Alejandro Callara, University of Pisa, Italy

Heartbeat-Evoked Potentials in Hypnosis and Meditation: Methods and Applications for Studying Consciousness

The heartbeat-evoked potential (HEP) is defined as the average brain activity measured by EEG or MEG, time-locked to the R-peaks of a simultaneously recorded electrocardiogram (ECG). It serves as a sensitive neural marker of various physiological and psychological conditions, including consciousness, emotion, and interoception. The amplitude of the HEP has been associated with interoceptive accuracy, emotional arousal, emotional dysregulation, and certain clinical disorders, such as anxiety and depression. Overall, the HEP provides valuable insights into the interaction between cardiac and neural processes.

However, studying the HEP presents several methodological challenges, primarily due to the contamination of EEG signals by direct cardiac field artifacts. Proper data preprocessing, careful epoch selection, and artifact reduction techniques are crucial to accurately isolate the neural components of the HEP. Here, we outline best practices for extracting HEPs from EEG data, highlighting essential steps in the processing pipeline.

Then, to illustrate the relevance of HEP analysis, we examine two distinct case studies: hypnosis and meditation. These altered states of consciousness provide unique conditions in which HEP investigations can enhance our understanding of the neural mechanisms underlying interoception, self-awareness, and consciousness, offering novel perspectives on brain-body interactions.

Short Bio

Alejandro Luis Callara is a Research Fellow at the Department of Information Engineering, University of Pisa. He earned his Bachelor's degree in Biomedical Engineering in 2012 and his Master's degree in Biomedical Engineering in 2015, both from the University of Pisa, Italy. In 2019, he obtained a Ph.D. in Information Engineering from the same institution. His research focuses on designing and developing models, methods, and frameworks for biomedical signal and image processing. He has expertise in advanced signal processing and image analysis, including supervised and unsupervised learning, statistical analysis, time-series analysis, and image segmentation. He is currently working on the **"THE – Tuscany Health Ecosystem"** Project.

Alejandro Galvez-Pol, University of the Balearic Islands, Spain

Rethinking perception-interoception research through an ecological lens

Recent research indicates that sensory processing and perception are influenced by internal bodily rhythms, such as heartbeats and respiration. However, existing studies typically rely on laboratory methods that: i) precisely align brief stimuli presentations with specific phases of bodily cycles; ii) adopt a limited view where physiological signals are relevant only to individuals' immediate tasks or goals; and iii) neglect how people actively engage with their surroundings in relation to these internal rhythms. In this seminar, I will discuss emerging ecological approaches to perception-interoception research. I will present evidence that individuals actively sense external sensory stimuli guided by ongoing bodily fluctuations, even without precise synchronization between stimuli and internal bodily cycles. Additionally, these internal states can be partially perceived and inferred by others, adding a socially interactive dimension to interoception. Finally, I will propose a new theoretical model in which bodily rhythms, instead of being background 'noise,' serve as dynamic perceptual gates, regulating how and when sensory signals are processed. This model integrates insights from predictive coding, active inference, and dynamical systems. Taken together, this ecological perspective suggests that perception and interoception are best understood as dynamic and integrated processes that emerge through the organisms' active engagement with their environment.

Short Bio

Alejandro Galvez-Pol is a cognitive neuroscientist whose research explores how people actively gather sensory information—a process known as active sensing. In contrast to traditional paradigms, his studies allow participants to freely engage in natural sensorimotor behaviors, such as eye and hand movements. A distinctive feature of Alex's work is his investigation of how internal bodily rhythms, including heartbeats and respiration, shape these active interactions with the environment. By bridging active sensing and interoception, his research offers a dynamic perspective on the relationship between brain, body, and environment. All in all, as Principal Investigator of the Active Cognition, Embodiment, and Environment Lab (ACE²Lab), he leads a research program focused on how bodily signals influence cognition and perception, particularly within more ecologically valid frameworks.

Andrea Zaccaro, University G. d'Annunzio Chieti-Pescara, Italy

Respiratory modulation of interoception revealed by heartbeat-related cortical oscillations

The cardiovascular and respiratory systems form a tightly coupled cardio-respiratory network, and this integration suggests that breathing continuously modulates the perception of cardiac signals. In this talk, I will present recent works investigating how the interplay between respiration and cardiac interoception shapes cortical dynamics. In previous works, we have shown that heartbeat-evoked potentials and interoceptive accuracy increase during exhalation. Recently, we found evidence in the time-frequency domain showing that oscillatory activity and functional connectivity also follow this respiratory pattern. We examined heartbeat-related power, inter-trial coherence, and functional connectivity during rest, a cardiac interoceptive task, and an exteroceptive control task. We found that during the interoceptive task, exhalation was associated with increased heartbeat-related power, inter-trial coherence, and functional connectivity in the alpha band compared to inhalation. These modulations, primarily localised in the right hemisphere, were associated with interoceptive accuracy and were independent of cardiac physiology. We proposed that these effects reflect precision-weighted prediction of cardiac signals within an interoceptive predictive coding framework, where exhalation facilitates attentional focus on internal cues by suppressing task-irrelevant distractors. This mechanism may be critical for self-regulation and has potential relevance for clinical interventions.

Short Bio

Andrea Zaccaro earned a PhD in Clinical Physiopathology from the University of Pisa and is currently a research fellow at the "G. d'Annunzio" University of Chieti-Pescara, where he is a member of the TEAM Lab. His research primarily focuses on human interoception, employing EEG to investigate the role of respiratory phases in cardiac interoceptive perception and studying heartbeat-modulated oscillations in both the time and time-frequency domains. He is also engaged in applying methods to examine cortical activity and connectivity elicited by bodily rhythms during various forms of interoceptive attention, such as breath control and mindfulness-based practices, and in exploring their potential applications in clinical contexts.

Daniel S. Kluger, University Hospital Münster, Germany

What can we learn from respiration-brain dynamics?

When trying to understand brain-body interactions, respiration takes on a unique role as a peripheral rhythm under conscious voluntary control. Critical avenues arise with regard to theoretical underpinnings as well as everyday implications. In this talk, I will provide an overview of M/EEG work on the fundamental interactions between respiration and brain activity, the behavioural relevance of these coupling effects, and translational applications in the clinical realm. This body of work (no pun intended) culminates in the proposal of a framework for *brain-body states* and a path towards embodied precision neuroscience.

Short Bio:

Dr. rer. nat. Daniel S. Kluger
Junior Group Leader
daniel.kluger@uni-muenster.de

Institute for Biomagnetism and Biosignal Analysis
University Hospital Münster
Malmedyweg 15, 48149 Münster, Germany

Academic career

since 2022 — Junior Group Leader (*Body, Brain, and Behaviour Lab*)
Institute for Biomagnetism and Biosignal Analysis, University Hospital Münster

2019 - 2022 — Postdoctoral Research Fellow in the MEG group of Prof. Joachim Gross
Institute for Biomagnetism and Biosignal Analysis, University Hospital Münster

Funding

2025 – 2030 — *A multimodal framework for body-brain dynamics in health and disease*
ERC Starting Grant - € 1.500.000 (PI)

2023 – 2026 — *A translational approach for body-brain coupling and human perception*
IMF Start-Up Funding - € 187.000 (PI)

2022 – 2025 — *The role of respiration in human perception and cognition*
DFG Research Grant - € 305.000 (PI)

2020 – 2021 — *A VR-based environment to support therapy for children on the autism spectrum*
BMBF GoBio Initial Grant - € 120.000 (co-PI with Dr. Omid Abbasi)

Education

2019 — PhD at the Institute for Psychology, University of Münster
Informational segmentation in event prediction: Temporal dynamics and predictive efficiency (summa cum laude)

Graduate of the interdisciplinary research programme of the Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, University of Münster

2015 — Research stay (supervised by Dr. Moritz Wurm)
Center for Mind/Brain Sciences (CIMeC), University of Trento, Italy
Topic: Multivariate analyses of fMRI and M/EEG data

2014 — M. Sc. Cognitive Neuroscience, University of Münster

Teaching experience

Recognised with the prize for *Excellence in Teaching* by the Psychology department's student body eight semesters in a row (2014 – 2017).

2014	Introductory Research Class (B.Sc. Psychology) Biological Psychology Seminar (B.Sc. Psychology)
2015	Methodology Course: fMRI and TMS (M.Sc. Psychology)
2016	Introductory Research Class (B.Sc. Psychology) Biological Psychology Seminar (B.Sc. Psychology)
2017	Introductory Research Class (B.Sc. Psychology) Methodology Course: fMRI and TMS (M.Sc. Psychology)

Supervision experience

In August 2023, the first PhD student under my supervision has started working on the IMF-funded project *A translational perspective on body-brain coupling and human perception*. I am currently supervising two PhD students in my own lab and co-supervising external PhD students from Aarhus University (2020 – 2025) and Magdeburg University (2025 – 2028). I have previously co-supervised one PhD thesis from the University of Münster (2019 – 2023) and supervised five Bachelor's theses as well as three Master's theses at the Department for Psychology, University of Münster.

Peer recognition *since PhD defense only*

2025	Keynote speaker at the *Adriatica Summer School 2025*, Pescara (Italy)
	Invited talk 'A dynamic link between respiration and arousal' at the *MindBrainBody Symposium 2025*, Charité Berlin (Germany)
	Organiser and speaker for the symposium 'State dependencies of brain-body interactions in health and disease ' at the International Conference on Cognitive Neuroscience (ICON), Porto (Portugal)
	Organiser and speaker for the tutorial symposium 'Methods for Analyzing Brain-Body Interactions in Consciousness Research' at the 28th Annual Meeting of the Association for the Scientific Study of Consciousness (ASSC), Crete (Greece)
	Invited talk 'Towards embodied precision neuroscience' at the *JKL Brain and Mind Symposium*, University of Jyväskylä (Finland)
2024	Invited talk 'Respiration-brain coupling in health and disease' at the conference and workshop *Brains and Bodies in Social Interaction, Learning and Wellbeing*, University of Jyväskylä (Finland) – Host: Prof. Tiina Parviainen
	Recipient of the Best Poster Award at the 11th *MindBrainBody Symposium 2024*, Charité Berlin (Germany)

Invited talk ‘Multimodal body-brain coupling in health and disease’ in the Seminar Series of the *University of Bielefeld* – Host: Prof. Christoph Kayser

2023 Recipient of the University Hospital’s *Paper of the Month* award (August) for ‘Modulatory dynamics of periodic and non-periodic activity in respiration-brain coupling’ (Kluger et al., Nat Comm 2023)

Invited talk ‘Body-brain coupling in health and disease’ in the Seminar Series of the *Institute of Clinical Neuroscience and Medical Psychology*, Heinrich-Heine University Düsseldorf (Germany) – Host: Dr. Joachim Lange

Invited talk ‘Multimodal combinations of M/EEG and peripheral physiology’ at the *CuttingGardens Conference 2023*, Münster (Germany)

Invited talk ‘Multimodal body-brain coupling in health and disease’ in the Seminar Series of the *Center of Functionally Integrative Neuroscience*, Aarhus University (Denmark) – Host: Prof. Micah Allen

Invited talk ‘Perspectives on respiration-brain coupling in health and disease’ at the *Annual Meeting of the International Symposium on Respiratory Psychophysiology*, Leuven (Belgium)

Invited talk ‘Respiratory coupling in human brain function’ at the *WAVES ’23* conference, Salerno (Italy)

2022 Invited talk ‘(Non-)rhythmic respiratory coupling in human brain function’ at the *Max-Planck Symposium* ‘Respiratory Modulations of Sensory and Cognitive Processes’, Frankfurt (Germany)

Invited talk ‘A role for respiration in neural dynamics’ in the Seminar Series of the *Max-Planck Institute*, Leipzig (Germany) – Host: Prof. Arno Villringer

Invited talk ‘A role for respiration-brain coupling in human perception’ in the Seminar Series of the *Karolsinka Institute*, Stockholm (Sweden) – Host: Prof. Artin Arshamian

Invited talk ‘Respiration modulates (non-)oscillatory human brain activity’ in the Seminar Series of the *Basic and Applied NeuroDynamics Lab*, University of Maastricht (Netherlands) – Host: Prof. Sonja Kotz

2021 Invited talk ‘Respiration, neural oscillations, and behaviour’ at the *Annual Meeting of the German Society for Physiology*, Frankfurt (Germany)

Invited talk ‘Functional interactions of body and brain’ in the Seminar Series of the *Center of Functionally Integrative Neuroscience*, Aarhus University (Denmark) – Host: Prof. Micah Allen

2020 Invited talk ‘Respiratory involvement in brain dynamics’ at the *Neuromatch 2020* conference

Other contributions to the research community

2024	Co-organiser of the *WAVES '24* Summer School and Neuroscience Symposium at Salerno (Italy)
	Teaching commitment for hands-on seminar 'Respiration-brain coupling' at the *WAVES '24* Summer School at Salerno (Italy)
2023	Administrator of the *MEG Germany* Mailing List (until today)
	Co-organiser of a local 'garden' of the *CuttingGardens 2023* conference at the Institute for Biomagnetism and Biosignal Analysis, University Hospital Münster
since 2018	Ad-hoc reviewer for Nature Communications, Trends in Cognitive Sciences, Journal of Neuroscience, eLife, Imaging Neuroscience, Biological Psychology, Network Neuroscience, Psychophysiology, PeerJ, Nature Communications Biology, Psychological Review, eNeuro, and many others
2017 – 2019	Student speaker on the Executive Board of *the Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience*, University of Münster

Key publications *Asterisks indicate shared authorship*

Kluger DS, Gross J (2021). Respiration modulates oscillatory neural network activity at rest. *PLoS Biology*, *19*(11), e3001457.

https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3001457

In this MEG study, we were able to provide the first non-invasive mapping of respiration-related changes in neural oscillations across the human brain. Our characterisation of phase-amplitude coupling within cortical and subcortical networks not only introduced the concept of respiration-modulated brain oscillations (RMBOs), but constitutes the foundation for a rich body of follow-up work in both health and disease.

Kluger DS, Balestrieri E, Busch NA, Gross J (2021). Respiration aligns perception with neural excitability. *eLife*, *10*, e70907.

https://elifesciences.org/articles/70907

This study seamlessly extended the fundamental resting-state results outlined above and provided first evidence for respiratory involvement in the temporal coordination of cortical excitability states. This functional link has immediate consequences for behaviour, as perceptual sensitivity for near-threshold visual stimuli was found to be directly coupled to breathing-related changes in occipital alpha power.

Kluger DS, Forster C, Abbasi O, Chalas N, Villringer A, Gross J (2023). Modulatory dynamics of periodic and aperiodic activity in respiration-brain coupling. *Nature Communications*, *14*(1), 4699.

https://www.nature.com/articles/s41467-023-40250-9

Further investigating the link between respiration and excitation-inhibition (E:I) balance, we were able to directly compare respiration phase-locked fluctuations of oscillatory vs non-oscillatory (1/f) activity in the resting human brain for the first time. While both components of neural activity systematically covaried with the respiratory cycle across multicentre EEG and MEG data, differential temporal dynamics in their coupling raise the possibility of a functional distinction in the way periodic and aperiodic activity is related to the breathing rhythm.

Brændholt M*, Kluger DS*, Varga S, Heck DH, Gross J, Allen MG (2023). Breathing in waves: Understanding respiratory-brain coupling as a gradient of predictive oscillations. *Neuroscience & Biobehavioral Reviews*, 105262.

https://www.sciencedirect.com/science/article/pii/S0149763423002312

In this invited review, we provided a comprehensive overview of the literature on respiration-related changes in neural network activity. Using the examples of panic disorder, autism spectrum disorder, and schizophrenia, we cast respiration and aberrant RMBOs as a key component of dysfunctional predictive processing in a variety of neuropsychiatric disorders.

Kluger DS, Allen MG, Gross J (2024). Brain-body states embody complex temporal dynamics. *Trends in Cognitive Sciences,* 28(8), 695-698.

https://www.cell.com/trends/cognitive-sciences/fulltext/S1364-6613(24)00116-5

Unifying recent theoretical and empirical work, we proposed a computational framework of high-dimensional brain-body states which embody nested internal and external dynamics governed by interoception. We lay out an ambitious programme towards embodied precision neuroscience and suggest ways to reduce arbitrary data complexity down to an observable number of features in order to accurately predict and intervene in pathological trajectories of body-brain interactions.

Leah Banellis, University of Aarhus, Denmark

Mapping individual fingerprints from the autonomic connectome

The autonomic connectome, a key component of the Central Autonomic Network, integrates neural and physiological processes to maintain homeostasis and adapt internal states to external demands. This bi-directional system recruits widespread neural regions, supporting its role in cognition, behavior, and mental health. In this study, we examined individual differences in autonomic connectivity to uncover its potential as a biomarker for broad mental health dimensions.

A sample of ~500 participants underwent resting-state fMRI alongside physiological electrocardiogram recordings. Instantaneous high-frequency and low-frequency heart rate variability (HRV) indices were computed to quantify cardiovagal output, serving as regressors in whole-brain connectivity analyses. This approach identified distinct functional networks associated with autonomic activity, revealing patterns of correlated fMRI activity linked to HRV indices.

Our findings provide evidence for individual-specific autonomic connectivity fingerprints, with variations in functional connectivity across anterior and posterior insular regions. These profiles were further investigated with differences in broad mental health dimensions. By mapping individual autonomic fingerprints, this work advances our understanding of brain-body interactions and their relevance for mental health. To further establish mechanistic links between autonomic connectivity and affective processing, future research should employ causal manipulations of affective state and physiological arousal.

Short Bio

Dr. Banellis is a Postdoctoral Research Fellow with Prof Micah Allen, at Aarhus University. She is interested in brain-body interactions involved in psychiatric symptoms, consciousness and interoception. For her PhD, she researched brain-heart interactions in healthy cognition and patients with disorders of consciousness, supervised by Dr. Damian Cruse at the University of Birmingham. Also with Dr. Cruse, she completed her MSc in Brain Imaging and Cognitive Neuroscience, researching electrophysiological markers of conscious speech processing. She obtained her undergraduate degree in Psychology with Human Biology at Plymouth University, with her BSc project on embodiment and meditation with Prof. Susan Blackmore.

Mariana Babo-Rebelo, IDIBAPS, Barcelona, Spain

Brain-heart coupling as a mechanism for self-consciousness

Theories of self-consciousness have postulated that the self is rooted in the body and that brain-body coupling may constitute the most basic mechanism underlying the sense of self. Given the constant dialogue between the brain and the heart, brain-heart coupling could be a potential candidate for such a mechanism. In this talk, I will be presenting three electrophysiological experiments exploring different facets of self-consciousness that are encoded by heartbeat-evoked responses (HERs), i.e. a marker of brain-heart coupling. First, I will show how the amplitude of HEPs is linked to the self-relatedness of spontaneous thoughts. More specifically, HEPs encode both the "I" dimension of the self, i.e. the self as the subject of the thought, and the "Me" dimension, i.e. the self as the object of the thought. Second, I will show that HEPs distinguish self from other during imagination. Finally, I will consider a minimal form of self, i.e. the self as the center of a reference frame, by contrasting egocentric and allocentric spatial orienting. I will show how HEPs also differ between self-centered and world-centered spatial representations. Overall, this work suggests that brain-body coupling contributes to different dimensions of selfhood.

Short Bio

Mariana Babo-Rebelo is a cognitive neuroscientist whose research explores the neural mechanisms of self-consciousness and their link to brain-body coupling. Her work spans a wide range of topics, including memory, spatial perspective taking, aesthetic experience, bodily perception, brain-heart coupling, somatosensory and motor systems. She employs electrophysiology techniques (MEG,

scalp and intracranial EEG) and psychophysiological measures (ECG, EMG), combined with behavioral experiments and virtual reality. Mariana Babo-Rebelo completed her PhD at the Ecole Normale Supérieure (Paris), before undertaking postdoctoral research at the Paris Brain Institute, University College London and Ecole Polytechnique Fédérale de Lausanne (Geneva). In 2025, she became a Ramon y Cajal researcher at IDIBAPS (Barcelona).

Miriam Nokia, University of Jyväskylä, Finland

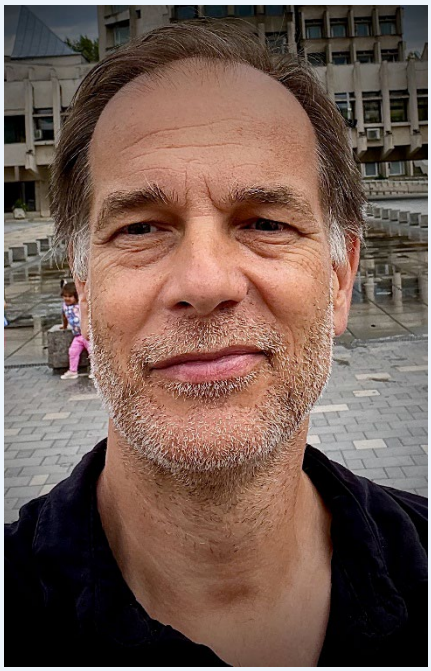
Phase matters – brain and body rhythms regulate learning

It is known that rhythms of the brain regulate cognition. For example, depending on the state of the hippocampus, external stimuli can lead to highly synchronized brain responses and efficient learning or less robust responses and impaired learning. Our studies in healthy adults suggest that also cardiac cycle phase and respiration phase affect learning: Hippocampus-dependent associative motor conditioning seems to occur more efficiently if the auditory conditioned stimulus is timed to start at diastole during expiration instead of systole during inspiration. However, there is great inter-individual variation in how bodily rhythm phases link to brain function and cognition.

Short Bio

Professor Miriam Nokia works at the Dept. of Psychology at the University of Jyväskylä, Finland. Nokia completed her PhD on hippocampal theta and learning in 2009 and has continued to study the neural basis of learning and memory throughout her career. Her special interest is the hippocampus and Nokia specializes in in vivo electrophysiology in freely moving rodents. In recent years Nokia's research group has also been studying how breathing and cardiac cycle phases might affect learning and memory in humans.

Somogy Varga, University of Aarhus, Denmark



Interoceptive Processing and Mental Disorder

Short bio:

Somogy Varga is a Professor at Aarhus University and Director of the Center for Philosophy and the Health Sciences. His research primarily explores interconnected issues in the philosophy of medicine, science, and psychiatry, and he has recently expanded into experimental philosophy. He is the author of four books and has collaborated with neuroscientists, psychologists, and medical professionals. Some of his articles have appeared in medical and psychological journals (e.g., Psychological Review and Neuroscience & Biobehavioral Reviews), while others have been published in philosophical journals.

Tahnee Engelen, University of Jyväskylä, Finland

Interoceptive signals shape first person perspective affective experiences

Both seeing emotions in others and going through an emotional experience oneself can be remarkably similar; physiological signatures, neural substrates, and even subjective feelings can align between these two distinct states. Yet there is a qualitative difference between the two and we are typically able to make a clear distinction between our own and someone else's emotion. In this talk, I will present work in which we show how we similarly draw upon physiological changes associated with emotions to judge emotions in both the self and others. Cardiac interoceptive signals however are uniquely used to understand our personal valenced states, thereby helping us maintain our sense of self throughout these shared experiences. I will further present ongoing work in which we aim to replicate these findings in more naturalistic affective settings where emotions are induced dynamically and comprising complex mixtures of discrete emotions. Here, we also aim to understand how such state-specific brain-body coupling, related to both emotions and the self, can have an impact on our mental wellbeing.

Short bio

Tahnée Engelen is a postdoctoral researcher studying multi-organ interoception and its state-dependence. After completing her PhD at Maastricht University and a postdoc at the Ecole Normale Supérieure in Paris, she is now working at the University of Jyväskylä where she uses multi-method approaches, including MEG-EEG, TMS-EEG and physiological recordings to study the impact that the rhythms of the viscera have on the brain, cognition, and affect.

Ya Ella Tian, The University of Melbourne, Australia

Understanding mental-physical comorbidity via integrated modeling of brain-body axis

Physical health and chronic medical comorbidities are underestimated, inadequately treated, and often overlooked in psychiatry. Integrated research into brain and body systems holds substantial clinical potential in addressing mental-physical comorbidity. In my talk, I will first present evidence of co-occurrent physical health problems in people with mental disorders, from epidemiology to physiology. I will then present several lines of evidence exploring the underlying mechanisms explaining the development and progress of mental-physical comorbidity, including aging, immunometabolic dysfunction and lifestyle changes and the key role of the brain in the intertwined relationships. To close the talk, I will discuss the way forward to reduce the adverse effect of physical comorbidity in people with mental illness.

Short Bio

Dr Ye Ella Tian is a National Health and Medical Research Council (NHMRC)-funded Senior Research Fellow at the Department of Psychiatry, The University of Melbourne, Australia. She is a psychiatrist and neuroscientist by training and holds a PhD in systems neuroscience. During her PhD, she develops the now widely used Melbourne Subcortex Atlas.

She currently holds an NHMRC Investigator Grant, investigating brain-body relationships in mental illness across the lifespan. She works at the interface between neuroscience, computation and translational research of applying brain imaging techniques to clinical research.

Yuri Antonacci, University of Palermo, Italy

Mapping the dynamics of physiological systems and their interactions: An Information Theoretic Perspective with applications in Network Physiology

Program of the Workshop

Session 1:

- Network Physiology – Understanding How Organ Systems Interact as a network
- Brain Dynamics – Exploring neural activity and connectivity
- Cardiovascular and Cardiorespiratory Interactions – Understanding the coupling between heart, lungs, and circulation

Session 2:

- Information Theory in Network Physiology – Principles and Methods
- Fundamentals of Information Dynamics – Theoretical foundations
- Brain-Body Interaction Analysis – Practical applications using information-theoretic approaches

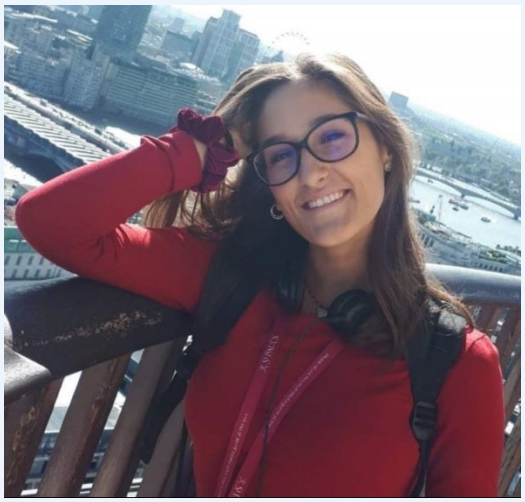
Session 3:

- Time-Series Extraction and Analysis – Techniques for obtaining and processing physiological signals
- Matlab Toolboxes for Brain-Body Interaction Analysis – Computational tools and applications

Short Bio

Yuri Antonacci received his Ph.D. in Bioengineering in 2021 from the University of Rome "La Sapienza." From June 2020 to February 2022, he was a postdoctoral research fellow in the Department of Physics at the University of Palermo (UNIPA), working on a national project exploring the complexities of systems like the human brain and financial markets. From March 2022 to February 2023, he held another postdoctoral position at UNIPA's Department of Engineering, focusing on information-theoretic and machine learning approaches for detecting physiological states in humans. He is currently an Assistant Professor at UNIPA's Department of Engineering. His teaching activities include biomedical signal processing and methods for bioengineering. His research interests include developing and implementing new methods for biomedical signal processing, particularly for analyzing brain signals in both physiological and pathological conditions. Within this field, he has authored almost 66 peer-reviewed publications, receiving about 700 citations (H-index: 15; Citations: 659; font: Scholar). He is a member of the IEEE Engineering in Medicine and Biology Society. He is an Editorial Board Member of the IOPscience journal Physiological Measurement and an Associate Editor for the IEEE EMBS Conference. He served on the local organizing committee for the 11th International Conference on Complex Networks and Their Applications in Palermo in 2022 and on the technical program committee for the same conference in 2023 and 2024. Additionally, he is a member of the technical program committee for the 2024 International Conference on Information Systems and Computing Technology in Xi'an, China.

Delia Lucarelli, University G. d'Annunzio Chieti-Pescara, Italy



TMS-EEG as a tool to explore the cortical correlates of the cardiac cycle

Cognitive neuroscience research is increasingly focusing on the role of brain states in stimuli processing. Neural activity occurring before and during stimuli presentation, investigated by means of oscillatory dynamics and network connectivity, has been shown to play a pivotal role in shaping cortical responses. However, bodily signals have been overlooked within this research area. The brain and heart share a complex, bidirectional relationship: while the central autonomic network regulates cardiac function, the brain concurrently receives continuous input regarding cardiac activity through multiple physiological pathways. Emerging evidence indicates that perception, behaviour, and emotional processing vary across the phases of the cardiac cycle (i.e., systole and diastole). If so many cognitive and physiological responses are affected by heart activity, what happens at the cortical level? Unfortunately, the cortical mechanisms underlying such phenomena remain not completely understood. Transcranial magnetic stimulation combined with electroencephalography (TMS-EEG) proves instrumental in this framework, as it permits to assess brain excitability and responsiveness to temporally precise stimuli, probing cortical activity at different instants of the cardiac cycle. In this context, we aim to explore whether the sensorimotor system, which is frequently implicated in behavioural studies examining cardiac cycle effects, adjusts its activity in accordance with cardiac phase. Uncovering such modulation may provide novel insights into how brain regions beyond the central autonomic network participate in heart-brain interactions.

Short bio

Delia Lucarelli is a PhD student in Neuroscience, Imaging and Clinical Sciences at the University of Chieti-Pescara and she is part of the Methods and Models for Brain Oscillations (MAMBO) lab, led by Professors Laura Marzetti and Vittorio Pizzella. She obtained her Master's degree in Cognitive Neuroscience from the University of Trento, where she began focusing on the use of transcranial magnetic stimulation combined with electroencephalography (TMS-EEG) as part of her thesis work. Her research interests lie in both the methodological aspects of the TMS-EEG signal, such as signal variability and the optimization of stimulation parameters, and its application in uncovering the neurophysiological mechanisms underlying brain function.

	Monday 8th	Tuesday 9th	Wednesday 10th	Thursday 11th	Friday 12th
09:30 - 10:30		Daniel Kluger	Ye Ella Tian	Symposium: Engelen T., Banellis L.	Francesca Ferri
10:30 - 11:00	Registration	Break	Break	Break	Break
11:00 - 12:00	Welcome & Inspiration	Miriam Nokia	Somogy Varga	Symposium: Lucarelli D., Callara A.L., Zaccaro A.	"From Hindsight to Insight: What I Wish I Knew During My PhD"
12:00 - 13:00	Alex Galvez-Pol	Student Spotlight	Student Spotlight	Q & A Session	Wrap-up & Highlights
13:00 - 15:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
15:00 - 16:00	Mariana Babo-Rebelo	Student Spotlight	Workshop: Yuri Antonacci	Trabocchi Coast Experience	
16:00 - 17:00	Break	Break	Break		
17:00 - 18:00	Poster Session	Workshop: Yuri Antonacci	Workshop: Yuri Antonacci		
	Welcome Dinner & DJ Set			Sunset Social & Dinner	