Event-related Optical Signal

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The human brain constantly monitors the environment to detect life-threatening changes even without conscious attention. Current theories of this pre-attentive change detection process suggest a prediction mechanism involving a functional connection between the Superior Temporal Cortex (STC) and the Inferior Frontal Cortex (IFC). By using event-related optical signals (EROS), the IFC and STC mismatch responses, which is the EROS counterpart of the ERP component Mismatch Negativity (MMN), have been consistently demonstrated. EROS measures the change in optical properties of the brain associated with neuronal activity and is able to localize brain activities temporally and spatially in the millisecond and sub-centimeter range. Due to correlational nature in brain imaging, the observed IFC-STC connection could be mediated via an unknown brain region. By applying Transcranial Magnetic Stimulation (TMS) to disturb the functioning of early IFC and measuring the later STC response with EROS, the functional connection of IFC-STC was demonstrated. However, this conclusion was limited to the detection of deviance in physical features which may not necessarily involve a prediction mechanism. The current study investigated the IFC-STC functional connectivity assumption in the pre-attentive detection of an abstract change which requires making predictions. The results showed abolishment of the later EROS STC mismatch response to deviance violating an abstract pitch interval rule, when TMS was applied at the IFC 80 ms after deviance onset. However, the STC mismatch response was preserved in the spatial, temporal, and auditory control conditions. These results provide evidence for the IFC-STC functional connection in pre-attentive abstract change detection.

How Perceptions of Trustworthiness are Influenced by (Arbitrary) Group Memberships: A Facial EMG and fMRI Investigation

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Perceptions of facial trustworthiness occur automatically. We investigated whether trustworthiness judgments are also affected by group membership. In two studies, we randomly assigned participants to a group - the red team or the blue team. Participants then viewed 44 photos from a face database that had been pre-rated as either high or low in trustworthiness. To each picture we added a red or blue square in the corner to signify that the target person was also on the red or the blue team. Participants were asked to rate how trustworthy the person in the photo looked. In Study 1, 44 participants did this while facial EMG was recorded from the cheek and brow regions. In Study 2, 30 participants performed the task in an fMRI scanner. Results from Study 1 showed that participants rated the trustworthy ingroup targets as being more trustworthy and the low outgroup targets as less trustworthy. Patterns of EMG, however, showed more smiling activity for low trustworthy ingroup members and high trustworthy outgroup members. Moreover, in Study 2, activity in the left amygdala varied as a function of the trustworthiness of the face and group membership, such that activity was greatest for both low trustworthy ingroup members and high trustworthy outgroup members. We interpret these results as support of the relevance hypothesis, where the combined information of perceived trustworthiness and group membership signals that untrustworthy-looking ingroup members and trustworthy-looking outgroup members demand more attention and even appeasement (as indicated by the facial EMG response).

Unsupervised Analysis of Sleep Data Detects Periods of Lucid Dreaming

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The scoring guidelines developed by the American Academy of Sleep Medicine for sleep polysomnographic recordings consist of rules made for the human eye that lack precision and objectivity. Here, we aim to provide a novel approach to clustering sleep data that is independent from visual scoring conventions and instead implements unsupervised analysis techniques which identify patterns in unlabeled data. Our method clusters unlabeled sleep polysomnographic (PSG) data based on a diverse range of features selected by a generalised time-series feature extraction tool, hctsa (highly comparative time-series analysis). We aimed to determine whether our unsupervised, data-driven approach could detect periods of lucid dreaming (during which sleepers become aware that they are dreaming). Although lucid dreaming is not reflected in current sleep scoring rules and was not distinguishable to trained human scorers based on EEG alone, our clustering approach was able to identify periods of lucid dreaming at a rate that was significantly above chance. These results suggest that our data-driven approach could fill a clear clinical need for more meaningful sleep classification by objectively detecting the electrophysiological activity associated with significant physiological and subjective changes during sleep. Overall, our method has the potential to address some of the limitations of existing visual sleep scoring methodology in order to develop a system that can be effectively tailored to a wide range of individuals, populations, and sleep states, better exploit rich physiological data to objectively reflect underlying states, and to consider changes in conscious experience during sleep.

Investigating distractor interference by cognitive load using pupillary luminance responses in the anti-saccade paradigm

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Observers need to select goal-directed at the expense of distracting stimuli in the environment for preferential information processing. This selection, according to load theory of attention, is modulated by cognitive load involved in frontal cortices, with greater distractor interference under high cognitive load. Although there is some evidence to support the theory, investigation has mostly used working memory tasks and has usually required additional manual responses to assess distractor processing. Distinct neural preparatory activity involved in the frontal network has been well documented during preparation for pro- and anti-saccades, in which subjects are instructed in advance to either automatically look at the peripheral stimulus (pro-saccade) or to suppress the automatic response and voluntarily look in the opposite direction from the stimulus (anti-saccade). Here, we combined the anti-saccade paradigm with pupillary luminance responses evoked automatically by task-irrelevant distractors to investigate distractor interference by cognitive load. Larger pupillary dilation following dark distractors was observed in the anti-saccade than pro-saccade preparation. These effects, however, were absent in pupillary constriction following bright distractors. Together, our results are in favor of load theory of attention, arguing the involvement of the superior colliculus (SC) underlying this behavior because the SC receives extensive projections from frontal-parietal areas and links to the pupil control circuit. These results also highlight the potential of using involuntary changes in pupil size to objectively investigate attentional selection under load without requiring manual responses.

Association between hippocampal integrity and relational memory performance in older adults with subjective cognitive decline

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Relational memory describes the binding of elements in events or scenes. These processes have been linked with aging and are compromised in patients with damage to the medial temporal lobe. The present study further investigated age-related differences in relational memory performance in 70 older adults with subjective cognitive decline (Mean = 65, SD = 6.7 years; 45 female), and the association with volumetric measures of hippocampal integrity. Using a spatial reconstruction task to assess relational memory through learning the location of a set of items in space, older adults showed a specific deficit in the binding of item with location. Specifically, older adults in the sample produced fewer correct pairings of items with the studied location, but an increased number of (incorrect) items placed in a studied location. Structure-function associations in relational memory performance remained when adjusting for the anticipated reduction in hippocampal volumes with increasing age. These findings further elaborate the pattern of relational memory impairments associated with aging and their association with volumetric measures of hippocampal integrity.

A Validation of Emotiv Flex for ERP Research

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The purpose of this study was to validate a consumer-grade electroencephalogram (EEG) device, the Emotiv EPOC Flex, for use in event-related potential (ERP) research. We collected data using a simultaneous setup of Flex and a research-grade EEG system, Neuroscan. Participants performed three ERP tasks: 1) A passive auditory oddball task; 2) An active auditory oddball task; and 3) A visual ERP task (N170 face task). Results indicate that the both the P300 auditory and mismatch negativity ERP components captured by Flex and Neuroscan were equivalent. Though the face-related N170 ERP peak was statistically different between the two systems, further analysis suggested that the signal captured by Flex was suitable for use in N170 paradigms. These results support the use of Flex for use in research settings and further reinforce the use of consumer-grade devices as viable, low-cost alternatives to research-grade EEG.

Examining the spatial dynamics of the center-of-gravity effects in inhibition of return and sensory adaptation

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Inhibition of return (IOR) refers to an orienting mechanism that biases attention against returning to previously attended locations. There is increasing evidence suggesting that IOR spreads beyond a cued location (local effect) and converges at the center-of-gravity (CoG) of a cued array. However, little is known about whether IOR and another, earlier, inhibitory cueing effect, called sensory adaptation, share the same CoG effect. To address this question, a multiple-cueing experiment was conducted with cue-target onset asynchronies of 400 and 1000 ms. Overall, we found that saccadic reaction time decreased as the distance between the target and the CoG of the cue array increased. However, only sensory adaptation revealed a local effect of inhibition when multiple cues were presented. Moreover, the CoG effect of sensory adaptation was found to be stronger and wider than that of IOR, suggesting that the spatial distribution of these inhibitory mechanisms are dissociable.

Risky business: impulsivity and decision-making in younger-onset dementia

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The ability to balance potential risks and rewards is critical for adaptive decision-making in everyday life. Impaired decision-making is commonly reported in individuals with dementia, yet most studies have relied on self- or informant-report methodologies, and the impact of affective processes on decision-making in dementia remains unclear. Here, we aimed to contrast balancing of risks and rewards in behavioural-variant frontotemporal dementia (bvFTD) patients, who show abnormal affective processing, versus patients who show intact affective processing (Alzheimer's disease; AD). Participants (38 bvFTD and 19 AD patients and 29 age-matched healthy controls) completed the Balloon Analogue Risk Task (BART), a computerised monetary decision-making task where participants chose to either pump a balloon or to stop pumping and 'cash in' the available reward. With each pump, the amount of reward increased, but the risk of the balloon bursting also increased. If the balloon burst, the reward was lost. Relative to controls, bvFTD and AD patients did not show any significant differences in the average number of pumps per balloon or the number of balloons burst. However, bvFTD patients collected significantly fewer rewards ($p=.017$), with a tendency to 'cash in' on smaller rewards rather than continuing to pump for potentially larger rewards. In contrast, AD patients only differed from controls on measures of reaction time ($p<.001$). BvFTD patients show deficits in monetary decision-making. These findings provide novel insights regarding sensitivity to reward and loss in dementia, and the potential affective mechanisms that contribute to maladaptive decision-making in these patient groups.

Diamonds are forever – priming effects from visual imagery on perceptual rivalry

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Visual illusions such as binocular rivalry and the motion after effect have been used as a mechanism to probe visual imagery, and associated vividness in an objective manor. Studies have indicated that visualising an object, colour, or motion can influence your perception when viewing a following image. Furthermore, how vividly an individual can visualise an image correlates with the perceptual change. It has not been explored if perceptual rivalry stimuli, such as can be influenced in the similar ways by visual imagery. The current study used a perceptual rivalry stimulus known as the diamond illusion to investigate whether visual imagery (visualising either horizontal motion or vertical motion) could prime a visual stimulus perceived as either a global object (a diamond moving horizontally) or perceived with local details (lines moving vertically). We hypothesised that visual imagery would prime both local and global percepts, with increased priming levels correlating with an increased vividness score. We also explored whether there would be different imagery priming effects based on the size and location of the diamond stimulus. As expected, visual imagery contributed to a priming effect. This effect also correlated with visual imagery vividness scores. This suggests visual imagery can have a priming effect on subjective stimuli, such as the diamond illusion. Given that the local and global perceptual forms of the illusion activate differing areas of the visual stream (V1, LOC), this research opens a new avenue of exploring how visual imagery can influence differing areas of the brain.

How variability affects mismatch negativity elicitation

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Mismatch Negativity (MMN) is an automatically elicited component of the difference in neural responses to a standard repeating pattern and deviating stimuli. In a prior study we observed MMN could be elicited to complex abstract patterns under low but not high variability conditions. The primary aim of this study was to test the hypothesis that extending the time of exposure to more variable stimuli would enable the brain to generate an MMN. The second aim was to determine if order effects occur when stimuli of differing variability follow one another. Neuronal responses were recorded from 60 participants with an EEG. MMN generated to rare pattern deviations was extracted from event related potentials. MMN amplitude was our dependant variable. Two conditions were developed to meet our aims; one with higher levels of complex pattern variability (Variance condition) and one with comparatively lower levels of complex pattern variability (Baseline condition). The Variance condition was twice as long

(40 mins, 2200 tones) as the Baseline condition and twice as long as that used in the previous study. Significant MMN was present to deviants within Variance and Baseline conditions and there was no significant impact of order. Our results suggest two important aspects about auditory processing. Firstly, that if given enough time, complex auditory deviations can be detected by the brain under both high and low variance conditions, supporting our first hypothesis. Secondly for this form of variability the order in which people are exposed to the different types of variance made no difference.

The Contribution of Spatial Frequencies in Perceptual Rescaling Mechanisms

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It is unclear whether certain spatial frequencies (SFs) in a background exert a stronger influence over others in the perceptual rescaling of a stimulus in the image. We systematically added or removed low (< 2 cp/d), medium (2 - 6 cp/d), and high (>6 cp/d) SFs from a Ponzo-like illusion display of a hallway to determine how these manipulations changed the perceived size of far and near rings. The point of subjective equalities (PSEs) among 5 experimental conditions (No SF, Low, Medium, High, All) were compared with each other for the far and near rings. Each background with SFs produced a strong illusion. An interaction was observed between Backgrounds and Ring Positioning [$F(4,60)=22.60$, $p<.001$]. Post-hoc Tukey pairwise comparisons showed that the size of the far ring was consistently overestimated in each background with SFs (all $p < .021$) while the size of the near ring was consistently underestimated (all $p < .003$). There were no statistical differences among Low, Medium, and High SFs (all $p > 0.63$). Perceptual rescaling was stronger for the far compared to the near ring ($p=.034$). Additional eye-tracking revealed that participants tended to gaze more towards the far than the near ring ($p=.013$). We further analysed the contribution of SFs with maximum likelihood estimation (MLE) and found that Low SFs provided the most reliable information for the far (weight=0.63, $r(14)=0.64$, $p=.007$) and near rings (weight=0.41, $r(14)=0.85$, $p<.001$). We conclude that a wide range of SFs contributes to perceptual rescaling in the Ponzo illusion but Low SFs fulfil a greater contribution.

The relationship between negative symptoms and cognitive function in schizophrenia

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There is ongoing debate regarding the relationship between clinical symptoms and cognitive function in schizophrenia. The present study aimed to take three data-driven approaches to investigate the potential relationship between these symptom clusters. Hierarchical cluster analysis with k-means optimisation was employed to identify homogeneous clinical subgroups in a sample of 130 schizophrenia spectrum participants. Emergent cluster groups were then compared on MATRICS cognitive performance and demographic variables. Next, follow-up investigatory analysis was performed for cognitive domains that revealed statistically significant differences between groups. This included Spearman's correlation analyses between clinical domains and the cognitive domain/s. Finally, a multiple regression analysis was performed to determine the amount of variance in cognition explained by the major PANSS subscales. There was a significant difference between clinical groups for social cognition at the $p<0.01$ level [$F(3, 105) = 4.181$, $p=0.008$, $eta^2=0.107$]. There was a weak to moderate, negative correlation between social cognition and the PANSS negative factor ($rs(87) = -0.298$, $p=0.010$). In combination, the PANSS factors made a significant contribution to the prediction of social cognition, accounting for approximately 12.4 % of the variance in social cognition score; $R2 = .124$ (Adj. $R2 = .099$), $F(3, 105) = 4.953$, $p<0.01$. Of the three predictors, only PANSS Negative made a unique contribution ($\hat{I}^2 = -.373$, $t = -3.557$, $p<0.01$), accounting for 10.6% of the variance in social cognition. In conclusion, negative symptoms seem to be related to social cognition, but not the other components of cognition, suggesting an independence between these domains in schizophrenia.

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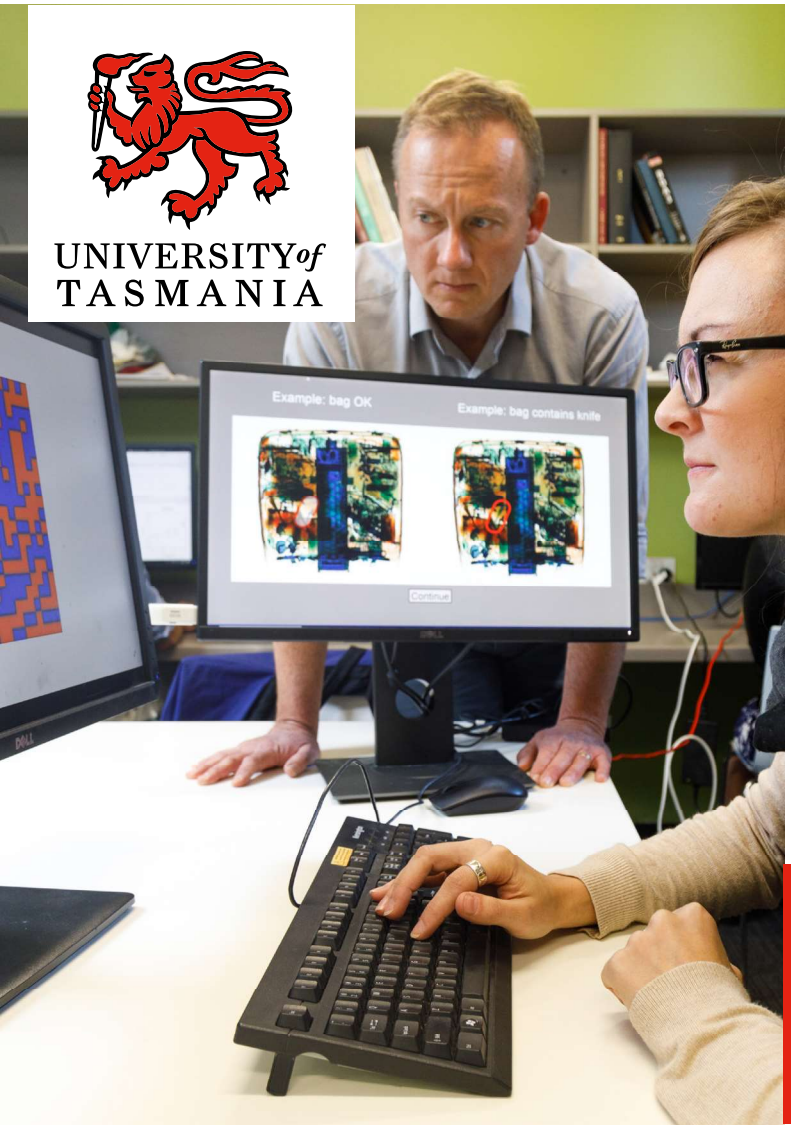

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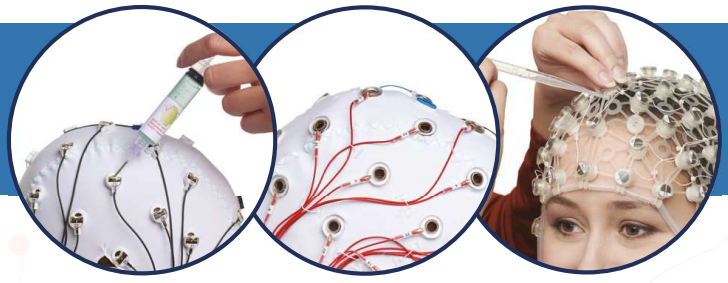

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