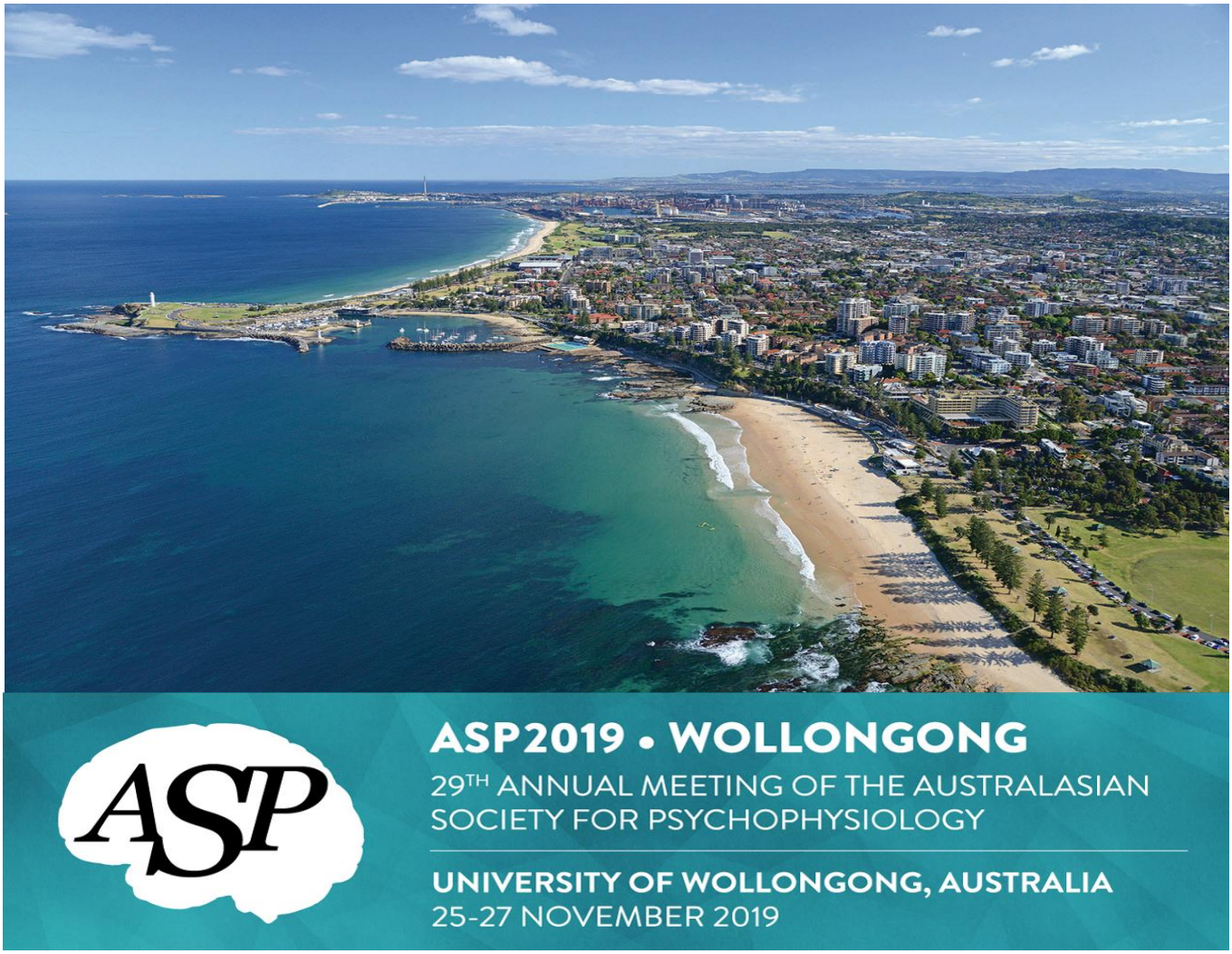
UNIVERSITY OF WOLLONGONG AUSTRALIA

Australasian Society for Psychophysiology, Inc

ASP2019
29th Annual Meeting of the Australasian Society for Psychophysiology

Conference Program



Day 1: Monday November 25		Day 2: Tuesday November 26		Day 3: Wednesday November 27	
8:30-9:00	Registrations Open (Building 20)	**8:30-9:00**	Registrations Open (Building 20)	**9:30-10:00**	Registrations Open (Building 20)
9:00-10:30	Session 1: Welcome & Oral Presentations	**9:00-10:30**	Session 4: Oral Presentations	**10:00-11:45**	Session 6: Oral Presentations
10:30-11:00	Morning Tea	**10:30-11:00**	Morning Tea	**11:45-12:15**	Morning Tea
11:00-12:00	Keynote 1: *Prof. Olivier Piguet*	**11:00-12:00**	Keynote 2: *A/Prof. Blake Johnson*	**12:15-13:15**	Keynote 3: *Prof. Frances Martin*
12:00-13:00	Lunch	**12:00-13:00**	Lunch	**13:15-14:00**	Lunch
13:00-14:30	Session 2: Oral Presentations	**13:00-14:50**	Session 5: Oral Presentations	**14:00-15:30**	Session 7: Oral Presentations
14:30-15:00	Afternoon Tea	**14:50-15:20**	Afternoon Tea	**15:30-16:00**	ASP Annual General Meeting
15:00-16:45	Session 3: Oral Presentations	**15:20-17:00**	EMCR Event	**16:00-16:30**	Afternoon Tea
17:00-19:00	Welcome Reception & Poster Session	**18:30-21:30**	Conference Dinner: LevelOne@Harbourfront	**16:30-17:00**	Awards Presentation & Conference Close

Welcome to ASP2019!

The organising committee from the University of Wollongong warmly welcome all delegates to ASP2019: the 29th Annual Meeting of the Australasian Society for Psychophysiology.

This three-day conference brings together researchers from a range of disciplines, including psychology, psychiatry, neuroscience and more to share new findings regarding the relationships between the brain and behaviour.

Please refer to the following sections of this booklet for all conference information.

Organising Committee

Lead Conveners: Professor Robert Barry and Dr Frances De Blasio

Conference Operations Team: Professor Stuart Johnstone, Dr Sue Thomas, Dr Lisa Marie-Greenwood, Dr Adam Verrender, Ms Jessica Mills, Mr Jack Fogarty

We would also like to thank our Sponsors for their contributions to ASP2019:

UNIVERSITY OF WOLLONGONG AUSTRALIA

COMPUMEDICS® 'Defining *Life's* Signals'

NEUROSPEC Research Neurosciences

We will also have exhibitor displays, so please be sure to visit them at ASP2019.

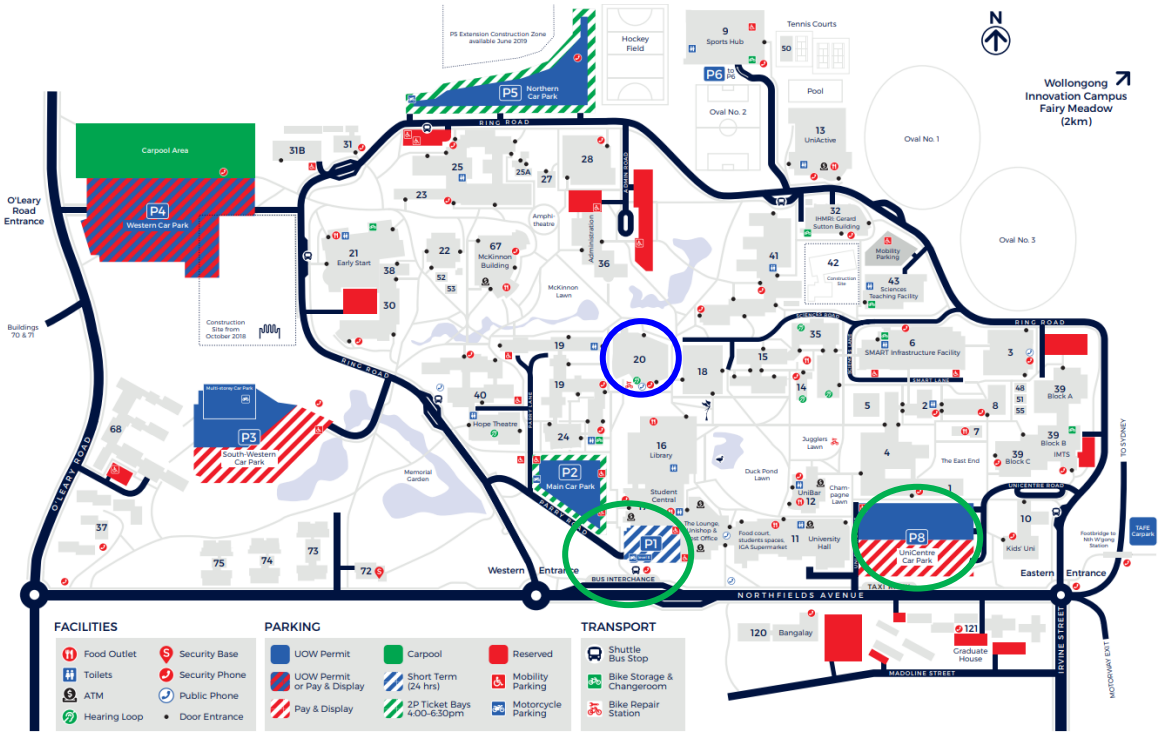
Contents

Conference Venue Information

The Communications Centre (Building 20)
University of Wollongong (UOW)
Northfields Avenue, Wollongong, NSW, 2500

https://maps.uow.edu.au/app/1/home

The Communication Centre (Building 20) is located in the centre of the Wollongong Campus, across from the UOW Library (Building 16).



The most convenient short-term parking is available in carparks: P1 (entry via *Western Entrance*, Northfields Avenue; pay prior to exit, ~$15/day), or P8 (entry via *Eastern Entrance*, Northfields Avenue; pay & display tickets, ~$10/day). There are also **two free shuttle buses** that service the university, with the most convenient stop being the bus interchange located on Northfields Avenue near P1.

The ***Gong Shuttle*** is a free transport for NSW public bus service that travels in clockwise (55C) and anticlockwise (55A) loops connecting UOW to the city (~40 mins for a full loop, ~20 mins to campus). This service operates every 10 mins from 7:00 am to 6:00 pm, and every 20 mins from 6:00 pm to 10:00 pm on weekdays. North Wollongong train station is a 20 min walk from the main campus, otherwise the free ***North Gong (NG) Shuttle*** links these. Route 9 stops at various points around the campus Ring Road, and route 9N runs directly between the station and Northfields Ave bus interchange. Note that the *NG* shuttle is running at its reduced timetable which is included on the next page.

North Gong (NG Shuttle) timetable in effect

Reduced Service Shuttle Bus – Weekdays							
Departs Station	Kids Uni	Sciences	Creative Arts	Early Start	Hope Theatre	Northfields Ave	Arrives Station
7:51	..	..	..	..	..	7:56	8:01
8:02	..	..	..	..	..	8:07	8:25 **
8:24	..	..	..	..	..	8:31	8:37
8:42	..	..	..	..	..	8:47	8:53
8:57	..	..	..	..	..	9:02	9:08
9:15	..	..	..	..	..	9:20	9:26
9:27	..	..	..	..	..	9:32	9:37
9:41	..	..	..	..	..	9:46	9:51
9:56	..	..	..	..	..	10:01	10:06
10:17	..	..	..	..	..	10:22	10:27
10:41	..	..	..	..	..	10:46	10:51
10:54	..	..	..	..	..	10:59	11:04
11:52	..	..	..	..	..	11:57	12:02
12:17	..	..	..	..	..	12:22	12:27
12:35	..	..	..	..	..	12:40	12:45
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13:17	..	..	..	..	..	13:22	13:27
13:41	..	..	..	..	..	13:46	13:51
13:54	..	..	..	..	..	13:59	14:04
14:17	..	..	..	..	..	14:22	14:27
14:35	..	..	..	..	..	14:40	14:45
14:51	..	..	..	..	..	14:56	15:01
15:08	..	..	..	..	..	15:13	15:18
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15:34	..	..	..	..	..	15:39	15:45
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16:17	..	..	..	..	..	16:22	16:29
16:35	..	..	..	..	..	16:41	16:47
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17:03	..	..	..	..	..	17:08	17:25 **
17:25	..	..	..	..	..	17:30	17:36
17:42	..	..	..	..	..	17:47	17:53
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18:09	..	..	..	..	..	18:14	18:19
18:21	..	..	..	..	..	18:26	18:31
18:37	..	..	..	..	..	18:42	18:47
18:52	..	..	..	..	..	18:57	19:02
19:05	..	..	..	..	..	19:10	19:15
19:17	..	..	..	..	..	19:22	19:27

** This trip is GKA-NG (9 Stops around Gwynneville/Keiraville before arriving at North Gong Station) For more info check UOW Shuttle app
Note that GKA-NG stops at Stand F across the road from the bus interchange

Delegate Information

Registrations: The registration desk will be open from 8:30 am on Monday 25 November (Day 1) and Tuesday 26 November (Day 2), and from 9:30 am on Wednesday 27 November (Day 3). The registration desk is located in the Building 20 Foyer at the University of Wollongong, Wollongong Campus.

Name Badges: Name badges will be provided to all delegates upon check-in at the conference registration desk. Please wear your name badge at all times while at the venue (and conference dinner) to facilitate interactions with other delegates, and to verify your access to the conference and your entitlement to refreshments (including dietary needs).

Refreshments and Lunch: Morning tea, afternoon tea and lunch will be provided on all three days of the conference, with the cost included in your registration. If nominated during registration, dietary requirements will be catered for.

Welcome Reception: Drinks and canapés will be served during the Welcome Reception & poster session from 5:00-7:00 pm on Monday 25 November. The cost of this event is included in your registration.

Assistance and Advice: Should you require any assistance during the conference, please visit the registration desk or speak to any of our conference organising committee, who can be identified by the yellow sticker on their name badge.

Information for Presenters:

Oral Presentations: The lecture theatre contains a Windows PC, document viewer, laptop connection facilities, and a presentation remote. The maximum speaking time for each presentation is 15 minutes, with an additional 5 minutes for questions. The session chair will notify you as you approach the time limit. **Please ensure that your presentation slides are loaded onto the presentation PC via USB no later than 15 minutes prior to the start of your session.**

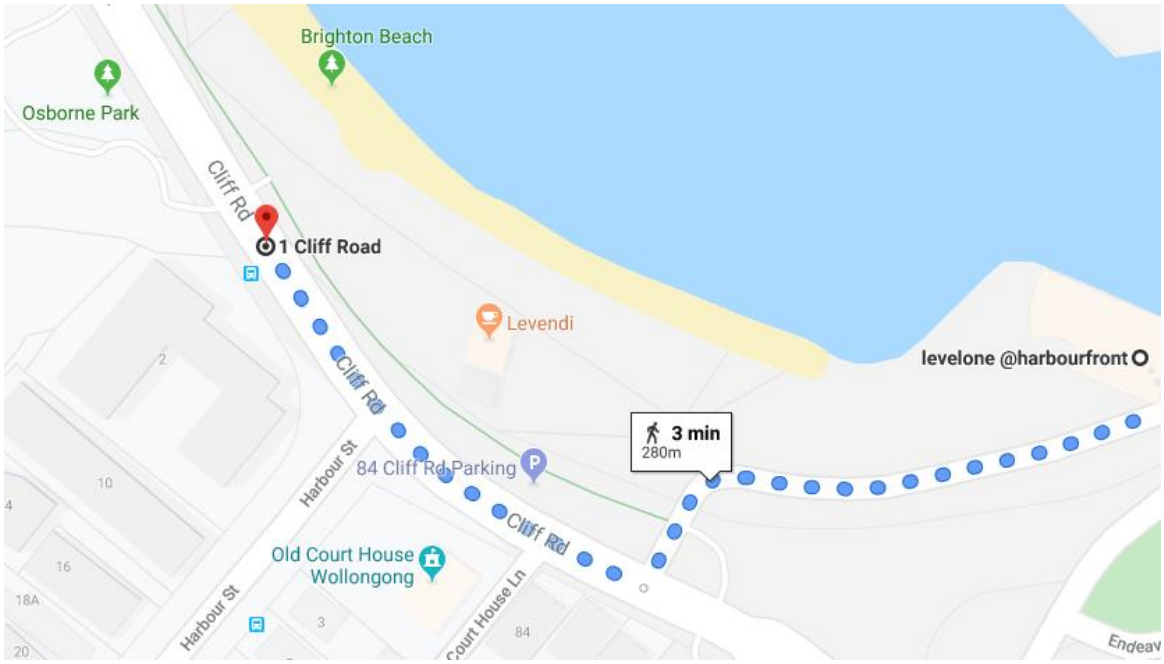
Posters: The poster session will be held from 5:00-7:00 pm on Monday 25 November (Day 1). **Posters should be given to a member of the organising committee before the end of lunch on Monday 25 November, or upon arrival**. Conference staff will hang the posters following afternoon tea (Day 1), and presenters should remove their posters at the end of the poster session. Poster size should be up to A0 (841 mm x 1189 mm) in portrait orientation, or up to B1 (707 mm x 1000 mm) in landscape orientation to fit the poster boards (1.8 [H] ×1.2 [W] m in size).

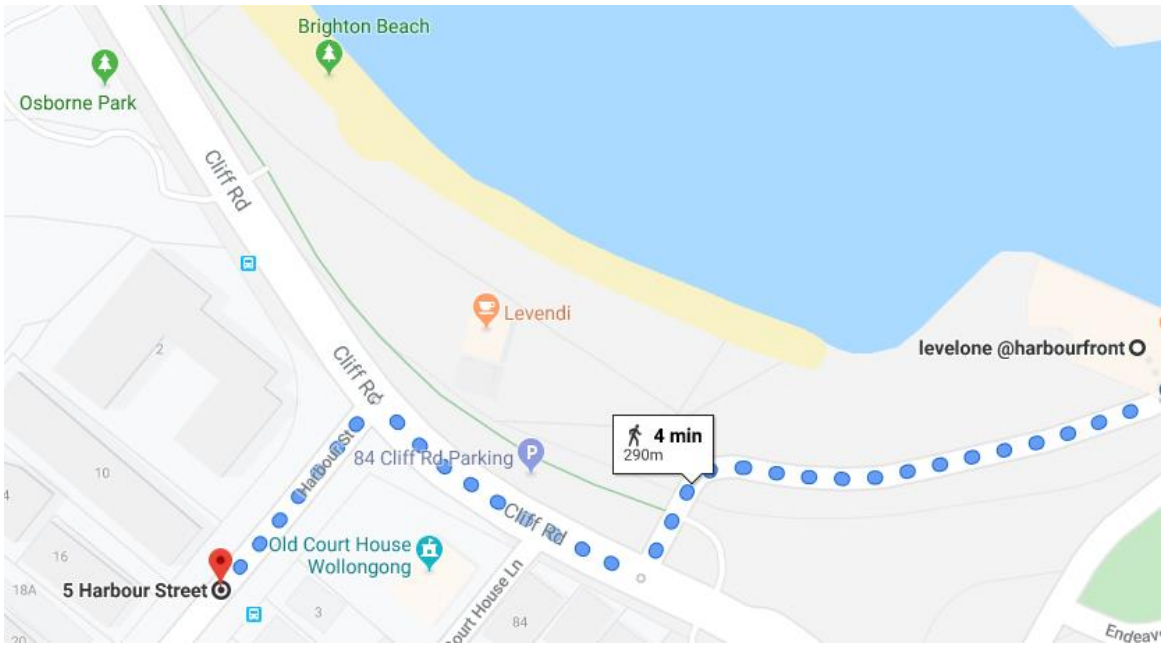
Conference Dinner Information

LevelOne@Harbourfront

Level 1/2 Endeavour Drive, Wollongong

www.levelonehf.com.au/home





LevelOne@Harbourfront is close to the free *Gong Shuttle* bus stops, being a 3 min walk from the Cliff Rd stop (55A), or a 4 min walk from the Harbour St stop (55C). Parking is also available along Endeavour Drive near the lighthouse.

Keynote Presenters

Keynote 1 – Professor Olivier Piguet

School of Psychology, University of Sydney
Brain and Mind Centre, University of Sydney
Charles Perkins Centre, University of Sydney

Olivier is an NHMRC Senior Research Fellow and Professor of Clinical Neuropsychology at the University of Sydney. A clinical neuropsychologist with over 20 years clinical experience in the field of ageing and neurodegeneration, he is the co-director of FRONTIER, the frontotemporal dementia clinical research group. Olivier trained in Geneva and Melbourne and completed his PhD at the University of Sydney followed by a postdoctoral fellowship at MIT. His research program investigates early clinical markers of frontotemporal dementia, prediction of disease progression and relations to brain abnormalities. He is particularly interested in social cognition, memory and executive function. He has published over 220 peer-reviewed journal articles on these topics.

Lost in translation! Social cognition disturbance in frontotemporal dementia

Monday 25, 11:00-12:00; abstract on page 53.

Keynote 2 - Associate Professor Blake Johnson

Department of Cognitive Science, Macquarie University
ARC Centre of Excellence in Cognition and its Disorders (CCD), Macquarie University
Hearing CRC, Macquarie University

Blake Johnson is an Associate Professor of Cognitive Science at Macquarie University. His research program uses electrophysiological measures of human brain activity (EEG and MEG) to study the development and function of neural mechanisms associated with perception and motor function. His current work focusses on neuromotor control of speech in the developing human brain.

Neuroimaging of speech articulatory motor control in the human brain

Tuesday 26, 11:00-12:00; abstract on page 40.

Keynote 3 – Professor Frances Martin

School of Psychology, University of Newcastle

Professor Frances Martin joined the University of Newcastle in 2012 as the senior Psychology academic on the Ourimbah campus. She is currently the Assistant Dean Research Training in the Faculty of Science. In her time at the University of Newcastle she has conducted research investigating the cognitive processes which may be involved in behavioural addictions, particularly related to social media, smart phones, and the internet. She also conducts research investigating the interactions between attention and emotion.

Behavioural Addictions?

Wednesday 27, 12:15-13:15; abstract on page 46.

Early & Mid Career Researcher (EMCR) Event

Tuesday 26 (Day 2), 15:20-17:00

Panel members

Dr Genevieve Steiner

Dr Steiner's psychophysiology research spans the early detection, prevention, and treatment of cognitive decline in older people with the aim of reducing dementia risk and improving quality of life. She is currently leading randomised controlled trials for mild cognitive impairment and early-stage Alzheimer's disease evaluating the efficacy of nutritional supplements, Chinese herbal medicine, and medicinal cannabis. She leads the Neurocognition Laboratory and is Research Director at the NICM Health Research Institute at Western Sydney University.

Dr Edwin Lim

Dr Lim is a neuroscientist and biostatistician, who works in the field of targeted metabolomics (tryptophan) in neuroscience research. He leads the Translational Metabolomics group in the Faculty of Medicine and Health Sciences at Macquarie University. Dr Lim uses innovative approaches, combining biochemical analyses with mass spectrometry techniques and data analytics with machine learning to identify early predictors for disease prognosis with publications in leading journals such as New England Journal of Medicine, Progress in Neurobiology and Molecular Psychiatry.

Dr Briony Larance

Dr Larance is a Vice Chancellor's Postdoctoral Senior Research Fellow at the University of Wollongong and an Illawarra Health and Medical Research Institute affiliate. Her research examines strategies to reduce the harms associated with illicit drug use, and effective treatments for substance use disorders. She undertakes prospective cohort studies, clinical trials, post-marketing surveillance studies and analyses of linked administrative data to generate critical knowledge relevant to health policy and clinical practice.

Dr Diana Karamacoska

Diana has recently completed her PhD in neuroscience at the University of Wollongong, and is working as a post-doctoral research fellow in vascular dementia at NICM Health Research Institute, Western Sydney University.

Dr Jeremy Lum

Jeremy completed his PhD in 2019 at the University of Wollongong investigating molecular alterations and novel therapeutic avenues for the treatment of schizophrenia and depression. He has since started his post-doc in Prof. Justin Yerbury's research group at the Illawarra Health and Medical Research Institute, where he is exploring gene therapy avenues for the treatment of motor neuron disease.

International ECRs:

Dr Jason He
Postdoctoral Research Fellow
Johns Hopkins University

Dr Dana van Son
Postdoctoral Associate
Yale School of Medicine

Dr Dawei Zhang
Postdoctoral Fellow
Karolinska Institut

Conference Program

Day 1: Monday 25 November	
08:30-09:00	Registration – Communications Centre Foyer (Building 20), UOW
09:00-10:30	**Session 1 – Welcome & Oral Presentations** Chaired by Prof. Robert Barry **Presentation 1:** Jack Fogarty *et al.* *The first 250 ms of auditory Go/NoGo processing* **Presentation 2:** Hiroshi Nittono *What is the role of high-frequency sound components in high-resolution audio? A mismatch negativity study* **Presentation 3:** Sarah Scott *et al.* *Does radio frequency electromagnetic field exposure affect emotional processing?* **Presentation 4:** Genevieve Steiner *et al.* *Reduced neuronal activation of attention and cognitive control mechanisms in amnestic mild cognitive impairment (aMCI) compared to healthy controls*
10:30-11:00	Morning Tea
11:00-12:00	**Keynote 1:** Professor Olivier Piguet *Lost in translation! Social cognition disturbance in frontotemporal dementia*
12:00-13:00	Lunch
13:00-14:30	**Session 2 – Oral Presentations** Chaired by Dr Adam Verrender **Presentation 5:** Susan Thomas *et al.* *Plasma glutamate levels in major depressive disorder: Relationships to symptoms* **Presentation 6:** Jessica Mills *et al.* *Problematic eating behaviours in atypical major depressive disorder: Links to plasma cortisol* **Presentation 7:** Kriti Sharma *et al.* *Relationships between psychopathology, physical health indicators and testosterone in major depressive disorder and healthy controls* **Presentation 8:** Alexandra South *et al.* *The dark triad, cortisol, testosterone and psychopathology across the sexes*
14:30-15:00	Afternoon Tea

15:00-16:45	**Session 3 – Oral Presentations** Chaired by Ms Jessica Mills **Presentation 9:** Adele Cave *et al.* *Eyes closed resting state EEG: Subjective cognitive impairment, mild cognitive impairment, and matched controls* **Presentation 10:** Nathan Nuzum *et al.* *Gut microbiota differences across healthy ageing and in Parkinson's disease: A systematic review* **Presentation 11:** Jennifer Baldock *et al.* *The effects of light level on the task-evoked pupil response during effortful listening* **Presentation 12:** Rebecca Mursic *et al.* *Vection and postural sway while listening to the Shepard-Risset glissando* **Presentation 13:** Timothy Byron *et al.* *Musically-surprising events as indexed by skin conductance levels*
17:00-19:00	**Welcome Reception & Poster Session**

Day 2: Tuesday 26 November	
08:30-09:00	Registration – Communications Centre Foyer (Building 20), UOW
09:00-10:30	**Session 4 – Oral Presentations** Chaired by Dr Frances De Blasio **Presentation 14:** Thomas Rout *et al.* *The relationship between arousal and EEG alpha power during mind wandering induced by a breath-counting task* **Presentation 15:** Georga Bovingdon *et al.* *Investigating the relationship between eyes-closed and -open resting-state EEG and behavioural outcomes* **Presentation 16:** Diana Karamacoska *et al.* *EEG-ERP brain dynamics in a continuous performance test* **Presentation 17:** Lisa Lole *et al.* *Flutters and features: Exploring the effect of free spins on the psychophysiological arousal of regular gamblers*
10:30-11:00	Morning Tea
11:00-12:00	**Keynote 2:** Associate Professor Blake Johnson *Neuroimaging of speech articulatory motor control in the human brain*

12:00-13:00	Lunch
13:00-14:50	**Session 5 – Oral Presentations** Chaired by Dr Susan Thomas **Presentation 18:** Adam Clarke *et al.* *The effects of Methylphenidate on the EEG of children with ADHD during an eyes closed resting condition* **Presentation 19:** Alexander Duda *et al.* *Investigating natural EEG frequency component correlates of mindfulness* **Presentation 20:** Nathan Attard *et al.* *Investigating the relationships between prestimulus EEG components and performance in the auditory Go/NoGo task* **Presentation 21:** Stuart Johnstone *et al.* *Examining the validity of EEG from a frontal single-channel dry-sensor portable device: Eyes-closed and eyes-open differences in children* **Presentation 22:** Agnes Iwasiw, *Symbiotic Devices* *EEG-based brain computer interface demonstration using motor imagery*
14:50-15:20	Afternoon Tea
15:20-17:00	**Early & Mid Career Researcher (EMCR) Event**
18:30-21:30	Conference Dinner- LevelOne@Harbourfront

Day 3: Wednesday 27 November	
9:30-10:00	Registration – Communications Centre Foyer (Building 20), UOW
10:00-11:45	**Session 6 – Oral Presentations** Chaired by Mr Jack Fogarty **Presentation 23:** Lauren Dewsbury *et al.* *Eyes closed resting alpha changes in women with chronic pelvic pain following acupuncture treatment* **Presentation 24:** Emma Kornfeld *et al.* *Mirroring responses differ for hands and faces* **Presentation 25:** Jacqueline Rushby *et al.* *The role of inhibition in the human mirroring system: An EEG and ERP study* **Presentation 26:** Jason Satel *et al.* *Exploring inhibition of return with steady-state visual evoked potentials* **Presentation 27:** Inga Griškova-Bulanova *et al.* *40 Hz auditory steady state response during psilocybin intoxication*

11:45-12:15	Morning Tea
12:15-13:15	**Keynote 3:** Professor Frances Martin *Behavioural Addictions?*
13:15-14:00	Lunch
14:00-15:30	**Session 7 – Oral Presentations** Chaired by Prof. Stuart Johnstone **Presentation 28:** Robert Barry *et al.* *Using caffeine as a tool to probe active ERP markers of cognitive processing in a Go/NoGo task* **Presentation 29:** Mark Schira *Time to split, say goodbye to the bilateral fovea hypothesis* **Presentation 30:** Adam Verrender *et al.* *Important methodological issues for detecting radiofrequency electromagnetic field exposure-related increases in EEG alpha spectral power* **Presentation 31:** Frances De Blasio *et al.* *Not all resting alpha frequency components index arousal*
15:30-16:00	**ASP Annual General Meeting**
16:00-16:30	Afternoon Tea
16:30-17:00	**Awards Presentation and Conference Close**

Conference Abstracts (in alphabetical order of first author)

The examination of orbitofrontal cortex volume in cannabis use disorder

Gabrielle M. Abbott[1*], Suraya Dunsford[1], Valentina Lorenzetti[2], Chao Suo[3], Mark Schira[1], Nadia Solowij[1,4], and Lisa-Marie Greenwood[1,4]

[1] School of Psychology, University of Wollongong, Australia
[2] School of Behavioural & Health Sciences, Australian Catholic University, Australia
[3] Brain & Mental Health Research Hub, School of Psychological Sciences and The Turner Institute for Brain and Mental Health, Monash University, Australia
[4] Illawarra Health and Medical Research Institute, Wollongong, Australia

Aims: Altered functioning of the orbitofrontal cortex (OFC) in regular cannabis users has been associated with deficits in executive functioning domains of self-regulation and decision-making. These cognitive processes have significant negative ramifications for the maintenance of substance dependence. However, there is a need to determine whether OFC volumetric abnormalities are apparent in adulthood and whether this is evident in severe stages of cannabis use disorder (CUD), which may inform neural targets for the development of novel intervention and prevention strategies. This study aims to determine whether OFC volume is altered in adult regular cannabis users with severe CUDs.

Method: Medial and lateral OFC volume were examined in thirty-nine regular cannabis users stratified into mild-to-moderate dependence (n = 21) and severe dependence (n = 18) groups using the Structured Clinician Interview for DSM-V, and 8 non-using controls matched for mean age, gender and IQ. All participants underwent a structured interview to assess demographic, substance use and psychiatric history. Cannabis users were also assessed for obsessive and compulsive symptoms related to their cannabis use.

Results: Analyses revealed no OFC volumetric differences between cannabis users and controls and found no volumetric differences as a function of CUD severity (i.e. OFC volume did not differ between mild/moderate and severe CUD). As a novel finding, we found severe CUD had greater obsession scores related to cannabis than mild-to-moderate CUD. However, obsessions and compulsions related to cannabis use were not associated with OFC volume.

Conclusions: This study suggests less of an association between OFC volume, CUD severity and obsessions and compulsions related to cannabis use than was hypothesised. However, in order to comprehensively investigate the OFC in CUD, multiple structural MRI analysis techniques should be utilised, instead of volume extraction alone (e.g. volume, surface area, morphology, thickness), functional MRI analysis should also be used (e.g. connectivity, activation). In addition, the cross-sectional design of the current study limits the insight available to understand the lack of OFC volumetric findings. A longitudinal investigation would help to inform whether OFC volumetric changes may occur in relation to changes in CUD severity.

Investigating the relationships between prestimulus EEG components and performance in the auditory Go/NoGo task

Nathan J. Attard[1,2*], Frances M. De Blasio[1,2], Georga Bovingdon[1,2], and Robert J. Barry[1,2]

[1]School of Psychology, University of Wollongong, Australia
[2]Brain & Behavioural Research Institute, University of Wollongong, Australia

Aims: Electroencephalographic (EEG) spectral amplitudes are typically thought to be associated with performance in the Go/NoGo paradigm, implicating ongoing EEG activity in the cognitive processes required for successful completion of the task. These EEG–performance relationships have been previously investigated in the context of *prestimulus* periods, using traditionally defined EEG band ranges, and in *resting-state* periods, using frequency principal components analysis (f-PCA). However, research has yet to examine the links between prestimulus brain-states and behavioural outcomes using f-PCA. The present study therefore aimed to assess these prestimulus EEG–behavioural associations in an equiprobable auditory Go/NoGo paradigm, using this improved methodology.

Method: Twenty-seven young adult university students (M_{age} = 20.6 years; 16 females) completed an equiprobable auditory Go/NoGo paradigm while continuous EEG was recorded. These data were EOG corrected and, for trials with correct responding, epochs were extracted (-500 to 499 ms relative to stimulus onset), baselined (-100 to 0 ms), and artifact rejected. Data from -500 to 0 ms in the accepted epochs were DC corrected, windowed, and zero-padded before being subjected to Discrete Fourier Transformation in order to obtain prestimulus spectral data at 1 Hz resolution. Prestimulus Go and NoGo EEG spectra (DC to 45 Hz) were then submitted to separate f-PCAs, each with unrestricted Promax rotation, and amplitudes were extracted for frequency components accounting for ≥2% variance. Go/NoGo performance was quantified in terms of response accuracy (commission errors in NoGo, and omission errors, fast and slow reaction time [RT] errors in Go) and Go processing speed (mean RT and RT variability). Separate multiple regressions were used to identify relationships between the prestimulus spectral component amplitudes and performance measures in Go and NoGo.

Results: The prestimulus Go and NoGo f-PCAs yielded eight and seven frequency components, respectively. There were no significant associations found between the prestimulus frequency component amplitudes and commission errors in NoGo, nor between the prestimulus frequency component amplitudes and omissions, slow RT errors, mean RT, or RT variability in Go. However, both focal and global amplitudes in a prestimulus alpha component peaking at 11 Hz showed significant associations with fast RT error rates in Go.

Conclusions: The present findings failed to confirm the limited prior reports of significant associations between prestimulus EEG amplitudes and equiprobable Go/NoGo performance. However, the novel association uncovered in Go between a natural prestimulus alpha component and fast RT error rates suggested that amplitude fluctuations at this frequency (~11 Hz) may play a role in impulsivity. Further research assessing prestimulus EEG is necessary to confirm these findings.

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

Jennifer Baldock[1*], Sarosh Kapadia[1], Willem van Steenbrugge[1], and Jason McCarley[1,2]

[1]Flinders University, South Australia, Australia
[2]Oregon State University, Oregon, USA

Aims: Task-evoked pupil responses (TEPRs) can be used as a non-invasive, proxy measure of autonomic nervous system activity during cognitive effort. 'Listening effort' can be defined as the mental exertion required to attend to, and understand, an auditory message. TEPRs have been used to measure listening effort in hearing research but might be useful in audiology clinics as well. There are conflicting reports regarding the effects of differing light levels on TEPR amplitude in various cognitive tasks, but this has not yet been examined during listening effort. Thus, this research aimed to systematically examine the effects of multiple light levels on TEPR amplitude during effortful listening.

Method: Thirty-six otologically normal adults (18-40 years) with no reported cognitive, hearing, speech or language difficulties participated. Each participant completed 16 conditions of a speech-in-noise test (the BKB sentence test) where the task was to correctly repeat target sentences presented in background babble noise. A 4 (light condition: 21 lux, 41 lux, 65 lux, 95 lux) x 4 (signal-to-noise ratio (SNR): -6 dB, -3 dB, 0 dB, +3 dB) repeated-measures design was used. Pupil diameter was continuously recorded. Data were analysed with a 4x4 repeated-measures ANOVA.

Results: There were statistically significant main effects of light level (p = <0.001) and SNR (p = <0.001) on TEPR amplitude. There was a statistically significant interaction between light condition and SNR in their effects on TEPR amplitude (p = <0.001). Results indicated that TEPR amplitude was more sensitive to changes in listening effort in dimmer light and that TEPR amplitudes were more greatly affected by light condition in poorer SNRs in the speech-in-noise task.

Conclusions: The results of this study provide the first empirical evidence that TEPR amplitudes are affected by light condition in a speech-in-noise task. Combined with the results of previous research, these findings suggest that the relationship between TEPR amplitudes and light levels might be dependent on the types of cognitive tasks under examination (e.g. sustained vs transient, arithmetic vs decoding speech in noise). Measurement of TEPRs may provide a unique opportunity to measure cognitive effort in a variety of settings. Thus, understanding the environmental factors that may affect this response is essential. In the context of listening, additional research should be carried out to further assess the effects of light levels in various types of listening tasks with various participant groups.

Using caffeine as a tool to probe active ERP markers of cognitive processing in a Go/NoGo task

Robert J. Barry[1,2]*, Jack S. Fogarty[1,2], and Frances M. De Blasio[1,2]

[1]School of Psychology, University of Wollongong, Australia
[2]Brain & Behaviour Research Institute, University of Wollongong, Australia

Aims: Caffeine is the most commonly-used stimulant in the world, and has been shown to produce an increase in arousal level. The general "arousal-as-amplifier" effect generates expectations that caffeine ingestion should result in widespread amplification of ERP markers in cognitive tasks. Previous caffeine/ERP studies have not found consistent outcomes supporting this hypothesis. Here we more carefully examined the hypothesis that caffeine should amplify task-specific ERP markers of *active processing* in the Go- and NoGo-processing steams of an equiprobable Go/NoGo task.

Method: We tested 24 young adults in a randomized double-blind placebo-controlled repeated-measures cross-over study examining the effects of 250 mg of caffeine vs. placebo in sessions 1 week apart. Each session presented two blocks of an auditory equiprobable Go/NoGo task with 60 dB SPL tones at 1000 and 1500 Hz (all 50 ms duration including 5 ms rise/fall time) in counterbalanced orders. On each occasion there were 150 Go and 150 NoGo trials, at a fixed SOA of 1100 ms. Continuous EEG from 0.15 to 30 Hz was sampled at 512 Hz from 19 scalp sites of the "10-20" system, plus 4 EOG electrodes. EEG was EOG-corrected, then artefacted trials and behavioural errors were rejected. Average ERPs were formed for Go/placebo, Go/caffeine, NoGo/placebo, and NoGo/caffeine; these were submitted to separate temporal PCAs using the covariance matrix input, with extraction and rotation of all components via Varimax.

Results: Significant amplitude enhancements with caffeine were obtained for N1-1, P3b, and SW in the Go processing stream, and the Processing Negativity, SW, and Late Positivity of the NoGo processing stream. These correspond to the major active cognitive processing markers associated with the separate Go and NoGo processing streams in the Sequential Processing Schema, as developed for this paradigm in our previous work.

Conclusions: The differential amplification of elements in the separate processing streams in this paradigm supports our more-focussed hypothesis for caffeine and arousal-as-amplifier, suggesting that caffeine may be useful in exploring functional processing in future ERP studies. The specific nature of these effects may also help understanding of previous inconsistent results in the literature.

Investigating the relationship between eyes-closed and -open resting-state EEG and behavioural outcomes

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Aims: Associations have been reported between resting electroencephalographic (EEG) activity and a number of Go/NoGo performance measures. However, these relationships have been assessed in relation to eyes-closed (EC) data, and the reactive change from EC to eyes-open (EO) conditions, while EO data is yet to be independently explored. The present study aimed to replicate the previously reported associations between resting EC and behavioural outcomes in the equiprobable Go/NoGo task, and to extend this analysis to include EO resting activity.

Method: Continuous EEG was recorded from 27 students (M_{age} = 20.2 years) from an undergraduate university population while they completed two 2 min blocks of resting with EO and EC. Sequential 2 s epochs were extracted, DC corrected, and automatically artefact rejected. Accepted epochs were subjected to Fast Fourier Transformation, and the mean (within-subjects) spectral amplitudes (DC to 45 Hz) were extracted. These spectral data were then submitted to separate frequency-PCAs for each condition (EO, EC), each using unrestricted Promax rotation.

Results: Eight frequency components were assessed in EC, and seven in EO; these peaked across the traditional delta to gamma band ranges. The current study failed to replicate the previously reported relationships between the spectral EC amplitudes in delta and alpha frequency components and mean Go reaction time, and between EC alpha frequency components and NoGo Commission errors. However, exploratory analyses uncovered associations between spectral amplitudes in three frequency components, two EC alpha components peaking at 9 and 10.5 Hz, and an EO gamma component peaking at 41.5 Hz, and fast reaction time errors. Relationships were also found between a delta-theta-alpha EO component and slow reaction time errors. Lastly, associations were found between an EC gamma component (peaking at ~30.5 Hz) and NoGo commission errors.

Conclusions: Overall, these relationships further contribute to the literature linking resting-state EEG and performance. However, the disparate findings point to the need for larger studies to obtain a reliable data base.

Musically-surprising events as indexed by skin conductance levels

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Aims: A body of work in the music psychology literature suggests that musical emotions are created by the interplay of music and the listener's unconscious statistical expectations gleaned from a lifetime of music listening. The most detailed neurophysiological model of these musical expectations is Huron's ITPRA model, which suggests that musically-surprising events lead to physiological arousal and related cognitive events. However, little psychophysiological research has examined musical expectations, especially over the longer periods of time more typical of pop songs, let alone symphonies. Skin conductance level (SCL) is a direct measure of arousal, and we expected that SCL would provide insight into how musical expectations alter over the course of a musical piece with several different levels of repetition and musically-surprising events.

Method: We measured SCL in 34 right-handed undergraduate participants (M_{age} = 21.0, *SD* = 3.6 years; 19 females; with a basic level of music perception ability) while they passively listened to unfamiliar 192 s musical sequences based around tonal harmony, each with six repeats of a 32 s pattern, itself comprised of repeats of three musical phrases of different surprisingness. There were two versions of the 32 s pattern, one without (A) and one with (B) a rhythmic alteration. These formed two sequences: AAAABA or BBBBAB. Each participant heard both sequences in counterbalanced order, although only the first-presented was assessed for this presentation. Mean SCL within each consecutive 2 s epoch were assessed, after adjusting for SCL lag (within-subjects).

Results: There was a strong overall decrement in SCL across the musical sequence, suggesting that the predominant effect of the music is calming. However, as participants became more familiar with the patterns and phrases through repetition, this decrement either plateaued or reversed, specifically in response to portions of the music that featured more musically-surprising events.

Conclusions: These SCL outcomes suggest that arousal responses associated with the general newness or novelty of the sequence are outweighed by higher level arousal responses to *musically-surprising* events that strengthen as the structure of the piece becomes clearer to participants.

Eyes-closed resting state EEG: Subjective cognitive impairment, mild cognitive impairment, and matched controls

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Aims: Dementia is a syndrome associated with a significant decline in cognitive functioning that impacts on the ability to perform everyday tasks and affects approximately 50 million people worldwide. Understanding the neuronal progression to dementia via the spectrum of cognitive decline may assist in identifying disease mechanisms involved in this process. Subjective Cognitive Impairment (SCI) is an everyday concern an individual has about a decline in their cognitive functioning, particularly within the areas of memory and attention. SCI carries an increased risk of future objective decline in cognitive abilities: both Mild Cognitive Impairment (MCI) and dementia. The present study aims to understand the differences in Eyes-Closed (EC) resting electroencephalographic (EEG) activity between older adults with SCI and those with MCI, each compared to healthy controls (HCs), to elucidate neuronal mechanisms associated with increased dementia risk.

Method: Participants were 39 older adults (n = 13 per group: HC, SCI, MCI) matched on age (HC: M = 69.49, range 62.82–79.87 years; SCI: M = 68.31, range 60.79–76.68 years; MCI: M = 69.64, range 60.52–79.32 years), sex (each 5:8 male:female ratios), and education. Significant differences were observed between HC and SCI compared to MCI in neuropsychological screening tests including The Modified Telephone Interview for Cognitive Status (TICS-M) and Montreal Cognitive Assessment (MoCA). Two minutes of EC resting EEG was recorded from 60 scalp sites. EOG-corrected data were divided into 2 s sequential epochs and Discrete Fourier Transformation was applied. EEG band amplitudes in delta (0.5–3.5 Hz), theta (4.0–7.5 Hz), alpha-1 (8.0–10.5 Hz), alpha-2 (11.0–13.5 Hz), beta-1 (14.0–20.5 Hz), and beta-2 (21.0–29.0 Hz) were compared between all three groups.

Results: Between SCI and HCs, significant group × topography interactions were observed in all six bands. For SCI compared to HC, delta, theta, beta-1 and beta-2 were greater frontally, with a right hemispheric enhancement for beta-2, and alpha-1 and alpha-2 were smaller parietally. For MCI compared to HCs, beta-2 was larger centrally, particularly in the left hemisphere, with a frontal enhancement. For SCI compared to MCI, delta and theta were larger frontally, alpha-1 was smaller parietally, and beta-1 was reduced on the left.

Conclusions: Focal topographic interactions were evident in all bands when comparing SCI group to HCs. Unexpectedly, the SCI group showed greater slow wave frontal activity than both HC and MCI groups, and the typical dominant parietal EC alpha was not observed. Greater frontal beta activity was evident in both the MCI and SCI groups compared to HCs. Previous research utilising Fluorodeoxyglucose Positron Emission Tomography (FDG-PET) has found a pattern of progression to further cognitive decline in individuals with MCI, exhibiting frontal hyperactivation. In the current study, a similar pattern of dominant frontal hyperactivation is suggested, particularly in the SCI group. These findings may provide insight into early detection of future objective decline for both SCI and MCI groups. Future research should explore the relationship between the pathophysiology of cognitive decline in SCI and neuronal activation, to determine possible early predictors of progression to MCI or dementia.

Exploring the relationship between metabolic indicators of neuroinflammation, excitatory neurotransmission, and ERP responses during a continuous performance test in mild cognitive impairment (MCI) due to AD

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Aims: Neurodegenerative diseases such as Alzheimer's Disease (AD) and the prodromal phase, mild cognitive impairment (MCI), are characterised by accelerated age-inappropriate cognitive decline. Currently, there are no early interventional strategies for MCI and it is not known what causes some patients to progress to AD. Previously, it has been shown that deficits in executive function can be a strong predictor for MCI conversion to AD. Furthermore, deficits in executive function are also the strongest cognitive predictor of future functional impairment. It is well known that many aspects of executive function are mediated by monoamine neurotransmitters, such as dopamine, norepinephrine, and epinephrine. This study aims to better characterise the neural substrates and the interaction with monoamine neurotransmitters that underlie cognitive deficits in MCI.

Method: This study will explore ERP component outcomes elicited during the AX variant of a continuous performance test (CPT) for people with MCI in comparison to cognitively normal people (HCs). Additionally, we will explore the relationship between ERP component amplitudes and cognitive deficits with peripheral neurotransmitters (or their metabolites), and inflammatory mediators.

Results: We predict that AX-CPT ERP components underpinning executive function (e.g., N2) will be attenuated in people with MCI compared to HCs, and that this relationship will be mediated by dysregulation of monoamine neurotransmitter levels and pro-inflammatory cytokines (e.g., TNF-α, IL-6, IL-1β).

Conclusions: This project will reveal what ERP component amplitudes are affected by cognitive decline in people with MCI, and how they relate to metabolic indicators of inflammation and neurotransmission.

The effects of Methylphenidate on the EEG of children with ADHD during an eyes-closed resting condition

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Aims: Attention-Deficit/Hyperactivity Disorder (AD/HD) is the most common psychiatric disorder of childhood, affecting approximately 5% of children globally. The DSM-5 classes it as a neuro-developmental disorder, with the symptom profile consisting of hyperactivity, impulsivity and inattention. Currently methylphenidate is the most prescribed medication for AD/HD in the world. Past EEG research has shown that children with AD/HD have an EEG profile defined by increased delta and theta and reduced alpha, beta and gamma activity. Studies of mixed stimulants have found that the stimulants result in normalisation of the EEG. The effects of methylphenidate have also been investigated, but only in an eye-open condition. The aim of this study was to investigate the effects of Methylphenidate on the EEG of children with AD/HD during an eyes-closed resting condition.

Method: Fifty children with AD/HD and 50 control subjects, between the ages of 8 and 12 years participated in this study. Subjects were initially assessed for AD/HD by a Paediatrician and a Psychologist, at which time an EEG was performed. Where a diagnosis was made, subjects returned within 1 week for a medication assessment and a second EEG was recorded 1.5 hours after the subjects has ingested 10 mg of methylphenidate. EEG was recorded during an eyes-closed resting condition from 19 electrodes, and Fourier transformed to provide absolute and relative power estimates in delta, theta, alpha, beta and gamma bands.

Results: Unmedicated, the AD/HD subjects had increased global absolute and relative delta, increased posterior relative theta, reduced global relative alpha, and reduced global absolute and relative gamma activity compared to control subjects. Methylphenidate resulted in global increases in absolute and relative beta activity, and in relative gamma.

Conclusions: Significant increases in fast wave activity were observed. However, unlike past research, it is debatable whether this should be considered as normalisation of the EEG. These results need consideration in terms of the subjects used in this study, as all were diagnosed with AD/HD, but were not necessarily good responders to the medication.

Electrodermal characteristics of musical repetition and change: Informing Huron's theory of expectation

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Aims: Huron's ITPRA theory postulates that music builds and interacts with our expectations and emotions. The theory encompasses a series of responses which occur with temporally unfolding musical stimuli. These responses are Imagination and Tension in anticipation of a musical event, which subsequently influence Prediction, Reaction and Appraisal upon evaluation of the event's outcome. With physiological arousal levels proposed as an outcome of some of these responses, and skin conductance level (SCL) indexing physiological arousal, we aimed to explore Huron's theory. We specifically examined SCL with expected (i.e. repeating) and unexpected (i.e. changing) musical rhythm and pitch. We predicted primarily that a change in SCL will occur in response to an unexpected musical event.

Method: Data were sampled from 34 right-handed undergraduate students, between the ages of 18.0 and 32.0 years, with basic music perception abilities. Continuous SCL data were recorded while participants completed 2 passive listening trials, each 3 minutes and 12 seconds in duration, comprising six 32-second patterns. Within each 32-second pattern, a rhythmic pattern of either no rhythm change (NC), or a rhythm change (RC) was followed by a change in pitch; shifting from an A minor-based epoch, to a D minor seventh-based epoch, and then to C major-based epoch. Trials were composed of four repeated musical patterns of either NC or RC, followed by a subsequent change to the alternate rhythm, and then concluded by reverting back to the original rhythm. The sequence was then inverted for the second trial, with trial order counterbalanced across participants. Absolute and relative SCL data were calculated across both trials, once SCL lag was corrected. The mean SCL for RC and NC patterns were plotted over eight 4-second epochs. The SCL across the first 6 repeated epochs was analysed, as well as effects of the later A minor vs. D minor epochs, and A minor vs. C major epochs, to also observe effects of pitch change on SCL.

Results: For both absolute and relative data, a significant linear decrement across the first 6 epochs was found for RC and NC patterns. While relative SCL continued to show a significant reduction with the subsequent change from A minor to D minor seventh, interaction effects in both the absolute and relative data indicated that such reduction was greater in the RC pattern, while little change was seen in the NC pattern. There was also significantly lower absolute and relative SCL in the C major compared to A minor-based epochs, however, this did not differ between the NC and RC patterns.

Conclusions: The linear decrement of SCL to expected musical stimuli supports the Imagination and Tension components of ITPRA. Additionally, the changes in SCL to unexpected pitch and rhythm events gives promising results that bring us closer to providing an empirical basis for ITPRA.

Validating a portable neurogaming headset to take EEG out of the lab

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Aims: We are using portable Electroencephalography (EEG) to measure brain activity in athletes to track brain health in contact sports and the effects of concussion on the brain. To study this we are leveraging the steady state visually evoked potential (SSVEP) – a robust, largely artefact-free measure that can be recorded quickly. Nevertheless, laboratory recordings are hard to organise for athletes because they are lengthy, sometimes uncomfortable, and require athletes to travel to the laboratory. To overcome this we are using a commercial EEG system (EMOTIV Epoc+), which is portable, inexpensive, easy to set-up and can be taken to the sporting fields. However the question is, how reliable are our SSVEP measures with the portable EEG? The aim of our study was to validate the SSVEP measures from the EMOTIV Epoc+ against those measured by an experimental-grade system (BIOSEMI).

Method: In this study, we compared the portable EEG (EMOTIV Epoc+) against the research-grade BIOSEMI. To setup, the EMOTIV was fitted over the BIOSEMI cap and recordings were taken from both systems simultaneously. Participants were given two-minutes of flashing lights (with counter-balanced brightness levels) followed by a five-minute blank screen.

Results: Preliminary results indicate SSVEP recordings in both BIOSEMI and EMOTIV EEG systems were similar across all participants, with both systems reliably recording the SSVEP. Some differences in signal-to-noise ratios were found, which could reflect a difference in the properties of the systems used.

Conclusions: While we acknowledge the differences between the two systems, the EMOTIV Epoc+ system appears to be able to measure SSVEP reliably. This validates our continuing research, taking the EEG measure out of the lab so we can record athletes' brain activity field-side.

Executive function performance effects on RS-EEG in typically-developing children

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Aims: Recent research has indicated that frontal delta activation (i.e. the reduction in delta power in an eyes-open compared to eyes-closed task) can predict executive function (EF) ability in children with AD/HD. To further explore EF effects on resting EEG, the current study examined frontal EEG measures (arousal, theta/beta ratio, and activation) in typically-developing children as a function of good versus poor performance on working memory (WM), inhibitory control (IC), and set-shifting (SS) tasks.

Method: A custom-built software program designed for brief portable assessment of neurocognitive attributes in children was used to collect all data. Frontal resting-state electroencephalogram was recorded from 102 children aged 7-12 years in eyes-closed, eyes-open, and focus conditions. Participants also completed three EF tasks deriving performance indices for WM, IC, and SS.

Results: Activation effects were present for frontal delta, theta, and alpha power. While EF performance effects on arousal were not significant, a main effect of Performance and a Performance by age effect approached significance for the IC task. EF performance effects on frontal theta/beta ratio were not supported. The lower WM performance group showed reduced resting frontal theta power, with a similar effect approaching significance for frontal alpha power. For SS, the frontal theta activation effect for was similar for both 7-9 year and 10-12 year groups who performed well, while this effect was substantially reduced for the 10-12 year compared to 7-9 year group for children who performed less well.

Conclusions: The frontal delta, theta, and alpha activation effects replicate previous reports in children. Results provide preliminary indications that individual differences in arousal and activation may be connected to EF ability in typically-developing children.

Not all resting alpha frequency components index arousal

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Aims: Spectral amplitudes are traditionally quantified into band activity occurring within broad frequency ranges (e.g., alpha ~8.0-13.0 Hz), or in narrower ranges within these broader bands (e.g., low alpha ~8.0-10.0 Hz and high alpha ~10.0-12.0 Hz). Investigations of the latter narrow-band activity has contributed to speculation that different frequencies may reflect different functionality, even when those frequencies occur within the same traditional band range. More recently, frequency principal components analysis (f-PCA) has been shown as a viable alternative quantification technique that efficiently separates spectra into natural (i.e., data driven) frequency components. The present study examined f-PCA derived resting alpha components as indices of arousal, assessing their relative global amplitudes in relation to skin conductance level (SCL).

Method: Twenty-seven young adults (M_{age} = 20.8 years) completed three 2 min resting blocks with alternating eyes-open (EO) and eyes-closed (EC) while continuous EEG and SCL were recorded. Following EOG correction, non-overlapping DC corrected and artifact free 4 s EEG epochs were subjected to Fourier Transformation, and the mean (within-subject) spectral DC-30 Hz amplitudes were submitted to separate f-PCAs for each block (EO_1, EC, EO_2). Frequency components carrying ≥ 2% variance that peaked within the traditional alpha band were identified for analysis. Mean (within-subject) SCL was computed across each 2 min block (EO_1, EC, EO_2).

Results: The EO_1 and EO_2 f-PCAs each yielded two substantial alpha components, confirmed to be congruent between the datasets, while the EC f-PCA yielded four alpha components. SCL showed the typical increase from EC to EO, indicative of an arousal shift. Spearman's Rank order correlations revealed inverse associations between the relative global peak amplitudes in each resting alpha component and SCL. Across the EO_1 and EO_2 data, the lower-frequency 9.25 Hz component correlation approached significance (ρ = -.20, p =.069), and the higher-frequency 11.50-11.75 Hz component reached significance (ρ = -.25, p = .034). In EC, only the lowest-frequency 8.50 Hz component correlation approached significance (ρ = -.29, p = .073).

Conclusions: Each of the two f-PCA derived EO alpha components, and one of four EC components showed evidence of being inverse indices of arousal. f-PCA provides an efficient and objective way to disentangle discrete frequency components, peaking within and across the traditional band ranges, and thus appears particularly suited for use in the investigation of the functional correlates of spectral data.

Eyes closed resting alpha changes in women with chronic pelvic pain following acupuncture treatment

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Aims: Chronic pelvic pain (CPP) is pain in the pelvis of greater than six months duration, and is severe enough to cause functional disability or require medical intervention. Endometriosis, a condition where tissue similar to the lining of the uterus is found in other places, is the most common cause of CPP. Worldwide, 24% to 40% of women with CPP also have a diagnosis of endometriosis. Women with endometriosis commonly have severe pelvic pain, period pain, and pain on sexual intercourse. Current medical treatment is ineffective for many women and is often discontinued due to side effects. Acupuncture is often employed as an alternative or adjunct treatment in various chronic pain conditions including osteoarthritis, low back pain and dysmenorrhoea; as it is minimally invasive, and low risk. In chronic pain populations, EEG alpha amplitudes are often elevated and peak alpha frequency (PAF) reduced, compared to controls. The aim of this study was to explore whether women with endometriosis-related CPP would exhibit reductions in eyes-closed resting-state EEG alpha amplitudes and increased PAF after an 8-week acupuncture intervention.

Method: Right-handed women aged 18–45 years (mean age = 28.9, SD ± 5.6) with a laparoscopic diagnosis of endometriosis were recruited (N = 13), and received 2 × 45-minute acupuncture sessions for 8 weeks. Data from subjective daily pain ratings, 2 min eyes-closed resting EEG, a conditioned pain modulation (CPM) task, and plasma pro-inflammatory cytokine (IL-6) were obtained pre- and post-intervention (T1, T2). Frequency principal components analysis (f-PCA) was used to decompose EEG data at T1 and T2 and ELISA to quantify IL-6 in plasma.

Results: Four f-PCA component pairs were consistent across T1 and T2: Alpha-II peaking at 9.0 Hz, Alpha-III/IV peaking at 10.0 Hz at T1 and 11.5 Hz at T2, Beta-I peaking at 19.0 Hz, and Beta-II peaking at 26.0 Hz at T1 and 26.5 Hz at T2. Alpha-II showed a global amplitude increase between T1 and T2. In the Alpha-III/IV component, a relative increase in PAF and global amplitude reduction were observed from T1 to T2. A relative reduction in subjective pain scores was also observed post-intervention, which significantly correlated with the relative reduction in Alpha-III/IV amplitude (r = .58; p = .019, one-tailed). CPM scores were highly variable (mean increase 86.25%, SD ± 381.25%), and no clinically meaningful changes were observed in IL-6 pre- vs. post-intervention.

Conclusions: A reduction in eyes-closed resting alpha amplitude, and relative increase in PAF was observed in the higher alpha component (Alpha-III/IV) for women with endometriosis and CPP following an 8-week acupuncture intervention, and this reduction was associated with a statistically significant reduction in subjective pain scores. EEG alpha may represent a viable prognostic marker for chronic pain and response-to-treatment which warrants further investigation.

Investigating natural EEG frequency component correlates of mindfulness

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Aims: Mindfulness can be described as the deliberate, present-moment awareness of one's own experience, without judgment, and can be formally practiced through meditation. Following the investigation of the benefits of mindfulness in clinical practice, research is now seeking to understand the underlying mechanisms and components which lead to beneficial health outcomes. The aim of this study was to investigate changes in the spectral power of the EEG in participants who practiced mindfulness.

Method: Thirty-three participants consisting of 17 females and 16 males between 19 and 33 years of age completed two testing sessions approximately one-month apart. Between sessions, participants engaged in a daily mindfulness breathing exercise. EEG data were recorded during an eyes-closed resting condition and mindfulness task using a 19-channel cap. Frequency Principal Components Analysis was used to explore naturally occurring frequency components in the data. Regional mean amplitudes that reflected the core components of the EEG that showed congruency across condition and time were assessed.

Results: Four components were identified as congruent between conditions and at both recording sessions. A complex component comprising of traditional delta, theta, and alpha frequencies peaked at 8 Hz in the first eyes-closed testing session, and at 4 Hz in the second eyes-closed condition, and in the mindfulness condition at recording sessions. Across conditions, this component demonstrated a significant reduction in amplitude at the second testing session compared with the first, and although this reduction was substantial in the resting condition, a small increase was seen in the mindfulness condition. A low alpha component, peaking between 9.5 Hz and 10.0 Hz, demonstrated significant amplitude reductions during mindfulness compared to rest, an effect that was found across sessions. In addition, a main effect of session was evident, with a significant increase in amplitude in the second testing session compared with the first session, across both rest and mindfulness conditions. However, these effects did not interact. A high alpha component peaking between 11.5 and 12.0 Hz, and a complex alpha-beta component peaking between 18.5 and 20.5 Hz, both showed significant amplitude reductions in mindfulness compared to rest across sessions. In the second testing session, the alpha-beta component showed an amplitude reduction in the rest condition, and an increase in amplitude in the mindfulness condition, each relative to the first testing session.

Conclusions: The decrease in alpha component amplitudes in mindfulness relative to the resting condition is contrary to most findings across the traditional bands. However, the increase in amplitude in all four components in the mindfulness condition, for the second relative to the first testing session, supports previous findings implicating proficiency of practice. These findings provide novel insights into the electrophysiological differences between resting and mindfulness states, and how they change with mindfulness practice.

Nucleus accumbens volume in cannabis use disorder and its association with obsessions and compulsions

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Aims: Smaller Nucleus Accumbens (NAc) volume has been assoicated with increased dependence in a range of substance use disorders. This brain region is heavily implicated in reward processing and the maintenance of compulsive drug use in chornic stages of addiction. However, the relationship between NAc volume, Cannabis Use Disorder (CUD) and compulsivity, has not been investigated in regular cannabis users. This study aimed to determine whether NAc volume is smaller in severe CUD and whether smaller NAc volume is associated with increased obsessive and compulsive symptoms related to cannabis use.

Method: NAc volume was compared between regular cannabis users who met criteria for severe CUD (n=17), mild-to-moderate CUD (n = 22) and non-using controls (n = 9), matched for age and sex. Cannabis users used cannabis at least 4 days per week for the past 12 months and were stratified into dependence severity groups using the Structured Clinician Interview for DSM-V. Regular cannabis users completed a modified for cannabis use Obsessive Compulsive Drug Use Scale (OCDUS-CAN) and associations were performed in relation to NAc volume.

Results: There were no significant differences in NAc volume between either CUD groups or cannabis groups and controls. Smaller left NAc volume was associated with a higher OCDUS-CAN Obsessions Subscale (p = .008).

Conclusions: This study suggests there may be a relationship between NAc volume and obsessive symptoms in CUD, indicating a possible target for treatment. However this study was limited by its sample size and cross-sectional design. Future research is warranted to further explore the NAc in CUD, and its association with the OCDUS-CAN. A longitudinal study including functional MRI techniques investigating the NAc with changing CUD severity and OCDUS-CAN scores over time would help establish the NAc role in CUD, and could lead to the development of novel treatments.

Plasma prolactin is dysregulated in depression and correlated with psychometric measures

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Aims: Prolactin is a hormone secreted by the anterior pituitary gland which has a range of functions related to reproduction. However, prolactin is also implicated in mental health, as well as cardio-metabolic disease risk. People with MDD are at increased risk of developing cardiometabolic disease, however the biopsychosocial pathways are not clear. In terms of depression and the onset of stress, prolactin secretion increases to promote stress adaptation and coping responses. In this context, prolactin counteracts glucocorticoid actions on the immune system and inhibits hypothalamic secretion of corticotropin-releasing hormone. In terms of cardiometabolic disease risk factors, prolactin has been associated with increased visceral adiposity, greater insulin resistance and higher BMI. This suggests one pathway by which people with depression and higher prolactin level due to high stress could be at risk of developing cardiometabolic disease. This study assessed whether plasma prolactin level differs in people with major depressive disorder (MDD) in comparison to healthy controls, and whether prolactin correlates with biometric and physiological measures (weight, BMI, waist circumference, blood pressure and heart rate) and psychometric measures.

Method: Plasma of 120 participants (n=60 depressed, n=60 control) were analysed to assess the level of prolactin. Depressed and control groups were gender and age matched. Biometric and physiological data (weight, BMI, waist circumference, blood pressure and heart rate) were collected, and participants completed the responses to Brief Symptom Inventory (BSI) and Depression Anxiety Stress Scale (DASS). Statistical Package for Social Sciences (SPSS) software was used for statistical analysis. Two-way ANOVA was used to compare prolactin between depressed and control groups, and between males and females. Correlations were conducted to determine associations between prolactin and biometric, physiological and psychometric data.

Results: Participants' age range was 18 to 54 years (mean = 25.05, SD = 6.61), including 68 females and 52 males. In comparison to the healthy controls, plasma prolactin level was significantly higher in the MDD group. Prolactin was also significantly higher in females than males. Prolactin significantly correlated with heart rate (r=0.243, p=0.008), but not with any other biometric or physiological measures. Among the psychometrics measures, prolactin was significantly correlated with most subscales of the BSI (Somatization, Major Depressive Disorder, Anxiety, Hostility, Phobia, Paranoid Ideation, Psychoticism, Interpersonal Sensitivity) and with DASS Anxiety, but not with Stress or Depression.

Conclusions: Prolactin was correlated with many types of psychopathology and therefore may be important to further investigate its role in relation to MDD and mental health. Though prolactin is proposed to be associated with the risk of cardiometabolic disease, it did not correlate with weight, BMI or blood pressure. Inclusion of additional parameters in future studies, such as plasma lipids, visceral fat, fasting blood glucose, insulin resistance, would facilitate more comprehensive examination of any associations between prolactin and risk factors for cardiometabolic disease.

The first 250 ms of auditory Go/NoGo processing

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Aims: The N1 of the average stimulus-locked electroencephalographic event-related potential (ERP) is a complex waveform comprising several overlapping ERP components associated with sensory information processing. Processing Negativity (PN) is an N1 component that is thought to be evident only in individuals who are selectively and *proactively* processing sensory input to facilitate stimulus discrimination via an attentional trace. Previous ERP research suggests that young adults elicit PN in auditory Go/NoGo tasks; however, there have been discrepancies in the identification (or labelling) of that component. To address those discrepancies, this study aimed to clarify the full N1 complex by decomposing and analysing the first 250 ms of ERP data elicited in two commonly used Go/NoGo tasks with varying attentional demands.

Method: ERP data were elicited in 60 healthy right-handed young adults (M = 20.4, SD = 3.1 years), during the successful completion of two auditory Go/NoGo tasks, differing in Go stimulus probability (50% vs. 70% Go). The first 250 ms of the averaged ERPs from each task were submitted to separate temporal principal components analyses (PCAs). PCA component amplitudes were then analysed in relation to stimulus type (Go vs. NoGo) and probability (Higher vs Lower); component-oriented source analyses were also conducted in eLORETA. Difference waveforms were calculated from the raw data to identify the traditional marker of PN – the Negative Difference (Nd).

Results: No PN (or Nd) component was identified in this study. Following a thorough assessment of the PCA data, the component labelled as a Go/NoGo PN in prior studies was considered to be a better match to N1c. In total, five components were identified in the first 250 ms of auditory Go/NoGo processing, including (in latency order) P1, N1a, N1b, and N1c; followed by either Go P2 or NoGo N2b. P1 and N1b amplitudes were sensitive to stimulus type (NoGo > Go), while N1a and N1c responded to stimulus probability (Lower > Higher); P2 increased with Go probability. eLORETA found complex neuronal sources involved in this Go/NoGo processing sequence, including several active prefrontal sources that were common to each component.

Conclusion: The Go/NoGo PCA component sequence identified in this study clarified the ERP markers of the first 250 ms of auditory Go/NoGo information processing in healthy young adults. The absence of PN could also suggest that young adults do not need to proactively process sensory information to successfully complete the auditory Go/NoGo task; alternatively, the present findings could question the link between PN and selective attention. The stimulus type and probability effects demonstrated functional specificities for several components, and perhaps some commonality between P1 and N1b, and between N1a and N1c. This can be supported by the source outcomes, which illustrated complex sequential processing in the cortex that could be used to develop a model of auditory Go/NoGo processing in future research.

The effect of sleep quality and duration on resting state EEG in typically-developing children

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Aims: Sleep plays a vitally important role in the cognitive, social, emotional and behavioural development of children. Research examining the physiological markers of sleep problems in children is scarce but important as it extends our understanding of the effect of sleep on these developmental outcomes. The current study explored whether typically-developing children aged 7-12 years who have poorer sleep quality or shorter sleep duration have different resting state EEG characteristics to their peers, focussing on arousal, resting activation, and a novel measure, attentional activation.

Method: Frontal EEG was recorded from 102 typically-developing children aged 7-12 years during eyes-closed and eyes-open resting conditions and a focus task, via a single-channel, dry-sensor EEG device. Single-channel, dry-sensor EEG recording devices are being implemented in research and real-world settings as an alternative to traditional, multi-channel electrode EEG caps. Sleep patterns were measured via a self-report questionnaire, the Children's Report of Sleep Patterns. Sleep quality scores were median split to create two sleep quality groups (i.e. good, poor). The same process was undertaken for sleep duration, creating two sleep duration groups (i.e. short, long). Age was considered in the analyses with two groups created (i.e. 7-9 years, 10-12 years).

Results: Sleep factors (quality or duration) had no effect on arousal levels, or delta, theta, alpha, or beta resting activation. The predicted attentional activation effect for beta was not found. For attentional activation long duration sleepers had a tendency for decreased theta power in the focus condition compared to the eyes-open condition, while for short sleepers, theta power increased in the focus condition compared to the eyes-open condition. For older children, poor and good quality sleepers had similar levels of delta across resting conditions, while for younger children, poor quality sleepers had increased delta power compared good quality sleepers across resting conditions. Similar effects were present for sleep duration. Finally, for older children, poor quality sleepers had decreased delta power compared to good quality sleepers across eyes-open conditions, while for younger children, poor quality sleepers had increased delta power compared to good quality sleepers in the eyes-open conditions. Similar effects were present for sleep duration.

Conclusions: The frontal delta, theta, and alpha resting activation effects replicate previous research. Further, these findings provide preliminary evidence that children with poorer sleep quality or shorter sleep duration may have different resting EEG characteristics to their peers. Taken together, these findings provide evidence for portable, flexible, accessible approaches to examining the physiological markers of poor sleep in children.

40 Hz auditory steady-state response during psilocybin intoxication

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Aims: Auditory steady-state responses (ASSRs) are used to test the ability of the brain to generate responses at specific frequencies. Disturbed 40 Hz ASSRs are observed in psychosis and schizophrenia. Similarly, altered 40 Hz ASSRs are found in GABAergic and glutamatergic models of psychosis. However, the role of serotonergic 5-HT2A receptors for 40 Hz ASSR impairments is unknown. This study aimed to investigate 40 Hz ASSRs in serotonergic model of psychosis induced by psilocybin, which acts as a 5-HT2A agonist.

Method: Psilocybin was administered orally in ratio of 0.26 mg/kg to 20 healthy volunteers (10 males). A crossover, double blind, placebo-controlled design was used. Auditory steady-state responses were recorded using high-density EEG during the peak of intoxication. Classical auditory steady-state stimulation with bursts of white noise (clicks) presented at 40 Hz was applied. To assess the effect of psilocybin, phase-locking index (PLI) of 40 Hz ASSRs was used as a primary measure.

Results: Psilocybin reduced fronto-central PLIs of 40 Hz ASSRs as compared to placebo.

Conclusions: Phase-locking reduction under the effect of psilocybin implies the importance of serotonergic system (specifically 5-HT2A receptors) in disturbances of synchronization to external auditory stimulation as observed in psychosis and schizophrenia.

Effect of expectedness of music on physiological arousal

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Aims: The physiological response to change in an environment is explained well in the Orienting Reflex (OR) Model proposed by Sokolov. The model suggests that the three main components - that is, habituation, recovery, and dishabituation - represent how we respond to unfamiliar events. Existing literature has supported these claims; however, very little has focused on this physiological theory in the field of music. A comprehensive model of psychological response to musical events, Huron's ITPRA model, proposes a cognitive process which we experience when perceiving unexpected musical events. Using Huron's model as a basis, our aim in the present study was to investigate if habituation is exhibited in the Skin Conductance Level (SCL) across all participants when subjected to musical stimuli with an unexpected change in the sequence. Based on Huron's model, it was hypothesised that there would be a difference between response to repeated expected sequences versus unexpected sequences in the music. It was also hypothesised that the properties of the OR would be apparent across all participants, that is, habituation, recovery and dishabituation.

Method: Thirty-four right-handed undergraduate Psychology students (M_{age} = 21.0, *SD* = 3.6 years) with a minimum level of musical ability participated in this study. SCL data were recorded as they passively listened to two sets of constructed musical sequences, presented in a counterbalanced order. These sequences were each made up of six 32 s patterns, for a duration of 3 min and 12 s, and consisted of instances of two patterns, one with a rhythmic change (RC), and one with no rhythmic change (NC). Sequence A consisted of four repetitions of the NC pattern, one instance of RC, followed by a return to the NC pattern. Sequence B consisted of four repetitions of the RC pattern, followed by an instance of NC, then back to the RC pattern. SCL data were averaged for each 32 s pattern, after adjusting for (within-subject) SCL lag, and both absolute and relative measures were analysed using Repeated Measures MANOVAs.

Results: Significant linear and quadratic decrement was found across the first four pattern repetitions, and the linear decrement was significantly steeper for Sequence A than Sequence B for the absolute (but not relative) SCL data; the remaining outcomes were consistent across the SCL measures (absolute, relative) and musical sequences (A, B). During the fifth pattern repetition, which involved a change from RC to NC, or vice versa, the participants did not recover or continue to show decrement, but rather demonstrated a plateau in their SCL data. In the sixth pattern repetition, after the original pattern resumed, the participants showed significant decrement to the music.

Conclusions: Consistent with Huron's model, the results demonstrated that the familiarity and expectancy of music impacts how we respond to it. When the music is more expected, habituation is seen, and arousal levels drop. However, when the music sequence becomes unexpected, habituation ceases, and this physiological response suggests there is a change in arousal.

Validation of a new electroencephalogram (EEG) device, the Emotiv Flex

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Aims: The objective of this study was to validate a new device to be used for event-related potential (ERP) research. The device, Emotiv Flex, is cheaper than many research grade EEG devices, (e.g., Neuroscan) which may make it more accessible to some researchers.

Method: The device was directly compared to Neuroscan using a simultaneous setup. The participants performed three tasks. Firstly, a passive auditory oddball task, where each subject is required to listen to two different tones passively. Secondly, an active auditory oddball task, where each participant is required to listen to two different tones but is required to count the higher pitch tones throughout the experiment. Lastly, an N170 task, where participants were shown photos of either faces or watches, either upside down or upright and required to indicate if the images shown were upright or upside down.

Results: The results suggested that the auditory P300 peak and mismatch negativity component were statistically equal for the Neuroscan and the Emotiv Flex. Although the N170 peak differed between the devices, intraclass correlations between the N170 waveforms showed a high degree of similarity, particularly in the right hemisphere.

Conclusions: Overall, these results demonstrated the Emotiv Flex as a viable and low-cost alternative to research-grade EEG for ERP research.

Neuroimaging of speech articulatory motor control in the human brain

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Speaking is among the most complex and difficult motor behaviours that our species is capable of performing. Mature speech production requires exquisite and precise control of some 100 muscles associated with the vocal tract. This control is finally achieved through a prolonged developmental learning process that begins in early infancy, advances in a rapid trajectory in the preschool years, and continues to be shaped and calibrated until at least late adolescence. Despite the physical complexity and extended learning time – and in contrast to expert motor performance in athletics and music – most humans smoothly achieve mastery of speech to a similar level of proficiency and without explicit instruction. How this is accomplished by the brain remains largely a mystery and is a central unanswered question of cognitive neuroscience and neurolinguistics. This presentation describes a novel methodological approach to the study of speech motor control and its development: Magneto-articulography for the Assessment of Speech Kinematics (MASK) articulography and neuroimaging in the same experimental setup. MASK provides detailed measurements of speech kinematic parameters that can be precisely related to brain activity measured concurrently with magnetoencephalography (MEG). Recent invasive electrocorticography experiments have demonstrated that these speech kinematic parameters are the main computational substrates of the speech motor cortex. MASK provides a noninvasive bridge to these important findings and sets the stage for cross-disciplinary efforts between researchers in experimental linguistics and cognitive neuroscience to study and understand the developmental neurobiology of human speech planning and production.

Examining the validity of EEG from a frontal single-channel dry-sensor portable device: Eyes-closed and eyes-open differences in children

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Aims: Changes in EEG when moving from an eyes-closed to an eyes-open resting condition have been referred to as activation. In children, activation is characterised by a global reduction in alpha, frontally-present reductions for delta and theta, and a frontal increase for beta. The present study aimed to replicate frontal EEG activation effects using single-channel, dry-sensor EEG, and extend current understanding by examining developmental change in children.

Method: Frontal EEG was recorded using a single-channel, dry-sensor EEG device while 182 children aged 7-12 years completed eyes-closed resting (EC), eyes-open resting (EO), and focus (FO) EEG tasks.

Results: Frontal delta, theta, and alpha power were reduced, and frontal beta power was increased, in the EO compared to the EC condition. The activation effects reduced with age for frontal delta and theta, increased for frontal alpha, with no developmental change for frontal beta.

Conclusions: Previous activation effects in children were replicated using EEG from a portable, single-channel, dry-sensor device. These findings contribute further to validation of the single-channel, dry-sensor, frontal EEG and provide support for use in a range of medical, therapeutic, and clinical domains.

EEG-ERP brain dynamics in a continuous performance test

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Aims: The brain's intrinsic neuronal activity underlies stimulus-related processes and responses. Brain dynamics studies have largely explored this relationship between the prestimulus EEG activity and poststimulus ERP outcomes. Recently, pretask EEG measures were proposed to better reflect the brain's intrinsic activity than the prestimulus period. This study aimed to characterise the EEG changes occuring as participants transition from a resting state to a task-situation, and explored their effects on poststimulus response outcomes in a Continuous Performance Test (CPT).

Method: Fifty-six adults had EEG recorded with eyes-open (EO) and while undertaking a visual CPT that involved responding to the Go imperative stimulus, only when it was preceded by a cue, and withholding responses to cued NoGo stimuli. PCA was used to decompose the artefact-free EEG spectra obtained from EO, and the task-based periods immediately pre-cue (PC) and pre-imperative (PI), and the ERP to the cued Go and NoGo imperatives. Response efforts were assessed by correlating behavioural outcomes with ERP component amplitudes. EEG amplitude changes from EO to PC, and from PC to PI were examined as predictors of performance.

Results: Longer mean reaction time (RT) was associated with greater RT variability (RTV) and reduced Go P2 amplitude. Delta/theta amplitude reductions from PC to PI predicted Go N1-1 and NoGo N2b enhancements. Alpha-1 decreases from PC to PI predicted larger Go/NoGo P2 and poorer NoGo accuracy rates, while alpha-3 decrements positively predicted NoGo P1. EO to PC EEG changes did not significantly predict performance.

Conclusions: More efficient and consistent responding was marked by greater Go P2 positivity. The decrease in low frequency EEG amplitude in the cue to imperative interval was thought to be more relevant to performance than the transition from rest to the task. This state-related change in neuronal activity reflects the stimulus anticipation and response preparation processes that underpin attention and cognitive control efforts.

Mirroring responses differ for hands and faces

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Aims: Mirror neurons (MNs) are a specific type of visuomotor neuron that fires during both the imitation and observation of motor movements. Given their imitation/observation matching properties, MNs are thought to represent a system for unifying perception and action, and may therefore play an important role in social cognition. However there is very little linking the original research examining mirroring responses for hand movements with more recent research examining emotional face movements. Furthermore, the latter may be confounding social processes with non-social motor processes, particularly as few of these studies also include a non-emotional facial movement. The main aim of the current study is to bridge the gap between these studies by directly comparing mirroring responses for hand movements with neutral face movements.

Method: Thirty-three controls (20 females; Age: *M*= 19.64 years, *SD* = 13.68) completed three blocks of movements (Left Hand, Right Hand, Neutral Face) in which they observed and imitated either a grasping hand movement or a neutral blowing movement. EMG and EEG were recorded simultaneously. EMG was recorded from the left and right forearms (flexor digitorum superficialis) for the Hand blocks, and from the orbicularis oris muscle (purses the lips) on the face for the Neutral Face block. Both mu suppression (9 – 10 Hz) and changes in EMG were calculated relative to the prestimulus baseline for each condition (Imitate, Observe) for three 1 second epochs post stimulus onset.

Results: EMG was significantly larger for the Neutral Face Block relative to the Hand Blocks, particularly for the Imitate Condition ($F = 35.15$, $p < .001$). This further interacted with time, such that muscle activity during the Neutral Face Block was increased in the second epoch relative to the mean of the first and third epochs for the Imitate Condition, while there was little to no change over time for the Observe Condition ($F = 24.50$, $p < .001$). For the EEG, mu suppression was largest for the Neutral Face Block, although this decreased linearly from the first epoch to the third ($F = 6.36$, $p = .017$). Suppression for each condition also differed topographically between blocks, showing an increase in the hemispheres for the Imitate Condition, particularly in the Neutral Face Block ($F = 6.04$, $p = .020$).

Conclusions: The current findings suggest that mirroring responses differ between hand movements and neutral face movements. Specifically, these responses may be stronger for more meaningful stimuli such as faces, which contain important social cues, relative to hand movements, which may be less meaningful. Additionally, mu suppression for the Neutral Face Block was topographically distinct from the Hand Blocks, which is important to consider in future research examining the relationship between MNs and social cognition.

SCL as an index of musical expectation

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Aims: This research explored reaction to rhythmic change in music, indicated by elicitation and habituation/dishabituation of the Tonic Orienting Reflex (OR), measured via skin conductance level (SCL). The assumptions around reaction to musical change are based on Huron's ITPRA model of musical perception as a cognitive process of expectation involving five components, Imagination, Tension, Prediction, Reaction and Appraisal. Specifically, we predicted that an electrodermal increase, related to the Prediction and Reaction response components, should occur in relation to musical change.

Method: Continuous SCL data were recorded in 34 undergraduate participants (M_{age} = 21.0, *SD* = 3.6 years; 15 males; with a basic capacity for music perception) as they completed a passive listening task in which they heard one of two constructed 'music like' stimuli (Music A and Music B). Each trial lasted 192 s, consisting of six 32 s patterns. All patterns were rhythmically mundane, consisting of a steady pulse of one chord per 500 ms, except for the pattern containing the rhythmic change which consisted of a chord beginning 250 ms earlier than others (19.75 s into the pattern). Half the participants heard Music A consisting of 4 patterns of no rhythm change, then one of rhythm change, followed by a return to the no rhythm change pattern. The other participants heard Music B, with 4 patterns of rhythm change, then one of no rhythm change, followed by a return to the rhythm change pattern. SCL means were calculated by averaging over each 32 s pattern for each participant, after adjusting for SCL lag (within-subjects).

Results: There was no statistically significant difference in mean SCL between the Music A and Music B group and group interaction effects failed to approach significance (all $p \geq .361$). With the first 4 repeated pattern presentations, decrement of mean SCL across the groups was apparent in a significant linear trend ($F = 27.96$, $p < .001$, $\eta_p^2 = .47$). While response recovery to the deviant stimulus (pattern 4 vs. 5) was not significant, decrement was suspended. Re-presentation of the habituated stimulus at pattern 6 produced further significant decrement ($F = 9.2$, $p = .005$, $\eta_p^2 = .22$).

Conclusions: The initial decrement supports the tonic habituation expected with repetition of the music pattern, frame-working potential effects of the rhythm variation. The rhythmic change did not produce the expected recovery increase in SCL, but the cessation of decrement suggests that there was some arousal to the change in stimulus at that point. The lack of a significant finding for recovery suggests the rhythmic change may not have been novel or significant enough, compared to other events happening throughout the music. Further research is needed to explore relationships between the involuntary tonic OR and Huron's Prediction and Reaction response components. Exploration of the link between Huron's Appraisal response component and the omission response and voluntary OR is also suggested.

Flutters and features: Exploring the effect of free spins on the psychophysiological arousal of regular gamblers

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Aims: Theoretical models implicate excitement as a fundamental motivator for gambling. Psychophysiological measures of arousal are uniquely placed to objectively measure experienced excitement, the gambling stimuli that influence it, and the mechanisms by which it encourages and maintains gambling behaviours. Electronic gaming machines (EGMs; a.k.a. 'slot machines' in North America and 'the pokies' in Australia) have been shown to be one of the most harmful forms of gambling due to their popularity, the continuous property of play, and fine-tuned reward schedules. While previous research has shown increased arousal in responses to wins amongst regular gamblers, very little research has explored the significance of *free spins*, despite frequent suggestions that these are the main goal of EGM players' gambling sessions. The current study sought to better understanding of the role free spins play in EGM gambling by investigating the psychophysiological reactions of regular gamblers to them during play on a computer-simulated task.

Method: Participants for this study were 31 regular gamblers recruited from within a licensed gaming venue. Two short subjective questionnaires were completed by participants *pre-* and *post*-task. They were also asked to play a realistic computer-simulated gambling task for approximately 7 minutes while their electrodermal activity (EDA) was recorded. Participants were randomly assigned to either a *bonus* (n = 15) or *control* (n = 16) condition: the former group experienced a pre-determined series of wins that were framed as free spins during the task, and the latter experienced the same series of events but these were not framed as a bonus feature. The difference in tonic skin conductance level (SCL) during the series of outcomes of interest in each *condition* was examined, controlling for *age, gender, baseline SCL*, and *risk of gambling harm.*

Results: A significant main effect of *condition* was found; overall the SCL of participants in the *bonus* condition during the series of outcomes was significantly lower than that of participants in the *control* condition (p = .024). There was also evidence for an interaction between *gender* and *condition* (p = .055), however, that qualified this main effect with respect to male participants. In comparison to the *control* condition, *female* participants had lower SCL in the *bonus* condition, whereas *male* participants showed higher SCL.

Conclusions: The current study offers valuable evidence on a consequence of a common design component of EGMs, through examination of psychophysiological arousal levels. The current study provides evidence that sympathetic nervous system activity changes in response to the presence of free spins. The finding of overall lower SCL in response to free spins is discussed as potential evidence for either greater focus on the activity or the relaxing effect of having achieved a desired outcome. The qualified effect for male participants may suggest that bonus features do not always have these same effects for everyone.

Behavioural Addictions?

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Recent advances in the field of addiction have given greater emphasis to subjective experience and compulsive behaviour, which signifies an important shift from focusing on the object of addiction to acknowledging that behaviours, which can induce changes in physical arousal and subjective experience, have the propensity to be overused and lead to what could be called addiction. Whereas gambling has been considered a potentially addictive behaviour for many years, beginning in the 1990s, the Internet, video-arcade games, and computer games were identified as potentially addictive activities. With the advent of the smartphone, further behaviours have the potential to fall into the group of behaviourally addictive activities. Mobile phones, now smartphones, are ubiquitous in today's society. One hundred and seventy-three million smartphones were shipped globally in 2009, and in 2015 this number had risen to 1.4 billion. Smartphones are now mini computers allowing access to a multitude of advanced and customisable applications and features and hence convenience, connection, and constant entertainment are among the many reasons why smartphone ownership has increased exponentially over recent years. In 2007, following a questionnaire study with 1762 (845 female) school students (Grades 4-12) and 709 (509 female) university students, we found that sub-clinical computer game and Internet addiction were rising in primary school age children, secondary school age children, and young adults. These addictive behaviours can be seen to exist on a continuum and potentially be unrelated to engagement in the behaviour. In a series of psychophysiological studies, we found that experiencing some of the symptoms of addiction led to reduced P3a and P3b amplitude in a three stimulus oddball task with P3b amplitude indexing a dichotomous distinction between participants with lower levels of engagement and/or no symptoms of addiction and participants with high levels of engagement and/or subclinical or clinical levels of addiction. In a further study, we found that neither addiction levels nor engagement levels affected MMN. To extend this work and as internet use expands particularly with the prevalence of smartphones, our research has focused on the cognitive effects of the use of smartphones. In particular, we have investigated the effect of cues of smartphones on attention with a view to determining the addictive properties of smartphones and the effect of the mere presence of a smartphone on cognitive processes. In a series of experiments, we have shown that smartphone presence decreases our ability to perform complex operations, for example, reducing P2 amplitude in a 2-back task in the presence of a smartphone for people with problematic smartphone use. We have also shown that problematic smartphone users have larger P3b amplitudes and shorter N2 latency when processing smartphone cues. In total our studies suggest that the cognitive performance of problematic or addicted smartphone users suffers from the presence of a smartphone and that problematic smartphone users display event-related potential differences in cue reactivity which resemble the activity in response to addiction-related material in substance addicted people.

Problematic eating behaviours in atypical major depressive disorder: Links to plasma cortisol

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Aims: Dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis indexed by altered cortisol levels is a common neurobiological accompaniment of Major Depressive Disorder (MDD). Depressogenic subtypes, including melancholia and atypical MDD, have shown different patterns of cortisol secretion in previous studies. Melancholia and atypical MDD also differ in clinical presentations of appetite and weight dysregulation; melancholia features appetite or weight loss, whereas atypical MDD features appetite or weight gain and overeating. Cortisol has an important role in energy metabolism and food intake; as such, the differences in appetite and weight changes in depressogenic subtypes may be related to cortisol differences. However, the role of cortisol in appetite and weight changes in depressogenic subtypes is not well known. This study examined the relationships between cortisol, problematic eating behaviours and MDD subtypes.

Method: Plasma cortisol levels, psychopathology and biometrics were compared between 80 unmedicated participants meeting the DSM-5 diagnostic criteria for MDD and 60 healthy controls. Depressed participants were sub-categorised into those with melancholic (n = 41, 23 female) or atypical (n = 39, 23 female) features of MDD according to DSM-5 criteria. Depressive symptoms were assessed using the Beck Depression Inventory (BDI-II) and Depression, Anxiety and Stress Scale (DASS-21). Problematic eating behaviours were measured using the Dutch Eating Behaviours Questionnaire (DEBQ) and Yale Food Addiction Scale (YFAS), which measures loss of control relating to highly palatable food. Statistical analyses included analyses of variance (ANOVA), Pearson's and Spearman's correlation coefficients.

Results: Depressed participants had higher cortisol levels than controls, and males had higher levels than females. Depressed participants with melancholic features had higher cortisol levels than those with atypical features. DEBQ Emotional eating and Yale Food Addiction symptomology were higher in those with atypical MDD compared to melancholia. When stratified by MDD subtype, cortisol was negatively associated with cravings and social impairment as a result of food intake in those with atypical MDD. Cortisol was not related to problematic eating behaviours in those with melancholia.

Conclusions: The results support previous research indicating HPA axis dysregulation in MDD, provide further evidence that MDD with atypical features shows different neurobiological correlates to MDD with melancholic features, and indicate that some aspects of depressogenic overeating are negatively related to cortisol. The associations between depressogenic overeating and lower cortisol in depressed individuals with atypical features provide further evidence that depressogenic eating in atypical MDD is related to neuroendocrine, specifically HPA, factors and is not purely psychological. These results suggest that interventions for weight gain as part of atypical MDD should integrate biological and psychological approaches, and warrant further longitudinal research examining the nature of the identified relationships.

Food addiction in major depressive disorder: Relationships to plasma dopamine

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Aims: Individuals with Major Depressive Disorder (MDD), particularly females, are at an increased risk of weight gain due to stress-related eating behaviours. A high proportion of those with MDD also meet the criteria for food addiction, or addiction-like behaviours associated with regular intake of highly palatable foods. Food addiction has been linked to dysregulation in dopamine neurotransmission pathways related to reward in the central nervous system. However, dopamine is also synthesised peripherally in the adrenal glands and is linked to the sympathetic stress response, which may be relevant to stress eating in MDD. At present, the role of peripheral dopamine in MDD and in food addiction remains unclear. This study assessed the relationships between peripheral dopamine and stress-related eating behaviours in MDD.

Method: Plasma dopamine levels, biometrics and psychopathology were compared between participants meeting the DSM-5 diagnostic criteria for MDD (n = 80) and healthy controls (n = 60). Depressive symptoms were assessed using the Beck Depression Inventory (BDI-II). Depressogenic thinking was indexed using the Automatic Thoughts Questionnaire (ATQ). Sleep disturbances were measured using the Insomnia Severity Index (ISI). Eating behaviours were evaluated using the Dutch Eating Behaviours Questionnaire (DEBQ), and food addiction using the Yale Food Addiction Scale YFAS). Participants were sub-categorised into those with MDD who met YFAS criteria, MDD who did not meet YFAS criteria and controls for a comparison by food addiction group.

Results: Twenty-three (23; 29%) MDD participants (and no control participants) met the Yale criteria for food addiction. Depressed individuals meeting food addiction criteria demonstrated significantly greater mood, cognition, sleep and disordered eating-related psychopathology compared to depressed individuals without food addiction and healthy controls. Depressed females with food addiction had higher plasma dopamine levels than depressed females without food addiction and female controls, while males demonstrated the opposite effect. When stratified for sex, plasma dopamine correlated positively with stress-related eating behaviours in females, and negatively in males. Plasma dopamine was not associated with mood or sleep disturbances.

Conclusions: The results provide new evidence indicating that food addiction is associated with greater mood, cognitive, sleep and appetite disturbances in MDD. The results also indicate that excess eating and weight gain in MDD, particularly in females, is associated with higher peripheral dopamine levels. The results support the need for longitudinal research investigating neurobiological factors in depressogenic problematic eating, with a view to develop interventions to reduce the risk of weight gain and chronic disease in those affected by MDD**.**

Vection and postural sway while listening to the Shepard-Risset glissando

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Aims: The Shepard-Risset glissando is an auditory illusion of pitch discrimination. The complex construction of this sound effect evokes an infinitely rising or falling tone that simultaneously never gets any higher or lower. A number of sensations and symptoms have been reported in response to the Shepard-Risset glissando. Notably: feelings of falling, disrupted equilibrium and disorientation, nausea, dizziness, emotional disturbances, changes in heart-rate, skin conductance, respiration and tingling sensations. We have recently demonstrated that these stimuli can even induce auditory illusions of self-motion (auditory vection). This study was aimed at investigating the anecdotal reports of disrupted equilibrium and falling sensations by objectively measuring fluctuations in postural sway.

Method: Fluctuations in centre of foot pressure (CoP) were continuously recorded from 23 participants during the presentation of five different auditory stimuli: 1) ascending, 2) descending and 3) combined Shepard-Risset glissando stimuli; 4) a phase-scrambled Shepard-Risset glissando stimulus; and 5) a white-noise control. Participants stood quietly on a Bertec balance plate with their feet shoulder-width apart, for a total of 20 trials (10 x eyes-open and 10 x eyes-closed). Each trial lasted 90 seconds and was comprised of 30 seconds of pre-sound silence, followed by 30 seconds of sound stimulation, and 30 seconds of post-sound silence. Each of the five auditory stimuli were presented four times (twice per block, for one eyes-open and one eyes-closed block). Participants also verbally reported subjective ratings of vection strength (0 – 10) and motion sickness (using the FAST motion sickness scale) after each trial. Detrended Fluctation Analysis (DFA) was used to examine the temporal dynamics and positional variability of each sway sample.

Results: All 3 Shepard-Risset glissandi induced stronger auditory vection than the 2 controls. It was also found that (weaker) auditory vection was possible even during eyes-open conditions. Ten out of the 23 (43.5%) participants reported auditorily induced-motion sickness at least once throughout the experiment. Participants who were more posturally unstable pre-sound were found to experience stronger auditory vection. Furthermore, participants who swayed more *during* the sound trials also experienced stronger auditory vection. However, there was no significant effect of sound type on postural sway during sound stimulation.

Conclusions: Contrary to anecdotal reports that Shepard-Risset glissandi cause pronounced equilibrium disturbances, these stimuli were not found to be more destabilising than our auditory controls. However, we did find that postural activity recorded before, and during, auditory stimulation predicted our participants' subjective perceptual experiences (auditory vection) and motion sickness.

What is the role of high-frequency sound components in high-resolution audio? A mismatch negativity study

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Aims: High-resolution digital audio, which has a higher quantization bit rate and/or a higher sampling frequency than the conventional compact disk (CD), has become popular among audiophiles. Although the two types of sounds are difficult to distinguish, previous studies have reported that listening to musical excerpts with inaudible high-frequency sound components produces greater alpha-band EEG activity compared to listening to the same excerpt from which the high-frequency components are removed. In this study, the mismatch negativity (MMN), a marker of auditory sensory memory, was measured to examine whether the presence or absence of high-frequency components in a series of sounds can be detected at the cortical level.

Method: Thirty-eight university students participated in the study. A white noise with a sampling frequency of 192 kHz and a duration of 50 ms was used as the standard stimulus. Two deviant stimuli were produced by applying a 22-kHz or an 11-kHz high-cut filter to the standard stimulus. For the two types of deviants, the MMN was recorded by the classic two-stimulus passive paradigm in separate sessions. The probability of deviant stimuli was .20 and the interstimulus interval was 450 ms. After the experiment, a two-choice discrimination test (ABX test) was performed for each pair.

Results: The 11-kHz high-cut deviant sound elicited a MMN and could be discriminated from the standard sound. In contrast, the 22-kHz high-cut deviant sound did not produce a MMN and the discrimination accuracy was not better than chance.

Conclusions: High-frequency sound components beyond the audible range do not form an auditory sensory memory trace. When high-resolution audio has a potential advantage over the traditional CD, the reason seems to be because its waveforms are less distorted in the temporal domain by digital filtering, not because it can record and reproduce higher-frequency sounds.

Gut microbiota differences across healthy ageing and in Parkinson's disease: A systematic review

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Aims: The relationship between microbiota differences and Parkinson's disease (PD) pathophysiology may involve alterations in bacterial metabolites, called short chain fatty acids (SCFAs), which are anti-inflammatory and help maintain the gastrointestinal (GI) wall. This is due to inflammation, subsequent neuroinflammation, and increased GI permeability being implicated in PD pathophysiology. Braak's hypothesis also states that PD may begin in the gut through an external neurotropic pathogen. Therefore, research has investigated whether gut microbiota differs between individuals with PD and controls, with differences having been observed across multiple studies. However, discrepancies in these studies' methodologies exist which precludes a consensus on the nature of relevant gut microbiota characteristics to PD pathophysiology. This systematic review aims to collate and assess data from studies describing the gut microbiota composition, in terms of gut microbiota diversity (alpha- and beta-diversity) and specific microbiota abundance, and its relationship to PD, and PD severity and symptoms (including motor and non-motor symptoms, like cognition) in PD individuals compared to healthy controls.

Method: A systematic search was performed of the following databases: PubMed, Embase, Scopus, CINAHL (through EBSCOhost), Global Health (through EBSCOhost) and CENTRAL (Cochrane Library). 7,604 studies were identified and through title, abstract, and full-text screening, all completed in duplicate, thirteen studies were included for review. Briefly, included studies were observational, case-control studies with human participants only. Studies had to have assessed gut microbiota characteristics between a PD group and a healthy control group (age and sex matched), or spousal control group.

Results: Eleven of 13 studies demonstrated a greater abundance of SCFA producing bacteria in control groups compared to PD, with 9 of 13 studies specifically showing the SCFA butyrate was greater in controls. Regarding alpha-diversity, there was limited consensus across studies with only 4 of 9 studies indicating a difference existed; of those 4, 1 showed PD groups had lower diversity while 3 showed PD groups had greater diversity. Regarding measures of cognition, mini-mental state scores were not associated with microbiota differences between groups across two studies, while one study showed two bacterial genera were associated with positive scores on the Montreal Cognitive Assessment.

Conclusions: Most included studies revealed lower abundances of specifically butyrate producing bacteria in PD groups, including *Faecalibacterium prausnitzii, Eubacterium biforme, Coprococcus eutactus, Roseburia faecis* and *Blautia*. In contrast, there is little consensus across studies regarding alpha-diversity differences. Additionally, drawing conclusions about how cognition relates to microbiota in PD is difficult considering the variety of results and the lack of sensitive or specific cognitive measures being conducted. Given that seemingly stronger evidence supports specific bacteria abundance differences, which are butyrate producing, than diversity differences, we propose the former is more relevant to PD pathophysiology and PD onset. We additionally propose that mechanisms related to lower abundance of butyrate producing bacteria, including inflammation leading to neuroinflammation and increased gastrointestinal permeability, may relate to PD pathophysiology. Considering previous research is only observational in nature, investigating how specific bacteria and their metabolites may alter throughout the course of PD via longitudinal studies is warranted.

Lost in translation! Social cognition disturbance in frontotemporal dementia

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Most living creatures do not live in a vacuum, they interact. They interact with other members of their group, with other species, as well as respond to changes in the environment. Optimal interactions increase satisfaction, wellbeing, maximise chances of survival of the individual and increase reproduction of their gene profile. Among these, socially-based interactions play a central role in humans. Indeed, social cognition is crucial in maintaining interpersonal relations. It helps navigate complex social situations and contributes to define who we are as individuals and how we are perceived. Social cognition comprises different facets, such as emotion recognition, emotion expression, empathy (i.e., the ability to share someone's emotional experience), theory of mind (i.e., the capacity to take someone's point of view), and knowledge of social norms). Humans are sensitive to even very minor departures from expectations in social interactions, but are generally poorly equipped to identify the cause(s) of these departures.

Frontotemporal dementia is a common younger-onset dementia, comprising three syndromes characterised by marked changes in behaviour or in language skills. Importantly, deficits in social cognition of various severity are present in all three syndromes. Neuroimaging investigations show that brain atrophy in frontotemporal dementia is found in many of the brain regions known to support social cognition, such as the orbitofrontal anterior temporal and anterior cingulate cortices, the insula, and the temporoparietal junction, as well as the amygdala.

This keynote will review the main aspects of the dynamic research on social cognition in frontotemporal dementia and related conditions. I will review the different components that are necessary for expert social functioning and how it fails. I will incorporate data from the clinical, neuroimaging (voxel-based morphometry, structural and functional connectivity), and neurophysiology (eye-tracking, skin conductance) literature. I will discuss how this research improves clinical diagnosis of these debilitating brain conditions and informs our understanding of the brain architecture underlying this complex human behaviour.

Hippocampal volume and cannabis use disorder severity

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Aims: Regular cannabis use has previously been associated with a smaller hippocampal volume. The hippocampus is implicated in the development of Cannabis Use Disorder (CUD) due to its role in memory and learning processes. Previous literature has suggested cannabis dependence severity may explain the variance in size of the hippocampus, rather than age of onset of cannabis use, years of cannabis use or amount of cannabis used. The objective of this study is to investigate whether regular cannabis users with a severe CUD differed significantly with smaller hippocampal volume compared to participants with a mild/moderate CUD and non-using controls, to consider how these differences in volume contribute to the development of cannabis dependence.

Methods: A total sample of 35 cannabis users and 8 healthy controls participated in the study. Regular cannabis users were grouped based on CUD severity assessed using the Structured Clinician Interview for DSM-V, with 21 mild-to-moderate cannabis users and 14 severe cannabis users. Participants underwent structural magnetic resonance imaging brain scans and subcortical hippocampal volumes were quantified using Freesurfer V.06 for statistical analysis. With intracranial volume adjusted for, all 3 groups hippocampal volumes were compared for differences in volume and across hemisphere.

Results: There were significant volumetric differences found between the control group, mild-to-moderate CUD group and severe CUD group (p <.001) whereby smaller hippocampal volumes we observed in the severe CUD group. The left hippocampus was significantly smaller than the right in both cannabis dependent groups (p <.001), with the severe CUD users showing the smallest left hippocampal volume in voxels (M = 3980.25, SD = 306.10) in comparison to controls (M = 4419.20, SD = 359.22) and mild/moderate CUD users (M = 4364.81 SD = 383.11).

Conclusions: These findings suggest that smaller hippocampal volume in regular cannabis users were specific to CUD severity. The hippocampus is largely responsible for the conditioning that occurs throughout the development of a drug addiction and associated withdrawal symptoms from drug-related cues. These findings support neurobiological models of addiction, implicating the hippocampus in in chronic stage of addiction in regular cannabis users.

Visual processing of the spatiotemporal fractal properties of natural scenes

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Aims: Natural scenes contain consistent photometric (luminance-based) and geometric (structure-based) regularities despite appearing vastly different (e.g. jungles, mountains). For instance, across natural scenes there exists a consistent distribution of luminance intensities as a function of spatial and temporal frequency known as the 1/f^a amplitude spectrum (a ~= 0.6-1.6). This distribution is scale-invariant, which is a fractal property of natural scenes that have statistically similar structure across spatial scales. For several decades the sensitivity of the visual system has been found to peak when stimuli have amplitude spectra that fall within a *natural* range. However, the driving factor behind this tuning—the associated *photometric* or *geometric* aspects of the amplitude spectrum—has not been extensively investigated. Recent studies focusing on the *spatial* aspects of natural scenes have found that image manipulations which distort the photometric information of a *static* image, but retain its structural information, cause no changes in visual sensitivity. This suggests that the visual system is tuned to natural *geometric* information over *photometric* information. However, it is unclear whether this same pattern of tuning extends to the *temporal* domain (i.e. how a tree sways in the wind). Here, we assess visual tuning to the *photometric* and *geometric* aspects of the amplitude spectrum in *both* space and time using *movie* stimuli.

Method: We used a Four Alternative Forced Choice Task (4AFC) to measure discrimination sensitivity in response to three types of synthetic noise movies: Greyscale, Thresholded, and Edges-Only. Greyscale stimuli were initially generated across a wide range of spatial (a = 0.25, 1.25, 2.25) and temporal (a = 0.25, 0.75, 1.25, 1.75, 2.25) 1/f^a amplitude spectra. Thresholded stimuli were generated by creating binarised (black and white) versions of the Greyscale stimuli. Lastly, the Edges-Only stimuli were generated by extracting the contours (edges) from the thresholded stimuli. Thresholding and edge-extraction drastically alter the *photometric* characteristics of the original Greyscale stimuli, however they retain highly similar geometry (measured here using fractal dimension). We hypothesised that if the visual system is tuned to the *geometric* properties of nature, we would observe a similar tuning pattern across movie types.

Results: Our findings indicate that discrimination sensitivity is primarily driven by the *geometric* properties of our stimuli in both space and time. An inverted U-shaped response profile peaking for stimuli with natural geometry in space and time (a = 1.25) was observed across movie types despite large differences in their *photometric* properties.

Conclusions: We thoroughly characterised the spatiotemporal tuning of the visual system to the *fractal* structure of nature. This preferential tuning may not be surprising given the stability of structure in natural scenes irrespective of scene illumination (e.g. the structural properties of a rock do not change whether it is morning or night, despite large changes in illumination/photometric properties across the two time points). Whilst only measured here at the behavioural level, our findings may infer that the neural processes underlying this tuning may have evolved to be sensitive to the most stable signal in our natural environment—*structure*.

The relationship between arousal and EEG alpha power during mind-wandering induced by a breath-counting task

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Aims: Mind-wandering is a ubiquitous phenomenon consuming up to 50% of our waking lives. Research using a breath-counting paradigm has observed alpha power to be consistently lower when the mind is wandering compared to on-task. Due to the relationship between global alpha power and arousal, it is possible that the observed fluctuations in alpha power are associated with an arousal mechanism. This is postulated by the decoupling perspective on mind-wandering, which suggests higher arousal is evidence for increased perceptual decoupling associated with a mind-wandering state. The current study aimed to examine global alpha power during mind-wandering and on-task states and extend this research by examining whether alpha power fluctuations observed within the breath-counting paradigm are associated with arousal.

Method: Thirty-seven participants completed a breath-counting task for a duration of 15 minutes. EEG was recorded from 19 channels, with skin conductance level (SCL) recorded simultaneously as the index of arousal. Participants indicated their mind was wandering with a button press. Event-related spectral perturbation (ERSP) analysis was used to quantify changes in global alpha power (8-13Hz) relative to the button press. Means for one-second time segments were calculated for both global alpha power and SCL, with six of these segments each being assessed prior to (−8 to −2 s) and following (2 to 8 s) the button press. Separate MANOVAs were conducted to examine differences in global alpha and SCL pre- vs. post-button press. Correlations were also performed to determine whether fluctuations in global alpha and SCL across pre- and post- button press periods were related.

Results: Global alpha power was significantly reduced during periods of mind-wandering compared to focus. However, SCL did not significantly differ between the mind-wandering and breath-focus states. Further, changes in SCL and global alpha power across levels of state (on-task relative to mind-wandering) failed to yield a significant correlation ($p = .137$).

Conclusions: Fluctuations in global alpha power between states of mind-wandering and focus were consistent with previous research. However, global alpha power did not correlate with SCL in this study. This suggested that the alpha power fluctuations observed in this paradigm are not associated with arousal, and instead may be related to other mechanisms such as inhibition of task-irrelevant stimuli.

The role of inhibition in the human mirroring system: An EEG and ERP study

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Aims: The discovery of the Mirror Neuron System (MNS) in the human brain has provided a neurobiological substrate for understanding human social cognition directly relevant to the ability to comprehend actions, glean intentions, and learn through imitation. Evidence from neurophysiology indicates a specific brain rhythm (Mu) reflects activation of the MNS. Accumulating evidence indicates this sensorimotor rhythm is found to desynchronise during action execution and also, importantly, during action observation. Its dual reaction to both observation and execution has established mu attenuation as an index of MNS functioning. The control problem of the MNS however, questions why we do not automatically imitate the actions of others during mere observation, despite the same neural activation as when we imitate. The current study investigated whether ERP (N2, P3) and EEG (theta power) indices previously associated with inhibition have a potential role in reflecting passive inhibitory processes within the MNS.

Method: Forty-one (23 females; Age M = 19.95, SD =3.89) right-handed undergraduate students completed two blocks of hand movements (left and right hand) in which they were randomly instructed to either observe or imitate a grasping hand movement. EEG was continuously recorded throughout the experiment. The EEG data was epoched for the -200 pre to 1000 ms post-stimulus period. A temporal principle components analysis was conducted to extract the ERPs. A P3 component with a peak latency of 490 ms was identified. No other ERP components of interest were derived. Theta rhythm was defined within the frequencies of 4-7 Hz. Amplitudes within these spectral frequencies were summed and squared to obtain power spectra. Theta suppression was measured as the difference between each condition (Imitate, Observe) and the 1000 ms prestimulus baseline.

Results: The P3 component was larger for the observe than imitate conditions in the hemisphere regions relative to the midline (Observe > Imitate x M < L/R: F = 5.15, p = .029), and in the left compared with the right hemisphere (Observe > Imitate x L > R: F = 5.67, p = .022). Similar effects were found for theta suppression (Observe > Imitate x M < L/R: F = 7.82, p = .008), although the left hemisphere maxima was somewhat frontal (Observe > Imitate x F > P x L > R: F = 4.59, p = .038).

Conclusions: This study provided compelling support for a passive inhibitory process occurring alongside MNS activation in order to prevent overt movement when it is incompatible with task goals. It provides support for the use of this alternate paradigm in future explorations of inhibition as it does not require a conscious decision or alternate response during inhibition tasks.

Exploring inhibition of return with steady-state visual evoked potentials

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Aims: The effects of spatial attention on steady-state visual evoked potentials (SSVEPs) have been well demonstrated in numerous studies by comparing responses from attended and unattended stimuli. Most importantly, the magnitude of attentional modulation of SSVEP signals has been found to scale with the amount of attention paid to the spatial location. Inhibition of return (IOR) is a phenomenon of attentional orienting that refers to slowed responses to targets presented at the same location as a preceding stimulus that starts around 600 ms post-cue and is sustained for a few seconds. Sensory adaption is an early low-level inhibitory mechanism that slows responses at a previously stimulated location. The current research examined the inhibitory effects of IOR and sensory adaptation by comparing post-cue SSVEPs across cued and uncued locations.

Method: In the present study, we used steady-state visual evoked potentials (SSVEPs) as a measure of attentional modulation to explore the neurodynamics of inhibitory cueing effects. A traditional spatial cueing task was used, with non-predictive peripheral cues preceding peripheral targets requiring either saccadic or manual responses. The peripheral boxes flickered at different frequencies throughout trials so that SSVEP signals could be extracted and compared across conditions.

Results: As expected, inhibition of return was observed behaviourally regardless of whether response modality was manual (10 ms) or saccadic (12 ms). Grand averages of SSVEP amplitudes at parieto-occipital electrodes PO7 and PO8 revealed a significant reduction in SSVEP amplitude at cued locations in the window of 100-500 ms post-cue, but not at later time points, regardless of response modality and stimulus frequency.

Conclusions: Since V1 is one of the major sources of SSVEP signals, these results suggest that the SSVEP modulations observed were caused by sensory adaptation in V1, as a result of reduced visual input activity from cued locations. Inhibition of return, however, did not have an effect on SSVEP signals. These findings provide further electrophysiological evidence for the theory of multiple mechanisms contributing to behavioral cueing effects.

Time to split, say goodbye to the bilateral fovea hypothesis

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Background: It is a basic principle of the organization of the visual system that the optic nerves from both eyes meet at the optic chiasm, where each nerve is split, one half crosses to the contralateral hemisphere, while the other half remains ipsilateral. This results in the puzzling observation that the cortical representation of our visual world is split into two halves, where each hemisphere receives input from the contralateral visual field. Historically, this has concerned many scientists and doctors, as it suggests that when we direct our gaze into the middle of something, such as the face of a loved one, or a word we want to read, this object will be split across our two hemispheres and neither hemisphere will see the whole. Hence, early on a bilateral representation of the fovea (BFP) has been suggested, a hypothesis that is still very popular in modern theories on reading and language.

Evidence: Firstly, the retinotopic representation of the foveal confluence in human visual cortex, specifically the central 0.5 degree, is substantial with more than 2000 mm^2 for V1, V2 and V3 alone, exclusively representing the contralateral visual field. No ipsilateral visual field representation can be seen in V1. Secondly, ipsilateral connections from the retina to the lateral geniculate nucleus exist, and are reasonably well described, but they are small in number. Reanalysing data by Bunt & Minckler and Fukuda et al., only a very small count (between 110 and 130 cells) was estimated. Thirdly, macular sparing, clearly cannot be well explained by an ipsilateral representation of the visual field. Many patients with hemianopia have no macular sparing whatsoever, which is irreconcilable with a significant ipsilateral representation. Further, the amount of surviving perception in patients that do have macular sparing is highly variable, ranging from 2 degrees to 6 or more. Fourthly, there are a substantial number of transcallosal fibers along the representation of the vertical meridian at the boundary of V1 and V2, especially in the foveal confluence, suggesting a double representation would be superfluous. Finally, fundus controlled perimetry in hemianopic patients revealed an absence of foveal sparing, instead uncovering a widening strip of peripheral sparing in roughly one third of the patients, demonstrating an overlap of the visual fields in the periphery but not in the fovea.

Conclusions: In summary the extensive and thorough literature clearly demonstrates that ipsilateral retino-cortical connections are minimal, smallest not largest in the fovea. However, dense and most likely fast transcallosal connections tightly interweave the cortical projection of the two visual hemifields, hence the consequences of the split representation for high level foveal tasks such as reading are much more elusive.

Does radio frequency electromagnetic field exposure affect emotional processing?

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Aims: Wireless communication technologies have become so ubiquitous in the 21st century that it is practically impossible to live without them. These technological devices emit radio frequency electromagnetic fields (RF EMFs), and concerns have been raised from the general public about the safety of this exposure. Research into the potential effects of RF EMFs on psychological processes have typically focused on cognition and cognitive performance, however, no verified adverse effects have been found. One area that has not been addressed which holds equal importance for everyday life is emotion and emotional processing. Theories in emotional processing propose that negative stimuli receive a higher processing priority, and are responded to more quickly and intensely than positive or neutral stimuli. This is known as the negativity bias. A common way of testing whether something has an effect on emotional processing is through indirect measures of cognition. The aim of this study was to determine whether RF EMF exposure effects the negativity bias in terms of the effect of emotion on cognition. Furthermore, the present study also aimed to deconstruct this bias into its two components, valence and arousal, to determine whether they are differentially affected by RF EMFs.

Method: Twenty-two participants (13 female, 9 male) completed four randomized, double-blind experimental sessions over consecutive days. In each of the sessions, participants were either exposed to an RF EMF signal (2 sessions) or a sham condition (no RF EMF; 2 sessions), depending on randomization and counterbalancing. During these sessions, participants completed a visual discrimination task, with images from the International Affective Picture System (IAPS) shown in the background while they performed the task. The IAPS images differed in valence (positive/negative) and arousal (high/low). Participants completed four, 4-minute blocks of the visual discrimination task. Electroencephalography data were recorded using a 19-channel cap, and event-related potentials (ERPs) were generated for correct responses in the visual discrimination task.

Results: The present study found a larger P3 amplitude to targets with negative compared to neutral stimuli in the background, which suggested that the task elicited a negativity bias. Furthermore, the effect of negativity bias on P3 amplitude was reduced in the RF EMF condition compared to sham. Lastly, no effect of RF EMF was found for P3 when valance and arousal were assessed separately.

Conclusions: Our results indicate that there may be an effect of RF EMF exposure on emotional processing. However, as this research has not yet achieved full counterbalancing, and as the results are yet to be replicated, more evidence is needed before firm conclusions can be drawn.

Relationships between psychopathology, physical health indicators and testosterone in major depressive disorder and healthy controls

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Aims: Individuals with major depressive disorder (MDD) have an increased risk of chronic physical health problems for reasons which are not fully understood. Neuroendocrine dysregulation in MDD is well-known, particularly with respect to the hypothalamic-pituitary-adrenal (HPA) axis and cortisol. Additionally, gender disparities in the prevalence of both MDD and cardiometabolic indicators suggest a potential role of the hypothalamic-pituitary-gonadal (HPG) axis and sex hormones. Dysregulation of testosterone, the principal male sex hormone, has been linked to both MDD and chronic metabolic health problems, however there is scarce research investigating endogenous testosterone levels in MDD. This study aimed to address this gap by assessing the relationships between psychopathology, physical health indicators and total plasma testosterone in physically healthy adult males and females with MDD compared to healthy controls. Specifically, the aim was to assess whether total plasma testosterone level: i) differed by sex and diagnostic group, and ii) was related to psychological factors and physical factors.

Method: Participants included 63 individuals meeting DSM-5 criteria for MDD (28 male, 35 female), with diagnosis confirmed with a semi-structured interview, and 60 controls (25 male, 35 female). Blood pressure, heart rate, height and weight were measured, BMI was calculated, and a non-fasting 10 mL blood sample was taken. Participants completed psychometric measures of quality of life (QoL) (World Health Organisation Quality of Life-Brief) and psychopathology (Brief Symptom Inventory). A between-groups two-way ANOVA was performed to assess whether total plasma testosterone level differed by sex and diagnostic status. Correlational analyses were conducted to assess relationships between testosterone levels, QoL, psychopathology, and biometrics.

Results: Participants with MDD had higher testosterone than controls and males had higher testosterone than females. There was no interaction between sex and diagnosis, indicating that both males and females with MDD had higher testosterone than controls. However, correlational analyses showed different associations between testosterone and psychological measures in males than females. For males, testosterone positively correlated only with hostility, while for females testosterone negatively correlated with the physical health domain of QoL and positively correlated with all measures of psychopathology. No correlations between testosterone and objective physical health indicators were identified for either sex.

Conclusions: This is one of the first studies to examine testosterone in relation to MDD in both males and females. The results indicate that the HPG axis may be involved more widely in MDD than formerly perceived. Testosterone levels were related to hostility in males and all psychopathology in females, suggesting that the hormone may be more broadly related to female mental health than previously recognised. Although no relationship between testosterone level and physical health indicators was identified, further research is warranted to evaluate whether elevated testosterone in MDD may provide a potential pathway between MDD and increased risk for chronic physical health conditions. Additionally, research examining interactions between the HPA and HPG axes, hostility and "fight or flight" responses to stress would also be of interest in the context of MDD and health.

The dark triad, cortisol, testosterone, and psychopathology across the sexes

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Aims: There is increasing interest in analysis of Dark Triad personality traits Machiavellianism, narcissism, and psychopathy, which are typified by anti-social and manipulative tendencies. These traits are assumed to occur in a continuum in the population and as such, sub-clinical and distinct from clinically diagnosed personality disorders. While the biological and endocrinological bases of personality have an established research record, studies investigating the Dark Triad personality traits are much less well represented in the literature. Personality traits have a large heritable component and have been linked to neurobiological characteristics including sleep-wake cycles, stress reactivity and hormones in previous research. Previous research has linked the Dark Triad traits to hormone concentrations, with an emphasis on testosterone and cortisol due to their known relationships with social dominance, status-seeking behaviour and stress responses. However, this research is limited by small sample sizes and predominantly male studies. Thus, relationships between the Dark Triad traits, cortisol, testosterone and other psychological variables in a more generalisable population remain unclear. The current study aimed to investigate salivary hormone concentrations of cortisol and testosterone in relation to personality and mental health measures, in a mixed sex community sample.

Method: This study investigated afternoon salivary cortisol and testosterone concentrations in relation to Dark Triad personality traits, Big 5 personality traits, and psychopathology in a community sample (N = 194; 126 Female; 18-63 years, M = 24.96). Salivary cortisol and testosterone were analysed using 'Salimetrics' assay kits.

Results: Male participants scored significantly higher on Machiavellianism and psychopathy and had higher salivary cortisol and testosterone concentrations than females. Females were significantly higher on psychological distress (stress, anxiety, interpersonal sensitivity and overall psychopathology severity) than males. Testosterone levels correlated positively with psychopathy and Machiavellianism. Once split by sex, these correlations were no longer significant. A regression analyses was performed to determine if the interaction between cortisol and testosterone was a significant predictor of Dark Triad traits, after accounting for sex, age and psychopathology. The interaction was not significant; however, sex was a significant predictor of psychopathy and Machiavellianism.

Conclusions: The results of the current study highlight sex differences in Dark Triad and psychopathology measures, as well as salivary hormones. These differences may have been underestimated by previous studies which often include small samples and only male participants.

Reduced neuronal activation of attention and cognitive control mechanisms in amnestic mild cognitive impairment (aMCI) compared to healthy controls

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Aims: Mild cognitive impairment (MCI), conceptualised as the prodromal phase of dementia, causes a decline in cognition, and affects around 30% of Australians aged 70 years and older. People with MCI who have a memory deficit (amnestic MCI; aMCI) have an increased risk of Alzheimer's disease (AD); the most common cause of dementia. The aim of this study was to characterise the real-time neuronal activity in people with aMCI whilst they engage in a cognitive task. This may help to elucidate the early changes in brain function that are associated with increased AD risk.

Method: Forty-two people with aMCI and sixteen healthy age, gender, and education-matched controls (HCs) completed an auditory equiprobable Go/NoGo task whilst having their EEG activity recorded (N = 58). The Go/NoGo paradigm is a two-choice task that requires a motor response to Go stimuli, but not to NoGo, and facilitates the mapping of neuronal activity associated with distinct cognitive processes such as attention, decision-making, and response control. EOG-corrected and averaged event-related potentials (ERPs) for correct Go and NoGo trials for each group were submitted to four separate temporal principal components analyses (PCAs).

Results: Four components were assessed for Go (N1-1, P2, P3b, and Slow Wave; SW) and NoGo (N1-1, P2, P3a, and Late Positivity; LP) from each of the PCAs. Go N1-1, P3b, and SW, and NoGo N1-1, P2, and LP had significant ($p < .05$) topographic × group interactions. Of these effects, individuals with aMCI generally had lower component amplitudes than HCs, with only the NoGo P2 showing a focal increase in people with aMCI.

Conclusions: Results demonstrate that compared to HCs, people with aMCI have reduced neuronal activation when encoding attentional information associated with auditory stimuli (Go and NoGo N1-1), disengaging from NoGo-specific sensory processing (P2), and initiating Go-specific motor response selection (P3b) and evaluation (SW). In addition to reflecting aMCI/early AD pathophysiology, these outcomes could partially reflect a strategic difference in task-related processing, whereby the aMCI group may be compensating for memory deficits. This study furthers our understanding of the brain and cognitive function changes in early-stage AD that precede major cognitive decline, and helps to characterise the neuronal activity and behaviour associated with increased dementia risk.

The effect of dynamic field-of-view restriction on experiences of cybersickness in virtual reality

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Aims: Head mounted device (HMD) based Virtual Reality (VR) technology is currently flourishing. However, mass market adoption of this technology is still being threatened by cybersickness (a type of motion sickness assumed to be due to either postural control problems or sensory conflicts experienced in VR). The purpose of this study was two-fold: 1) to see if dynamic field of view (FOV) reduction serves as an effective countermeasure for HMD-based cybersickness; and 2) to determine whether individual differences in spontaneous postural instability could predict who will eventually become sick or remain well in HMD-based VR.

Method: 40 participants were exposed to a commercially available HMD game (Marvel Powers United) under both full-field and dynamic FOV restriction conditions (each of these trials lasted 10 minutes). Participants had their vection (illusory self-motion) and sickness symptoms recorded during each trial. Prior to each trial, participants stood normally on a force plate and had their centre of foot pressure (CoP) continuously recorded for periods of 30 s.

Results: Individual differences in their spontaneous postural instability (as measured by Detrended Fluctuation Analysis on this CoP time-series data) were found to predict both the strength and the likelihood of their motion sickness during simulation. Cybersickness was found to increase steadily over the course of each exposure, and was significantly reduced with the use of dynamic FOV restriction.

Conclusions: These results support prior findings that postural instability can be used to identify people who are more susceptible to cybersickness, and that dynamic FOV restriction can also serve as a viable countermeasure. This experience of cybersickness is accompanied by physiological changes previously reported in VR contexts which have been measured via skin conductance and electroencephalography measures.

Plasma glutamate levels in major depressive disorder: Relationships to symptoms

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Aims: Major depressive disorder (MDD) is a highly prevalent mental disorder. While several pathophysiological mechanisms have been proposed to underlie this disorder, including monoamine, inflammatory and hypothalamic–pituitary–adrenal axis disturbances, the pathophysiology of MDD remains unclear. There is accumulating evidence of involvement of glutamate in the pathophysiology of MDD. Glutamate is the main excitatory neurotransmitter in the brain and plays a key role in learning, cognition and brain plasticity, however excessive glutamate signalling can be neurotoxic, resulting in neuronal damage and death. Excessive excitatory glutamatergic neurotransmission has been proposed as a cause of MDD. Recently, elevated plasma glutamate levels have been reported in individuals with MDD, however the relationship between peripheral glutamate levels and psychopathological symptoms has yet to be closely examined. We aimed to investigate plasma glutamate levels in individuals with MDD and healthy controls, and relationships with psychopathology and quality of life.

Method: Sixty untreated individuals meeting DSM-5 MDD criteria were recruited, along with sixty healthy controls. Diagnoses were confirmed using semi-structured interviews. Blood samples were taken between 9-11 am from a vein in the cubital fossa. Plasma glutamate was measured using a standard enzyme linked immunosorbent assay (ELISA) method. Samples and standards were run in triplicate. Participants completed psychometric measures of mental health symptoms including the Depression, Anxiety and Stress Scales and the Brief Symptom Inventory, and the World Health Quality of Life Brief questionnaire. Analysis of variance was used to assess differences by sex and diagnostic status. Correlations were performed to assess relationships between the variables.

Results: Groups did not differ significantly on age or male: female ratios. Plasma glutamate levels were significantly higher in participants with MDD than healthy controls, and also higher in males than females. There was no diagnosis by sex interaction, indicating that glutamate levels were higher in both males and females with MDD than controls. Plasma glutamate levels correlated significantly with a wide range of psychopathology including depression, anxiety, suicidal ideation, obsessive-compulsive and psychotic symptoms. Additionally, there were significant negative correlations between glutamate levels and all domains of quality of life.

Conclusions: The current results add to a growing body of studies reporting elevated peripheral glutamate levels in individuals with MDD. Additionally, our results indicate that plasma glutamate levels are meaningfully and broadly related to psychopathology, and negatively related to quality of life. While further research is needed to understand relationships between peripheral and brain glutamate levels, our results suggest that peripheral levels are important to mental health and wellbeing. Because glutamate levels can potentially be manipulated by dietary interventions, this may be a worthwhile topic for further investigation.

Important methodological issues for detecting radiofrequency electromagnetic field exposure-related increases in EEG alpha spectral power

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Aims: While there is currently no evidence that the radiofrequency electromagnetic fields (RF-EMF) emitted by mobile phones adversely affect human health, RF-EMF exposure has repeatedly been shown to increase resting EEG alpha spectral power. However, the reliability of this effect is uncertain, as a number of studies have also either failed to observe any effects of RF-EMF on EEG alpha, or have reported alpha power decreases during RF-EMF exposure. Given that there have been large variations in methodology between studies; it is possible that the discrepancy in results between studies may be accounted for by methodological differences. The present study aimed to resolve whether methodological issues importantly impact the observed effect of RF-EMF exposure on EEG alpha spectral power, by investigating if the choice of eyes open or eyes closed conditions, and/or exposure duration, influences whether an increase in EEG alpha spectral power is observed during RF-EMF exposure.

Method: Thirty-six (50% male) healthy adults participated in three double-blind, randomised, and counterbalanced experimental sessions, each involving one 30 min exposure to a 'Sham', 'Low power' or 'High power' RF-EMF signal. Eyes open and eyes closed resting EEG was recorded using a 19-channel EEG cap at the end of a baseline interval (no exposure), and at the beginning and end of the 30 min exposure interval. Alpha power (8 – 12 Hz) was calculated for nine electrode sites (Fz, F3, F4, Cz, C3, C4, Pz, P3 and P4). Planned contrasts (one-tailed) were used to test whether the increase in EEG alpha power during Exposure compared to Sham depended on eye condition, and whether the increase in EEG alpha power during Exposure compared to Sham depended on exposure duration.

Results: There was a greater increase in EEG alpha power in the eyes open compared to the eyes closed condition in both the Low (p = .04) and High (p = .04) power RF-EMF exposure conditions compared to Sham. The EEG alpha power increase in the eyes open condition was also found to be larger at the End (during the last 4 mins) compared to the Start (first 4 mins) of a 30-min exposure in the High power RF-EMF condition (p < .01) compared to Sham. This, however, did not reach statistical significance in the Low power RF-EMF condition (p = .07) compared to Sham.

Conclusions: The use of eyes closed conditions, and insufficient RF-EMF exposure durations, are likely explanations for the failure of some studies to detect an RF-EMF exposure related increase in alpha power, as such methodological choices decrease signal-to-noise ratios and increase type II error.

All for one or four for one? The effect of number of generated words on language lateralisation

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Aims: The gold-standard assessment of the cerebral lateralisation of language (i.e., the relative dominance of left-versus right-hemisphere activity during language processing) using functional transcranial Doppler ultrasound (fTCD) is the Word Generation task. This involves participants generating words beginning with a visually-presented letter. The paradigm was first introduced in 1996 with the instruction to generate four words but later changed in 1998 to generate as many words as possible. To date, no one has tested whether this instruction affects lateralisation estimates. The aim of this work was to compare the lateralisation index based on the two different instructions in the word generation paradigm.

Method: To ensure the 22 undergraduate participants complied with instructions, participants were required to generate words overtly (previous work involved silent generation). In a within-subjects design, participants were instructed to generate 'four' words or as 'many' words as possible in a counterbalanced order.

Results: The instruction manipulation was successful at the behavioural level with an average (*SD*) of 3.76 (0.57) words reported in the 'four' condition and 6.44 (1.92) words reported in the 'many' condition. Left lateralisation was evident at the group level; however, the lateralisation index was not affected by instructions: 'four' = 2.07 (3.01), 'many' = 2.21 (3.45). Interestingly, when task-order was examined, the lateralisation index was lower for participants who started with the 'four' condition: Four first = 0.66 (3.35), Many first = 2.93 (2.18).

Conclusions: The major finding of the study is that the initial instructions in two condition, counterbalanced, within-subjects design, had a significant impact on the physiological response. This has implications for research comparing atypically lateralised populations such as dyslexia, as their interpretation of the instructions and/or behaviour may have a significant impact on the outcomes.

A global EPOC: Characterisation of research using Emotiv's consumer EEG device

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Aims: The aim of this study was to systematically capture all peer-reviewed publications of Emotiv EPOC research in order to provide a characterisation of the global distribution of the device and the scenarios in which it has been used.

Method: We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. Publications were identified through searching electronic databases: PsychINFO, MEDLINE, Embase, Web of Science, and IEEE Xplore, and were categorised according to application (BCI, clinical, signal processing, experimental research, and validation) and location of use.

Results: We identified 344 publications, with the majority (n = 248) applied in brain-computer interface studies. Experimental research studies had the second highest publication rate (n = 51), with validation studies (n = 28), signal processing studies (n = 9), and clinical applications (n = 8) following. Published EPOC studies were also conducted around the world with the top five countries being the United States (n = 34), India (n = 24), China (n = 20), Poland (n = 16), and Indonesia (n = 15). The top five individual cities that published EPOC studies were Islamabad (n = 10), Singapore (n = 10), and Bandung, Indonesia, Cairo and Sydney (each n = 7).

Conclusions: Application of the Emotiv EPOC in peer-reviewed studies is diverse. From control of robotic limbs and wheelchairs, to user authentication in security systems to identification of emotional states, the device has been used in myriad situations and in countries across the world. The affordable nature of the device may enable EEG research for teams to whom traditional systems are inaccessible.

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