



# **Alpine Brain Imaging Meeting**

Champéry, Switzerland, January 8-12, 2023

## **PROGRAM**



**<http://www.unige.ch/ABIM/>**

## SPONSORS

*We are grateful to the following institutions and companies for their generous financial support:*



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# **Alpine Brain Imaging Meeting**

Champéry 2023

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Frédéric Grouiller

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## **Locations:**

Registration, opening keynote lecture and welcome reception on Sunday will be held at the *Hotel Suisse*. Talks and poster sessions during the week will take place at the *Palladium Sport and Conference Center* (see map for details).

For more information, see website: <http://www.unige.ch/ABIM/>

## **GENERAL INFORMATION**

**Registration** will take place at the *Hotel Suisse* (Rue du Village 55; see map) on Sunday, the 8<sup>th</sup> of January from 16:00 to 17:30. During the following days, participants can register in the conference room at the *Palladium* conference center (Route du Centre Sportif, 1), only during meeting hours, from 15:00 to 20:00. Additional information can also be obtained at the *Hotel Suisse* outside these hours.

The **opening keynote lecture** (Sunday at 17:30) will be held at the *Hotel Suisse* (Rue du Village 55) and will be followed by an informal **welcome reception** with wine & snacks. All other **talks** and **poster sessions** during the week will take place at the *Palladium* conference center (see program). Posters should be exposed throughout the conference from Monday to Wednesday to allow sufficient viewing time for all participants. **Three poster sessions** will be held on Monday 9<sup>th</sup>, Tuesday 10<sup>th</sup> and Wednesday 11<sup>th</sup> of January in the afternoon (see program and poster map). Speakers are invited to check their presentation in the conference room no later than at 15:00 on the day of their lecture.

Free **internet access** by WiFi is available in the lounge and in the café of the *Hotel Suisse*, as well as in the *Palladium* conference room.

There are several **restaurants** in Champéry, including one at the *Palladium* (which is open all day including evenings). Since many restaurants in town are relatively small, you are encouraged to book a table in advance, especially if you go with a large group. The staff at the *Hotel Suisse* or at the *Palladium* can help you with this. The kitchen closes generally around 21.30.

A **farewell dinner** is planned on Thursday night at the restaurant *Le Gueullhi* (Route de la Fin, 11). The dinner will be free for all registered participants, excluding drinks. Please refer to the staff at the registration desk before Tuesday January 10<sup>th</sup> for any changes regarding your participation to the dinner. A **prize ceremony** will be held with best poster and best presentation awards.

**Ski slopes** can be reached from two places, either using the cable car leaving from Champéry or the chairlift leaving from the Grand-Paradis (see map). Ski-passes of four days (Mon-Thu) can be bought at the *Hotel Suisse* with a group discount (announced during registration on Sunday evening) or individually at the cable car departure. Public buses are available for going to or coming back from the Grand-Paradis.

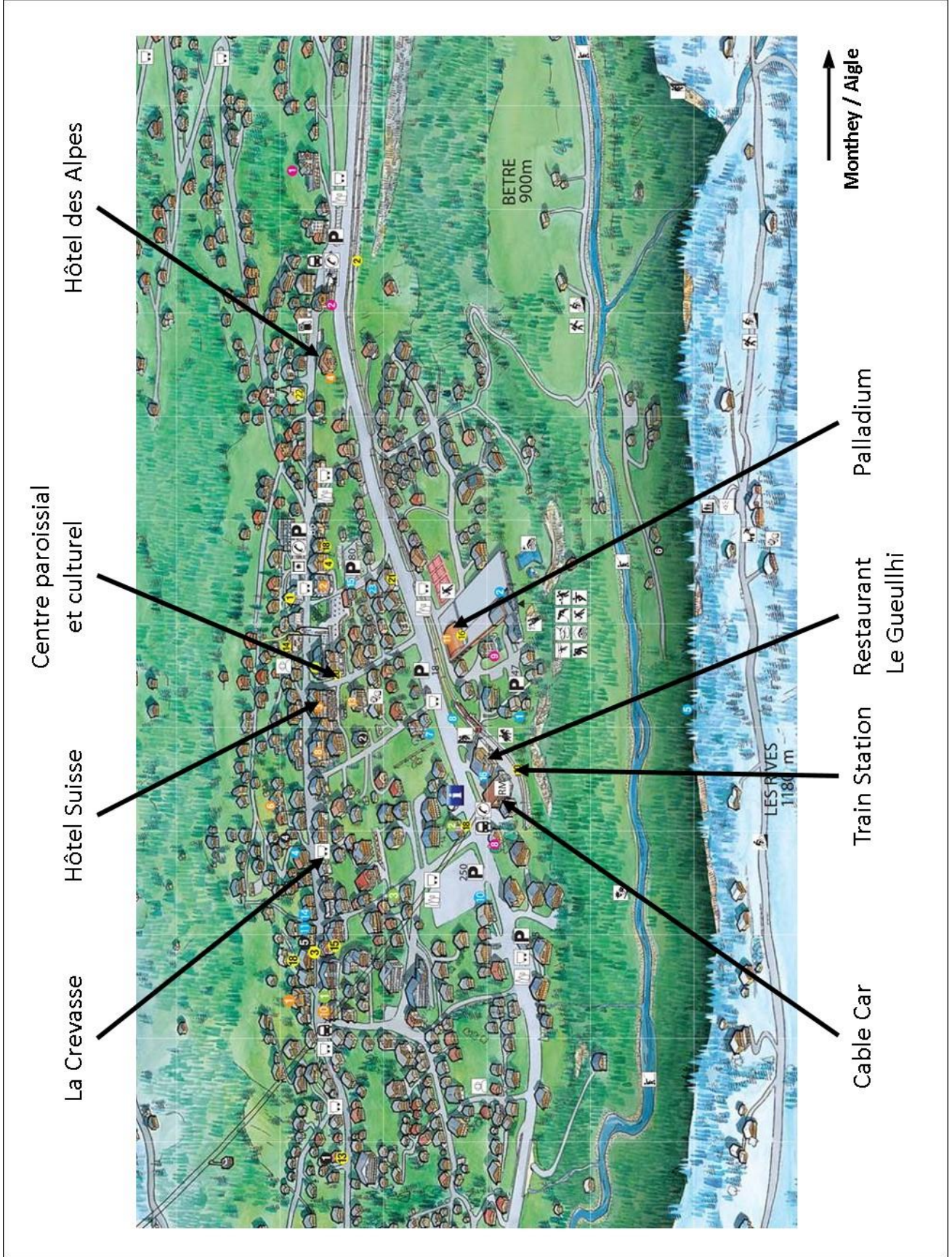
A **swimming pool** and **skating arena** can also be found at the *Palladium*.

The abstracts of the talks are listed in this book in order of appearance.

A ★ marks presentations from invited speakers. Poster abstracts are ordered according to their category and day of presentation.

**More information is available on <http://www.unige.ch/ABIM/>**

# MAP



# Alpine Brain Imaging Meeting 2023

## PROGRAM OVERVIEW

SUNDAY, January 8<sup>th</sup>

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### OPENING LECTURE

16:00-17:30 Registration (Hotel Suisse)

17:30 Opening Keynote Lecture (Hotel Suisse Conference Room)

Michael PLATT | *University of Pennsylvania, USA*

- *Climate Change and the Social Brain*

18:30-20:30 Welcome Reception sponsored by *CIBM Center for Biomedical Imaging*

(Hotel Suisse)

MONDAY, January 9<sup>th</sup>

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### *Development of Numerical and Musical Skills*

15:00 Welcome Coffee & posters

15:30 Elisabeth BRANNON | *University of Pennsylvania, USA*

- *Recent investigations characterizing the development and evolution of the approximate number system*

16:20 Clara JAMES | *University of Applied Sciences and Arts Western Switzerland HES-SO & University of Geneva, Switzerland*

- *Never too late: musical training-driven brain and cognitive benefits in healthy elderly*

16:40 Giovanni LEONE | *Inserm, Paris, France*

- *Plasticity in control and memory circuits forecasts PTSD symptoms evolution*

17:00 Coffee Break

17:30 Psyche LOUI | *Northeastern University, USA*

- *Why Music Moves Us: New Directions in Music for Brain Health*

18:20 **Andrew YONELINAS** | University of California, Davis, USA

- *The role of the hippocampus in working memory*

18:40 **Poster Blitz Presentations**

18:50-20:00 **Poster Session: Emotion & Motivation; Language & Music; Learning & Memory.**

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TUESDAY, January 10<sup>th</sup>

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### ***Interoceptive Awareness***

15:00 Welcome Coffee & posters

15:30 **Athina DEMERTZI** | *Liège University, Belgium*

- *At the boundaries of mental state reportability*

16:20 **Hal BLUMENFELD** | *Yale School of Medicine, USA*

- *Shared subcortical arousal networks across perceptual modalities*

16:40 **Viviana LEUPIN** | *University of Fribourg, Switzerland*

- *Interoceptive signals determine the earliest markers of awareness for visual threshold stimuli: evidence from ERPs and their sources*

17:00 **Coffee Break**

17:30 **Anil SETH** | *University of Sussex, UK*

- *From beast machines to dreamachines*

18:20 **Andria PELENTRITOU** | *University Hospital (CHUV) and University of Lausanne (UNIL), Switzerland*

- *Cardio-audio synchronization elicits neural and cardiac surprise responses in human wakefulness, sleep and coma*

18:40 **Poster Blitz Presentations**



18:50-20:00 **Poster Session: Clinical Neuroscience; Perception.**

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WEDNESDAY, January 11<sup>th</sup>

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### ***Brain Dynamics***

15:00 Welcome Coffee & posters

15:30 **Diego VIDAURRE** | Aarhus University, Denmark

- *Models to characterise endogenous and task-related brain network dynamics*

16:20 **Thomas KOENIG** | University Hospital of Psychiatry, Translational Research Centre, & University of Bern, Bern, Switzerland

- *Towards a more objective use of resting-state EEG microstate findings across studies*

16:40 **Matthias MÜLLER** | University of Leipzig, Germany

- *What if they were wrong? Putting the Pd and signal suppression hypothesis on a stress test with a multi-dimensional approach*

17:00 **Coffee Break**

17:30 **Joana CABRAL** | University of Minho, Portugal

- *Brain Energy Landscapes across conditions*

18:20 **Erie BOORMAN** | UC Davis, USA

- *Cognitive maps, cognitive control, and inference*

18:40 **Poster Blitz Presentations**

18:50-20:00 **Poster Session: Clinical Neuroscience; Methods.**

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THURSDAY, January 12<sup>th</sup>

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### ***Social Actions and Decisions***

15:00 Welcome Coffee & posters

15:30 **Emilie CROSS** | Western Sydney University, Australia

- *Using human—robot encounters to explore human behavioural and brain plasticity*

16:20 **Roland BENOIT** | *University of Colorado, Boulder & Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany*

- *How imaginings shape our preferences: Computational and neural mechanisms of simulation-based learning*

16:40 **Matthias GRUBER** | *Cardiff University, UK*

- *Intrinsic functional connectivity determines how curiosity and prediction errors enhance memory*

17:00 **Coffee Break**

17:30 **Matthew RUSHWORTH** | *University of Oxford, UK*

- *What is special about the social brain?*

18:20 **Richard RAMSEY** | *Macquarie University, Sydney, Australia*

- *Lonely brains at rest: A population neuroscience approach to understanding resting-state functional connectivity in lonely individuals*

18:40 **Elenor MORGENROTH** | *EPFL, Geneva, Switzerland*

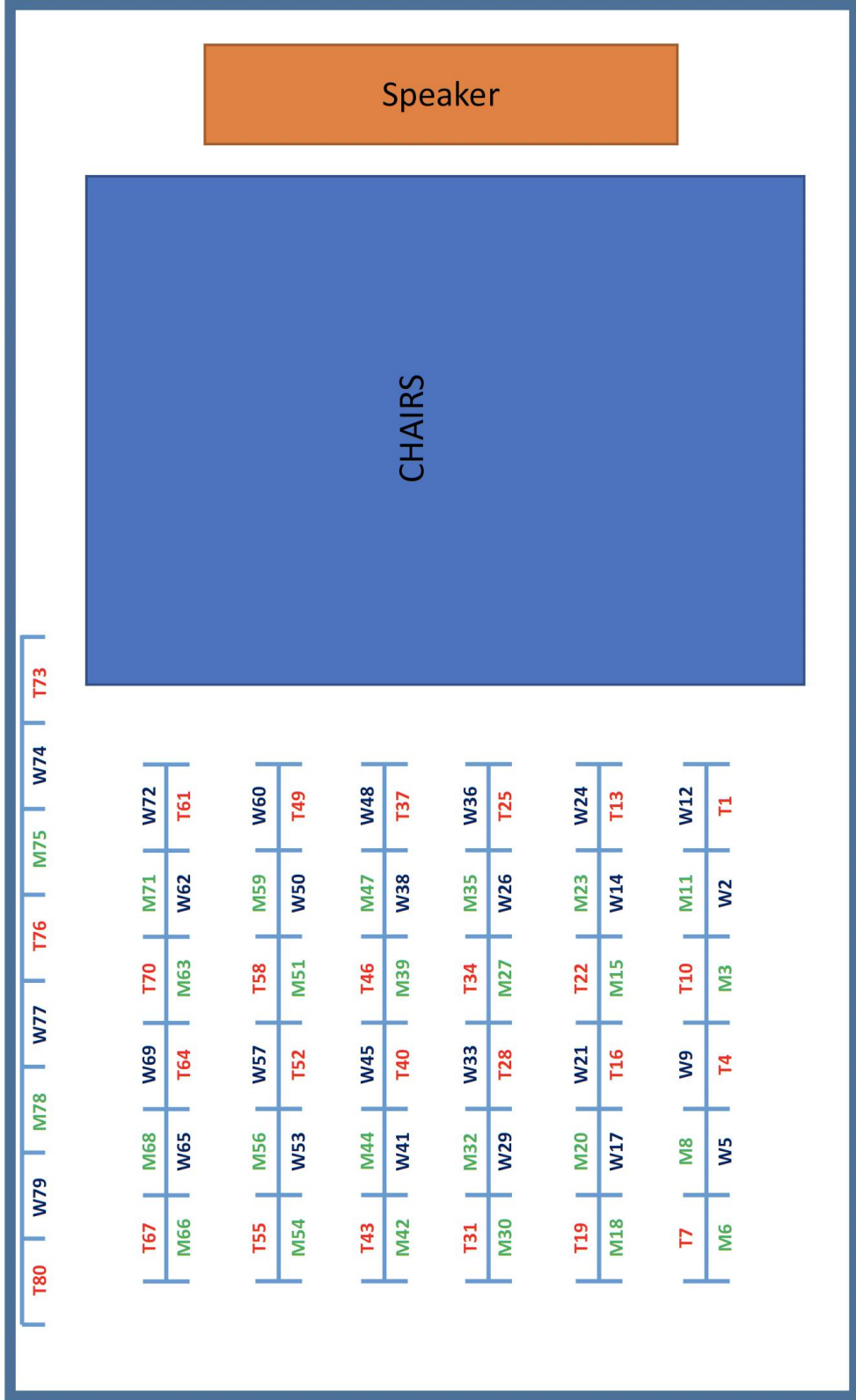
- *The neural organization of emotion experience during film*

19:00-20:00 **Moving to dinner location**

20:00 **Farewell dinner with prize ceremony**

- *Restaurant “Le Gueullhi”*

# POSTER MAP



**M3-M15 Emotion & Motivation**  
**M18-M59 Language & Music**  
**M63-M78 Learning & Memory**

**T1-T43 Perception**  
**T46-T80 Clinical Neuroscience**

**W2-W45 Clinical Neuroscience**  
**W48-W79 Methods**

# **ABSTRACTS OF ORAL PRESENTATIONS**

The themes of the days are:

Sunday: OPENING LECTURE

Monday: DEVELOPMENT OF NUMERICAL AND  
MUSICAL SKILLS

Tuesday: INTEROCEPTIVE AWARENESS

Wednesday: BRAIN DYNAMICS

Thursday: SOCIAL ACTIONS AND DECISIONS

The abstracts of the talks are listed in this book in order of appearance. A ★ marks presentations from invited speakers.

*Sunday*

## Opening Lecture

01 ★

### Climate Change and the Social Brain

Michael Platt<sup>1</sup>

<sup>1</sup>Departments of Neuroscience, Psychology, and Marketing, University of Pennsylvania

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Deeper and more numerous social connections promote health, well-being, survival, and even financial success. By the same token, social exclusion and the loss of social partners result in feelings similar to physical pain. In my talk, I will discuss our work aimed at defining the biological mechanisms that mediate our ability and desire to connect and the impact of these capacities on resilience. We leverage a unique 17-year field study of thousands of free-ranging rhesus macaques and a biobank including genomic, neuroanatomical, and brain transcriptomic data, collected before and after a major cyclone, and parallel neurophysiological and pharmacological work in the laboratory. We find that monkeys who have more friends are more successful and show increased gene expression and structural connectivity within the social brain network, particularly the middle superior temporal sulcus (mSTS). Neurophysiological studies in our lab show mSTS neurons encode a rich array of information necessary to guide dynamic, evolving social interactions. Pharmacologically inactivating mSTS impairs the sophistication of social interactions. In the field, monkeys who lived through the cyclone showed upregulation of aging-related genes in immune and inflammatory pathways, accompanied by physical decline. Behaviorally, monkeys responded to the acute and chronic stress of the cyclone by becoming more social and less aggressive, and monkeys who made more social connections had higher survivorship after the hurricane, as did their offspring. Our studies data indicate that biological predispositions for social connections shape resilience to the stresses of life, including catastrophic disruptions due to climate change.

*Monday*

## **Development of Numerical and Musical Skills**

O2 ★

### **Recent investigations characterizing the development and evolution of the approximate number system**

Elizabeth Brannon<sup>1</sup>

<sup>1</sup>University of Pennsylvania

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The ability to use numbers is one of the most complex cognitive abilities that humans possess and is often held up as a defining feature of the human mind. I will describe the developmental and evolutionary precursors to adult mathematical cognition. I will illustrate how studying numerical illusions can illuminate the nature of the primitive number sense. I will probe the relationship between the ANS and symbolic math by asking whether non-symbolic computations facilitate symbolic mathematics. Finally, I will present new findings that demonstrate that loss aversion in economic decision-making increases over development and can be parsed into a response bias to reject possible losses and a calculation bias that develop asynchronously from childhood through adulthood.

# Development of Numerical and Musical Skills

## O3

### **Never too late: musical training-driven brain and cognitive benefits in healthy elderly**

Clara E James<sup>1, 2</sup>, Eckart Altenmüller<sup>3, 4</sup>, Tillmann HC Krüger<sup>4</sup>, Florian Worschech<sup>3, 4</sup>, Frédéric Grouiller<sup>5, 6, 7</sup>, Kristin Jünemann<sup>4</sup>, Christopher Sinke<sup>4</sup>, Matthias Kliegel<sup>2, 8</sup>, Dimitri Van De Ville<sup>9, 10, 11</sup>, Damien Marie<sup>1, 5, 6, 7</sup>

<sup>1</sup>University of Applied Sciences and Arts Western Switzerland HES-SO, Geneva School of Health Sciences, Geneva Musical Minds lab (GEMMI lab), Geneva, Switzerland, <sup>2</sup>Faculty of Psychology and Educational Sciences, University of Geneva, Geneva, Switzerland, <sup>3</sup>Hannover University of Music, Drama and Media, Institute for Music Physiology and Musicians' Medicine, Hannover, Germany, <sup>4</sup>Center for Systems Neuroscience, Hannover, Germany, <sup>5</sup>Hannover Medical School, Centre of Mental Health, Department of Psychiatry, Social Psychiatry and Psychotherapy, Section of Clinical Psychology & Sexual Medicine, Hannover, Germany, <sup>6</sup>Swiss Center for Affective Sciences, University of Geneva, Geneva, Switzerland, <sup>7</sup>CIBM Center for Biomedical Imaging, MRI HUG-UNIGE, Geneva, Switzerland, <sup>8</sup>Center for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Switzerland, Geneva, Switzerland, <sup>9</sup>Neuro-X Institute, Ecole Polytechnique Fédérale de Lausanne (EPFL), Campus Biotech, Geneva, Switzerland, <sup>10</sup>Faculty of Medicine, University of Geneva, Campus Biotech, Geneva, Switzerland, <sup>11</sup>CIBM Center for Biomedical Imaging, MRI EPFL & SP UNIGE-EPFL, Geneva, Switzerland

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Age-related cognitive decline is a major impediment to healthy aging, independence, and well-being. Ingrained beliefs that aging is solely defined by decline prevent many older persons from engaging in learning new skills. Our approach proposes learning new skills in healthy older adults after retirement.

We investigated musical training-driven benefits for abilities traditionally considered to decline during normal aging: working memory, executive function, hearing in noise, and fine motor skills, as well as for brain structural and functional plasticity.

The study followed a longitudinal design, offering intensive piano training versus "musical culture" training (active listening and learning about music) to groups of retired non-musician elderly (n~150, 60 in Geneva and 90 in Hannover, Germany), over 12 months. Psychometric and neuroimaging data were collected at baseline, 6 and 12 months after training onset, and after a delay of 6 months.

Initial analyses show enhanced speech in noise perception, improved working memory and long-term verbal memory, associated with plasticity of gray and white matter, with the piano group exhibiting greater alterations. Increased cortical thickness and gray matter volume occurred in the piano group in primary and secondary auditory areas. Functional network plasticity could be associated with increased hand dexterity and auditory-motor integration in the piano group.

Unveiling specific positive effects of music practice and analytical music listening on age-related cognitive decline can contribute to maintaining mental health and quality of life of older adults, decrease the need for assisted living, and promote such approaches on a large scale in the community.

# Development of Numerical and Musical Skills

## O4

### **Plasticity in control and memory circuits forecasts PTSD symptoms evolution**

Giovanni Leone<sup>1</sup>, Hannah Casanave<sup>1</sup>, Charlotte Postel<sup>1</sup>, Florence Fraisse<sup>1</sup>, Thomas Vallée<sup>1</sup>, Fausto Viader<sup>1</sup>, Vincent de la Sayette<sup>1</sup>, Denis Peschanski<sup>2</sup>, Jacques Dayan<sup>1, 3</sup>, Francis Eustache<sup>1</sup>, Pierre Gagnepain<sup>1</sup>

<sup>1</sup>Inserm, U1077, EPHE, UNICAEN, Normandie Université, PSL Université Paris, CHU de Caen, GIP Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine (NIMH), 14000 Caen, France.,

<sup>2</sup>Université Paris I Panthéon Sorbonne, HESAM Université, EHESS, CNRS, UMR8209, Paris, France.,

<sup>3</sup>Pôle Hospitalo-Universitaire de Psychiatrie de l'Enfant et de l'Adolescent, Centre Hospitalier Guillaume Rénier, Université Rennes 1, 35700 Rennes, France.

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PTSD has long been characterized as a memory disorder rooted in the alteration of hippocampal integrity. Recently, we have found a disruption in memory control mechanisms, characterized by the imbalance between predictive and reactive control of intrusive memories. Here, we investigated how these two disorders evolved in 52 individuals exposed to the 2015 Paris terrorist attacks and whether plastic changes forecasted the future evolution of PTSD symptoms severity. We acquired high-resolution hippocampal volumes and fMRI activations during a memory suppression task one and three years after the attacks, and a further clinical evaluation five years after. We combined computational modelling and DCM to model predictive and reactive prefrontal control over the hippocampus during memory suppression. Remitted participants (n=18) showed recovered balance between predictive and reactive memory control in time ( $F=2.962$ ,  $p=.043$ ), but no significant hippocampal plastic changes. On the contrary, participants with persistent PTSD (n=34) showed a persistent imbalanced memory control towards predictive mechanisms and a further reduction of CA2-3/DG volume ( $F=4.001$ ,  $p=0.023$ ). Individual improvements in reactive control and CA1 between one and three years after the trauma forecasted the future reduction of avoidance and intrusive symptoms five years after, respectively (RC-Avoidance:  $F=2.395$ ;  $p=0.009$ ; CA1-Intrusion:  $F=1.992$ ,  $p=0.025$ ). These findings revealed the centrality of neurocognitive plasticity of control and memory circuits in understanding trauma persistence and remission. Our results shed light on a dual mechanism involving both prefrontal memory control and hippocampal functioning restoration to inaugurate future clinical improvements and remission from PTSD.



# Development of Numerical and Musical Skills

## 05 ★

### Why Music Moves Us: New Directions in Music for Brain Health

Psyche Loui<sup>1</sup>

<sup>1</sup>Department of Music, College of Arts, Media and Design, Northeastern University

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Music is an integral part of every human society, and musical experiences have been associated with human health and well-being since antiquity. Recent use-inspired research on Music-Based Interventions (MBIs) include receptive (music listening) and active (music making) programs designed to make measurable changes to human health and well-being. Designing these interventions consistently and with measurable benefits require addressing the question of dosage, which refers to the duration and intensity (dosage) of the intervention. I argue that cognitive neuroscience can inform the question of dosage in MBIs by quantifying the effects of receptive and active music interventions on predictive coding in the central nervous system. As a ubiquitous feature of biological systems, predictive coding is posited to underlie perception, action, and reward. I will present recent work that encompasses behavioral testing, neuropsychological assessments, and neuroimaging (EEG and fMRI) studies in my lab on how and why humans across societies learn to love music, uncovering the role of different types of prediction on the activity and connectivity of the reward system. Given that music taps into a relatively domain-general reward system which in turn motivates a variety of cognitive behaviors, I will also consider how this knowledge can be translated into MBIs for those with neurological and/or psychiatric disorders, presenting preliminary results on Alzheimer's Disease and Parkinson's Disease.

# Development of Numerical and Musical Skills

## O6

### **The role of the hippocampus in working memory**

Andrew Yonelinas<sup>1</sup>

<sup>1</sup>University of California, Davis

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The role of the hippocampus in visual working memory has been controversial. I describe studies of visual working memory in lesion patients and fMRI that indicate that the hippocampus supports a global familiarity signal that supports working memory.

*Tuesday*

## **Interoceptive Awareness**

07 ★

### **At the boundaries of mental state reportability**

Athena Demertzi<sup>1</sup>

<sup>1</sup>GIGA-CRC In Vivo Imaging, GIGA Institute, University of Liège, Belgium

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During resting conditions spontaneous experience is ongoing, dynamic, and rich in mental content taking the form of mental states. Mental states are transient cognitive or emotional occurrences that are described in terms of particular content (what the state is ‘about’) and the relation we bear to this content (e.g. imagining, remembering, fearing). Ongoing experience can also show moments of mind blanking during which there is a failure to report the content of thoughts, often accompanied by a post-hoc realization that our mind “went away”. Here, I will discuss the possibility of a contentless mind as this is reported in healthy, waking conditions and will delineate the brain physiology which underlies contentless phenomenology. This work essentially proposes that non-reportable mental events can happen during wakefulness, and challenges the view of the mind as a constant thought-oriented operator.

# Interoceptive Awareness

**O8**

## **Shared subcortical arousal networks across perceptual modalities**

Hal Blumenfeld<sup>1, 2, 3, 4</sup>, Shanae Aerts<sup>1, 4</sup>, Tuan Bui<sup>1</sup>, Kate Christison-Lagay<sup>1</sup>, Mariana M. Gusso<sup>1</sup>, David Jin<sup>1, 4</sup>, Aya Khalaf<sup>1</sup>, Sharif I. Kronemer<sup>1, 4</sup>, Erick Lopez<sup>1</sup>, Anjali Mangla<sup>1</sup>, Nancy Wu<sup>1</sup>, Thomas Xin<sup>4</sup>, Taruna Yadav

<sup>1</sup>Yale School of Medicine Department of Neurology, <sup>2</sup>Yale School of Medicine Department of Neuroscience, <sup>3</sup>Yale School of Medicine Department of Neurosurgery, <sup>4</sup>Yale School of Medicine Interdepartmental Neuroscience Program

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Subcortical arousal systems are known to influence long-lasting states such as sleep/wake and sustained attentional vigilance. However, the role of these subcortical systems in dynamic short-term modulation of conscious perceptual awareness has not been fully investigated. To identify subcortical networks that are shared across sensory modalities, we first analyzed fMRI data from large publicly available visual, auditory and taste perception data sets (N=1556). We performed model-free fMRI analysis using a spatiotemporal cluster-based permutation test to detect changes at task block onset and with individual task events. Conjunction analysis revealed a common network of subcortical arousal systems shared across perceptual modalities, including transient fMRI increases in midbrain tegmentum, thalamus, and basal forebrain. Cortical salience and top-down attention network regions were also shared across modalities, although cortical modality-specific changes were also observed. Next, we investigated visual perception using a report-independent paradigm, employing pupil, blink and microsaccade metrics with machine learning to detect consciously perceived stimuli without overt report (N=65). We again found transient fMRI increases in the same subcortical arousal networks including midbrain, thalamus and basal forebrain for consciously perceived stimuli, independent of task report. Finally, to directly measure subcortical signals during perceptual awareness we recorded from the intralaminar thalamus centromedian nucleus (CM) in patients with implanted electrodes. In both visual (N=7) and auditory (N=1) threshold perceptual awareness tasks, we found a thalamic event-related potential specific for conscious perception, peaking ~450ms after perceived stimuli. These findings suggest that subcortical arousal circuits participate in dynamic phasic modulation of conscious perception across sensory modalities.

# Interoceptive Awareness

09

## **Interoceptive signals determine the earliest markers of awareness for visual threshold stimuli: evidence from ERPs and their sources**

Viviana Leupin<sup>1</sup>, Juliane Britz<sup>1</sup>

<sup>1</sup>University of Fribourg

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We can investigate neural correlates of consciousness (NCC) by comparing the brain response to different perceptual outcomes of a visual threshold stimulus: when it is consciously perceived, both early sensory (P1), perceptual (VAN) and post-perceptual (LP) ERP components are stronger than when it is not perceived. Because the brain is inextricably linked with the body, cyclic variations of bodily signals, namely the cardiac and respiratory phase, can likewise influence perceptual awareness. Baroreceptor activity (BRA) during the systolic cardiac phase interferes with sensory stimulus processing. Cardiorespiratory coupling likewise increases BRA during exhalation, which also affects the detection of simple stimuli. To determine how the cardiac and respiratory phase influence awareness-related brain activity, we presented visual stimuli at the discrimination threshold. We compared ERPs and their intracranial sources when subjects correctly identified the stimuli with and without awareness and found that both the earliest markers of awareness and the brain areas recruited to achieve awareness vary with the cardiac and respiratory phase. If a visual stimulus is presented when BRA is minimal (diastole and inhalation), the P1 is the earliest marker of awareness. In the phases when BRs are more active (systole and exhalation), the VAN is the earliest marker of awareness. Time-resolved statistics on the intracranial sources indicate that a visual stimulus reaches conscious awareness differently if it is accompanied by BRA or not. Taken together, we show that cyclic variations of bodily signals modulate the timing and the underlying mechanisms of the NCC.

# Interoceptive Awareness

O10 ★

## From beast machines to dreamachines

Anil Seth<sup>1</sup>

<sup>1</sup>Sussex Centre for Consciousness Science, University of Sussex, and Program on Brain, Mind, and Consciousness, Canadian Institute for Advanced Research (CIFAR)

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Consciousness remains one of the central mysteries in science and philosophy. In this talk, I will illustrate how the framework of predictive processing (or active inference) can help bridge from mechanism to phenomenology in the science of consciousness – addressing not the ‘hard problem’, but the ‘real problem’. I will advance the view that predictive processing, precisely because it is not itself a theory of consciousness, is an excellent theoretical resource for consciousness science. I will illustrate this view first by showing how conscious experiences of the world around us can be understood in terms of perceptual predictions, drawing on examples from psychophysics and virtual reality. Then, turning the lens inwards, we will see how the experience of being an embodied self rests on control-oriented predictive (allostatic) regulation of the interior of the body. This approach implies a deep connection between mind and life, and provides a new way to understand the subjective nature of consciousness as emerging from systems that care intrinsically about their own existence. Contrary to the old doctrine of Descartes, we are conscious because we are beast machines. I’ll finish by describing a recent art-science collaboration – the Dreamachine – which involves stroboscopically induced visual hallucinations – experienced by tens of thousands of people – and a large-scale online survey of ‘perceptual diversity’, The Perception Census.

# Interoceptive Awareness

**O11**

## **Cardio-audio synchronization elicits neural and cardiac surprise responses in human wakefulness, sleep and coma**

Andria Pelentritou<sup>1</sup>, Christian Pfeiffer<sup>2</sup>, Nathalie Ata Nguepjo Nguissi<sup>1</sup>, Manuela Iten<sup>3</sup>, Frédéric Zubler<sup>4</sup>, Sophie Schwartz<sup>5, 6</sup>, Marzia De Lucia<sup>1</sup>

<sup>1</sup>Laboratoire de Recherche en Neuroimagerie (LREN), Department of Clinical Neurosciences (DNC), University Hospital (CHUV) and University of Lausanne (UNIL), Switzerland, <sup>2</sup>Robotics and Perception Group, University of Zurich, Zurich, Switzerland, <sup>3</sup>Department of Intensive Care Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland, <sup>4</sup>Department of Neurology, Inselspital, Bern University Hospital, University of Bern, Switzerland, <sup>5</sup>Department of Neuroscience, Faculty of Medicine, University of Geneva, Geneva, Switzerland, <sup>6</sup>Swiss Center for Affective Sciences, University of Geneva, Geneva, Switzerland

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The human brain can encode temporal regularities in auditory sequences when sound onsets are locked to cardiac inputs. Here we investigated whether cardio-audio regularity processing can occur in the absence of perceptual awareness by administering auditory sequences while recording continuous electrocardiography and electroencephalography in a cohort of comatose patients (N=64) i.e. in a deep unconscious state, and of healthy volunteers during sleep (N=26). We investigated the neural and cardiac correlates of violated auditory prediction by administering sound sequences which were unexpectedly interrupted by omissions. Auditory regularities were either based on synchronizing sounds to the ongoing heartbeat (synchronous) or by administering sounds at a fixed pace (isochronous). In coma survivors and only in the synchronous condition, unexpected omissions elicited a modulation of the neural response to sound omission at -59-66 ms and 277-460 ms following omission onset. In healthy volunteers during N2 sleep, we observed a modulation of the neural response to unexpected omissions within the isochronous sequences at 83-226 ms and within the synchronous sequences at -49-67 ms and 272-450 ms following omission onset, the early peak driven by a modulation of background slow oscillations due to the auditory stimulation. In healthy volunteers, cardio-audio regularity encoding was further demonstrated by a heartbeat deceleration upon omissions in the synchronous condition across all vigilance states. Cardio-audio regularity encoding can occur in the absence of consciousness and is preserved across all vigilance states, outlining a potential mechanism by which the unconscious brain utilizes the continuously monitored bodily signals to anticipate threats or dangers.

*Wednesday*

## **Brain Dynamics**

**O12** ★

### **Models to characterise endogenous and task-related brain network dynamics**

Diego Vidaurre<sup>1,2</sup>

<sup>1</sup>Aarhus University, <sup>2</sup>Oxford University

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The brain needs to activate multiple networks in a temporally coordinated manner in order to perform cognitive tasks, and it needs to do so at different temporal scales, from the slowest circadian cycles to fast subsecond rhythms. When trying to characterise these processes, our choice of methods has an impact on the way we understand brain function. In this talk, I will overview our work on the Hidden Markov model, including varieties of the HMM that models task information together with the data. I will discuss practical matters like reliability of the estimations and how we can relate these models to behaviour in effective ways.



# Brain Dynamics

**O13**

## **Towards a more objective use of resting-state EEG microstate findings across studies**

Thomas Koenig<sup>1</sup>, Christoph Michel<sup>2</sup>

<sup>1</sup>Translational Research Center, University Hospital of Psychiatry, University of Bern, Switzerland,

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Over the last decade, EEG resting-state microstate analysis has evolved from a niche existence to a widely used and well-accepted methodology. The rapidly increasing body of empirical findings started to yield overarching patterns of associations of biological and psychological states and traits with particular microstate classes. However, currently, this cross-referencing among apparently similar microstate classes of different studies was typically done by “eye-balling” of printed template maps by the individual authors and lacked a systematic procedure. To improve this situation, we present an effort to systematically collect the actual data of template maps from as many published studies as possible and present them in their entity as a matrix of spatial similarity. In addition, the tool allows the import of novel template maps from ongoing studies and the systematic extraction of the findings associated with particular microstate maps in the literature. Once made available to the community, we hope that this tool will be useful in coming to a more comprehensive, objective, and overarching representation of microstate findings.

# Brain Dynamics

## O14

### **What if they were wrong? Putting the Pd and signal suppression hypothesis on a stress test with a multi-dimensional approach**

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We tested a central prediction of the signal suppression hypothesis in visual search (Gaspelin et al., 2015): processing of distractors will be proactively suppressed below the level of nonsingleton distractors (fillers) when foreknowledge of the singleton's feature (color or shape) exists. A contrasting proposal holds that salient stimuli capture attention initially, and irrelevant stimuli are excluded later. In two EEG studies, we concurrently measured stimulus-driven steady state visual evoked potentials (SSVEPs) and intrinsic alpha band responses along with event related potentials (ERPs). Although we found a distractor positivity (Pd) elicited by distractors that is seen as neural signature of proactive distractor suppression, SSVEPs and alpha band responses provided converging evidence against early proactive suppression of highly salient distractors. Results indicate that both, stimulus and goal-driven allocations of attention occur in conjunction with one another. With a letter probe task in which on some trials, probes (e.g., letters) are superimposed upon the search items, Gaspelin and colleagues (2015) found reduced recall for letters in the singleton distractor compared to fillers, interpreted as evidence for the suppression of the single distractor. These findings may, however, be explained by global facilitation of the target's features (green color) shared by the fillers (also green). In line with this interpretation, by manipulating the color of fillers, probe recall "suppression" for singleton distractors was abolished and probe recall for fillers was enhanced as a function of target-filler color similarity. Together, the results undermine central predictions of the signal suppression hypothesis.

# Brain Dynamics

O15 ★

## Brain Energy Landscapes across conditions

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Distinct Psychiatric, Psychologic or Neurophysiologic conditions have been found to relate to an altered recurrence of functional networks in brain activity. Beyond its biomarking potential, this finding offers new theoretical insight into brain function. Borrowing tools from statistical Physics to characterize dynamical systems, brain activity can be represented as a trajectory in an energy landscape, in which the valleys – or dwells - represent functional networks towards which the trajectory recurrently returns with a given probability. Under this theoretical framework, distinct conditions are associated with alterations in the energy landscape, affecting the occupancy and/or dwell time of specific networks and the transitions between them. Dynamical systems theory is thus emerging as a powerful tool to gain insight into the rules orchestrating brain activity, providing new perspectives to design therapeutic strategies for mental health.

# Brain Dynamics

**O16**

## **Cognitive maps, cognitive control, and inference**

Park Seongmin<sup>1,3</sup>, Maryam Zolfaghar<sup>2,3,4</sup>, Jacob Russin<sup>2,3</sup>, Randall O'Reilly<sup>2,3,4</sup>, Erie Boorman<sup>1,3</sup>

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Recent work has shown that abstract, non-spatial relationships between entities or task states are organized into representations called cognitive maps. Here we investigated how cognitive control enables flexible top-down selection of goal-relevant information from multidimensional cognitive maps retrieved from memory. We examined the relationship between cognitive control and representational geometries by conducting parallel analyses of fMRI data and recurrent neural network (RNN) models trained to perform the same task. We found both 2-D map-like representations in a medial temporal lobe and orbitofrontal cortical network and simultaneous 1-D orthogonal representations of relevant task dimensions in a frontoparietal network, supporting representational stability and flexibility, respectively. These representational motifs also emerged with distinct trajectories over training in the RNN. We further show that increasing control demands due to incongruence (conflicting responses) between current task-relevant and irrelevant dimensions produces warping along the context-invariant axis in subjective representations, and the degree of warping further accounts for individual differences in cognitive control. Together, our findings show how complementary representational geometries balance generalization and behavioral flexibility, and reveal an intricate bidirectional relationship between cognitive control and cognitive map geometry.

*Thursday*

## **Social Actions and Decisions**

**O17** ★

### **Using human—robot encounters to explore human behavioural and brain plasticity**

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Understanding how we perceive and interact with others is a core challenge of social cognition research. This challenge is poised to intensify in importance as the ubiquity of artificial intelligence and the presence of humanoid robots in society grows. This talk examines how established theories and methods from psychology and neuroscience are revealing fundamental aspects of how people behave with robots. Robots provide a resolutely new approach to studying brain and behavioural flexibility manifest by humans during social interaction. As machines, they can deliver behaviours that can be perceived as “social”, even though they are artificial agents and, as such, can be programmed to deliver a perfectly determined and reproducible set of actions. As development of service robots, home companion robots and assistance robots for schools, hospitals and care homes continues apace, the extent to which we perceive and treat such machines as social agents and how we engage with them over the long term remains largely unexplored. This talk describes research that bridges social cognition, behavioural neuroscience and robotics, with important implications not only for the design of social robots, but equally critically, for our understanding of the neurocognitive mechanisms supporting human social behaviour more generally.

# Social Actions and Decisions

O18

## **How imaginings shape our preferences: Computational and neural mechanisms of simulation-based learning**

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Our ability to imagine future episodes has much in common with our ability to remember past episodes. Such episodic simulation is largely based on the same core network of brain regions and exhibits similar phenomenological properties. Here, we further examine the hypothesis that we also learn from merely simulated episodes, in much the same way as we learn from actual past experiences. Using functional MRI and computational modelling, we tested the hypothesis that this simulation-based learning is based on a common mechanism of reinforcement learning. Our participants made a series of choices between two people that they were personally familiar with. They then vividly imagined an interaction with the chosen person (serving as the conditioned stimuli) in a presented scenario that was either pleasant (e.g., eating ice cream on a sunny day; positive unconditioned stimuli) or unpleasant (e.g., getting stuck in a thunderstorm; negative unconditioned stimuli). Critically, over the course of the experiment, participants acquired a preference for the person that they had imagined more frequently in a pleasant scenario. They moreover showed a positive shift in their general attitude towards that person. Notably, this simulation-based learning can best be accounted for by a Rescorla-Wagner model of reinforcement learning that is mediated via a striatal prediction error. This region supports the updating of value by interacting with the dorsomedial prefrontal cortex, a region that encodes representations of individual people. This study thus highlights that mere simulations shape our real-life preferences and sheds light on the underlying computational and neural mechanisms.

# Social Actions and Decisions

**O19**

## **Intrinsic functional connectivity determines how curiosity and prediction errors enhance memory**

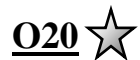
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In recent years, research on curiosity – the desire to seek new information – has been rapidly growing. Studies have shown that both curiosity but also positive information prediction errors (IPEs) – when information is more interesting than previously expected – enhance later memory. However, the memory-enhancing effects of curiosity and IPEs differ considerably between individuals. Here, we investigated whether inter-individual differences in intrinsic functional connectivity between cortico-mesolimbic brain regions related to curiosity and IPEs account for these memory differences. Eighty participants took part in a trivia paradigm and a separate 10-minute resting-state fMRI scan. Curiosity (i.e., high – low curiosity) and IPEs (i.e., positive – negative IPEs) independently enhanced memory of answers to trivia questions. Importantly, we found a double dissociation in how intrinsic functional connectivity was associated with memory enhancements. That is, inter-individual differences in intrinsic functional connectivity between ventral tegmental area and nucleus accumbens were associated with the magnitude of curiosity-based – but not IPE-related – memory enhancements. In contrast, inter-individual differences in intrinsic functional connectivity between anterior cingulate cortex and hippocampus were associated with the magnitude of IPE-driven – but not curiosity-related – memory enhancements. These findings demonstrate that intrinsic mesolimbic and cingulo-hippocampal functional connections account for the extent of curiosity-related and IPE-driven memory enhancements, stressing the importance to differentiate effects of curiosity and IPEs on learning. Furthermore, the findings help to refine our recently proposed PACE (Prediction, Appraisal, Curiosity, and Exploration) Framework that attempts to integrate theoretical ideas on the neurocognitive mechanisms of how curiosity is elicited, and how curiosity enhances learning and memory.

# Social Actions and Decisions



## What is special about the social brain?

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Activity in several human brain areas have been linked to cognition in social contexts. A long-standing question, however, is how “special” are these brain areas?. Are they uniquely human? Are they uniquely concerned with social cognition? A series of experiments employing both recording of activity in these brain areas and examination of the impact of disrupting activity have begun to provide some answers. Recent results suggest that key parts of the neural circuit in medial frontal cortex and superior temporal sulcus can be identified in other primate species where they are also important for using socially derived information to guide behaviour. Part of what makes the areas important for social cognition is the way in which they can focus on 1) information about individual identity in a manner that is flexible and related to the demands of the current context; 2) information concerning diverse combinations of individuals that vary in composition and in fundamental features of their social attitude such as whether they are cooperating with us or competing with us.



# Social Actions and Decisions

O21

## **Lonely brains at rest: A population neuroscience approach to understanding resting-state functional connectivity in lonely individuals**

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Loneliness is a discrepancy between the perceived and desired quality of social connections, which has been associated with a range of negative health outcomes, such as higher morbidity and mortality. However, the neurobiological basis of loneliness is far from clear. In light of this, the current project systematically examined how resting-state functional connectivity (RSFC) patterns vary as a function of loneliness using a large secondary dataset (N>35k from the UK Biobank). In two pre-registered analyses, we used a Bayesian estimation analytical framework to assess how RSFC varies across large-scale brain networks as a function of self-reported loneliness. We performed two separate analyses to build replication into our analytical approach. Across both analyses the results showed that loneliness was associated with small increases and decreases in RSFC between a widespread and distributed set of brain networks, including coupling between visual, affective, attentional, and default-mode resting-state networks. The magnitude of these effects was relatively small (~0.1-0.2 change in the correlation coefficient between brain networks), but consistent with other recent population neuroscience studies of individual differences. These results suggest that loneliness is underpinned by widespread reorganisation across many brain circuits, which span a range of functions. In the short term, the results provide novel insight into the nature of functional re-organisation that occurs between major brain networks when individuals experience loneliness. In the longer term, a richer mechanistic understanding of loneliness at a population neuroscience level can help to inform interventions that aim to alleviate the persistent consequences of loneliness.

# Social Actions and Decisions

O22

## The neural organization of emotion experience during film

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Emotion is an elusive concept in neuroscience, partly owed to disregard of emotion theory of how emotion may be organised. Here we consider three dominant accounts of emotion organisation to examine which best describes the neural response to emotional film. We join a behavioural dataset of 43 subjects' ratings of fourteen short films (total duration ~2h40min) and a dataset of 30 subjects watching these films during fMRI. We extract three groups of brain maps for emotion dimensions, discrete emotions and emotion components, respectively. Testing for the main effect of subject, film and emotion in each group, we reveal that the effect of emotion exceeds the effects of subject and film. This validates that our dataset captures substantial variance related to emotion. Next we show that components predict discrete emotions in a model that generalises from behavioural to fMRI dataset. Further, we use representational similarity analysis, comparing the representation of discrete emotions and of emotion components between behavioural annotations and fMRI. There is a trend towards the relationship between emotion components and discrete emotions being preserved across datasets. These results support that emotion components play a central role in the neural representation of emotion experience even across modalities and samples. Finally, we examine if our data supports a three-dimensional organisation of emotion in both behavioural and fMRI, which we could not reinforce based on our findings. This research supports the notion that the neural representation of emotion experience most closely resembles a componential representation rather than a discrete or dimensional one.

# POSTER ABSTRACTS

Ordered according to these categories:

Emotion & Motivation (M3-M15)

Language & Music (M18-M59)

Learning & Memory (M63-M79)

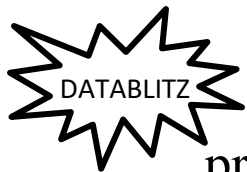
Perception (T1-T43)

Clinical Neuroscience (T46-T80/W2-W45)

Methods (W48-79)

The letter preceding the abstract number indicates the day of presentation:

M: Monday, T: Tuesday, W: Wednesday



Indicates that this abstract will be presented during poster blitz presentation

# *Emotion & Motivation*

## **M3**

### **Investigating the neural correlates of reward learning in patients suffering from narcolepsy and Parkinson's disease**

Gabriel Hinnen<sup>1</sup>, Armand Mensen<sup>2</sup>, Ramin Khatami<sup>2</sup>, Kristoffer Aberg<sup>3</sup>, Virginie Sterpenich<sup>1</sup>, Sophie Schwartz<sup>1</sup>

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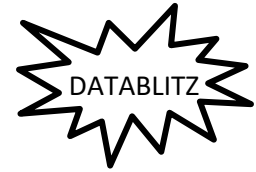
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Reward learning is an essential part of our everyday life, as it helps us attribute values to things. We can either learn by approaching positive reinforcements (approach learning), or by avoiding negative outcomes (avoidance learning).

In this project, 12 narcoleptic patients (NC), 15 Parkinson's disease patients (PD) and 15 healthy controls were compared for a reward learning task in an fMRI protocol. We also modelled the learning profile as a parametric modulator, translating how much each subject takes into account the positive or negative prediction error during the task.

First, we show that, behaviourally, all subjects were more rapid to respond to high versus low reward. A whole-brain analysis revealed in all subjects a higher activity in the bilateral nucleus accumbens (NAcc) for positive feedbacks and in the bilateral insula for negative ones. Second, we observed that learning profiles differ between groups, as control subjects were more sensitive to approach learning and PD patients more to avoidance learning. At the brain level, activity in the left NAcc and in the ventral tegmental area (VTA) was correlated with the approach learning profile in control subjects, and with the avoidance learning profile in PD subjects.

These results suggest that the perception of a positive or negative feedback on a trial by trial basis doesn't induce differences between populations, while the dynamic learning of these occurrences does. These differences appear not only behaviourally, but also at the cerebral level, where they tend to be underlied by abnormal left NAcc and bilateral VTA activity.



## **M6**

### **Musical pleasures modulate $\mu$ -opioid system activity in the brain**

Lauri Nummenmaa<sup>1,2,3</sup>, Kerttu Seppälä<sup>1,2,4</sup>, Eleni Rebelos<sup>1,2</sup>, Jussi Hirvonen<sup>1,2</sup>, Jouni Tuisku<sup>1,2</sup>, Vesa Putkinen<sup>1,2</sup>

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**Introduction:** The  $\mu$ -opioid receptor (MOR) system has been proposed to mediate musical pleasures, because music heightens social closeness and increases pain threshold, indicating central opioid release. Pharmacological work has also shown that blocking  $\mu$ -opioid receptors dampens music-induced pleasure. However, there is currently no in vivo imaging evidence supporting the involvement of MORs in musical hedonia.

**Methods:** Musical pleasure was induced by playing subjects their self-selected favourite music. Haemodynamic responses were recorded from 30 subjects during an fMRI experiment with repeated blocks of pleasurable music and baseline. Fifteen subjects also underwent positron emission tomography (PET) with agonist radioligand [11C]carfentanil with high affinity for  $\mu$ -opioid receptors. MOR availability was measured twice: while listening to pleasurable music and during no-music baseline. Subjective pleasure ratings were measured throughout the experiments.

**Results:** Listening to pleasurable music evoked consistent haemodynamic activation in auditory cortices and limbic and paralimbic emotion circuits. PET data revealed that musical pleasures increased [11C]carfentanil binding potential (BPND) in several brain regions including brainstem, thalamus, ventral striatum, temporal pole and orbitofrontal cortex. Fusion analysis of the PET and fMRI data revealed that haemodynamic responses to musical pleasures were linearly dependent on regional MOR availability.

**Conclusions:** Our results provide first-ever neuroimaging evidence that listening to pleasurable music modulates MOR system activation. These results indicate that the  $\mu$ -opioid system also governs complex aesthetic rewards in addition to biologically relevant rewards such as food and physical contact and reveal the neuromolecular pathway for music-induced relaxation and analgesia.

# *Emotion & Motivation*

## **M8**

### **Componential representations of emotions - a video game study**

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The neural representation of emotions has been a topic of great interest but still remains debated. While the theory of discrete/basic emotions has received much attention in psychology and neuroscience, fMRI studies have shown a substantial overlap between brain regions that are activated across different emotions. This project aims to study if appraisals are crucial in the generation of different emotional states by recruiting different processing systems, as postulated in appraisal theories. If so, we hypothesise that it should be possible to define distinct appraisal and corresponding neural patterns for different emotions. Building upon previous work in the lab, in this study, we manipulated two appraisals: goal obstructiveness and uncertainty. To create more immersive and naturalistic stimuli, we implemented these manipulations via an in-house video game. Unlike conventional stimulation methods such as pictures and movies, the interactive aspect of video games enables self-initiated goal-directed actions and direct self-relevant experience of their consequences, thereby evoking strong and ecologically valid emotions.

During the experiment, we recorded all components of emotion as postulated in the Component Process Model - action tendencies, physiology, facial expression, neural representations and reports of appraisals and feelings. We found a set of distinct behavioural factors contributing to the classification of the manipulation of goal obstructiveness and uncertainty respectively, which are coherent with our manipulations in the game. These behavioural changes were also contributing differentially to participants' emotion ratings. Furthermore, we were able to characterise each behavioural factor with unique patterns of activations in cortical and subcortical brain regions.

# *Emotion & Motivation*

## **M11**

### **Synchronized brain activity during naturalistic film in fMRI—how it can help us understand emotions**

Laura Vilaclara<sup>1</sup>, Arwen Giraud<sup>1</sup>, Loris Constantin<sup>1</sup>, Patrik Vuilleumier<sup>3</sup>, Dimitri Van De Ville<sup>1,2</sup>, Elenor Morgenroth<sup>1</sup>

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Naturalistic stimuli have gained significant popularity in fMRI. Having a closer to life setting to study the brain in all its complexity is indeed a major advantage, especially in the context of affective sciences where emotion elicitation is a major challenge. Unfortunately, using such complex stimuli comes at a considerable cost: the loss of a clear, simple, and contrasting paradigm.

Intersubject functional connectivity (ISFC) is ideal to palliate for this added difficulty of not having alternating conditions to draw conclusions from. In resting state, the functional connectome is constructed from within-brain region-to-region correlation of time series. Here, we take advantage of the fact that all subjects are watching the same film to extract the “intersubject connectome”. All processes that are not consistent among subjects will vanish and only movie-driven activity will dominate.

Brain function, films and emotion are all very dynamic processes in essence. To capture their temporal dependencies, we compute dynamic ISFC (dISFC) by using a sliding-window approach. We used fMRI data from thirty subjects watching fourteen high emotion content full films from the LIRIS database. Discrete categories of emotions (such as fear) and appraisal describing items (such as congruence with social norms) were annotated for each movie.

After thresholding the dISFC to only keep significant excursions, we examine how temporal variations in the common experience of our subjects are related to emotion. We conclude that while ISFC is highly driven by low-level sensory features, there is nonetheless meaningful variations corresponding to higher-order processes.

# *Emotion & Motivation*

## **M15**

### **Episodic simulation sets the stage for prosociality**

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Humans vary in the amount of empathy and prosocial behavior they display in response to others' misfortunes. To explain this, we often look at attributes of the given other (e.g., social group or perceivable distress). But we frequently respond to misfortunes of others who are distant in space and time, which additionally invites imagination. Imagination has been shown to moderate empathy and prosocial behavior, but the composition of imagined representations and its relevance for behavior is unknown. We used fMRI in healthy human adults (N = 48) to identify brain regions preferentially active when imagining familiar places and people, respectively. Resulting activation maps replicate parahippocampus-linked (places) and temporoparietal-junction-linked (people) subnetworks of the default network. Participants separately imagined misfortunes happening to random combinations of the previously imagined people and places. This allowed testing whether activity in the previously identified activation maps predicts affective empathy ratings and dictator game allocations in response to the person in a given event (target). Empathy and dictator game allocations were predicted by activity in both activation maps, with place-related activity being equally or more predictive than people-related activity. These results held across group- and participant-level masks as well as covariate adjustment. Surprisingly, like people-related activity, place-related activity during event imagination was best predicted by how much participants liked the imagined target (as opposed to liking and being familiar with the place). These findings suggest that scene imagery informs empathy and prosocial behavior in complement to person imagery and that scene imagery is more pronounced towards liked targets.



# *Language & Music*

## **M18**

### **Longitudinal or cross-sectional analysis of letter and speech sound association?**

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The first and critical step for reading development is learning letter-speech sound (LS) association. In adults and children, LS integration was extensively studied using cross-sectional designs with a consensus that the left superior temporal cortex is the integration site (Blau et al. 2009). Relatively little is known about the development of LS integration in children on both behavioral and neuronal level and this constitutes the goal of my research. Polish children from kindergarten to 8th grade participated in a behavioral experiment with a computer-based letter to phoneme game in which they had to judge whether letters match phonemes. Children learned accurate LS association within one year of reading instruction, but they needed more time (around 3 years) to automatize this ability, as reflected by decreasing reaction times. On neuronal level, in longitudinal fMRI study (N = 67), we found significant changes in the pattern of brain activation during the first two years of education. While the brain activity in sensory areas decreased in response to unimodally presented speech sounds (auditory) and letters (visually), it increased when children processed multimodal LS pairs. Forty children returned for an additional scan in the 8th grade of primary school (third time point). I will present how the pattern of brain activation changed in children who already automatized LS integration.

# *Language & Music*

## **M20**

### **Effect of audio and motor rhythms on speech perception**

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Speech perception and speech comprehension are enhanced when they are preceded or accompanied by a similar co-occurring rhythmic temporal structure (audio or motor). What's more, these rhythms influence cortical activity, by increasing cortical coupling at the specific frequency of the rhythms. Although these phenomena have already been described, the respective contribution of the auditory and motor components has not been studied. Moreover, in the population these effects vary, and the origin of this interindividual variability is still unclear. In view of this, we record the electroencephalogram of 22 participants during a speech detection task preceded or not by a rhythm. We used sentences with a precise temporal (metrical) structure and we degraded their spectral content to render the task more difficult. These sentences could be preceded or not by an auditory, motor or audio-motor rhythm (1.65 Hz). Participants also performed a Spontaneous Speech Synchronization test. This test is based on the ability to synchronise the speech production with a heard speech. This allowed to divide the population into low and high synchronisers. Our results indicate that audio and audio-motor rhythm facilitate speech perception, visible at the reaction time level. On the other hand, while speech entrainment is visible in EEG data at several metrical levels, the specific effect of priming is only visible on the first part of the experiment. We will discuss these findings in light of effects of perceptual learning as well as their relation with synchronization skills.

# *Language & Music*

## **M23**

### **Human frontal cortex contributions to the recognition of primate vocalizations**

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The ability to process verbal language is unique to humans but relies on other forms of communication such as affective vocalisations that we share with other primate species, particularly great apes (Hominidae). To better understand these processes at the brain level, we asked twenty-three human participants to categorize vocalizations of four primate species including human, great apes (chimpanzee and bonobo), and monkey (rhesus macaque) during functional MRI acquisition. Focused on frontal brain regions, model-based analyses revealed the implication of the bilateral orbitofrontal cortex (OFC) and inferior frontal gyrus pars triangularis (IFGtri) respectively correlating and anti-correlating with the fitted probability of accurate species classification. Further conjunction analyses revealed enhanced activity in a sub-area of the left IFGtri specifically for the accurate classification of chimpanzee calls compared to human voices. Our data therefore reveal distinct frontal mechanisms that shed light on how the human brain evolved to process non-verbal language.

# *Language & Music*

## M27

### **Interoception and the musical brain: Evidence from cross-sectional and longitudinal resting-state fMRI study**

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Musical training has been linked to enhanced interoceptive abilities and increased resting-state (RS) functional connectivity (FC) within the interoceptive brain network. We aimed to replicate and extend these findings with cross-sectional and longitudinal study design. 20 professional musicians and 24 matched individuals with no prior musical experience (training group) participated in the study. All participants underwent a single RS fMRI scan and completed heartbeat counting and discrimination tasks outside of the scanner (time point 1). The training group additionally underwent a 6-months-long keyboard course and had RS scans and interoception tests repeated twice more (after 3 and 6 months of training).

We found no evidence for increased interoceptive abilities in professional musicians relative to non-musicians, nor did we observe any improvements in interoception over the course of the keyboard training. RS FC analysis revealed increased FC within the sensorimotor network in professional musicians compared to the training group at the first time point. This difference was no longer present at the end of the training.

These results challenge the view that musical training may improve interoceptive processing. Yet, the results suggest that even (relatively) short musical training may increase communication within the somatomotor RS network, which consists of some hubs important for interoceptive processing (namely pre- and postcentral gyri and supplementary motor area bilaterally, extending into the opercular cortex).

# *Language & Music*

## **M30**

### **Brain functional plasticity of tonal working memory and behavioral outcomes following 12-month music interventions in 110 healthy older adults**

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Cognitive decline represents a main threat among the negative effects of aging, heavily impacting the quality of life and autonomy of older adults. Working memory (WM) is particularly affected. WM involves temporarily storing, updating, and manipulating information while no longer perceptible. Age-related decline of WM is important because it is scaffolding complex tasks such as abstract reasoning. Interestingly, recent data suggest that musical practice might prevent age-related WM decline, but experimental evidence remains sparse.

This study aims to test this hypothesis by comparing two types of musical education. This longitudinal randomized control trial in 150 healthy older adults offers either piano (intervention group) or music sensitization education (active control group). Over 12 months participants receive weekly training (60 minutes) and exercise at home for ~30 minutes daily. Measurements take place at 4 timepoints (0, 6, 12 months & post-training (18 months)) on a comprehensive behavioral test battery as well as on magnetic resonance imaging (MRI) including a tonal WM task in the scanner. We measured brain activity while participants were manipulating and comparing 3-tone patterns.

We will present here the longitudinal results of the full intervention in 110 participants, after 12 months of musical training, concerning behavioral and brain WM data comparing both groups. We expect positive transfer effects from musical training to tonal WM in both groups, larger in the piano group than the control group, at the fronto-parietal network and the behavioral level.

# *Language & Music*

**M32**



## **Bridging coordinative and neural dynamics**

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Coordination is an essential aspect of any form of interaction with others. In a dance or between musicians in an orchestra, each individual has to coordinate with the action of his or her partner in order to adjust his or her own correctly. Similarly, in a conversation, there is a need to adapt and anticipate the interlocutor. In this respect, joint activity are good contexts to assess adaptation and prediction processes. Here, we recorded the intracranial brain activity of patients with drug-resistant epilepsy while they performed a verbal coordination task with a virtual partner. More precisely, patients had to repeat short sentences synchronously with the virtual partner. Based on a Kuramoto model, which describes the synchronisation behaviour of coupled oscillators, the virtual partner can track the instantaneous phase of the patient's speech signal and predict it so that it can adjust in real time with the patient. Moreover, by changing the coupling strength parameters, we could modulate patients capacity to synchronise speech with the virtual partner. This coordination task allows us to monitor the coupling between the patient and the virtual partner in a continuous manner. This allows to bridge the neurophysiological activity with the behaviour. This approach highlights a spatially and frequency specific activity network that cannot be observed by looking at neurophysiological activity alone. Our results show that combining dynamically resolved behavior and neural data is a powerful avenue to better understand natural speech processing.

# *Language & Music*

## **M35**

### **Stability of point-process generalized linear models of neural activity during speech processing**

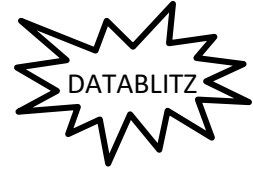
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Microelectrode arrays allow recording neuronal activity in human during complex cognitive behavior, such as speech processing. Neuronal models can help interpreting the resulting high dimensional neural activity. A specific type of discrete and flexible model, the point process generalized linear model (PPGLM), has been widely used to capture the effect of neural history dependency as well as exogenous sensory inputs on neural activity. PPGLMs can be directly fitted to neuronal recordings, but can sometimes generate unstable dynamics leading to non-realistic firing rates despite passing common statistical goodness-of-fit tests, as was shown previously. We introduced a continuous representation of the discrete PPGLM that accurately reproduce the PPGLM dynamics. Using tools from dynamical system theory, we showed under which conditions the system shows stable, bistable or unstable dynamics, and extended previous results for one neuron to networks with arbitrary number of neurons and connections. Our results are validated against simulated networks of PPGLMs, as well as neuronal recordings during speech processing. Our findings open the way for a direct analysis of latent dynamics underlying neural population activity.



**M39**

**The time course of brain reorganisation over 6 months of piano training in novice pianists playing music: a longitudinal fMRI study**

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Learning to play the piano is a complex task, integrating multiple sensory modalities and higher-order cognitive functions. With increasing expertise, the task should become easier as learners' focus shifts away from basic technique while playing. We hypothesise this shift reflects a functional reorganisation observable via neuroimaging methods in multiple brain networks. Thus, we scanned twenty-four novice learners (female, 18-23yo) using fMRI while they listened to and subsequently played increasingly complex musical pieces after 1, 6, 13 and 26 weeks of training.

We observed overlapping and differential patterns of brain reorganisation related to listening and playing within the ventral and dorsal auditory streams, the motor system, cognitive control and subcortical structures (caudate nuclei, putamen, hippocampus). The right dorsal auditory stream and the bilateral opercular inferior frontal gyri were specifically modified for music listening but not playing, while a partial overlap occurred in the bilateral superior and middle frontal gyri, the triangular inferior frontal gyri and the anterior cingulate cortex. Within the motor system and subcortical structures, we predominantly observed changes related to playing the instrument. The time-course of the functional remodelling showed a gradually decreasing involvement of all regions, with different patterns of dynamics depending on the brain system.

These results suggest that just 6 weeks of learning could evoke training-related changes in brain activity while playing music. Afterwards, a gradual reorganisation in brain activity for listening and playing music occurs, indicative of decreasing cognitive effort despite increasing task difficulty.



# *Language & Music*

## M42

### **Neural manifolds in human superior temporal gyrus scaffold speech phonological processing**

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Recent work in early sensory and motor cortices has shown that functionally-relevant population activity can be represented as a set of trajectories confined to a low-dimensional neural manifold, a subspace spanned by the patterns of correlated neural activity. However, it remains unknown whether the same encoding principles apply to speech comprehension, a multi-level hierarchical neural processing that integrates several cognitive functions. To find whether speech-associated manifolds can be uncovered from neural activity in human cortical networks, we analyzed population activity recorded with a microelectrode Utah array implanted in the anterior superior temporal gyrus (aSTG) of a patient with pharmacoresistant epilepsy while he performed an auditory task. We regressed out neural representation from distinct linguistic features, including spectrogram and envelope of the sound, phonemes, word duration, and semantic. We then applied dimensionality reduction methods to these representations and obtained speech-associated manifolds. Our results show that phonological representations were the main contributor to neural variance, although other features contributed as well. Consonants and vowels are represented as distinct trajectories on a low-dimensional neural manifold, and cluster along speech acoustic features, i.e. manner of articulation for the consonants, and formants for the vowels. Crucially, this clustering was maximized for a restricted time window after the phoneme onset, around 200 ms for vowels and 400 ms for consonants. These findings extend previous work on single-neuron to neuronal population responses to auditory stimuli in the aSTG, and shed new light on neuronal dynamics during speech processing by uncovering phoneme-specific trajectories confined to a speech-associated neural manifold.

# *Language & Music*

## **M44**

### **Neural dynamics of acoustic and semantic representations for natural sounds**

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My PhD project focuses on the neural dynamics underlying the transformation of the acoustic signal of natural sounds into semantic representations. The acoustic signal is first represented as frequency over time in the cochlea, then it is submitted to a spectro-temporal modulation transformation in early auditory areas before being transmitted to the superior temporal gyrus (STG) and ventrolateral prefrontal cortex (VLPFC) where semantic representations seem to emerge. Numerous MEEG studies investigated this question using different paradigms to segregate acoustic and semantic representations, but none of them presents a comprehensive characterization of the acoustical structure neither considers natural language processing models of semantics or deep neural networks (DNNs). My PhD project aims to propose a clear experimental paradigm coupled with acoustic and semantic computational models and DNNs to examine precisely how natural sounds are represented in different areas as a function of time using MEG recordings.

# *Language & Music*

## M47

### **How does early neural entrainment induced by rhythmic emotional vocal stimulation affect anticipatory processes in preterm and full-term infants?**

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Social synchrony and newborn socio-emotional development depend on anticipation and prediction mechanisms. The ability to build up such capacities is thought to be already at work at an early stage of development and is strongly related to neural entrainment induced by rhythmical patterns (e.g., in language). During interactions, in the early stage of development, adults communicate with the so-called infant-directed speech, which is slower than adult-directed speech, mainly at delta frequency. In preterm infants, early anticipatory problems can lead to subsequent communication and social impairments. This study, therefore, aims to investigate the neural mechanisms of short-term anticipatory and prediction processes in moderate to late preterm and term infants at 6 months of corrected age. Newborns will undergo EEG recordings during the presentation of parent, stranger, or cello auditory stimuli in delta or theta rhythm. We predict a differential effect of the rhythm in each auditory condition, with higher Steady-State Evoked Potentials (SSEPs) and gamma band amplitudes in delta compared to theta rhythm. Furthermore, we also predict an impact of prematurity, with reduced anticipatory abilities in preterm infants. Some results of a pilot study will be presented. Subsequent research phases will allow us to disentangle the role of rhythmical and vocal entrainment on infants' anticipatory responses. This study will improve our understanding of human voice processing prediction mechanisms and increase our knowledge of short-term prediction brain pathways at an early stage of development in at-risk newborns to develop initial interventions for sustaining early abilities in interpersonal communication.

**Keywords:** anticipation, prediction, prematurity, Steady-State Evoked Potentials, and wavelets decomposition.

# *Language & Music*

## **M51**

### **A game of Song Scramble: exploring the brain's music network**

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In this work, we show the development of a music localiser for functional magnetic resonance imaging (fMRI) in the context of a larger project exploring individual differences in linguistic, musical and domain-general skills, at behavioural, neural and genetic levels. fMRI localisers are simple paradigms where participants are exposed to stimulation with basic contrasts, useful to assess the cortical organisation and effort subtending basic functions. To these aims, we developed a music network fMRI localiser based on the contrast between unfamiliar intact songs and their 'scrambled' versions, where the rhythmic, melodic and phrasal structure is heavily disrupted while preserving basic acoustic features. Here, we explain how we developed the task and we show preliminary results in our first 8 participants. This task is administered within an fMRI session which also includes a language localiser, a visual category localizer for the ventral occipitotemporal cortex including the visual word form area, a resting state sequence, and finally, standard anatomical and diffusion-weighted imaging. Monolingual, multilingual and polyglot participants are currently undergoing these tasks. Participants also provide survey and behavioural data including, but not limited to, language and music experience and use. In this specific exploration, we aim at revealing the brain networks engaged by the holistic processing of naturalistic musical passages in non-experts, and to show if and how they may be modulated by musical and linguistic skill and/or aptitude. The final dataset will include 150 participants, their behavioural, genetic and neural data and will be eventually be made available to prospective users for further analyses.



**M54**

**An ERP study of the influence of bodily resonances on emotional prosody perception**

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Emotional prosody is defined as suprasegmental and segmental changes in voice and related acoustic parameters that can inform the listener about the emotional state of the speaker. Despite a large corpus of literature in psychological and brain mechanisms in emotional prosody perception, the perspective of embodied cognition in these mechanisms have been largely neglected. Here we investigated the influence of induced bodily vibrations in the categorization of ambiguous emotional vocalizations in an event-related potential study. The factorial design included Vocal emotion [anger and fear] and Vibration [anger, fear, and none] as factors. Emotional voices were morphed between a fearful expression with the speaker's identity-matching angry expression, creating blends of emotions in each voice. Emotional congruent and incongruent vibrations were delivered on the skin through transducers placed close to the vocal cords. The main hypothesis was that induced bodily vibrations would constitute a potential interoceptive feedback that would influence the perception of emotions, especially for more ambiguous voices. Behavioural results showed that vibration skewed participants emotional ratings by accentuating responses congruent with the vibration. ERP results indicated that the P200 component subtending the early processing of emotional prosody was significantly modulated by vibrations in the congruent setting which could be considered as a facilitation effect for early emotional prosody processing. A significant modulation of the late positive component was also observed for low ambiguity vocalizations in the incongruent setting, suggesting an error processing mechanism. These results suggest that vibrations would play a significant role in vocal emotion perception through embodied mechanisms.

# *Language & Music*

## **M56**

### **Speech and music recruit frequency-specific distributed and overlapping cortical networks**

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To what extent do speech and music processing rely on domain-specific and domain-general neural networks? Adopting a dynamical system framework, we investigate the presence of frequency-specific and network-level selectivity and combine it with a statistical approach in which a clear distinction is made between shared, preferred, and category-selective neural responses. Using intracranial EEG recordings in 18 epilepsy patients listening to natural and continuous speech and music, we show that the majority of focal and network-level neural activity is shared between speech and music processing. Our data also reveal an absence of regional selectivity. Instead, neural selectivity is restricted to distributed and frequency-specific coherent oscillations, typical of spectral fingerprints. Our work addresses a longstanding debate and redefines an epistemological posture on how to map cognitive and brain functions.

# *Language & Music*

## **M59**

### **The brain integration of affective prosodic and semantic information in sarcasm understanding**

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Language may serve many purposes, among them, is the communication of emotions. These emotions can be conveyed in different ways in speech, either with prosody or in a lexico-semantic manner or combination of both. These two types of emotional information are differently communicated, interactive, and activate some common brain regions in the brain, such as the superior temporal gyrus and the inferior frontal gyrus (Buchanan, 2000; Meyer, 2003). However, how these different cues are integrated at both the behavioral and brain level is still little understood. To better understand this semantic and prosodic integration, researchers often used incongruity paradigm (Kotz et al., 2015, Lin et al., 2020). Indeed, when affective prosodic and semantic cues are incongruent, like in the case of sarcasm or irony, the listener needs to integrate this different information to decode the intended affective message. Very few brain studies investigated sarcasm processing at the brain level and showed that the inferior frontal gyrus (IFG) and particularly the IFG pars orbitalis was involved in sarcasm understanding (Matsui et al., 2016). Moreover, some authors suggest that understanding sarcasm relies on the ability to make inferences about others' mental states, that is the theory of mind (Zhu & Wang, 2020), and activates prefrontal areas including the ventromedial prefrontal cortex (Tamir et al., 2016). Altogether, our fMRI study will attempt to shed light on brain mechanisms implied in sarcasm understanding and investigate the functional connectivity between brain regions involved in voice processing, semantic and prosodic cues integration, and higher-order social cognition mechanisms.

# *Learning & Memory*

## **M63**

### **Signal detection theory components and decisional factors influence electrophysiological correlates of recognition memory**

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The human memory appears to have almost infinite capacity. However, behavioral and electrophysiological studies of recognition have essentially been performed using forced-choice tasks, barring the distinction with signal detection theory (SDT). Two models of recognition memory resulted from those studies: a two-factor model, where correct recognition reflects the contribution of familiarity and recollection (by posterior regions and frontal cortex respectively) and a one-factor model that remains controversial.

Here we seek to identify electrophysiological markers of recognition memory using a “yes-no” task. Twenty-two participants were asked to identify 360 images seen 24 hours ago, mixed with 360 foils, while a 128-channels EEG was recorded. SDT responses yielded 4 conditions: Hit, Miss, Correct Rejection and False Positive. To identify electrodes and time windows of interest, we conducted a waveform non-parametric repeated-measure ANOVA on the type of answer. Two regions of interest of several electrodes were identified as predictors of performance: one posterior left and one medio-central cluster. One time-window (470 to 670ms) returned significant differences. Post-hoc analyses of SDT components revealed an effect of the answer type (i.e., yes vs. no answer) on the frontal cluster while SDT components were more differentiated on both posterior clusters.

Our study suggests that neither the one-factor, nor the two-factor model is sufficient to reflect both memory and decisional processes underlying recognition memory. Electrophysiological traces strongly differ according to response type (“yes” vs. “no”), suggesting that not only familiarity/recollection influence recognition, but so do decisional output components.



# *Learning & Memory*

## **M66**

### **Cerebral functional reorganization following working memory therapy in stroke patients**

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Annually, 5 million people are facing physical or cognitive disabilities after a stroke. Working memory (WM) impairments remain prominent in chronic stroke patients. WM is defined as the ability to maintain and temporarily process information. Several studies have shown that a WM rehabilitation focusing on the updating component of WM, and enhancing it mostly through multicoding, is effective. However, little is known about the neural correlates of WM improvement following such intervention. Thus, the purpose of this study is to investigate functional reorganization following cognitive WM updating therapy, in order to extract predictive data on its effectiveness. So far, a total of 5 patients have been included. Inclusion criteria are deficit in the updating component of working memory, >3 months post-stroke. Functional MRI acquisitions are performed pre- and post-therapy, using verbal and spatial WM 2-back tasks, with letters or shapes. Results show specific modulation patterns for each patient that are associated with improvements in the use of the strategies learned during rehabilitation. Increased activation after therapy in the superior temporal gyrus and superior parietal gyrus, as well as in Broca's and Wernicke's areas are observed in patients who improved. In conclusion, the main brain modulations following this therapy concern certain specific fronto-temporo-parietal regions. Thus, patients in whom these regions are preserved should be able to benefit from this therapy, whereas patients suffering from lesions in these regions would have little or no benefit from such therapy.

# *Learning & Memory*

## **M68**

### **Caution after conflict detection: Can people strategically adjust their decision thresholds within trials?**

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Adapting a learning perspective on cognitive control, we aimed to test if we can selectively reinforce conflict processing in four task switching experiments (n=508). In each trial, participants had to categorize a unique word based on its size or animacy which could either be associated with the same (congruent) or different (incongruent) response key in the currently irrelevant task. Crucially, we systematically rewarded congruent or incongruent trials more to test if people could dynamically adjust their response strategy depending on the congruency condition. As predicted, the group rewarded more on incongruent trials showed reduced congruency effects in accuracy. We speculated that this global modulation of conflict processing may be driven by condition-specific increases in response caution which can only occur after initial stimulus processing. To test this idea, we applied standard and conflict drift diffusion models and extended them by allowing for separate boundary shifts for congruent and incongruent trials following conflict detection. Posterior predictive checks suggested that our data was best captured by incorporating these boundary shifts into a conflict drift diffusion model which additionally accounts for fast errors by superimposing controlled and automatic diffusion processes. Interestingly, while both groups increased their boundary more for congruent trials, the group rewarded more on incongruent trials showed a similar increase for incongruent trials. These findings suggest that people only increase effort where it pays off most, namely on easy-to-solve congruent or reinforced incongruent trials. In sum, conflict processing can be selectively reinforced, possibly through the systematic upregulation of response caution.

# *Learning & Memory*

## **M71**

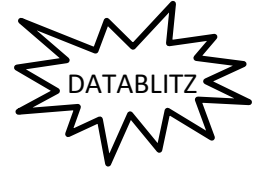
### **Sleep architecture during childhood: link between sleep oscillations and cognition**

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From birth to adulthood, micro and macro architectures of sleep change and are associated with improvements of cognitive functions such as declarative memory. Indeed, during childhood and adolescence, sleep oscillations features such as spindles frequency (in the sigma frequency band; 12-15 Hz) and slow-waves amplitude (in the delta frequency band; 1-4 Hz) increase as the brain matures. What is the extent of these changes with development and how they relate to the structuring of cognitive abilities is still unknown. To tackle this question, we recorded the polysomnography of 61 healthy children aged between 5 and 12 years old ( $M = 8.02$ ,  $SD = 1.72$ ) with a portable electroencephalogram device (EEG) at home and asked them to perform associative declarative memory tasks before and after the recorded night. As reported in the literature, we found an increase of spindle frequency in N2 sleep with age, a decrease of slow-wave in N3 with age, and a decrease of high-theta (5-8 Hz) frequency found in Rapid Eye Movement (REM) sleep with development. Moreover, memory performances were positively correlated with REM high-theta frequency (5-8 Hz). Our preliminary results suggest that through development, brain maturation induces changes of sleep oscillations such as slow-waves, REM theta and spindles, often associated with memory consolidation. Our study therefore shed light on the relationships between brain activity during sleep and cognitive functions in the developmental brain.



## M75

### **Neural signatures of contingency awareness**

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The recognition of the conditioned-unconditioned stimulus (CS-US) association in human fear conditioning is referred to as contingency awareness. A common view is that such simple forms of associative learning are independent of awareness. We challenge this view in an experiment where only some participants learned the association between CS and US. In this preregistered study (<https://osf.io/vywq7>), the participants heard words paired with tactile stimulation followed by either a neutral sound (CS-) or unpleasant loud noise (CS+). The condition depended on the word+vibration side compound. The participants were only instructed to listen carefully. Based on structured interviews, the participants were divided into aware (N=48) and unaware (N=30) groups. Questionnaires were administered to explore potential predictors of contingency awareness. Only the aware group showed signs of learning as expressed in a larger CS+/CS- difference in stimulus preceding negativity developing shortly before the US. In terms of oscillatory brain activity, the aware group showed stronger alpha-beta suppression before and in response to the vibration. Moreover, the aware group scored higher on the intolerance to uncertainty scale and had a narrower distribution of trait anxiety. These findings support the notion that associative learning cannot occur without contingency awareness. Contingency awareness is indexed by generally amplified neural patterns reflecting expectation of an aversive event and informative cues, as well as violation and confirmation of the expectation. The probability of becoming aware of the contingencies varies with intolerance to uncertainty. Finally, extremely high or low anxiety hinder contingency awareness and thus acquisition of conditioned fear.

# *Learning & Memory*

## **M78**

### **Effect of music on brain resting-state network development in premature newborns**

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A Neonatal Intensive Care Unit music intervention aims to counterbalance negative outcomes due to premature birth and lay the foundation for future functioning through early neurodevelopment and plasticity.

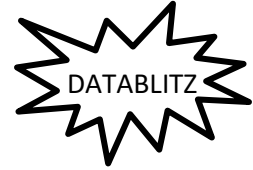
43 premature babies are exposed on average 2 times daily to a standardized music intervention starting after 33 weeks Gestational Age (GA). Internetwork resting-state functional connectivity developmental changes are investigated with resting-state fMRI scans at 33 and 40 weeks GA.

Independent component analyses (ICA) reveal resting-state activity in primary sensory and higher order cortical areas. Novel findings at 33 weeks GA include the insula and a prefrontal-limbic network with Anterior Cingulate Cortex (ACC), ventral medial Prefrontal Cortex (vmPFC), amygdala already present, and at 40 weeks, a network involving the insula, ACC and vmPFC.

Assessing longitudinal strengthening of resting-state functional connectivity is based on connectome analysis. The accordance, or functional connectivity, between the ICA resting-state networks are connections in a network representation. A circuitry of interest (COI) for maturation is defined by comparing the control groups' ICA-based connectome at 33 to 40 weeks GA. The networks are assessed in functional connectivity via a t-test on each connection, and after FDR correction.

the COI indicates maturation between sensorimotor cortex and brainstem & thalami, posterior cingulate cortex & precuneus and auditory cortex. The music group further exhibits accelerated strengthening of auditory-sensorimotor internetwork functional connectivity.

This is the first longitudinal study investigating premature neural network maturation following music exposure. Further analyses include full term newborns, and assess emotion regulation circuitry development involving prefrontal-limbic and salience networks.



## T1

### **fMRI and behavioural evidence that mental rotation relies on brain areas involved in motor planning**

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Functional neuroimaging suggests that parietal and premotor regions are implicated in various motor and cognitive tasks. However, it is unclear whether these regions serve several, computationally independent functions, or underlie a common core function that is reused to serve evolutionary newer functions. We hypothesized that the capacity to mentally rotate images relies on a phylogenetically older motor process that is rooted within parietal and premotor areas. This hypothesis predicts that activations of brain regions involved in internally generated motor planning predict performance in mental rotation (MR). To address this hypothesis, we asked 30 healthy participants to perform finger presses either when finger selection was externally-triggered or was performed by the participant (internally-triggered). We compared fMRI activation patterns across conditions on a group-level. Additionally, in a separate session outside the scanner participants performed two MR tasks on pictures of hands or letters. The critical fMRI comparison (internally-triggered > externally-triggered) yielded significant activations in parietal, premotor and occipitotemporal regions. We next extracted from each significant cluster the maximum t-value for each participant and investigated whether they predicted individual reaction times on the MR tasks. Activation of only the parietal and premotor regions, and not the occipito-temporal regions, predicted cognitive performance, but only when MR involved hands. No significant results were observed for MR of letters. Our results indicate that neural resources in parietal and premotor cortex recruited during motor planning also contribute to MR of bodily stimuli, suggesting that a common core component underlies a motor and a cognitive function.

# *Perception*

## **T4**

### **Preterm infants show an atypical processing of the mother's voice**

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To determine how atypical early sensory experience affects brain development, it is crucial to understand the consequences of prematurity on language perception at birth. Previous studies have shown that preterm babies process mother and stranger's voices more similarly, than their pairs at term do. To date, however, the neural oscillatory correlates in the time-frequency domain of maternal voice processing in preterm newborns are unknown. At term equivalent age, ten preterm and ten full-term newborns underwent high-density EEG recordings during mother or stranger speech presentation. The speech was either naturalistic (in the forward order) or non-naturalistic (backward).

Only full-term newborns showed enhanced activation for the mother speech in theta and low-beta frequency bands in the left temporal areas, indicating a selective enhancement for the mother's voice, whereas preterms showed significant activation for stranger naturalistic speech in theta frequency band. A group effect terms > preterms for the mother's voice is evident in the theta and low-beta frequency bands. A significant group contrast in the low and high theta bands in the right temporal regions indicates higher activations for the stranger's speech in preterms. Finally, only term newborns presented a late gamma band increase in response to maternal naturalistic speech associated to a significant group contrast (full-term>preterm) for the maternal naturalistic voice.

The current study demonstrates, using neural time-frequency patterns, that preterm infants exhibit atypical processing of the mother's naturalistic voice, which induces selective brain responses only in full-term newborns, whereas preterms are selectively activated by stranger voices in both temporal hemispheres.

# *Perception*

## **T7**

### **Implicit racial bias modulates the PPS multisensory facilitation depending on the avatar ethnicity**

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Peripersonal Space (PPS) is defined as the action-space surrounding our body, in which all physical interactions with the external environment happen<sup>1</sup>. Probably due to this reason, stimuli that appear in our PPS are processed faster than stimuli in the far space. Importantly, PPS boundaries are not fixed in time but can be modulated by external factors<sup>2</sup>. Among them, social factors seem able to modulate PPS through top-down high-level regulation. For example, the presence of another person modulated PPS representation<sup>3</sup>. Although social modulation of PPS starts to be explored in the last decade, the influence of racial bias on PPS boundaries is still not investigated.

22 participants took part in a Virtual Reality PPS-multisensory interaction experiment (visuo-tactile). During this task, a human avatar approached the participant, and tactile input was provided at different distances of the avatar to measure the PPS multisensory facilitation. Two ethnicities of the avatar, African or Caucasian, were used In order to investigate changes in PPS facilitation related to avatar features. Before the experiment, the participants performed an IAT test to measure the implicit racial bias, while the physiological measurements (HR, HRV, EDA) were recorded during all the exposures. The results showed an interaction between PPS multisensory facilitation and the avatar ethnicity, in the function of the IAT score. Moreover, the EDA response was greater during black avatar exposure compared to white ones.

The present study investigated for the first time the PPS boundaries modulation related to implicit racial bias, as a high-level social factor influence.



# *Perception*

## **T10**

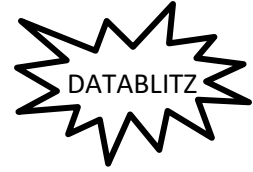
### **Relationship between the activation in the insula and submodalities of interoceptive awareness**

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Subjective senses that arise from within the body are referred to as interoceptive awareness. Previous neuroimaging studies have been investigated the neural substrates of interoceptive awareness, suggesting that the right anterior insula is the most relevant region. In these studies, however, attention to the internal bodily signals (i.e., interoceptive attention) and perceptual accuracy of the signals (interoceptive accuracy) were not dissociated from interoceptive awareness. Therefore, we tested if the activation of the right anterior insula is truly associated with interoceptive attention and accuracy, respectively. Total of 28 participants underwent a heartbeat counting task and fMRI scanning in the same day. The results revealed that interoceptive attention activated the bilateral insula almost equivalently, whereas only the right anterior insula showed an activation that correlated with interoceptive accuracy. These findings elaborate the neural substrates for interoceptive awareness, showing that interoceptive attention and accuracy that were previously considered as interoceptive awareness have distinct neural substrates.



**T13**

**Taste matters: Neurocomputational mechanisms of appetite suggestion induced placebo effects on experienced hunger and food choices.**

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This study tested if and how contextual factors such as suggestions about appetite alter the experience of interoceptive signals such as hunger. One hundred and seventy-two healthy female participants were, while in the fasted and hungry state, administered a placebo suggested to either curb or enhance appetite. Participants then performed a dietary decision-making task to identify with computational modeling and functional magnetic resonance imaging the underlying neurocomputational mechanisms of placebo action. The results replicated an expectancy-based placebo effect on hunger. The curbed appetite group felt less hungry than the enhanced appetite group, and this effect was scaled by the prognostic expectancy about the placebo's efficiency. Drift diffusion modeling revealed that the curbed appetite suggestion group considered taste less, and healthiness more and more rapidly during evidence accumulation toward food wanting than the enhanced appetite suggestion group. FMRI in a subgroup of 57 participants revealed (1) a moderation of value encoding within the ventromedial prefrontal cortex (vmPFC) by suggestion and prognostic expectancies, (2) mediation of the suggestion effect on hunger by dorsolateral prefrontal cortex (dlPFC) responses during food choice formation, and (3) the recruitment of dlPFC – vmPFC connectivity during food choice formation that was moderated by the tastiness and healthiness drift weights specifically in the curbed appetite suggestion group. These findings indicate that contextual suggestion effects on experienced hunger were underpinned by rapid attentional filtering of expectancy congruent attributes of food, and the recruitment of brain regions associated with valuation and the attentional control of action selection.

# *Perception*

## **T16**

### **Distinct sensitivity to spectrotemporal modulation supports brain asymmetry for environmental sounds**

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Does auditory brain asymmetry emerge from acoustical cues or from domain-specific neural networks? We first show that natural environmental sounds are mainly composed of a combination of pure temporal (rhythm) and pure spectral (timbre) modulations. We then synthesized various friction sounds for which action (friction motion) and material (surfaces) content was crossed and balanced, and selectively degraded their temporal or spectral dimensions. In a behavioral experiment, we demonstrate that discriminating actions and materials respectively relies on pure temporal and spectral modulations. We further show with functional magnetic resonance imaging that action and material contents are respectively decoded in left and right hemispheres, in superior temporal and left inferior frontal regions. Our results show that auditory hemispheric asymmetry reflects a differential neural sensitivity to temporal and spectral modulations present in environmental sounds, and suggest that the specialization of each auditory system for acoustic cues that are present in sounds from daily life provides a complete domain-general account of auditory hemispheric asymmetry that is both ecologically valid and coherent with the theory of efficient neural coding.

# *Perception*

## **T19**

### **The Gravity Prior: Perceptual Decision-making Under Uncertainty in a Space Analog Environment**

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Does gravity affect perception? This question comes into sharp focus as plans for interplanetary human space travel solidify. Within the framework of Bayesian brain theories, gravity encapsulates a powerful prior, anchoring agents to a reference frame by way of the vestibular system, informing their decisions, and possibly their integration of uncertainty, as they navigate the environment. What happens when such a strong prior is altered? We address this question using a self-motion estimation task in a space analog environment under conditions of altered gravity. Two participants were cast as remote drone operators in low-Mars orbit in a virtual reality environment on board a parabolic flight, where both hyper- and microgravity conditions were induced. From a first person perspective, participants viewed a drone exiting a Martian cave and had to first predict a collision; and provide a confidence estimate on their response. The Bayesian brain infers outcomes from noisy sensory inputs integrated with an internal model of the environment. To determine how inference is altered under different gravity conditions we evoked uncertainty in the task by manipulating the drone's angle of trajectory. We find that stimulus (trajectory angle) uncertainty in hypergravity significantly pushed agents to predict a crash relative to normal and micro-gravity; and that, in microgravity, collision prediction errors scaled positively with reported confidence ratings. These results suggest that implicit variables relating to uncertainty affect decision-making distinctly under different conditions of gravity, highlighting the possible need for automatized, compensatory mechanisms when considering human factors in space research.

# *Perception*

## **T22**

### **A Comparative Assessment of Human Hearing Thresholds for Pure Tones Predictable in Time and Frequency**

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Much of perception can be explained in terms of predictive processes but not all predictions are equal: results from the last decades of research point to separate mechanisms for making predictions about the timing of sensory events, and about their content. While both kinds of predictions have been shown to facilitate perception in different sensory modalities, their influence on hearing thresholds specifically remains unknown. Aiming to quantify the perceptual advantage granted by prediction in both modalities, we measured the audiograms of 28 participants for pure tones in quiet, during four tasks. The first task was modelled after the classical adaptive procedures long established in psychoacoustic research and clinical practice, which carry a lot of intrinsic predictive information. The second relies on a new automated method where the timing and frequency of oncoming tones are as unpredictable as possible. In the last two tasks, we varied the predictability of trials in both modalities, by spacing tones with either constant or varying time and frequency intervals. We find that the anticipation of tones indeed produces lower absolute thresholds, with a better performance than that predicted based on the conditions of low predictability. Further analyses show that 1. predictions in time and frequency both aid detection while interacting in a non-additive fashion, 2. the improvement on thresholds is most significant in our range of best hearing sensitivity. All in all, our findings suggest that threshold measurements derived from audiometry procedures with intrinsic predictability are biased by top-down components.

# *Perception*

## **T25**

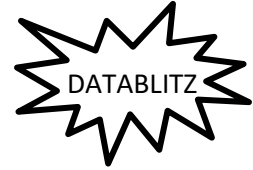
### **The influence of tonic arousal on phasic arousal and on the attentional balance at the behavioral and physiological levels**

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The control of attention requires a good balance between voluntary and involuntary attention. Distraction by unexpected auditory events often occurs in daily life and can be important to adapt to environmental situations. Although it has been shown that unexpected salient sounds impair task-performance, an increasing number of studies demonstrated that unexpected stimuli can be beneficial for the performance. Current theories attribute this beneficial effect to a transient increase in the arousal level, under the control of the Locus Coeruleus – Norepinephrine (LC-NE) system. Animal studies suggest that tonic and phasic activity of the LC-NE system are linked, with an intermediate level of tonic arousal accompanied by high phasic bursts and optimal performance. The objective of the study was to investigate the impact of tonic arousal on voluntary and involuntary attention and on phasic arousal at behavioral and physiological levels in Human. We modulated the tonic arousal by using calm and exciting music extracts. We recorded electroencephalography, pupil dilation, skin conductance and heart rate in 16 healthy young adults performing the Competitive Attention Task. At the behavioral level, an increase in tonic arousal resulted in less missed responses in the high compared to low tonic arousal condition, suggesting improved sustained attention. At the physiological levels, preliminary results suggest that skin conductance is sensitive to the tonic arousal level; while pupil dilation is more sensitive to phasic modulations. Event-Related Potentials to the target sounds were found reduced under high tonic arousal level.



**The Neurobiology of Hypnotic Suggestibility and Response to Hypnosis**

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Hypnosis and suggestion have a range of clinical applications and can be used to manipulate perceptual and cognitive processes. Despite this, the neural basis of suggestibility, and response to hypnosis, remain poorly understood, with existing research hampered by restrictive samples and exclusion of individuals who are medium in suggestibility. This research project (funded by The Leverhulme Trust [RPG-2017-291] and BIAL Foundation [269/18]) will deliver an open access dataset of people screened for suggestibility, and assessed on personality metrics, behavioural tests, (f)MRI, electroencephalography and genetics. The wide range of objectives include, investigating: 1) brain metrics of those who differ along the suggestibility spectrum (e.g., high, medium and low), and 2) the changes in functional connectivity that occur during hypnosis. Phenomenological self-reports and resting-state fMRI scans were collected under three conditions: 1) rest 2) hypnosis, and 3) relaxation. Analysis of 60 individuals across the suggestibility spectrum, showed that at rest, higher levels of suggestibility were associated with mostly negative correlations between a wide range of brain regions, including sensorimotor and visual areas. Hypnotic depth, reported during the hypnosis period, was characterised by negative correlations between visual and attentional brain regions and between sensorimotor regions. The findings provide key insight into the neural underpinnings of suggestibility and hypnotic experience. A more comprehensive set of analyses will be presented at the meeting, showing the results of the fMRI and EEG resting state analyses. The dataset is intended to be of use to researchers who are interested in suggestibility and who study states of consciousness.

# *Perception*

## **T31**

### **Subthalamic theta activity encodes a decision variable in patients with obsessive-compulsive disorder**

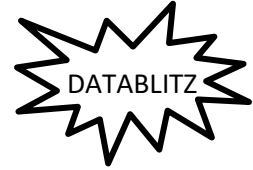
Michael Pereira<sup>1</sup>, Audrey Kist<sup>1,2</sup>, Julien Bastin<sup>2</sup>, Stephan Chabardes<sup>2,3</sup>, Mircea Polosan<sup>2,4</sup>, Nathan Faivre<sup>1</sup>

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Local field potentials recorded in the subthalamic nucleus (STN) of patients undergoing deep-brain stimulation (DBS) have provided a unique window to understand its role in decisions requiring the inhibition of motor responses. However, it is still unclear whether the STN merely inhibits motor output or whether it encodes a decision variable per se. Here, we recorded STN activity in participants with obsessive-compulsive disorder detecting faces embedded in noise in a delayed-response task followed by a confidence rating. This paradigm allowed us to disentangle motor and decisional activity in the STN. We found that post-stimulus theta activity reliably exhibits three hallmarks of a decision variable in a detection task: i) a difference between detected and missed stimuli, which is ii) modulated by stimulus intensity and iii) further increased by high confidence ratings. We also tested the causal role of the STN on detection and confidence in a different cohort of participants. Unlike for speeded-response tasks [1], however, we found no behavioral differences on and off DBS. Our results reveal decision-related activity in the STN dissociated from motor output but with no causal role in decision-making, similar to parietal regions in non-human primates [2]. These findings have interesting implications for the understanding of the effects of STN-DBS on psychiatric disorders.





### **Peripersonal space modulation across wakefulness and sleep stages**

Giulia Ricci<sup>1</sup>, Tommaso Bertoni<sup>2</sup>, Jacinthe Cataldi<sup>3</sup>, Aurélie M. Stephan<sup>3</sup>, Julia Fellrath<sup>2</sup>, Brunella Donno<sup>2</sup>, Mattia Galigani<sup>4</sup>, Francesca Garbarini<sup>4</sup>, Jean Paul Noel<sup>5</sup>, Francesca Siclari<sup>3</sup>, Andrea Serino<sup>2</sup>

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Defining neural mechanisms that enable consciousness is a central and unanswered question in neuroscience. While wakefulness is a continuous flow of conscious experiences, sleep is associated with either presence and absence of such experiences, representing the only case where consciousness fades under normal physiological conditions. A crucial role in the assessment of bodily self-consciousness is played by Peripersonal Space (PPS), defined as the space where the body-environment interactions occur. The PPS space is encoded by multisensory neurons, which show an enhanced processing of tactile stimuli when a concurrent visual/auditory stimuli occur in near, compared to far, distance from the body.

In this study, electroencephalographic (EEG) data of 15 participants were collected through a high-density system (256 electrodes) in order to investigate how the response to audio-tactile stimuli delivered at different distances from the body is modulated by wakefulness, non-REM and REM sleep stages. In the sleep session, participants were awakened and asked whether they were dreaming or not.

To measure the neural PPS effect, event-related alpha and beta-high power was computed for each stimulus. Furthermore, we extracted the event-related responses corresponding to 20 seconds before awakenings and correlated them with the participant’s dreaming condition.

Results show a significant PPS effect during wakefulness, which is modulated during sleep. Furthermore, we found a significant interaction between the PPS response before awakenings and the dreaming condition. This finding can provide new insight for healthcare and treatment of diseases such as disorder of consciousness (DOC) and cognitive motor dissociation (CMD).

# *Perception*

## **T37**

### **Forest before trees, or trees before forest? Temporal hierarchy of gist and object recognition in scenes.**

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Real-world scenes are complex visual stimuli, but despite high complexity we are able to recognize scenes rapidly and efficiently. What seems crucial for such fast recognition is that scenes are structured and typically composed of a background, which defines the general meaning of the scene (the gist), and foreground objects, which add further information about the environment. Here we focused on the temporal dynamics of scene perception and investigated how perceptual representations of scenes develop over time.

In two experiments images of real-world scenes were displayed as stimuli for 67 ms (Exp. 1: N=38, color images; Exp. 2: N=33, grayscale images). All images depicted either a natural or a man-made background and a single natural (animal) or man-made (furniture) foreground object, combined in congruent or incongruent ways (thus not predictive of each other). Participants performed a speeded classification of either backgrounds or objects (in separate blocks) as natural or man-made while EEG signal was recorded. We analyzed reaction-times (RTs) of a manual response to target stimuli as an index of recognition speed, and latency of event related potentials (ERPs) to uncover the neural mechanism. We found that both RTs and ERP latencies were shorter for objects as relative to backgrounds and that congruency of images (congruent or incongruent) and the identity of targets (natural or man-made) significantly impacted the speed of their processing. Thus, our study indicates that the visual system can classify local objects before global gist, providing support for the local-to-global hierarchy of human conscious vision.

# *Perception*

## **T40**

### **Early Gaze direction processing: insights from ERP decoding**

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Distinguishing the direction of another person's eye gaze is extremely important in everyday social interaction, as it provides critical information about people's attention and, therefore, intentions. The time course of gaze processing has been investigated for years using event-related potentials (ERPs) recorded with electroencephalography (EEG). However, when our brain distinguishes the gaze direction (GD) *per se*, i.e. irrespectively of other facial cues, remains unclear. To solve this question, the present study aimed to investigate temporal dynamic of gaze direction, using an ERP decoding approach, based on the combination of a support vector machine and error-correcting output codes. We recorded EEG in 60 young healthy subjects performing GD detection or head orientation tasks. Both tasks presented 3D realistic faces with five different head and gaze orientations each: 30, 15 degrees to the left or right, and 0 degrees. While the classical ERP analyses did not show clear GD effects, ERP decoding analyses revealed that discrimination of GD, irrespectively of head orientation, started at 180 ms in GD task and at 200 ms in face orientation task. Moreover, GD decoding accuracy was higher in GD task than in face orientation task, and was the highest for the direct gaze in both tasks. These findings suggest that the decoding of brain patterns is modified by the task relevance, which changes the latency and the accuracy of GD decoding.

# *Perception*

## **T43**

### **Dopamine supports motor and learning contributions to auditory temporal attention**

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Attention is a fundamentally rhythmic process, imposed by the underlying intrinsic neural dynamics. In the auditory domain, periodic temporal attention optimally operates at ~1.5 Hz, and its capacities can be enhanced by synchronized overt rhythmic movements. The neurophysiological underpinning of this strong interdependency between temporal attention and motor functions is unknown. We hypothesize that the dopaminergic system –which is crucial for timing as well as motor functions– effect this interaction. We compared the behavioural performance of parkinsonian patients –on- or off-medicated with L-Dopa, a precursor to dopamine– to age-matched healthy participants, while they were performing an auditory temporal attention task involving or not a motor contribution. We first report that the optimal sampling rate of auditory temporal attention is similar across groups in the passive task. Second, motor tracking improves performance accuracy in healthy participants and on-medicated patients but not during dopamine deprivation in Parkinson's disease. Finally, we show that taking L-Dopa during a first experimental session improves the participants' performance during a second off-medicated session, but not vice-versa. Hence, while the dopaminergic system seems not implicated in auditory temporal attention proper, it is a determining factor in the learning capacities of the patients in such task and effects the motor contribution to auditory attention.

**T46**

**Interhemispheric Resting State Functional Connectivity Predicts Visuomotor Integration Network in Children with Hydrocephalus**

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Hydrocephalus is a condition where ventricles are enlarged due to an increased amount of cerebrospinal fluid. Especially in infantile hydrocephalus, as the posterior horns of the ventricles are expanding, it can cause damage to the posterior cortex. The white matter damage due to ventricular dilatation in hydrocephalus can be associated with impaired development of visuomotor integration skills. This study examines the neurodevelopmental and functional connectivity of the visuomotor integration network comprising the inferior fronto-occipital fasciculus, superior longitudinal fasciculus, and frontal aslant tract. We examined 11 children with treated hydrocephalus and compared them with 20 typically developing aged-matched controls. Participants underwent Functional MRI (fMRI) scanning with a sequence designed to facilitate the analysis of resting state fMRI data, and were administered the Beery-Buktenica Developmental Test of Visual-Motor Integration and Block Design from WISC-IV. Compared to the typically developing controls, tracts within both hemispheres for each pathway in hydrocephalus participants revealed decreased functional connectivity and lower scores on the neuropsychological measures. The findings may help establish whether children with hydrocephalus require early interventions to improve their development of visuomotor integration skills. The current study may stand as the first to explore the visuomotor integration network in a hydrocephalus population, which may initiate further studies to contribute to our findings.

**T49**

**Common oscillatory patterns for Parkinson's disease and heroin dependent patients: a resting-state EEG study**

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Parkinson's disease (PD) patients on Dopamine Replacement Therapy (DRT) presenting motor and non-motor fluctuations are at increased risk to develop behavioral addiction in the ON stage. Parkinson's disease and substance-abuse disorder both entail a dysfunction of the basal ganglia system subtending goal directed behavior and reward. In the current study, we aimed to compare cortical resting-state EEG oscillations between PD patients during their ON and OFF DRT stages, heroin-addict patients after drug injection and healthy controls.

Results show shared oscillatory patterns for PD patients ON-DRT and HD patients ON Heroin in the frontal, central and temporal areas of the scalp. In the frontal, central and temporal areas, increased theta (4-8 Hz) power was observed for PD-ON compared to PD-OFF patients, and both PD-ON and HD patients compared to healthy controls. Increased theta power also correlated across groups in an exploratory analysis with the ECMP sub-scores for risky-behavior and hyper-emotivity scores, in line with the increase in impulsivity observed of the hyperdopaminergic state. In the frontal and central areas, PD-ON and HD patients also presented an increased low-beta power (12-20Hz) compared to PD-OFF patients. Increased low-beta power also correlated across groups with anxiety and hyper-emotivity scores.

Altogether, these results suggest potential shared neural mechanisms for ON-DRT non-motor symptoms of Parkinson's disease patients and substance-addiction with anomalies in theta and low-beta frequencies and may be a first step toward the identification of biomarkers for the neuropsychiatric side effects of DRT.

Keywords : EEG, Parkinson's disease, addiction, resting-state

### **Theta oscillations and minor hallucinations in Parkinson's disease reveal decrease in frontal lobe functions and later cognitive decline**

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Cognitive decline and hallucinations are common and debilitating non-motor symptoms, occurring during later phases of Parkinson's disease (PD). Minor hallucinations (MH), appear at early phases and have been suggested to predict cognitive impairment in PD, however, this has not been well-established by clinical research. Here, we investigated whether non-demented PD patients with MH show altered brain oscillations and whether such MH-related electrophysiological changes are associated with cognitive impairments that increase over time. Combining model-driven EEG analysis with neuropsychiatric and neuropsychological examinations in 75 PD patients, we reveal enhanced frontal theta oscillations in PD patients suffering from MH and link these oscillatory changes with lower cognitive frontal-subcortical functions. Neuropsychological follow-up examinations five years later confirmed MH-specific theta oscillations and revealed a stronger decline in frontal-subcortical functions in MH-patients with stronger frontal theta alterations, defining an MH and theta oscillation-based early marker of a cognitive decline in PD

## **T55**

### **EEG markers of peripersonal space encoding predict clinical outcome in patients with disorders of consciousness**

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The peripersonal space (PPS), the space immediately surrounding the body, has a dedicated multisensory representation in the primate brain, characterized by neural populations responding to touch on specific body parts, and external (visual or auditory) stimuli near those body parts. It acts as a multisensory-motor interface between the self and the environment and may be linked to bottom-up components of conscious processing. Here, we aimed at testing whether EEG correlates of PPS representation (i.e., the preferential processing of multisensory stimuli near the body), could act as markers of residual conscious information processing in patients with disorders of consciousness, and therefore predict clinical outcome. We studied 62 patients from the acute neurorehabilitation department, with disorders of consciousness of variable severity. Patients underwent weekly sessions of bedside EEG recordings until their discharge, while receiving near/far auditory/audiotactile stimuli in a 2X2 design, to probe PPS representation. Normative data on healthy subjects suggests that the hallmark of PPS processing is a selective decrease in high-beta power for near audiotactile stimuli, compared to other conditions. Based on this result, we extracted an index of PPS processing from the EEG session at admission and correlated it with the disability rating scale at discharge, as a measure of projected long-term clinical outcome. Our EEG index of PPS processing significantly predicted clinical outcome, and improved estimates based only on clinical scales at admission. This suggests that EEG markers of spatially specific multisensory processing have a promising potential in predicting the clinical evolution of patients with disorders of consciousness.



### **Balance in idiopathic normal pressure hydrocephalus: microstructural brain correlates**

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**Aim:** To assess the relationship between brain structural damage and postural control before and after cerebrospinal fluid tap-test (CSFTT), a test to predict response to shunting, in patients with idiopathic normal pressure hydrocephalus (iNPHp).

**Methods:** Fifty healthy controls (HC) and 40 iNPHp underwent balance assessment and MRI including diffusion weighted images, pre- and post-CSFTT. Center of pressure (COP) trajectories during eyes open (EO) or closed (EC) conditions and diffusion metrics were derived. Repeated-measures ANOVA and non-parametric correlation analysis were used to compare posturographic measures and to assess their relationship with diffusion metrics. **Results:** After quality check, 40 HC (30 females; mean age 75.1) and 24 iNPHp (7 females; mean age 78.7) were included. Data post-CSFTT were available for 19 iNPHp. COP speed in antero-posterior direction and sway area were greater in iNPHp and EC condition ( $F(1,62)=5.52$ ,  $p=0.022$  and  $F(1,62)=6.71$ ,  $p=0.012$ , respectively). In HC, such parameters correlated with diffusion metrics of tracts involved in balance control. Orientation dispersion index (ODI) and intracellular volume fraction of forceps minor (FM) and anterior thalamic radiation positively correlated to balance parameters during EC condition in iNPHp ( $R=0.43$  to  $0.48$ ,  $p=0.02$  to  $0.04$ ) and negatively in HC ( $R=-0.20$  to  $-0.44$ ,  $p=0.005$  to  $0.22$ ). The relationship inverted post-CSFTT, with a negative correlation between sway area and FM ODI in iNPHp ( $R=-0.52$ ,  $p=0.03$ ).

**Discussion:** iNPHp present altered balance which relate to brain microstructural damage, with a normalization post-CSFTT.

## **T61**

### **Brain network dynamics associated with self-awareness disorders in neuropsychological post-COVID-19 condition: fMRI co-activation patterns of the brainstem pons**

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It has been estimated that 30% of the population infected by SARS-CoV-2, rising to 75% after hospitalization, appear to suffer from long-term consequences that are now referred to as post-COVID-19 condition (PCC). Early studies on the PCC distinctly show evidence of alterations of the self-awareness mechanisms and hypo-metabolism in the temporal lobes, the cerebellum as well as in the brainstem.

As part of the COVID-COG cohort, 45 participants that have been diagnosed with mild to severe COVID-19 underwent neuropsychological tests, psychiatric and respiratory questionnaires 6 to 9 months after their infection. Anatomical and resting-state functional magnetic resonance images (fMRI) were acquired. Based on their ability to evaluate their own memory deficits, participants were categorized into three groups (LoA: loss of awareness, NA: normal awareness, HA: hyper awareness).

Analysis of the brain network dynamics of the brainstem pons revealed an increase in both occurrences and average duration of a specific co-activation pattern (CAP) in participants with LoA. Precisely, limbic structures such as the insula, thalamus and orbitofrontal cortex appear to be involved. Further, ordinary least squares (OLS) models showed that CAP occurrences, followed by age, were the best predictors of the self-awareness of fatigue symptoms.

This study puts a spotlight on some of the clinical phenotypes of the PCC. The associated neurological manifestation, as observed with fMRI, appears to be consistent with other self-awareness disorder. These findings might reveal a challenge in the identification of the population at risk and the characterization of long-term effects of a SARS-CoV-2 infection.

## **T64**

### **Consistent patterns of functional connectivity are associated to APOE4 at different stages of Alzheimer's disease.**

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Alzheimer's Disease (AD) is the most common cause of dementia in the aged population. Functional brain change in AD, as revealed by functional magnetic resonance imaging (fMRI), is characterised by disruption of neuronal brain networks. Carrier-status of the ApolipoproteinE4 (ApoE4) allele is associated with faster progression of AD, and therefore a potentially more pronounced disintegration of brain functional connectivity (FC). Here, we investigate FC changes associated with carrying ApoE4 allele, to link individual brain network properties with AD risk. We included in the study 137 participants from the Alzheimer's Disease Neuroimaging Initiative database (ADNI), and group them based on their ApoE4 carrier-status (54 carriers vs. 83 non-carriers), as well as their clinical status (42 Cognitive Normal, 38 Subjective Memory Complaint, 44 Mild Cognitive Impairment, 13 Alzheimer's Disease dementia). We then investigated regional FC properties and compared clinical status and carrier-status effects on these ones with non-parametric two-way ANOVA. Twenty-five brain regions with functional network centrality associated with ApoE4 carrier-status were identified and included mostly regions of both dorsal and ventral attentional network, respectively 15.2% and 14.6% of the networks. Our findings suggest that FC alterations associated with ApoE4 concern all disease stages of AD. Beyond the classical memory dysfunction present in AD individuals, these findings along with previous reports indicate that attentional systems are affected (Li et al., 2011) and in particular linked with the presence of AD genetic risk. Further, our results supports the possible use of the identified patterns as response markers for future, very early therapeutic intervention in AD.

### **Mechanisms Underlying Improved New Word Learning with High-Definition Transcranial Direct Current Stimulation**

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Aphasia is frequent in patients with brain lesions and recovery often limited. New treatments allowing patients to regain language functions are therefore necessary. Transcranial direct current stimulation (tDCS) is promising but effects remain inconsistent because it is not known which neural processes need to be targeted. Here, we investigated the neural and behavioral effects of high-definition (HD)-tDCS combined with new-word learning in healthy participants. We hypothesized that enhancing functional connectivity (FC) of language regions facilitates word learning.

Thirty-six healthy subjects were randomly allocated to anodal HD-tDCS over either the left inferior frontal gyrus (IFG), the left temporo-parietal junction (TPJ), or sham stimulation. On day one, subjects performed a naming task (pre-test). On day two, participants underwent a new-word learning task with rare nouns and verbs concurrently to HD-tDCS for 20 minutes. The third day consisted of a post-test of naming performance. EEG was recorded at rest and during naming on each day.

We observed better verb learning during Broca stimulation than sham stimulation. HD-tDCS over Broca's area enhanced functional connectivity between key nodes of the language network and this correlated with improved learning. HD-tDCS over Wernicke's area enabled stronger local activation of the stimulated area (as indexed by greater alpha and beta-band power decrease) during naming, but this did not correlate with learning.

Thus, tDCS can induce local activation or modulation of network interactions, depending on the stimulation site. Only the improvement of network interactions, but not the increase in local activation, leads to improved word learning.

### **Brain plasticity induced by cognitive rehabilitation in virtual reality**

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Studies showed that gamified training using serious virtual reality (VR) video games can decrease attentional neglect symptoms but the neural changes induced by such training remain poorly understood. The aim of this study is to examine how a VR-based gamified rehabilitation programme on patients with acquired brain injury (ABI) and attention deficits influences their symptoms and reorganize neural attentional networks, especially the ventral (VAN) and dorsal (DAN) attention networks. We recruited 8 patients with ABI and attentional deficits. They completed 20 sessions of rehabilitation using VR-based training tailored to each patient's deficits. Before and after the training, they performed spatial attentional assessments and fMRI acquisitions using a spatial attentional task. Assessments showed significant decrease of patient's attentional deficits. In fMRI, activation maps showed an increase of activation in the left cuneus and a decrease of activation bilaterally in inferior and superior frontal gyrus, in left middle cingulate gyrus and supramarginal gyri, and right angular gyrus. Analysis of ROIs with VAN and DAN revealed significant training-related increase of activation in the left and right intraparietal sulcus of the DAN after training. Further analyses showed a trend for a positive correlation between patient's improvement symptoms and increase of activation in the left intraparietal sulcus. New cognitive rehabilitation program using VR improves spatial attention deficits, decreases the recruitment of the ventral attentional regions and increases the recruitment of the dorsal attentional regions. In conclusion, VR training yields to improve the efficacy of the spatial attentional networks.

### **Effect of pediatric hydrocephalus on the hippocampus**

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Infantile hydrocephalus is characterized by an abnormal cerebrospinal fluid (CSF) buildup in the brain's ventricles due to ineffective CSF reabsorption, resulting in increased pressure on the surrounding brain structures. This pathology has been associated with various structural and cognitive impairments, but this aspect is surprisingly not well studied.

The objective of this project was to explore the relationship between hippocampal size and behavioural impact in terms of a working memory task. 8 patients with hydrocephalus (mean age: 8.85 yo), and 26 healthy controls (mean age 8.74 yo) were recruited.

Participants underwent a T1-weighted MRI scans, rs-fMRI and behavioral tests. After preprocessing the MRI scans using FSL, right and left hippocampal volumes were extracted through automatic and manual segmentation using FreeSurfer 7.2.0. We analyzed the results for a visuospatial working memory task (Mr. Peanut). Correlation between hippocampus volumes and participants' scores at the Mr. Peanut task were examined.

Healthy controls exhibited a significantly greater hippocampal volumes relative to hydrocephalus patients.

Overall, regression analysis showed that there was a positive correlation between hippocampal volumes and behavioral scores. Interestingly the slope was steeper in healthy controls (with a significant correlation between Mr. Peanut task scores and total hippocampal volumes) than in children with hydrocephalus.

### **Enhancing imagery rehearsal therapy for nightmares with targeted memory reactivation**

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Nightmare disorder (ND) is characterized by dreams with strong negative emotions occurring during rapid eye movement (REM) sleep. ND is mainly treated by imagery rehearsal therapy (IRT), where the patients are asked to change the negative story line of their nightmare to a more positive one. We here used targeted memory reactivation (TMR) during REM sleep to strengthen IRT-related memories and accelerate remission of ND. Thirty-six patients with ND were asked to perform an initial IRT session and, while they generated a positive outcome of their nightmare, half of the patients were exposed to a sound (TMR group), while no such pairing took place for the other half (control group). During the next 2 weeks, all patients performed IRT every evening at home and were exposed to the sound during REM sleep with a wireless headband, which automatically detected sleep stages. The frequency of nightmares per week at 2 weeks was used as the primary outcome measure. We found that the TMR group had less frequent nightmares and more positive dream emotions than the control group after 2 weeks of IRT and a sustained decrease of nightmares after 3 months. By demonstrating the effectiveness of TMR during sleep to potentiate therapy, these results have clinical implications for the management of ND, with relevance to other psychiatric disorders too. Additionally, these findings show that TMR applied during REM sleep can modulate emotions in dreams.



**T80**

**Topographic mapping of EEG and evoked potentials in pre-reflective and reflective self-experience – role of Default Mode Network and Cortical Midline Structures**

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**Introduction.** The notion of selfhood is fundamental in human consciousness and has been divided into two main components, the minimal or pre-reflective (i.e., first-person) perspective and the narrative or reflective (i.e., third-person) perspective. So far, evidence on the neural correlates of these components is scarce, despite their importance in physiological conditions, like dreams and out-of-body experiences, and in psychopathology with self-disorders. With our study, we investigated their event-related potentials (ERPs) correlates with a lexical task in healthy volunteers.

**Methods.** 30 individuals (22F, 8M; mean age 25.2 years) performed a lexical task where they expressed trait judgments on the self or on a close other to elicit pre-reflective and reflective self-states during a 64-channel EEG recording. With the data, we performed both ERP analysis with the topographic analysis of variance (TANOVA) method and source localization with standardized low-resolution brain electromagnetic tomography (sLORETA).

**Results.** We identified a window of difference between topographies of pre-reflective and reflective self-experience at 254-310 ms post-stimulus-onset. The sources contributing to the difference were located, for the self-reference, in the right temporal and neighboring areas, and, for the other-reference, in the left frontal and neighboring areas. Overlapping regions were over the right cingulate and temporal structures.

**Conclusions.** Our results confirm different neural correlates in pre-reflective and reflective self-experience. The source analysis pointed at a right laterality in pre-reflective and to a more distributed involvement in reflective states. The networks engaged include cortical midline structures (CMS) and default mode network (DMN), which have an important role in self-related processing.



## W2

### **Effects of EEG- microstate neurofeedback on attention and impulsivity in adult attention-deficit/hyperactivity disorder (ADHD)**

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EEG neurofeedback (NFB) may represent a new therapeutic opportunity for attention-deficit hyperactivity disorder (ADHD), a neuropsychiatric condition characterized by attentional deficits and high impulsivity.

Traditionally, several groups have reported abnormal EEG patterns in this population, including an elevated Theta/beta power ratio (TBR). As a result, most neurofeedback therapies for ADHD have been based on downregulating the TBR. However, more recent studies have failed to either confirm elevated TBR in ADHD (e.g. via meta-analysis) or replicate the beneficial effects of NFB using this biomarker. These divergent results call for more research to identify more reliable, causal markers of ADHD.

In our recent work using resting-state EEG, we described alterations of brain microstates (i.e., stable periods of recurrent brain states) in adult ADHD, potentially representing a functional biomarker of the disorder.

The present study aims to use NFB to manipulate EEG microstates in ADHD patients and healthy controls, in order to observe its causal effects on neurophysiological, clinical and behavioural parameters.

During this currently on-going study, ADHD patients were trained to both upregulate and downregulate the prevalence of a specific microstate on separate days. EEG recording at rest as well as a continuous performance task (CPT) were recorded before and after 30 minutes of microstate-based neurofeedback training.

Intra- and across-session statistical contrasts, both in terms of brain activity changes and performance, will evidence the impact of microstate changes relative to ADHD behaviour.

# *Clinical Neuroscience*

## **W5**

### **Specification of attentional deficit in Attention deficit/hyperactivity disorder (ADHD)**

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Attention deficit/hyperactivity disorder (ADHD) is considered as one of the most common developmental disorders diagnosed in childhood. As the name implies, children and adolescents with ADHD are known to have attentional deficits, but what is less clear is what type of attentional processes are particularly affected. Indeed, attention is not a unitary phenomenon, but it is a multifaceted construct supported by multiple brain processes such as voluntary and involuntary attention. However, the different facets of attention have been rarely simultaneously investigated in ADHD.

The Competitive Attention Test developed by Bidet-Caulet and collaborators (2015) allows to study the balance between voluntary and involuntary attentional processes, and to simultaneously measure different facets of attention, such as sustained attention, voluntary attention orienting, distraction, attentional lapses, impulsivity and motor control. This study aimed to specify the attentional deficits in children and adolescents with ADHD using the Competitive Attention Test.

The performance of children and adolescents with ADHD obtained during the competitive attention test are compared with those of healthy peers previously tested and included in a normative database. The comparison is performed both at the individual and group levels to highlight the attentional specificities of each patient, as well as the common deficits among the group that could be used as behavioral markers of ADHD.

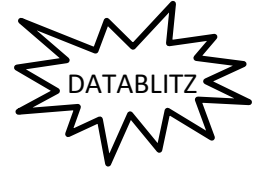
### **Cortical signatures of positive and negative schizotypy: a worldwide ENIGMA study**

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Positive and negative schizotypy are associated with impaired neurodevelopment and increased risk for schizophrenia. Cortical alterations have been suggested in both schizotypy dimensions. However, a comprehensive neuroanatomical mapping remains to be established. Here, we present the first large-scale meta-analyses of cortical morphometric patterns of positive and negative schizotypy in healthy individuals and compare these patterns with neuroanatomical alterations of schizophrenia and neurodevelopmental disorders. The sample comprised 2,730 unmedicated healthy individuals (12-68 years, 47% male) from 29 cohorts of the worldwide ENIGMA-Schizotypy working group. Cortical effect size maps of positive and negative schizotypy scores were generated using standardized methods. Pattern similarities were assessed between cortical maps of both schizotypy dimensions and effect size maps from comparisons of schizophrenia, attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and 22q11.2 deletion (22q11DS) psychosis. Positive schizotypy was associated with thinner left inferior frontal gyrus (pars-opercularis:  $r=-.071$ , pars-orbitalis:  $r=-.06$ ), while negative schizotypy was associated with thicker right medial orbitofrontal cortex ( $r=.07$ ), and thicker bilateral rostral anterior cingulate ( $r=.06$ ) (all  $p_{\text{fdr}} < .05$ ). Cortical maps of both schizotypy dimensions were correlated with schizophrenia-related cortical alterations. Positive schizotypy-related cortical differences were correlated with those of ADHD and 22q11DS -psychosis, while negative schizotypy-related cortical differences were correlated with those of ADHD and ASD (all  $r > .29$ ,  $p_{\text{spin}} < .05$ ). This study revealed thinner and thicker frontal cortical thickness in positive and negative schizotypy, respectively. Cortical pattern similarity analyses suggest neurobiological continuity for both schizotypy dimensions with schizophrenia, as well as overlapping and unique associations with neurodevelopmental disorders.



**W12**

**A neuromarker for drug and food craving distinguishes drug users from non-users**

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Craving is a core feature of substance use disorders. It is a strong predictor of substance use and relapse, and linked to overeating, gambling, and other maladaptive behaviors. Craving is measured via self-report, which is limited by introspective access and sociocultural contexts. Neurobiological markers of craving are both needed and lacking, and it remains unclear whether craving for drugs and food involve similar mechanisms. Across three fMRI studies (N=99), we identified a cross-validated neuromarker that predicts self-reported intensity of cue-induced drug and food craving ( $p < 0.0002$ ). This pattern, the Neurobiological Craving Signature (NCS), includes ventromedial prefrontal and cingulate cortices, ventral striatum, temporal/parietal association areas, mediodorsal thalamus, and cerebellum. NCS responses to drug versus food cues discriminate drug users versus non-users with 82% accuracy. The NCS is also modulated by a self-regulation strategy. Transfer between separate neuromarkers for drug and food craving suggests shared neurobiological mechanisms. Future studies can assess the discriminant and convergent validity of the NCS, and test whether it responds to clinical interventions and predicts long-term clinical outcomes.

# *Clinical Neuroscience*

## **W14**

### **The association of early life adversities with the cerebral correlates of social anxiety disorder**

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It is a fundamental experience of psychiatric-psychotherapeutic work that early life adversities (ELA) correlate with the occurrence of social anxiety disorder (SAD) and other psychiatric disorders. Recently, however, it was found that ELA can also foster psychological resilience. It remained unclarified, though, if and how a history of ELA might affect the cerebral correlates of SAD. Previously, we delineated how ELA moderate the cerebral response to anxiety-relevant stimuli in the (dorsolateral) prefrontal cortex ((DL)PFC). Here, we broaden the perspective to the resting state and demonstrate in a functional magnetic resonance imaging study (N=121) opposite connectivity patterns in SAD depending on a history of ELA. This effect involves not only the DLPFC but occurs in an extensive network including the subgenual cingulate cortex as well as large portions of the visual and sensorimotor cortex areas. First, these opposing connectivity patterns in SAD depending on a history of ELA may explain the partially inconsistent results of previous studies on the neural resting state correlates of SAD. And, furthermore, these results emphasize the importance of the capture and consideration of ELA in studies on the cerebral representation of SAD – and in analogy potentially also other psychiatric disorders.

# *Clinical Neuroscience*

## W17

### **Visuomotor adaptation and changes of plasticity in the attentional system during development**

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Studies in adults have shown that a shift of the visual field creates a visuomotor adaptation inducing an immediate plasticity in the attentional system. In this project, we investigate, in children, the effects of such adaptation on three components of the attentional system (alerting, orienting and executive control of attention). These components involve specific neural networks having a different developmental trajectory: the alerting network shows a more rapid maturation while the orientation and executive control networks have a prolonged developmental trajectory. These differences in maturation may be related to states of neural plasticity specific to each network. We investigate the plasticity of these components in healthy children using virtual reality adaptation (VR-A). To date, 8 children between 7 and 14 have participated in the study. They perform a VR- A session, preceded and followed by manual pointing tests and fMRI acquisition. fMRI results showed large increase of activation in frontal areas after VR-A for all networks, with the largest modulations observed in orienting network in right middle cingulate cortex and middle frontal gyrus. In comparison, adults show the largest modulations in parietal areas. Alerting network shows bilateral modulations in superior frontal gyrus and left inferior frontal gyrus, and executive control of attention network in bilateral caudate nucleus and right middle frontal gyrus. These preliminary results suggest that children recruit more dorsal brain areas following the visuomotor adaptation. A possible explanation could be that the differences in modulations of each attentional component are due to different developmental states of each network.

# *Clinical Neuroscience*

## **W21**

### **EEG microstate quantifiers and state space descriptors in burst suppression epochs during anesthesia**

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**Background:** With ongoing duration in anesthesia, EEG microstate quantifiers and state space descriptors show different trajectories in healthy brains and in brains vulnerable to postoperative delirium (POD). Aim of this study is to analyze the course of these global EEG parameter in burst suppression intervals in patients with and without vulnerability to POD.

**Methods:** Data derive from 73 intraoperative multichannel EEGs from the randomized controlled Surgery Depth of Anesthesia and Cognitive outcome (SuDoCO)-study (SRCTN 36437985). Only combined suppression / bursts epochs will be analyzed. For each of these pairs, the time since onset of anesthesia and specific microstate quantifiers (duration, occurrence, global field power) and state space descriptors (sigma, phi, omega) will be available.

**Results:** The analyses are ongoing and results will be complete at the time of the ABIM conference. Preliminary analyses of a subset of EEGs suggest different trajectories of the ratios (burst / suppression) of several global EEG parameter with ongoing time in anesthesia.

**Conclusions:** Results of these analyses may help to understand the course of whole-brain electrical activity in patients vulnerable to POD. As POD develops several hours to days after surgery, identification of EEG biomarker during anesthesia would allow to implement specific preventive strategies in patients vulnerable to POD.

# *Clinical Neuroscience*

## W24

### **Dynamic regulation of neural variability during working memory reflects dopamine, functional integration, and decision-making**

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The regulation of moment-to-moment neural variability may permit effective responses to changing cognitive demands. However, the mechanisms that support variability regulation are unknown. In the context of working memory, we leverage the largest available PET and fMRI dataset to jointly consider three lenses through which neural variability regulation could be understood: dopamine capacity, network-level functional integration, and flexible decision processes. We show that with greater working memory load, increased variability was associated with elevated dopamine capacity and heightened functional integration, effects dominantly expressed in the striato-thalamic system rather than cortex. Strikingly, behavioral modeling revealed that working memory load evoked substantial decision biases during evidence accumulation, and those who jointly expressed a more optimal decision bias and higher dopamine capacity were most likely to express increased striato-thalamic variability under load. We argue that the ability to align striato-thalamic variability to level of demand may be a hallmark of a well-functioning brain.



# *Clinical Neuroscience*

## **W26**

### **Self-regulation of attention in children in a virtual classroom environment: a feasibility study**

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Nowadays, children with attention-deficit hyperactivity disorder (ADHD) are mainly treated with psychostimulant drugs such as methylphenidate (Ritaline®), which are well known for their numerous side effects. EEG-Neurofeedback (EEG-NFB) is a promising alternative, but a large number of training sessions are necessary. Our protocol combines EEG-NFB therapy with an immersion in a virtual classroom environment. We think that this playful context can boost the motivation and involvement of children, and thus drastically reduce the number of sessions needed.

To evaluate the feasibility of this new protocol, we first carried out this study on a small cohort of 6 healthy children (between 6 and 10 years-old). They performed 8 EEG-NFB sessions. They all stayed motivated until the end and expressed their joy during the sessions.

Pre- and post- simultaneous EEG-fMRI sessions were done to assess potential changes in brain activity and connectivity induced by the present EEG-NFB protocol. Despite large movements made by the children inside the scanner, we successfully computed Independent Component Analysis on resting-state fMRI runs and identified networks of interest such as the fronto-parietal attentional network. We also compared activation induced by a go/no go task to previous results found in a group of (doing the same task). Finally, a post-training transfer run done in the MRI revealed inhibition of brain activity in several regions when the children were focused.

# *Clinical Neuroscience*

## **W29**

### **Dynamic connectivity of the hippocampal subfields unveils potential vulnerability markers in offspring of bipolar patients**

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Bipolar disorder (BD) is a highly heritable disorder characterized by emotion dysregulation and recurrent oscillations between mood states. Despite the proven efficacy of early interventions, vulnerability markers in high-risk individuals are still lacking. BD patients present structural alterations of the hippocampus, a pivotal hub of emotion regulation networks composed of multiple subfields with different projections. However, the hippocampal dynamic functional connectivity (dFC) in BD remains unclear.

We hypothesize that 1) hippocampal dFC differentiates BD patients, offspring of BD patients (BDoff), and healthy controls (HC); 2) hippocampal dFC correlates with symptoms; 3) these correlations differ between these groups. To test these hypotheses, we studied for the first time the dFC of hippocampal subfields through micro-co-activation pattern ( $\mu$ CAPs) analysis of resting-state fMRI data of 97 subjects (26BD, 18BDoff, 53HC).  $\mu$ CAPs allow a data-driven segmentation of the seed-region.

We found that dFC between the hippocampal body and a somatomotor-network (or somatomotor- $\mu$ CAP) was lower both in BD patients (pFDR=0.0001) and in BDoff (pFDR=0.02) than in HC. Inversely, dFC between the hippocampal head and a limbic- $\mu$ CAP was higher both in BD patients (pFDR=0.000153) and in BDoff (pFDR=0.004) than in HC.

Furthermore, the correlation between a frontoparietal- $\mu$ CAP and both depression and emotion dysregulation symptoms was significantly higher in BD than HC (pFDR<0.02).

Overall, we observed alterations of large-scale functional brain networks associated with decreased cognitive control flexibility, abnormal somatomotor and limbic processing in BD. BDoff presented an intermediate phenotype between BD and HC, suggesting that hippocampal dFC might represent a marker BD vulnerability.

# *Clinical Neuroscience*

## **W33**

### **NeuroTin: EEG neurofeedback to alleviate chronic tinnitus.**

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Tinnitus affects 1 in 10 adults and consists of an aversive background noise in one or both ears associated with excess auditory activation, reduced alpha band power, and increased delta band power in the auditory cortex. Neurofeedback training may improve self-control of auditory activation and reduce tinnitus symptoms. We investigated whether neurofeedback therapy could alleviate chronic tinnitus and whether patients suffering from chronic tinnitus could learn to reliably and voluntarily regulate the activation of the auditory pathways. 90 patients were included in one of 3 separate arms: Cognitive Behavioral Therapy (CBT), the current gold-standard therapy; rt-fMRI neurofeedback; EEG neurofeedback. 21 participants underwent 15 neurofeedback sessions in the EEG arm. Sensors were weighted to target the auditory pathways based on the measured N1-P2 response to an auditory stimuli and participants were trained to up-regulate alpha band power and down-regulate delta band power. Quality of life improvements and tinnitus handicap were assessed before, after, and 6 months after training through 5 standard questionnaires. After EEG neurofeedback training, 9 participants improved in most questionnaires, 6 participants improved only the Tinnitus Handicap Inventory (THI) score, and 6 participants did not improve. Down-regulation of the delta band power was difficult: only a few participants could down-regulate the delta band with low reproducibility. On the contrary, up-regulation of the alpha-band power was a success: most participants, especially those who improved their clinical outcomes, managed to up-regulate the alpha band reliably.

## **W36**

### **Visuospatial impairments in acute and chronic stroke: insights from voxel and atlas-based lesion-symptom mapping**

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Patients with hemispheric stroke often have profound visuospatial impairments that can either persist or spontaneously resolve in the chronic phase. Knowing which symptoms and brain areas characterize the acute and chronic phases can contribute to the design of effective rehabilitation strategies.

To identify the association between visuospatial impairments and anatomical damage in two populations of acute and chronic stroke patients, we first conducted a factorial analysis on neuropsychological tests assessing deficits in the visuospatial domain and then used the results for voxel-, atlas-, disconnection-based lesion-symptom mapping.

Behavioral results showed that the acute population was mostly impaired in lateralized attention while the chronic population suffered from constructional apraxia. Multivariate voxel-based and atlas-based mapping showed that lateralized attention in the acute group was related to damage in the superior, middle frontal, and precentral gyri, while constructional apraxia in the chronic group was related to the temporal and inferior parietal lobes. Consistently, disconnection of fronto-frontal, fronto-subcortical, and somatomotor-somatomotor areas, and damage to several macroscopic anatomical tracts explained acute lateralized inattention, while chronic constructional apraxia was related to visuo-visual disconnections and damage to the vertical occipital fasciculus.

Our results show that constructional apraxia and damage/disconnection of dorso-ventral higher-order visual areas impair stroke patients in the long term. This may be related to the focus of rehabilitation strategies on the spatial component of the patient's deficits and not enough on object-based impairments. This work may inform future rehabilitation strategies and help patients to recover persisting deficits beyond lateralization of spatial awareness.

# *Clinical Neuroscience*

## **W38**

### **Dysfunctional cerebello-cerebral network associated with vocal emotion impairments**

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The cerebellar involvement in emotion recognition has been explored with facial expressions (Adamaszek et al., 2017), but rarely in the auditory modality (i.e., emotional prosody). However, anatomical and neuroimaging studies point to the cerebellum's functional integration in the neural network involved in emotion processing (i.e., orbitofrontal, cingulate, temporal and insular cortices, amygdala and basal ganglia) (Pierce and Péron, 2020). The aim of this study was to investigate emotional prosody recognition in patients with cerebellar dysfunction and to suggest the possible impact of such damage across whole brain.

27 patients with cerebellar lesions and 27 matched control have performed an emotional prosody recognition task composed of five prosodies (anger, fear, sadness, happiness, neutral) to rate on six scales (anger, fear, sadness, happiness, neutral, surprise). Patients have also realized motor, neuropsychological and psychiatric tests. By combining imaging information from patients with normative connectome data from 97 neurotypical individuals, we have estimated lesion-induced dysfunctions across the whole brain.

Results revealed impaired recognition among patients for neutral or negative prosody, with poorer sadness recognition performances by patients with right cerebellar lesion. Network-based lesion symptom mapping revealed that sadness recognition performances were linked to a network connecting the cerebellum with left frontal, temporal and parietal cortices.

Overall, in addition to taking part in the sensory processing of vocal emotion by performing an optimal processing of the salient acoustic parameters (Thomasson et al., 2021) through interactions with temporal areas (Stockert et al., 2021), the cerebellum would participate to higher levels (cognitive evaluative judgments) of emotional processing.

# *Clinical Neuroscience*

## **W41**

### **Neurobiological correlates of an innovative cognitive behavioral therapy aiming to reduce negative symptoms in patients with schizophrenia**

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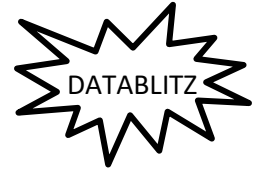
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Besides psychotic symptoms (hallucinations, delusions), cognitive deficits and negative symptoms may occur in patients with psychotic disorders. Negative symptoms (blunted affect, alogia, anhedonia, avolition, social withdrawal) are the most important predictors of long-term impairment. This study evaluated the efficacy of an innovative cognitive behavioral therapy (MOSAIC-therapy) comprising a combination of individual sessions of cognitive behavioral therapy (CBT) and corresponding group sessions. Therapy-associated changes in negative symptoms and their neurobiological correlates were evaluated.

MOSAIC-therapy (30 sessions of individual CBT & 30 group training sessions within 8 months) was compared with SUPPORT-therapy (supportive individual sessions and enjoyable group activities) in a randomized controlled trial. Sixty patients with psychotic disorders participated. Assessments for negative symptoms (PANSS-neg) were carried out before initiation (T0) and after completion of the interventions (T2). Furthermore, fMRI data (3T) were obtained during the assessment of nonverbal emotional expressions (facial & vocal) and analyzed with SPM12 ([www.fil.ion.ucl.ac.uk/spm](http://www.fil.ion.ucl.ac.uk/spm)).

Statistical analysis did not reveal significant differences between MOSAIC-therapy and SUPPORT-therapy regarding the reduction of negative symptoms ( $p = 0.44$ ). However, pre-post comparisons showed symptom reduction within each group with a moderate to large effect size (MOSAIC-therapy:  $p < 0.001$ ,  $d = 0.66$ , SUPPORT-therapy:  $p = 0.006$ ,  $d = 0.49$ ). The extent of individual reduction of negative symptoms (independent of therapy group) was correlated with reduced activity ( $T2 < T0$ ) in the bilateral temporal voice area (TVA) during assessment of nonverbal emotional expressions. This finding indicates an important link between clinical improvement and neurobiological modulations within regions involved in the processing of social cues.



**Altered correlation of simultaneously recorded EEG-fMRI connectomes in temporal lobe epilepsy**

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Whole-brain functional networks/connectomes have been characterized on different temporal and spatial scales in humans using EEG and fMRI but the precise relationship between those results is unclear. Here, we aim to characterize the spatial correlation between EEG and fMRI connectomes in left and right temporal lobe epilepsy (r/ITLE) using simultaneous EEG-fMRI recordings.

From two independent centers, we acquired resting-state concurrent EEG-fMRI from a total of 35 healthy controls and 34 TLE patients (18 rTLE and 16 ITLE). The data – averaged fMRI activity and EEG source imaging - was projected onto the same brain atlas. For each subject, connectomes based on fMRI (Pearson correlation) and EEG (corrected imaginary part of the coherency) were calculated. Correlations between the group-averaged EEG-fMRI connectivity were statistically compared by permuting the group labels.

In controls, average EEG-fMRI whole-brain connectivity was moderately correlated ( $r \sim 0.3$ ). For both centers, correlation between EEG-fMRI connectivity was increased in rTLE patients (vs. controls) for EEG-delta, theta and alpha. Conversely, correlation between EEG-fMRI connectivity of ITLE patients was decreased (vs. controls, EEG-beta). While altered EEG-fMRI correlation in rTLE patients was global, in ITLE patients it was localized (Default Mode Network).

The increased correlation of EEG-fMRI connectivity in rTLE patients and decreased correlation in ITLE patients suggests a differential organization of mono-lateral focal epilepsy of the same type, to be considered when comparing EEG and fMRI connectivity. Each modality provided distinct information, highlighting the benefit of multimodal assessment in epilepsy. Multimodal topological lateralization patterns could help when clinically defining the epileptic focus of patients.

# *Methods*

## **W48**

### **Exploring the syntax of microstates during unconsciousness with Microsynt**

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Microstates represent electroencephalographic (EEG) activity as a sequence of switching, transient, metastable states. Growing evidence suggests the useful information on brain states is to be found in the higher-order, long-term temporal structure of these sequences. Here we propose “Microsynt”, a method that highlights higher-order interactions of microstate sequences of any length and complexity. Microsynt extracts an optimal vocabulary of “words” based on the length and complexity of the full sequence of microstates. Words are then sorted into classes of entropy and their representativeness within each class is statistically compared with surrogate and theoretical vocabularies. Here we applied the method on previously collected EEG data from healthy subjects undergoing surgery, and compared their “fully awake” (BASE) and “fully unconscious” (DEEP) states. Results show that microstate sequences are not random but tend to behave in a more predictable way, favoring simpler sub-sequences, or “words”. Contrary to high-entropy words, lowest-entropy binary microstate loops are prominent and favored on average 10 times more on average than what the theoretically expected. Progressing from BASE to DEEP the representation of low-entropy words increases while the opposite is true for high-entropy words. In BASE sequences of microstates tend to be attracted towards “A – B – C” microstate hubs, particularly A – B binary loops. Conversely, with full unconsciousness, sequences of microstates are attracted towards “C – D – E” hubs, particularly C – E binary loops. Microsynt can form a syntactic signature of microstate sequences that can be used to reliably differentiate two or more conditions



# *Methods*

## **W50**

### **Generalized additive mixed models for pupillometric data**

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By using `mgcv` package on R (Wood, 2017), the main objective of this article is to provide a clear understanding and interpretation of generalized additive mixed models (GAMM) (Hastie and Tibshirani, 1986, 1990) applied to psychological research which especially includes a factorial design across time or any other continuous variables. Using a spline approach, GAMM is an extension of generalized linear mixed effects model (GLMM) in which predictors can be estimated with smooth functions allowing a non-linear and more flexible prediction of the relationship between explicative and response variables than linear or polynomial regression, taking into account the variability between subjects. To illustrate the advantages of this semi- or nonparametric technique, we implement these models on pupillometric data collected with Tobii eye tracker HTC VIVE Pro during an emotional task where conditions such as sound stimuli and light characteristics were manipulated. Indeed, in addition to be an uncontrolled physiological variation due to the autonomic nervous system activation and therefore a reliable and commonly used measure in affective and cognitive psychology, pupil size is inherently a continuous variable varying over time which illustrates well the advantages of GAMM for the analysis of psychological and physiological data.

# *Methods*

## **W53**

### **Towards quantitative functional brain mapping: the spatial accuracy of Arterial Spin Labelling**

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Functional Magnetic Resonance Imaging (fMRI) is widely established as non-invasive tool to investigate brain functions, in clinical and research contexts. Blood Oxygenation Level Dependent (BOLD) is by far the most used contrast for fMRI. However, BOLD is an indirect measure of neuronal activity and its specificity can be biased by abnormal neurovascular coupling.

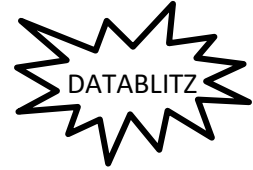
Arterial Spin Labelling (ASL) is a valid non-invasive alternative that allows for a direct and quantitative measurement of the cerebral blood flow. Although ASL may locate more precisely the neuronal activity, it is occasionally used in functional mapping.

This work aims at assessing the specificity of functional ASL (fASL).

Twenty-eight healthy participants executed a clenching hand task and received a somatosensory stimulation of the thumb, while BOLD and ASL were acquired simultaneously. Subjects were, subsequently, enrolled in a Transcranial Magnetic Stimulation (TMS) session for the definition of hand somatotopy.

The Euclidean distance between fASL and BOLD ranged between 10.1 mm and 16.6 mm. In respect to BOLD, fASL localized significantly: i) more lateral ( $p < 0.05$ ), ii) anterior ( $p < 0.05$ ) and iii) inferior ( $p < 0.001$ ) during motor task. Similar results were observed at group-level during pneumatic stimulation. fASL activation followed the post- and pre-central sulci more precisely than BOLD. fASL was more adjacent than BOLD to TMS, with a significant shift ( $p < 0.001$ ) along the inferior-to-superior direction.

Our results confirm the specificity of fASL in targeting the regional neuronal excitability. fASL could be applied in pre-surgical evaluation of neurosurgical patients where spatial accuracy is of high importance for the mapping eloquent cortex.



### **A method to induce low and high flow states while keeping participants on task – A confirmatory study**

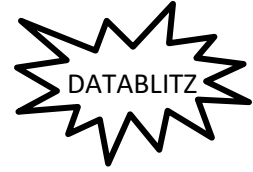
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Flow has been defined as a state of full immersion that may emerge when the skills of a person match the challenge of an activity. It is a special case of being on task where keeping focused on the task feels effortless. Most experimental investigations of the neural or physiological correlates of flow contrast conditions with different levels of challenge, with the risk of inducing off-task states, such as boredom or frustration. It thus remains unclear whether previously observed correlates of flow may rather be correlates of being on task versus off-task.

To remedy this, we have previously presented a method using an action video game to induce states of low and high flow while controlling that participants remain on task in both conditions. Our results also showed that peripheral physiological measures (electrodermal activity, cardiac, and respiratory measures) were not sensitive enough to distinguish states of high and low-flow when on-task behavior is controlled for. Given the noisy environment of the MRI scanner and the unusual position that participants had to play in, there were concerns about the reliability of these results. Here we present a study with 50 participants conducted in an environment with minimal noise sources. We confirm the results that (i) we were able to induce significantly different levels of flow state while keeping participants on-task, and (ii) peripheral physiological measures were not sensitive enough to distinguish between our flow conditions. This confirms the concerns raised about previous physiological characterizations of flow against conditions that did not control for on-task behavior.



**Tracking Conjunctive Representations through EEG Decoding**

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In contrast to traditional stage models of information processing, recent evidence from animal models indicates that non-linear, “mixed-selectivity neurons” integrate basic features into conjunctive representations as a critical step during action selection. Yet, so far it has not been possible to directly measure and probe the functional properties of conjunctive representations in humans. We assessed the electroencephalogram (EEG) of participants performing a rule-selection task with varying trial-to-trial constellations of stimuli, stimulus-response rules, and responses. A novel combination of a linear decoding stage and a subsequent representational similarity analysis (RSA) of the frequency-decomposed EEG allowed us to track basic rule, stimulus, and response representations, as well as their non-linear conjunction on the level of single trials. Conjunctive representations were indeed highly robust during the entire response-selection phase. Also, the strength of these representations closely mirrored a non-linear response-time (RT) priming pattern (the so-called “partial-repetition costs”)—so far, the only available, behavioral indicator of conjunctive representations. Most importantly, the strength of conjunctive representations was a potent predictor of trial-by-trial RT variability, outperforming the predictive power of the constituent representations. Subsequent experiments using a combined rule-selection and stop-signal paradigm also showed that stopping an intended action requires suppressing the underlying conjunctive representation, while the success of stopping attempts depended inversely on the strength of the conjunction at the time of the stop-signal. Combined, EEG-decoded conjunctive representations act as critical drivers of successful action and provide a bridge between cognitive theories of action control (e.g., event-coding theory) and animal models of mixed-selectivity neurons.

# *Methods*

## **W62**

### **Changes in air-temperature coincide with mass shootings in United States**

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#### **Introduction:**

Mass shootings are incidents involving multiple victims of firearm-related violence. With 180 events between 1966 and 2021, the United States has had more mass shootings than any other country. In recent literature the factors mental health, access to firearms and perpetrator life histories are frequently discussed. Climate and specifically changes in temperature as contributing factor is currently not well understood. However studies reveal clear associations between violent behaviour and higher air temperature. Our study aims to fill this obvious omission. Hence we investigated the change of air temperature around mass shooting events.

#### **Methods:**

We used the National Institute of Justice database including 180 mass shooting events between 1966 and 2021. All meteorological datasets were extracted from the database of the National Oceanic and Atmospheric Administration. Reliable air temperature was found for 171 of the 180 events. We chose a distributed lag model (DLM) with a time lag of +/- 5 days. The function was based on a Weibull model. For testing for significance we used an independent samples t-test from null.

#### **Results:**

Preliminary results with 70 datasets indicate a higher temperature before the event with a temperature drop of 1.5° at the day of the event (t= 2.39, p=.020).

#### **Discussion:**

Our findings indicate a typical evolution of temperature around a mass shooting event with a higher temperature before and a significant drop of temperature on the day of the mass shooting. These results demonstrate, that a sudden change in air temperature seems a risk factor for violent behaviour.

# *Methods*

## **W65**

### **EEG markers to task-irrelevant stimuli under high and low levels of flow**

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We used EEG to characterize the neural bases of the state of flow, as defined by Csikszentmihalyi & Larson (2014) - a state of full immersion and optimal performance in the ongoing activity. We induced a high versus a low flow state in each participant through two individually tailored video game play sessions. Importantly, the induced low flow state guaranteed that participants stayed on task, trying their best as in the high flow state, avoiding confounds from off-task behaviors such as boredom or frustration.

As in Castellar et al (2019), we used an auditory oddball paradigm that required participants to respond to rare auditory oddball stimuli while playing their assigned game sessions, either in a high or a low flow state. We predicted that the target oddball sounds in the high flow state would elicit slower RTs and reduced P300 amplitudes as compared to the low flow state, in accordance with the hypothesis that stimulus events irrelevant to the video game task would receive fewer processing resources in the high flow state.

Here we demonstrate the feasibility of EEG recording during game play by showing that ERP markers of the auditory oddball, in particular the N100 and P300 components, can be recovered at the individual subject level. We discuss how data collection has been adapted to limit artifacts (head motion, jaw tension during game play), and how artifact correction has been optimized, with respect to numerous eye movements. Finally, we present preliminary data from our planned design to further characterize the neural bases of flow.

# *Methods*

## **W69**

### **Single subject-level decoding of multiple visual shapes from fMRI brain activity**

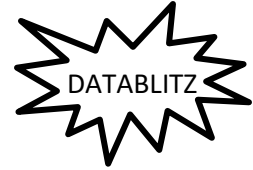
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Multivariate pattern analysis (MVPA) of fMRI signals has boosted our understanding of how objects are represented in the human brain. However, while the distributed patterns of response to objects when they fall into few known categories, such as faces or places, is now well established, the multivariate decoding of several less familiar, more visually similar objects is less studied, despite being relevant to many applications as in learning to read new words. In order to fill this gap in knowledge, the current work presented 6 relatively similar and rather unfamiliar shapes drawn from an old, now unused alphabet, to adult participants (N=17), performing a 1-back task during whole-brain fMRI. In a separate condition, the same participants also performed a 1-back task on more visually distinct objects drawn from 6 different well-known categories. We first confirmed that participants performed similarly in these two experimental conditions. We then built a MVPA decoder in the native space of each participant and for each experimental condition, using activation maps extracted from a trial-based general linear model. By these means, we were able to decode both familiar and unfamiliar shapes with high accuracy, significantly above chance level. In both cases, population-wide probability maps showed that all relevant classification clusters fell into visual areas, yet with distinct performances within sub-regions of the ventral cortex. Overall, our results demonstrate that, thanks to sequential model-based optimization of hyperparameters and model selection, multiple visually similar and relatively unfamiliar shapes can be accurately distinguished in the human visual cortex at the single-subject level.



### **Resting-state fMRI of lumbar spinal cord: imaging and analyses challenges**

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Functional MRI (fMRI) has been frequently applied in the brain and, more recently, in the cervical spine to investigate motor, sensory, and cognitive function.

However, direct adoption of fMRI in the lumbar cord is challenging, notably due to the lower size of the cord and the lower signal to noise ratio. An additional issue is the absence of dedicated processing pipelines, as most tools have been developed for deployment in the cervical cord [1]. To tackle this issue, the current study proposes a systematic comparison of denoising preprocessing steps.

In particular, we performed lumbar fMRI in 20 healthy volunteers during rest. Leveraging this unprecedented dataset, we advance the first functional connectivity analyses in the lumbar region. First, we used a static functional connectivity approach and systematically assessed the impact of distinct denoising procedures on the resulting connectivity patterns, with a specific focus on the expected sensory (dorsal-dorsal) and motor (ventral-ventral) networks [2]. Then, we applied dynamic functional connectivity (dFC) on the most optimal preprocessing combination, using the SpiCiCAP framework that involves hemodynamic deconvolution [3].

Our exploration brings new insights to build future pipelines for lumbar fMRI data analysis and provides a first glance into functional architecture of the spinal cord at large.

[1] De Leener et al. (2017), SCT: Spinal Cord Toolbox, an open-source software for processing spinal cord MRI data. *NeuroImage*.

[2] Barry et al. (2014), Resting state functional connectivity in the human spinal Cord, *eLife*.

[3] Kinany et al. (2020), Dynamic functional connectivity of resting-state spinal cord fMRI reveals fine-grained intrinsic architecture, *Neuron*.



# *Methods*

## **W74**

### **Fingerprinting the newborn brain**

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Individual characterization of subjects based on their functional connectome (FC), the so-called brain fingerprinting, has become a sought-after goal in contemporary neuroscience research. An increasing amount of studies relying on functional magnetic resonance imaging (fMRI) have demonstrated to uniquely characterize and accurately identify adult individuals in both healthy and clinical populations. However, to date, little is known about fingerprinting the newborn brain.

In this study, we rely on resting-state fMRI data of n=500 subjects from the developing Human Connectome Project (dHCP) to assess whether it is possible to identify neonatal subjects based on their FCs in both control preterm, and full-term infants. By employing two identification scoring methods, differential identifiability and success rate, we provide fingerprint scores for the two newborn groups. Remarkably, we find that FC fingerprinting is very reliable within the same session in both preterm and full-term newborns, whereas this does not hold when considering different fMRI sessions. Finally, by leveraging the edgewise and nodal FC fingerprinting patterns, we find a significant relationship between behavioural significance and identification scores.

Overall, our preliminary investigation of fMRI connectome identifiability provide also the first characterization of newborns' brain fingerprinting in relation to different age groups

# *Methods*

## W77

### **Multi-band acquisitions for simultaneous corticospinal BOLD fMRI: A pilot study**

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Functional magnetic resonance imaging (fMRI) has provided valuable insights into brain function for decades and has recently been transposed to probe spinal mechanisms. Simultaneous brain and spinal cord fMRI (a.k.a. corticospinal fMRI) offer a unique opportunity to investigate the neural mechanisms at the cortical, subcortical, and spinal levels of the central nervous system. However, corticospinal imaging is challenging, notably due to the anatomical differences between the brain and spinal cord. While recent advances have begun to undertake this endeavour, most approaches currently attempt to image two sub-volumes for the brain and spinal cord using different acquisition parameters. This requires extensive pre-scan preparation and could potentially induce several confounding factors. In this pilot study, we attempted to identify an optimal sequence to simultaneously acquire the brain and cervical spinal cord fMRI in a single volume. Our approach utilized a 3T fMRI acquisition using an accelerated multi-band echo-planar imaging (MB-EPI) sequence to have faster acquisition with low signal-to-noise penalty, high resolution, and distortion-free images. We utilized an iterative approach to assess the effects of tuning several acquisition parameters like in-plane resolution, slice thickness, repetition time, flip angle, parallel imaging factor, and simultaneous multi-slice imaging factor. We found that our tailored MB-EPI measurement was relatively faster than the standard EPI sequences previously used in corticospinal imaging studies and produced functional images that are robust to geometric distortions and had a satisfactory signal-to-noise ratio in gray matter. This pilot study emphasizes the potential and feasibility of MB-EPI sequences for single-volume corticospinal imaging.

# *Methods*

## **W79**

### **Electrophysiological characterization of striatal temporal interference brain stimulation (tTIS)**

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Deep brain regions are critically involved in neural processing during motor learning processes. One approach in systems neuroscience for investigating underlying mechanisms is noninvasive brain stimulation (NIBS). However, conventional NIBS approaches have the disadvantage that they cannot focally stimulate deep brain regions without engaging the overlying cortex due to their steep depth-focality trade-off. We have recently demonstrated in human subjects that transcranial temporal interference stimulation (tTIS) of the striatum can modulate brain activity in the target region and the associated functionally relevant brain network (Wessel & Beanato et al., bioRxiv). Furthermore, it enhanced the motor learning capacity, especially in older healthy subjects. In the present follow-up study, we use standard transcranial magnetic stimulation-based assessments (Chen et al. 2004, Experimental Brain Research) to further characterize effects on inhibitory and excitatory circuits in human motor cortex before, during, and after tTIS. This will allow us to describe underlying electrophysiological mechanisms and optimize the tTIS intervention for future clinical studies.

# PARTICIPANTS

Poster abstracts are preceded by a 'M', 'T', or 'W' depending on the presentation day

Talk abstracts are preceded by a 'O'

\* Presenter abstracts

<b>ARNAL</b>	LUC	T22
<b>ARTONI</b>	FIORENZO	W48*
<b>BAVELIER</b>	DAPHNÉ	W57 W65 W69
<b>BECK</b>	JOANNA	M18*
<b>BENIS</b>	DAMIEN	M47 M54 T4 T49*
<b>BENOIT</b>	ROLAND	O18*
<b>BENZ</b>	DIETMAR	
<b>BERNASCONI</b>	FOSCO	T52*
<b>BERTHAULT</b>	EMMA	M20*
<b>BERTONI</b>	TOMMASO	T7 T34 T55*
<b>BIDET CAULET</b>	AURÉLIE	T25 W5
<b>BLANKE</b>	OLAF	T52
<b>BLUMENFELD</b>	HAL	O8*
<b>BOKER</b>	STEVEN	
<b>BOMMARITO</b>	GIULIA	T58*
<b>BOORMAN</b>	ERIE	O16*
<b>BOSCHERON</b>	JULIETTE	
<b>BRANNON</b>	ELISABETH	O2*
<b>BRITZ</b>	JULIANE	W48
<b>CABRAL</b>	JOANA	O15*
<b>CERAVOLO</b>	LEONARDO	M23* M54 W38
<b>CHEN</b>	SOPHIE	M20 T25
<b>CIONCA</b>	ALEXANDRE	T61*
<b>CLERGET</b>	ALICE	T76*
<b>COLL</b>	SÉLIM	M63* T1
<b>CROSS</b>	EMILIE	O17*
<b>DE KLOE</b>	TAMARA	
<b>DE RIBAUPIERRE</b>	SANDRINE	T46* T73*
<b>DE TIMARY</b>	PHILIPPE	
<b>DEBRACQUE</b>	CORALIE	M23
<b>DEMERTZI</b>	ATHINA	O7*
<b>DOGANCI</b>	NAZ	T1*
<b>EAGLESON</b>	ROY	T46 T73
<b>ELLIOTT</b>	MARK	
<b>FAIVRE</b>	NATHAN	T31
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<b>FARRON</b>	NICOLAS	T70* W17
<b>FÉRAT</b>	VICTOR	W2* W26
<b>FERRER</b>	EMILIO	
<b>FILIPPA</b>	MANUELA	M47 M78 T4
<b>FISCHI-GOMEZ</b>	ELDA	
<b>FLEURY</b>	VANESSA	T49
<b>FOGLIA</b>	CAROLINA	T55
<b>GARRETT</b>	DOUGLAS	W24*
<b>GIOVANOLA</b>	YASMINE	M66*
<b>GIRONDINI</b>	MATTEO	T7*
<b>GRAND</b>	ARNAUD	W50*
<b>GRANDJEAN</b>	AURÉLIE	T25 W5*
<b>GRANDJEAN</b>	DIDIER	M23 M47 M54 M59 T4 W38
<b>GROUILLER</b>	FRÉDÉRIC	O3 M30 W26 W45 W53
<b>GRUBER</b>	MATTHIAS	O19*
<b>GUIBERT</b>	FABRICE	W69*
<b>HARUKI</b>	YUSUKE	T10*
<b>HÀ-VINH LEUCHTER</b>	RUSSIA	W26
<b>HELD</b>	LESLIE	M68*
<b>HERMAN</b>	ALEKSANDRA	M27* M39
<b>HERVAIS-ADELMAN</b>	ALEXIS	
<b>HINNEN</b>	GABRIEL	M3*
<b>HUMMEL</b>	FRIEDHELM	W79
<b>HÜPPI</b>	PETRA	M78 T4
<b>IANNOTTI</b>	GIANNINA	T1 W45 W53*
<b>IVANOVA</b>	BISSERA	
<b>JAMES</b>	CLARA	O3* M30
<b>JANAKAN</b>	SIVAYOKAN	
<b>JANATA</b>	PETR	
<b>JOËSSEL</b>	FREYA	W57* W65
<b>KELL</b>	CHRISTIAN	
<b>KIRSCHNER</b>	MATTHIAS	W9*
<b>KOBAN</b>	LEONIE	W12*
<b>KÖNIG</b>	THOMAS	O13* T80 W21
<b>KRACK</b>	PAUL	T49
<b>KREIFELTS</b>	BENJAMIN	W14* W41
<b>LALANDE ROBERT</b>	PAUL	T16*
<b>LEONE</b>	GIOVANNI	O4*
<b>LEUPIN</b>	VIVIANA	O9*
<b>LINDENBERGER</b>	ULMAN	W24
<b>LOUED-KHENISSI</b>	LEYLA	T19*
<b>LOUI</b>	PSYCHE	O5*

<b>MAMMERI</b>	KEVIN	M71*
<b>MARIE</b>	DAMIEN	O3 M30*
<b>MARIN</b>	NADEGE	T22*
<b>MARZILIANO</b>	PINA	
<b>MATHIEU</b>	ANNE	T25*
<b>MAYR</b>	ULRICH	W60*
<b>MCGEOWN</b>	WILLIAM	T28*
<b>MERCIER</b>	MANUEL	M56
<b>MICHEL</b>	CHRISTOPH	O13 W2 W48
<b>MIKUTTA</b>	CHRISTIAN	W62*
<b>MOHAMED</b>	ISAIH	M32*
<b>MOHAMED YOONUS IMRAN</b>	MOHAMED NAJEEB SIKKANDER	
<b>MOHAMMADI</b>	NOSRATULLAH	M35*
<b>MONN</b>	MÉLISSA	W17*
<b>MORGENROTH</b>	ELENOR	O22* M11
<b>MORILLON</b>	BENJAMIN	M56 T16 T43
<b>MORUCCI</b>	PIERMATTEO	
<b>MUELLER</b>	MATTHIAS	O14*
<b>NACCACHE</b>	LIONEL	
<b>NAVARRO</b>	JORDAN	
<b>NEUNER</b>	BRUNO	W21*
<b>NGUYEN</b>	ARTHUR	W65*
<b>NUMMENMAA</b>	LAURI	M6*
<b>OLSZEWSKA</b>	ALICJA	M27 M39*
<b>OREPIC</b>	PAVO	M42*
<b>PAVLOV</b>	YURI	M75*
<b>PELENTRITOU</b>	ANDRIA	O11*
<b>PEREIRA</b>	MICHAEL	T31*
<b>PIANI</b>	MARIA CHIARA	T80*
<b>PIGUET</b>	CAMILLE	W29
<b>PLANCHAMP</b>	LOU	W26*
<b>PLATT</b>	MICHAEL	O1*
<b>PLEGAT</b>	MARIE	M44*
<b>PRETI</b>	MARIA GIULIA	T64
<b>PREUSCHOFF</b>	KERSTIN	
<b>PROIX</b>	TIMOTHÉE	M35 M42
<b>RAMBOSSON</b>	ISABELLE	M47*
<b>RAMPININI</b>	ALESSANDRA	M51*
<b>RAMSEY</b>	RICHARD	O21*
<b>RENAUD</b>	OLIVIER	W50
<b>REYNAUD</b>	EMANUELLE	
<b>RICCHI</b>	ILARIA	W72*
<b>RICCI</b>	GIULIA	T34* T55

<b>RIONTINO</b>	LAURA	
<b>RUSHWORTH</b>	MATTHEW	O20*
<b>RUTKOWSKA</b>	NATALIA	T37*
<b>SACCARO</b>	LUIGI FRANCESCO	W29*
<b>SANI</b>	ILARIA	W36
<b>SANTORO</b>	ANDREA	W74*
<b>SAREEN</b>	EKANSH	W77*
<b>SAUVAGE</b>	CLEMENT	
<b>SHELTIENNE</b>	MATHIEU	W33* W65
<b>SCHMIDT</b>	LIANE	T13*
<b>SCHNIDER</b>	ARMIN	M63
<b>SCHÖN</b>	DANIELE	M20 M32 M44 M56*
<b>SELOSSE</b>	GARANCE	M54*
<b>SETH</b>	ANIL	O10*
<b>SKULTETY</b>	VIKTOR	
<b>SONG</b>	JIE	W36*
<b>STERPENICH</b>	VIRGINIE	M3 M71
<b>TAN</b>	MI XUE	M8*
<b>TAUTVYDAITE</b>	DOMILE	T40*
<b>THOMASSON</b>	MARINE	W36 W38*
<b>VAN DE VILLE</b>	DIMITRI	O3 O22 M8 M11 M30 T58 T64 W29 W69 W72 W77
<b>VAN DER VEEK</b>	ANNEMIJN	M78*
<b>VETTER</b>	PETRA	
<b>VIDAURRE</b>	DIEGO	O12*
<b>VILA CLARA</b>	LAURA	O22 M11*
<b>VOLLBERG</b>	MARIUS	M15*
<b>VUILLEUMIER</b>	PATRIK	O22 M8 M11 M15 W26 W36
<b>VULLIEMOZ</b>	SERGE	W45
<b>WESSEL</b>	MAXIMILIAN JONAS	W79*
<b>WILDGRUBER</b>	DIRK	W41*
<b>WIRSICH</b>	JONATHAN	W45*
<b>WITTMANN</b>	ADRIEN	M59*
<b>YONELINAS</b>	ANDREW	O6*
<b>ZALTA</b>	ARNAUD	T43*