Adriatica SUMMER SCHOOL

3-7 GIUGNO 2024

Pescara, Italy

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PROGRAM

	Monday 3rd	Tuesday 4th	Wednesday 5th	Thursday 6th	Friday 7th
9.30-10.00	Registration	Lecture: Daniele Marinazzo	Lecture: Marcello Costantini	Lecture: Sulian Ben Hammed	Lecture: Patric Bach
10.00-10.30	Opening				
10.30-11.30	Lecture: Norman Farb	Lecture: Tjeerd Boonstra	Lecture: James Kilner	Lecture: Zakaria Djerbara	Lecture: Vittorio Gallese
11.30-12.00	Break	Break	Break	Break	Break
12.00-13.00	Lecture: Laura Marzetti	Seminar on the IDG framework (Giulia Sonetti)	Oral presentations: Parrotta, Paredes, Di Lernia	Lecture: Massimiliano Zampini	Lecture: Noga Arikha
13.00-14.30	Lunch	Lunch	Lunch	Lunch	Closing remarks
14.30-15.30	Poster presentations	Oral presentations: Zaccaro, Lukoff, D'adamo	Lecture: Peggy Series	Workshop on the IDG framework (Giulia Sonetti)	
15.30-16.30	Oral presentations: Biddell, Guidotti, Saltafossi	Lecture: Joachim Gross	Lecture: Katerina Fotopoulou		
16.30-17.00	Coffee Break	Coffee Break	Coffee Break		
17.00-18.00	BI4E Workshop on Research Ethics and integrity (Ger Kelly)	Lecture: Viviana Betti	Oral presentations: Frattura, Ciaunica		
18.00-18.30					
	Welcome Dinner (19.30)		Social Dinner & DJ set (20.00)		

Norman Farb, University of Toronto Mississauga (UTM), Canada

Norman Farb is Associate Professor at the University of Toronto Mississauga. He studies the neuroscience of human identity and emotion, focusing on how cognitive biases shape emotional reactions that determine well-being. For example, why do some people seem to shrug off stressful encounters, whereas others cannot let them go? Is it something about how they construe themselves and the world? What consequences do habitual patterns of self-reference have for well-being? How can we measure seemingly ephemeral constructs such as self-reference and emotion? To answer these questions, his work employs multiple levels of analysis, including first and third-person qualitative reports, behavioral task performance, physiological responses, and patterns of neural activity and connectivity derived primarily through functional MRI. In his research, he is particularly interested in how cognitive training practices such as mindfulness meditation foster resilience against stress, reducing vulnerability to affective disorders such as depression.

SENSORY INHIBITION AS A MARKER OF DISTRESS AND SENSE FORAGING AS A POTENTIAL SOLUTION

Interoception, the representation of the body's internal state, is central to theories of emotion, motivation, and wellbeing. Yet interoception is an understudied relative to the external senses. A potential reason for this disparity is the challenge in manipulating interoceptive stimuli, combined with difficulties in relying on participant self-report of interoceptive experience. Meeting this challenge requires innovation in experimental methods, with promising paradigms emerging for interoception of the cardiac, respiratory, and gastrointestinal systems. Then, informed by a rich history of mind-body practices and phenomenological techniques, objective measures of physiology and neural function can help to characterize individual differences in interoceptive processing. In reviewing theories of interoception and wellbeing, healthy experience can be characterized by

allowing the complete representation of the viscerosomatic signals before appraisal and regulatory responses are employed. Cognitive neuroscience evidence supports this principle: in community-dwelling participants, subjective appraisals of sadness following a sad-mood induction did not distinguish between levels of concurrent depressive symptom burden. Instead, the degree of sensory suppression (as measured by fMRI) following such inductions was closely associated with symptoms. Furthermore, in participants with a history of recurrent depression, the degree of sadness-evoked sensory suppression was associated with depression history, residual symptoms, and future relapse risk over a two-year follow-up period. To mitigate sensory inhibition, "sense foraging" practices appear efficacious: neuroimaging and clinical evidence converge to suggest that attentional training can reduce the tendency to inhibit sensory activity, with the preservation of interoception in the face of stress a marker of emotional resilience and flourishing.

Laura Marzetti, University of Chieti-Pescara, Italy

Laura Marzetti is Associate Professor in Applied Physics and head of the Methods and Models for Brain Oscillations (MAMBO) lab at the University of Chieti-Pescara. She began her research career in Germany at the University of Ulm and completed a PhD in Functional Neuroimaging at the University of Chieti-Pescara in collaboration with the Fraunhofer FIRST Institute Berlin on the development of methods for MEG/EEG functional connectivity analysis. Her current research focuses on the development of methods and tools to exploit the characteristics of functional brain networks in a multimodal framework and in real time. Her major research lines are multidimensional functional connectivity methods and real time estimation of functional connectivity for brain-state-dependent neurostimulation.

BRAIN STATE DYNAMICS AND COMPLEXITY IN MINDFULNESS MEDITATION

Mindfulness meditation has garnered significant attention in scientific research for its potential impact on psychological well-being. Indeed, mindfulness interventions demonstrated efficacy in reducing symptoms of anxiety, depression, and stress, while also promoting positive affect and emotional resilience. These behavioral effects are paired to neuroplastic changes in brain regions associated with emotional processing, attention regulation, and self-awareness with both short- and long-term characteristics. Methods to extract brain states and to assess their modulations across meditation practices can be successfully employed to study neuroplastic changes. In addition, brain state transitions reveal complexity patterns that differ across meditation practices in a way that is related to meditative expertise. These findings have implications for the development of targeted interventions aimed at improving mental health outcomes and fostering overall life satisfaction through mindfulness-based practices.

Daniele Marinazzo, University of Ghent, Belgium

He is a full professor in the department of Data Analysis at Ghent University (Belgium). Following his training as a statistical physicist, he investigates dynamics and structure of complex systems. His research with his group ranges from theoretical and computational physics to methodological and computational aspects of neuroscience research and experimental neurophysiology. He is Deputy Editor at PLOS Computational Biology, Co-Editor-in-Chief at Neurons, Behavior, Data Analysis, and Theory, and Academic Editor at Network Neuroscience, NeuroImage, and Brain Topography. He is the representative of Ghent University in EBRAINS.

HIGHER ORDER INFORMATIONAL CONTENT: THE PERFECT TOOL FOR BRAIN-BODY AND BRAIN-ENVIRONMENT RESEARCH?

Systems composed of many units, whose behavior goes beyond the sum of the individual behaviors of the singles, are ubiquitous. Examples relevant to what we do are the brain, the body as a whole, and the social systems we live in, and multisensory research is the optimal framework for this mindset. When it comes to analyzing collective behavior we are often stuck with pairwise dependencies (often correlations). In this talk, I will describe a framework rooted in information theory to mine multiplets of variables sharing common information about the dynamics of complex systems, and provide some examples in neuroscience, physiology, and behavioral scores. I propose that widespread concepts such as integration, emergence, manifolds, and dimensionality reduction, can be seen through the lens of information-based synergy. This framework seeks for higher order behaviors, in a complementary way with respect to mechanisms.

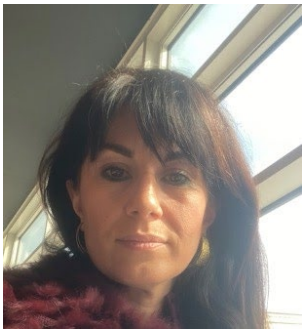
Tjeerd Boonstra, Maastricht University, The Netherlands

Tjeerd Boonstra is Associate Professor at Faculty of Psychology and Neuroscience at Maastricht University. He is interested in the large-scale organisation of complex systems such as the brain. He is running an electrophysiology lab where his group records EEG data during different cognitive paradigms and non-invasive brain stimulation. He also collects and analyses EMG activity from multiple muscles to investigate the role of neural synchronisation in motor coordination. By combining data analysis techniques such as dynamic connectivity analysis, mode decomposition, graph theory and computational modelling, he is trying to identify the key principles that organise the activity of large ensembles of neurons.

BRAIN-MUSCLE NETWORKS OF POSTURE AND GAIT

The human body is a complex system consisting of many subsystems and regulatory pathways. The musculoskeletal system gives the body structure and creates the ability to move. It is made up of more than 200 skeletal bones and over 300 skeletal muscles. The central nervous system controls these movements through the spinal motor neurons, which serve as the final common pathway to the muscles. While the anatomical and physiological components of the musculoskeletal system are well characterized, the organizational principles of neural control remain incompletely understood. In this presentation, I will discuss the use of functional connectivity and network analysis to investigate the functional organization of the distributed neural circuitry from which motor behaviours emerge. Examples will be given of intermuscular and corticomuscular coherence during different motor behaviours, including postural tasks and locomotion, and how coherence is modulated by age and sensory function. By estimating intermuscular coherence between numerous muscle pairs, the weights of so-called muscle networks can be estimated. Network analysis has been widely used to investigate functional integration in the central nervous system and this approach can be extended to investigate the network topology of functional interactions between muscles. When combining both approaches, we can map the brain-muscle networks involved in human motor control. This combined approach fits within the broader framework of network physiology and is well placed to provide new insights and interventions for movement disorders.

Viviana Betti, La Sapienza University of Rome, Italy



She is Associate Professor at the Department of Psychology at La Sapienza University (Rome). She is leading the Cosync Lab and she is head of Neuroscience and Applied research at IRCCS Fondazione Santa Lucia. Her scientific activity has been characterized by a strong interest in innovative methodological approaches and cutting-edge research, particularly in the study of the mechanisms underlying the formation of brain networks. She received, in 2017, an ERC Starting Grant for the HANDmade project focused on the study of intrinsic fluctuations in brain activity and how behavioral and mental activity changes depending on the effector we use to interact with the external environment. Recently, she received an ERC Proof of Concept Project which will build an integrated platform made by virtual reality and electromyography for rehabilitation.

HOW MANUAL BEHAVIOR SHAPES SPONTANEOUS AND TASK-EVOKED BRAIN ACTIVITY AND CONNECTIVITY

The hand is the main means of interaction with the environment. Humans use common hand postures to move and manipulate everyday objects. These voluntary actions are versatile and adapt flexibly to environment and object properties. Although hand movements are intrinsically variable and complex, they are constrained to a few dimensions or motor primitives, which consist of basic muscle or joint co-activations patterns. However, it remains unclear how the low dimensionality of hand movements supports the adaptability and flexibility of natural behavior is unknown. Another important issue is how and whether the brain maintains an internal model of the hand, and if the functional organization of the brain differs between individuals with high and low dexterity. In my talk, I will present MEG and fMRI studies that support the idea that specific features of manual behavior are encoded in the brain, even in spontaneous brain activity (i.e., in the absence of motor, cognitive or sensory stimulation). Additionally, virtual reality studies suggest that virtual grafting of a bionic tool elicits a sense of embodiment that is similar to or even stronger than that of its natural counterpart. These results pave the way for the development of next-generation robotic prostheses.

Joachim Gross, University of Muenster, Germany

Joachim Gross is Professor of Systems Neuroscience, Director of the Institute for Biomagnetism and Biosignalanalysis at WWU Münster since 2017, and Wellcome Trust Senior Investigator. His group investigates the functional role of brain oscillations using Neuroimaging and computational methods. He obtained his M.Sc in Physics and Mathematics in San Angelo, USA in 1993 and his degree in Physics in Hannover, Germany in 1995. He was a PhD student at the Institute of Medicine, Research Center Juelich, and the MPI for Cognitive Neuroscience in Leipzig. In 1998, he started working as a PostDoc in the Clinic of Neurology at the University of Duesseldorf on pathological oscillatory brain processes in movement disorders and pain. In 2006, he was appointed Professor at the University of Glasgow, where he worked at the Centre for Cognitive Neuroimaging (CCNi), Institute of Neuroscience and Psychology, and served as the Head of the MEG Lab. He was Acting Director of the CCNi from 2010 to 2017.

DECODING BODY AND BRAIN STATES WITH RHYTHMIC AND NON-RHYTHMIC FEATURES OF BRAIN SIGNALS

ARegional brain activity is shaped by a number of factors. First, different brain states are associated with specific signatures in brain activity. Second, brain activity is modulated by body state. Third, different brain areas have characteristically different brain activity that is shaped by the underlying anatomy and regional-specific connectivity. Fourth, brain activity changes with age. While these modulators of brain activity are well established we still know relatively little about the specific features in brain activity that are changed. Here, I report first results of a new project where we employ large-scale time-series phenotyping of MEG data. We use a large set of features to characterise source-localised MEG data and identify features that are informative for predicting age, changes in brain state or that follow cortical gradients. In all cases, these non-standard features outperformed traditional spectral measures.

Marcello Costantini, University of Chieti-Pescara, Italy

I am a cognitive neuroscientist, currently working as Associate Professor at the Department of Psychological, Health and Territorial Sciences, University "G. d'Annunzio", Chieti-Pescara, Italy. The fil rouge of my research is the role of the physical and the biological body in making sense of the external world. In this, I refer to the physical body as the structural and morphological features of the body while the biological body refers to the inner state of the body (e.g. the cardiorespiratory and the immune system). To study this topic, I use different techniques such as psychophysics, brain stimulation (TMS), neurophysiology (EEG) and neuroimaging (fMRI).

THE INTERPLAY OF INTERNAL BODY SIGNALS AND BRAIN ACTIVITY

Recent research challenges the traditional view that brain activity is self-contained within the brain. Instead, brain fluctuations—and the resulting perceptions and behaviors—are increasingly understood to be influenced by both internal and external environments, including the cardiovascular and immune systems, to name just a few. Our understanding of cognition now incorporates how visceral signals interact with cortical processes. In this talk, I will present evidence from our lab demonstrating a clear effect of internal body signals on cortical activity, emphasizing the complex interplay between physiological states and neural dynamics. This neural modulation by internal signals impacts our behavior, including social interactions.

James Kilner, University College of London, UK

James Kilner is Professor of Human Motor Neuroscience Clinical and Movement Neurosciences at UCL. He is the head of the Brain Body and Behaviour Lab at the Institute of Cognitive Neuroscience. His research focuses on interoception, the process of sensing and interpreting internal body signals. His work explores how interoceptive signals influence perception, cognition, and actions, with recent focus on the role of interoception in social interactions and active sampling. His research also delves into cardiac-related sensory attenuation and active sampling. He investigates why sensory sensitivity changes during the cardiac cycle, whether predictive coding plays a role in interoception, if sensory attenuation is linked to mental health disorders like anxiety, and how we actively sample the world considering this sensory attenuation.

PREDICTIVE CODING AND INTEROCEPTION

Interoception is the sensing and processing of signals that arise within our bodies. The most studied interoceptive signal is that from the heart. We know that when the heart beats our ability to detect other sensory signals, touch, sight and hearing is reduced. However, why this occurs is not known. Recent theoretical accounts of interoception have focussed on the role of prediction in interoception, the predictive-coding models of interoception. However, there is little empirical data to support these accounts. An alternative view is that our awareness of our cardiac signals is not likely to be based on baroreceptor signals but rather on cardiac related signals that are present on all exteroceptive channels. This suggests that to interpret cardiac related signals we require a fuller understanding of the links between heart rate and signals arising from the heart beating.

Peggy Series, University of Edinburgh, UK

Peggy Series is an Assistant Professor at ANC, School of Informatics, University of Edinburgh, UK, since July 2006. She received her PhD in Computational Neuroscience, at U. N. I. C., Gif-sur Yvette, France, with Yves Fregnac and Jean Lorenceau. Her thesis focused on the non-classical properties (contextual modulations) of the receptive fields of primary visual cortex neurons and their perceptual correlates. From 2002 to 2004, she was a postdoctoral fellow in the laboratory of Alex Pouget at the University of Rochester, NY, USA. She then joined the Gatsby Computational Neuroscience Unit, at UCL, in London, UK. In 2006-07, she spent 9 months in NYC, working at NYU with Eero Simoncelli. Now, she is the PI of the Computational Psychiatry Lab which focuses on understanding the factors behind individual variability and clinical disorders using Bayesian inference and Reinforcement Learning

SCHIZOPHRENIA AND AUTISM AS DISORDERS OF PREDICTION

A growing idea in computational neuroscience is that perception and cognition can be successfully described in terms of predictive processing or Bayesian inference: the nervous system would maintain and update internal probabilistic models that serve to interpret the world and guide our actions. This approach is increasingly recognized to also be of interest to Psychiatry. Mental illness could correspond to the brain trying to interpret and act upon the world through distorted internal models, or incorrectly combining such internal models with sensory information.

I will discuss how this approach has led to important developments in the field now known as "Computational Psychiatry". In particular, I will review the theoretical frameworks that have been used to describe impairments in schizophrenia and autism and describe results from my lab that aim to test, refine, and contrast those theories. Based on our research looking at visual illusions and the representation of peri-personal space, I will also discuss how such approach can be combined with neural network modelling to investigate how they relate to differences in the neural substrate, such as differences in connectivity or in the balance between excitation and inhibition.

Katerina Fotopoulou, University College of London, UK

Aikaterini (Katerina) Fotopoulou, PhD, is a Professor in Psychodynamic Neuroscience at University College London. Her lab focuses on topics and disorders that lie at the borders between neurology and psychology, funded initially by a Starting Investigator Grant 'Bodily Self' and more recently a Consolidator grant 'METABODY' from the European Research Council. See here for projects and publications (www.fotopoulou.com). *Katerina is the founder of the* International Association for the Study of Affective Touch *(IASAT), a fellow of the Association of Psychological Science and President-Elect of the European Cognitive and Affective Neuroscience (ESCAN) society*

I CAN CONTROL MY HEART: ALTERING INTEROCEPTIVE SELF-EFFICACY IN THE LAB AND IN THE CLINIC

Disruptions in interoception have emerged as a transdiagnostic pathogenic mechanism for several disorders at the mental-physical health interface, such as eating, functional or somatic symptom disorders. However, the interdisciplinary expertise required to identify and therapeutically target psychophysiological mechanisms has limited the efficacy of related therapeutic endeavours that tend to focus on only on limited levels and domains of interoception. Following co-design with users, we have developed and tested beliefs updating across many domains and levels of interoception in subclinical and clinical eating disorders and then we designed and tested the efficacy and mechanisms of action of a novel, interdisciplinary (psychophysiological) therapeutic module (InMe) in 100 individuals with low interoception awareness, stratified for subclinical disordered eating or somatisation symptoms. In a two-arm parallel group randomised controlled trial (RCT) we compare the InMe intervention to an active control intervention (imagery training without biofeedback). INME uses cardiac biofeedback during guided respiration exercises to train individuals to down-regulate their own heartrate under different conditions of stress, while also enhancing related metacognitive beliefs. Results showed significantly higher changes of the trials primary measure of interoception at

follow-up for INME than for the control intervention ($p<0.05$). Advanced analyses methods also revealed important mediators and moderators of this effect and the subpopulations likely to benefit. We discuss the multidimensionality of interoceptive pathways, as well as the potential of further developing and testing this interoception-intervention as an augmented-therapy module for other pharmacological and behavioural interventions targeting disorders at the mental-physical health interface.

Suliann Ben Hamed, Paris (CNRS), France

Suliann Ben Hamed is Research Director of Neural Basis of Cognition and Action at CNRS (Paris). Her group focuses on how the brain represents space and uses these representations to help us interact with our environment. She aims to understand how individual neurons, local neural networks, and distributed cortical networks implement these two fundamental cognitive functions. She seeks to understand how neurons and cortical networks combine sensory information from multiple sensory organs to construct our internal representations of space, self and others. The long-term goal is to increase our fundamental collective understanding of these essential cognitive functions and thereby contribute to the rehabilitation of brain deficits.

DYNAMICS AND FLUCTUATIONS OF ATTENTIONAL CONTROL AND THEIR IMPACT ON PERCEPTION AT MULTIPLE TIME SCALES

Attention is a crucial cognitive function that guides gaze and the exploration of our environment through the selection of relevant information and the suppression of irrelevant information. Attentional control is implemented by the frontal eye fields. Recent evidence demonstrates that attentional control is highly flexible and dynamic and shapes our interaction with the world. Using a combination of machine learning and dimensionality reduction approaches, I will present electrophysiological evidence from the macaque frontal eye fields describing attentional control dynamics at multiple temporal scales from several cycles per second to a few cycles per hour. I will first describe attentional saccades that are organized at an alpha rhythm, and that subserve the top-down control of attentional exploration of space, the selection of relevant information, as well as both proactive and reactive suppression of irrelevant information. I will then describe, how states of impulsivity, optimal behavior and distractibility, impact attentional processes, at the scale of several minutes. These behavioral states of impulsivity and distractibility are described by two independent neural states. These neuronal states are independent from the neuronal state implementing attention but can interfere with it. Last, I will show that prefrontal attentional control consistently fluctuates at a rhythm of circa 5 cycles per hour, impacting both overall prefrontal information (i.e. how efficiently

the world is perceived) as well as behavioral responsiveness (i.e. how fast subjects respond). At the neuronal level, these fluctuations impact the phase locking between local (MUA alpha) and distal (LFP theta) neural processes. These fluctuations in attentional control in the range of a few cycles per hour are impacted by noradrenergic neuromodulation. Overall, I will thus show that attentional control that guides gaze and the exploration of our environment should be viewed as a highly dynamic and flexible process encompassing multiple neuronal mechanisms, some of which are under voluntary control, others being associated with internal states the origin of which remain to be identified.

Zakaria Djebbara, Aalborg University, Denmark

Zak Djebbara is an assistant professor at Aalborg University focusing on the role of architectural affordances in cognition and behavior by use of mobile EEG, VR, and computational neuroscience. Zak is antidisciplinary and makes use of any method relevant to the research question. Currently investigating how sensorimotor brain dynamics modulate behavior and cognition through rhythms.

UNRAVELING COGNITION AND BEHAVIOR IN MOTION THROUGH ENVIRONMENTAL RHYTHMS

Human behavior is shaped between brain, body and environment. While neuroimaging has seen rapid advances over the years, the body and environment have received much less attention in the cognitive sciences. Only recently has the body reclaimed its position in understanding behavior, leaving the environment as the only variable whose role is scarcely understood. There are several kinds of environments, however, we focus here on the built environment. To overcome the static reduction of the environment to e.g., "environment 1," we present here a dynamic approach that aims to quantify the continuous relationship. Additionally, as oscillations and rhythmic patterns facilitate the communication between brain, body and environment, identifying rhythms in the continuous signals make an excellent approach to human behavior. We present Mobile Brain/Body Imaging research applied to build environments, illustrating the feasibility of mobile neuroimaging. We combine this technique with Virtual Reality, providing full control of the environment, in our recent work on neural entrainment, sensorimotor brain dynamics, and environmental features. Finally, we present an alternative approach to the quantification of environmental features, placing the environment back in the triad of human behavior.

Massimiliano Zampini, University of Trento, Italy

Massimiliano Zampini is a Full Professor in Psychology at the University of Trento. His research purports to investigate how our brain organizes, represents, and selects the information from each of our different sensory modalities (such as audition, somatosensation, vision, olfaction and smell) for making sense of a multisensory world. One of his favourite topics is multisensory perception of food, one of the most multisensory experiences of our life. Moreover, He is also interested in how we build our body representation true the different multisensory cues that we receive.

THERMAL PERCEPTION AND BEYOND: UNRAVELING THE INTRICACIES OF ENVIRONMENTAL TEMPERATURE'S IMPACT ON THE BODY AND THE BRAIN

According to the grounded cognition perspective, our perception relies on current and past sensorimotor experiences, emphasizing the interaction between bodily states and the surroundings. While our environment provides various cues, temperature emerges as a critical factor for body survival and well-being. Initially, I will try to summarize the current state of knowledge on thermal sensitivity, delving into neural mechanisms responsible for temperature perception, with a focus on sensitivity variations across different body regions. Despite a wealth of research on the topic, there remains a gap in quantifying thermal perception when the entire body is involved. Therefore, I will introduce an innovative experimental paradigm we have developed to address this gap and discuss our preliminary findings, indicating both high participant accuracy and minimal variability. These results suggest an intrinsic mechanism in our body governing thermal sensitivity. Building on these findings, we have explored multisensory interactions between temperature and vision. Additionally, I will delve into the interplay between spatial perception and environmental temperature, examining how temperature cues influence individuals' perception of the surrounding space. Finally, my review will

touch upon the potential of virtual reality (VR) devices in psychological research. The abstract concludes by briefly discussing the potential of virtual reality (VR) devices in psychological research. I highlight the unique opportunities afforded by VR technology to create immersive and controlled experimental environments while acknowledging its current limitations.

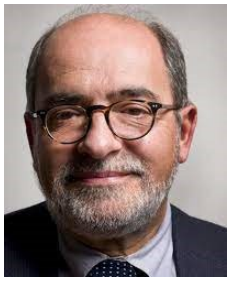
Patric Bach, University of Aberdeen, UK

Patric investigates how people plan their own actions and understand those of others. He studied Psychology at the Ludwigs-Maximillians-University in Munich, Germany and received his PhD at the Max-Planck-Institute for Cognitive Neuroscience in Munich and Leipzig. From 2004, he worked as a post-doc in Steve Tipper's lab at Bangor University, Wales, before took up a Lecturer position at Plymouth University in 2009. Since 2020, he is Professor for Psychology at the University of Aberdeen.

TOWARDS A NEW VIEW OF VISUAL PERSPECTIVE TAKING

Visual perspective-taking underpins human social interactions, allowing us to understand how the world appears to others, to empathize and to engage effectively with them, therefore promoting a sense of social connectedness. However, currently, there is no model of perspective taking that could explain the mechanisms that underpin perspective taking, which features of the other person, or the interaction promote it, and which personal characteristics separate good perspective takers from not so good ones. Here, I will review recent findings from our lab that indicate, first, that perspective taking is, at least in part, a perceptual ability to, which allows us to operate on another person's perspective as if it were our own view. Second, they show that these abilities are under partial control of the perceiver, who can decide which weight their judgments give to their own and the other person's representation of the environment, but who cannot fully disregard either perspective. Third, they show that spontaneous shifts into another's visual perspective are promoted by the human-likeness of the target person, in way that reflects the perceiver's individual attributions of human-like appearance and human-like to the person they are viewing. Finally, they show that perspective taking abilities are tied to the perceiver's personal characteristics. People who find it difficult to take another's perspective (and disengage from their own) are more likely to exhibit higher schizotypal traits and report lower abilities to predict and understand social interactions. Together, these data provide a new view of perspective taking, the role it plays in social interaction and our connectedness to others.

Vittorio Gallese, University of Parma, Italy



Vittorio Gallese is a Full Professor of Psychobiology at the Department of Medicine and Surgery - Neuroscience Unit - of the University of Parma. A neuroscientist, his main contributions include the discovery, together with his colleagues in Parma, of mirror neurons, and the development of a neuroscientific model of perception and intersubjectivity, the Embodied Simulation Theory. His scientific production is attested by over 300 international publications, the publication of two books as an author and three books as an editor. He won the Grawemeyer Award for Psychology for the year 2007, received an Honorary Degree from the Catholic University of Louvain, Belgium, in 2010, the Arnold Pfeffer Prize for Neuropsychoanalysis in New York in 2010, the Musatti Prize of the Italian Society of Psychoanalysis in 2014, and the Humboldt Forschung Preis from the Alexander von Humboldt Stiftung, Germany, in 2019. Gallese's research activity since its beginning has been focusing on the relationship between the sensory-motor system and cognition, in non-human primates and humans. He is currently investigating the neurobiological and bodily roots of intersubjectivity, empathy, aesthetic experience and a variety of psychoathological conditions, among which Schizophrenia.

EMBODIMENT IN THE DIGITAL ERA. A NEUROSCIENTIFIC PERSPECTIVE

Embodiment is the still poorly investigated key entry point to a deeper understanding of how digital technologies shape our identity, our social relationships and the world where we are living. The disintermediation of perception and meaning making operated by the new digital mediascape has literally revolutionized the world. Interconnected mobile digital devices are changing the style of our interaction with images and words, multiplying our 'province of meaning', projecting it into multiple dimensions beyond the reach of our naked eye. We must investigate the impact that the new digital technologies and related social practices have upon social life and culture. Capitalizing upon the results obtained by experimental aesthetics when applied to art and cinema, and by privileging embodiment and the performative quality of perception and cognition, Embodied simulation, a model of perception and cognition, is proposed as an ideal starting point to address these issues.

Noga Arikha, European University Institute - Florence, Italy

Noga Arikha is a philosopher, essayist, and historian of ideas. After a PhD at the Warburg Institute, London (2001), she was an "Art and Neuroscience" Fellow at the Italian Academy at Columbia, NY, taught at Bard College and the Bard Graduate Center (NY), and was Chair of Liberal Arts at Parsons in Paris / PCA (Paris). She now works across the disciplines as a "science humanist", fostering dialogues between neuroscientists, psychologists, clinicians, social scientists, humanists and artists in order to investigate our embodied selves. She is Associate Fellow of the Warburg Institute, Honorary Fellow of the Center for the Politics of Feelings (London), and Research Associate at the Institut Jean Nicod, ENS (Paris).

CULTURES OF EMOTION

There is always a cultural context within which research is conceived and communicated, and which allows for certain questions to arise, just as cultural context interacts with the construction of subjectivity, self-understanding and emotional experience. The nature of scientific research is such, however, that within the lab this cultural context can be easily forgotten. Yet it is worth remembering that it is only over the last three decades that the scientific exploration of the embodied, feeling subject has been scientifically validated, and that the culturally driven affective turn in neuroscience and psychology has enabled insights whose real-world applications are being developed now. Two elements need further unpacking: 1) an analysis of the interplay of this research with variegated cultures of emotion - that is, the anthropological nut of how the "psychic unity of mankind" is declined culturally; and 2) the injection of its outputs into the social and political sciences, which has not yet recognised the ordinary political agent as the embodied, feeling self that these new scientific practices are finally showing us up to be.

By revisiting how scientific truth meets cultural construction, and taking on board the enactive, embedded nature of the embodied, extended, intersubjective self, I propose in this talk to bridge the gap between lab and world in both these directions - from the research on subjectivity to the world of cultural subjects, and back from world to lab.

WORKSHOPS AND SEMINAR

Ger Kelly, Munster Technological University, Cork, Ireland

Prof Kelly is a multidisciplinary engineer and former Head of Mechanical, Biomedical and Manufacturing Engineering at MTU who established the research ethics and integrity functions at MTU. He is the current Vice Head of the iEd Hub a collaboration between industry and academia for the co-design of industry-relevant life science programmes. Prof Kelly was a member of the team which secured BI4E Boosting Ingenium for excellence at MTU and the Ingenium European University Alliance. Prof Kelly has long established links and collaborations with THENSA in South Africa as part of the HERESA project and the SATN doctoral training programme and is currently co-chair of the Ireland SA biomedical research cluster.

ADVANCING RESEARCH INTEGRITY PRACTICES AND POLICIES: FROM RECOMMENDATION TO IMPLEMENTATION

Workshop (1.5 hs. Mon 03/06 h17)

This workshop is concerned with identifying key challenges for research staff and postgraduate students around Research Integrity principles & Good Research Practice, Research Misconduct, research ethics, informed consent and responsible dissemination of research. A number of dilemmas will be posed to illustrate the complexity of scenarios faced and to help identify support mechanisms to address these challenges.

Giulia Sonetti, Polytechnic University of Catalunya, Barcelona, Spain

Dr. Giulia Sonetti is a transdisciplinary researcher with a diverse background spanning architecture, renewable energy, and environmental evaluation. Dr. Sonetti has organized, spoken at, and facilitated numerous shared science and multi-stakeholder workshops across Europe. She has also designed and managed several national and EU FP7/H2020 research projects. Her areas of expertise include inter/transdisciplinary approaches, university campus sustainability management strategies, organizational change, and transformative education methods. Dr. Sonetti's passion lies in co-creating environments that facilitate transformative learning and contribute to systemic change within formal and informal academic settings. Her expertise encompasses systems thinking, participative action research, contemplative practices, and community engagement. With a PhD and two M.Sc.s, she leverages her knowledge and skills to investigate the social field's role as a crucial driver of transformative change. Currently, Dr. Giulia Sonetti holds the position of Transdisciplinary Researcher at the Polytechnic University of Catalunya, Barcelona, Spain. Alumna of the Postdoc Academy for Transformational Leadership, funded by the Robert Bosch Stiftung Foundation in Berlin, she will carry on a Marie Curie Individual Fellowship at the ISGlobal all 2025/2026 called "Cycling to Care" (c2c), an action research project that aims to position emotional well-being as a catalyst for pro-environmental behavioural change, intertwining mental health with sustainability awareness.

INNER DEVELOPMENT GOALS (IDG) FRAMEWORK

First Session / IDG Seminar (1h, Tue 04/06 h12)

Understanding Climate Anxiety: A Transdisciplinary Approach with Inner Development Goals This interactive seminar investigates the theoretical underpinnings of climate anxiety through the lens of Inner Development Goals (IDG). Participants will explore how environmental crises impact mental health and provoke climate-related stress, with a particular focus on young people. The session introduces the IDG framework, discussing how it supports personal well-being and proactive environmental behaviors. Participants will examine the role of inner worlds—comprising emotions,

thoughts, identities, and beliefs—in shaping sustainable actions and how language and deep leverage points within systems thinking can transform environmental engagement. The seminar sets the stage for understanding the integration of emotional resilience with environmental action, offering a pathway for effective transdisciplinary efforts towards sustainable living.

Second Session / Practical Workshop (2hs. Thu 06/06 h14)

Emotional Well-being and Environmental Sustainability Following the theoretical groundwork laid in the first session, this practical workshop focuses on implementing the Inner Development Goals (IDG) to explore the climate-related links to body-mind interactions through hands-on activities and group engagements. Participants will engage in role-playing scenarios that leverage their disciplinary backgrounds, utilizing IDG tools to develop actionable plans that address the intersections of climate and emotional well-being, both in research and educational projects. The workshop will facilitate a transdisciplinary effort, merging methods and perspectives from various disciplines along with diverse thoughts, words, and actions from participants. This session aims to empower participants to integrate and apply these insights, fostering a comprehensive understanding and innovative approach to tackling climate anxiety through a holistic lens.

POSTERS AND ORAL PRESENTATIONS

Hannah Biddell, University of Queensland

Title: Arousal Coherence: Feeling our way through uncertainty

Authors: Hannah Biddell

Abstract: The focus of this presentation is "Arousal Coherence" - how well individuals' (subjective) affective arousal aligns with (objective) markers of their physiological arousal, such as changes in heart rate or pupil dilation. We approach both forms of arousal through the lens of Active Inference, looking closely at the role affective arousal may play in optimising interoceptive inferences (about autonomic arousal), and how these inferences may shape the way the brain estimates its own uncertainty. We suggest that the link between affective and autonomic arousal may reflect a crucial element in the way the predictive brain updates and enacts uncertainty estimates, and thus impact the veracity of down-stream inferences. We present three (as yet unpublished) empirical studies supporting the significance of arousal coherence in individuals' capacity to effectively discern and adapt to changes in uncertainty in their internal and external environments. Relative to Individuals with higher coherence, those with low arousal coherence show a diminished capacity to navigate and adapt to changing uncertainty. Higher arousal coherence was associated with higher psychological wellbeing, emotional awareness and physiological self-regulation (study 1), and superior ability to detect and learn from subtle changes in the external environment, evidenced by higher accuracy in probabilistic learning (study 2) and higher capacity to discern the authenticity of others' emotional expressions (study 3). This line of research suggests that arousal coherence may offer a valuable and accessible marker of interoceptive integration accuracy, and offers new avenues for thinking about pathologically inflexible inferences (as in affective disorders), and more broadly, for the way that we can optimally navigate uncertainty.

Roberto Guidotti, University of Chieti-Pescara

Title: Exploring the properties of the meditative brain networks

Authors: Roberto Guidotti, Antea D'Andrea, Alessio Basti, Antonino Raffone, Vittorio Pizzella & Laura Marzetti

Abstract: The role of mindfulness meditation in enhancing well-being is becoming central. Extensive practice has been linked to reduced stress and anxiety (Hadash and Bernstein, 2019), mirroring changes in brain processes related to attention, emotion regulation, and interoception (Raffone et al. 2019). In particular, two popular meditation styles, focused attention (FA) and open monitoring (OM), are thought to engage these processes differently (Lutz et al. 2008). FA involves sustained attention on a specific object, while OM encourages a broader awareness of present-moment experiences with particular emphasis to emotion. Neuroscientifically, these distinctions may shape differently the structure and function of human brain networks. Previous studies have shown that long-term meditation practice can change white matter pathways and modulate large-scale brain network interactions (Tang et al. 2015). Using machine learning, we investigated the impact of extensive FA and OM practice. Specifically, we examined: i) how large-scale fMRI functional connectivity patterns predict meditation state (FA or OM) in expert meditators and novices, and ii) the influence of expertise and age on brain network in long-term meditators. Our findings demonstrate that long-term meditation practice not only induces shared changes in brain connectivity but also leads to distinct neural adaptations specific to the level of expertise.

Martina Saltafossi, University of Münster

Title: Respiratory rhythm and multisensory perception

Authors: Martina Saltafossi, Andrea Zaccaro, Daniel S. Kluger, Mauro Gianni Perrucci, Francesca Ferri, Marcello Costantini

Abstract: The brain continuously processes information from both the external environment and visceral signals generated by the body. This ongoing exchange allows signals from the heart and lungs to influence perception. Previous work demonstrated that cardiac cycle phase interacts with multisensory integration, i.e., the non-linear combination of information coming from multiple senses. This study explored respiratory modulations of reaction times and multisensory integration in a simple detection task with 40 participants exposed to unimodal (Auditory, Visual, Tactile) and bimodal (Audio-Tactile, Audio-Visual, Visuo-Tactile) stimuli. Linear mixed effects models were performed on reaction times and the Race Model Inequality approach was employed to quantify multisensory integration, with a specific focus on respiratory phases. First, respiration was found to significantly modulate reaction times irrespective of the stimulus type, with distinct temporal dynamics for unimodal and bimodal stimuli. Notably, reaction times were slower during the expiration-to-inspiration phase. Then, the Race Model Inequality analysis revealed higher multisensory integration for Audio-Tactile and Audio-Visual stimuli during expiration-to-inspiration phase. Participants also adapted their respiratory cycle, as their response onsets preferentially occurred during early expiration. These findings indicate that respiration is not merely a bottom-up mechanism but is actively adjusted to optimize the signal-to-noise balance between interoceptive and exteroceptive signals. From a predictive processing perspective, these results suggest that respiration acts as a "master clock" aligning external information sampling with fluctuating states of neural excitability. This intricate interplay between respiration and neural processes sheds light on the dynamic nature of multisensory integration and its modulation by peripheral factors.

Andrea Zaccaro, University of Chieti-Pescara

Title: Cardiac interoceptive attention and the respiratory phase modulate heartbeat-evoked oscillations

Authors: Andrea Zaccaro, Francesca della Penna, Eleonora Parrotta, Mauro Gianni Perrucci, Marcello Costantini & Francesca Ferri

Abstract: Heartbeat-evoked potentials (HEPs) are EEG voltage fluctuations reflecting the cortical processing of cardiac signals. In the time-frequency domain, recent studies have observed significant heartbeat-evoked oscillations (HEOs) both at rest and during tasks involving bodily self-awareness. In the time domain, our recent findings indicated heightened HEP positivity during exhalation compared to inhalation in a task centred on attending to cardiac sensations, likely indicating increased cardiac interoceptive attention. Here, we aimed to explore whether HEOs can be influenced by cardiac interoceptive attention and the respiratory phase. We examined HEOs (heartbeat-evoked power and inter-trial coherence) across the respiratory cycle in healthy volunteers at rest, during a cardiac interoceptive task (Heartbeat Counting Task, HCT), and during its exteroceptive control condition. We observed a significant increase in power and inter-trial coherence evoked by the heartbeat in theta and alpha bands during exhalation compared to inhalation, specifically during HCT. These findings support previous results demonstrating the impact of respiration on modulating cardiac interoception and suggest that alterations in HEOs in the alpha band may be linked to the selective inhibition or disengagement from competing or distracting exteroceptive stimuli outside the focal point of attention, particularly during exhalation.

Riccardo Bertaccini, University of Bologna

Title: Defective bottom-up processing and positive traits drive audiovisual impairments along the schizotypal continuum

Authors: Bertaccini, Riccardo; Ippolito, Giuseppe; Tarasi, Luca; Zazio, Agnese; Stango, Antonietta; Bortoletto, Marta; Romei, Vincenzo

Abstract: Everyday life floods our perceptual machinery with manifold streams of information, which are often audiovisual in nature. Altered dynamics encompassing this multisensory domain are often paired with maladaptive behavior, and have been reported in clinical and sub-clinical population known to be more prone to hallucinatory and illusory phenomena due to enlarged audiovisual temporal binding windows (TBW), such as those suffering from schizophrenia or displaying high schizotypal traits. However, it remains to be clarified whether these deficiencies are indeed due to poor bottom-up mechanisms, and the extent to which positive personality sub-traits within these samples might be a latent factor driving such faulty mechanics. To this aim, we resorted to psychophysics, clinimetrics and signal detection theory, by asking a sample of healthy individuals screened as for their schizotypal traits (i.e., high vs low, 25 individuals each), to perform a modified version of the renown sound-induced flash illusion. Results from logistic fitting applied to behavioral data show that individuals with high schizotypal traits display enlarged TBW (assessed via d-prime) as compared to participants with low schizotypal traits. Further, the width of the such audiovisual TBW across groups appears to be predicted by the degree of positive traits, as quantified via principal component analysis ran on clinimetric data. These pieces of evidence corroborate existing literature and are suggestive of specific alterations occurring at the earliest levels of the audiovisual hierarchy, which might be driven, or at least intertwined, with positive personality sub-traits along the schizotypal continuum.

Amar D'adamo, Universidad Carlos III de Madrid

Title: Exploring the Subjective, Behavioral, and Affective Changes in Body Perception through the Alteration of Footstep Sounds: a focus on Individual differences

Authors: Amar D'Adamo, Marte Roel, Ana Tajadura-Jiménez

Abstract: Mental representations of the body are influenced by motor efferents and multisensory signals. Modifying the auditory feedback of self-generated walking sounds in real time can result in people perceiving their body as lighter or heavier, as moving slower or faster, and may lead to changes in gender identity. This phenomenon, known as the auditory body-weight illusion, has also been shown to induce variations in happiness levels. Individuals with eating disorders have shown distinct effects on their body perception when exposed to such acoustic manipulations. In this study, we employed an improved digital sound system together with a full-body motion capture suit and physiological sensors, to further our understanding of subjective, behavioral, and affective changes derived from this illusion. We further investigated the influence of group differences in terms of body concerns and levels of physical activity on the effects of such an illusion. Participants underwent a pre-screening assessment. The selected sample (N=104) answered questionnaires about their body perception and emotional state and completed a body visualization task after each randomized/counterbalanced experimental condition. The results successfully replicated previous research, with participants reporting sensations of being heavier or lighter based on the manipulated sounds. Analyses revealed an impact of individual differences in each of the experimental dimensions. We reveal and highlight the role of individual differences in body perception, offering avenues for personalized sonification strategies. Given the portability and transparency of acoustic transformations, this illusion is particularly relevant for health as it can be integrated in daily life and thus impact participants' habits and health.

Eleonora Parrotta, "Sapienza" University of Rome

Title: Interoceptive illusions as a tool to understand perception as an anticipatory process of expectations: A predictive Coding perspective

Authors: Eleonora Parrotta, Patric Bach, Giovanni Pezzulo, Andrea Zaccaro, Mauro Gianni Perrucci, Marcello Costantini & Francesca Ferri

Abstract: Emerging Embodied Predictive Coding frameworks propose that individuals' experience of the internal milieu, or the body's internal state, is shaped by our beliefs and prior knowledge about the body's expected state, rather than being solely based on its veridical state. Here, we explore how predictive coding models and the free energy minimization framework provide insights into interoceptive processes, focusing on the mutual influence between cardiac and pain perception through the lenses of interoceptive illusions.

Illusions offer an excellent starting point to understand perception as an anticipatory process of expectation, describing a process of error-based inference, whereby carefully crafted stimuli provide evidence for models (expectations) deviating significantly from reality. The first series of studies examined whether threat (i.e., pain) expectations could induce a misperception of heartbeat frequency, revealing that participants expected increased heart rate in anticipation of high-pain stimuli, and this belief was perceptually instantiated in their interoceptive reports, despite no actual change in heart rate. Importantly, when individuals experienced such cardiac misperceptions, it affected the amplitude of the Heartbeat Evoked Potential, a neuronal signature of the cortical processing of cardiac signals, suggesting the involvement of precision-weighted predictive mechanisms in the neural processing of cardiac signals. The second stream of studies serves as a counterpart to the cardiac illusion, where cardiac feedback was manipulated to induce pain expectations and misperceptions. Results showed that false faster cardiac feedback elicited heightened pain expectations, biasing perceptual pain judgments and physiological responses. This effect was evident in participants perceiving identical noxious stimuli as more intense and unpleasant, and experiencing a deceleration in heart rate consistent with the orienting cardiac response to threatening stimuli. This research highlights the reciprocal relationship between cardiac perception and pain processing within the framework of Embodied Predictive Coding. Understanding these

mechanisms provides insights into how prior beliefs shape our perception and experience of internal states, contributing to the development of interventions for conditions involving altered interoceptive processing.

Renato Paredes, National University of Cordoba, Pontifical Catholic University of Peru

Title: E/I imbalance impairs multisensory causal inference increasing the proneness to experience sound-induced flash illusions in the schizophrenia spectrum

Authors: Renato Paredes, Francesca Ferri, Vincenzo Romei and Peggy Seriès

Abstract: The schizophrenia spectrum is characterised by a disrupted sense of the self with known impairments in tactile sensitivity, proprioception, body-self boundaries and self-recognition. These are thought to be produced by failures in multisensory integration mechanisms, commonly observed as enlarged temporal binding windows during audiovisual illusion tasks. To our knowledge, there is an absence of computational explanations of multisensory integration deficits in patients with schizophrenia and individuals with high schizotypy, particularly at a neurobiological level. We implemented a multisensory causal inference network to reproduce the responses of individuals scoring low in schizotypy in a simulated double-flash illusion task. Next, we explored the effects of E/I imbalance, feedback weights and synaptic density in the network's visual illusory responses. Using quantitative fitting to empirical data, we found that an increase of recurrent excitation or cross-modal connectivity in the network enlarges the temporal binding window and increases the overall proneness to experience the illusion, matching the responses of individuals scoring high in schizotypy. Moreover, we found that an increase of the E/I balance by either neural mechanism increases the probability of inferring a common cause from the stimuli. Based on these findings, we discuss body related schizophrenia symptomatology from a multisensory causal inference perspective.

Daniele Di Lernia, Catholic University of the Sacred

Title: I got you under my skin. Affective touch modulates cognitive, autonomic and endocrine response.

Authors: Daniele Di Lernia, Elisa Zanier, Giuseppe Riva

Abstract: Traditional approaches in neuroscience and psychology have predominantly focused on how external sensory inputs (e.g., vision, hearing) influence behavior, cognition, and health, often overlooking the critical dimension of interoception—the perception of the body's internal state. Recent advancements underscore the significance of interoceptive processes in shaping wellbeing and health, yet the development of methodologies targeting these processes remains largely unexplored. Addressing this gap, we developed a non-invasive device designed to target the interoceptive system by stimulating the specialized interoceptive C-Tactile afferents on the skin, i.e., affective touch. Preliminary findings suggest that affective touch may alleviate stress, anxiety, and pain, while promoting parasympathetic responses, emotional bonding, and social inclusion in both human and animal models. To evaluate the cognitive, autonomic, and endocrine effect of affective touch on healthy participants we planned two studies. In Study 1 (N=20) we aim to assess the affective touch impact under resting conditions in healthy participants, while In Study 2 (N=34) we aim to evaluate its effect under acute, experimentally-induced stress conditions. Both studies will involve comprehensive assessments, including biological (blood samples), autonomic (Heart Rate Variability - HRV), and cognitive measures, providing an integrated understanding of affective touch effects on healthy participants.

Martina Frattura, University of Bologna

Title: Nudging Permeability: Human Perception through Conscious Embodied Experiences

Authors: Annarita Ferrante, Martina Frattura

Abstract: The proposed theoretical framework is grounded in the concept of Nudging Permeability, a term denoting the intentional alteration of the perception of places through conscious embodied experiences. This framework draws heavily from the multidisciplinary approach to integrated design, specifically incorporating insights from neuroarchitecture, neuroscience, environmental psychology, architecture, psychology, and physiology. Neuroarchitecture, which weaves together principles from neuroscience, environmental psychology, and architecture might serve as a foundational element in the perspective of a human-centered design. The theoretical framework is further supported by the Embodied Cognition Theory, emphasizing the role of sensory-motor experiences as the cradle of human perception and action, culminating in a system of potential actions within the space. Humanistic-scientific notions in design provide a holistic perspective, considering the impact of culture-memory, expectations, and the intrinsic relationship between individuals and their environment. This framework positions neuroscience as a measure of the individual and architecture as a measure of space, both integrated with other humanistic-scientific notions. The overarching goal is to explore the elements and nudges that architecture can contribute to neuroscience, fostering an exchange of knowledge that empowers users to be conscious of their impact within a given space.

Jennie Lukoff, Erasmus University Rotterdam

Title: Exploring Daily Aggression and Substance Use Among Multi-Problem Young Adults: An Experience Sampling Method (ESM) Study

Authors: Lukoff, J.S., van de Groep, I.H., Schelling, L., Brinkman, W.P., Franken, I.H.A. & Marhe, R.

Abstract: Young adults grappling with antisocial behavior and addiction encounter persistent challenges despite ongoing intervention efforts. Existing literature highlights the value of exploring daily fluctuations in maladaptive behaviors using the Experience Sampling Method (ESM). In contrast to laboratory studies with limited ecological validity, ESM captures mood and behavior fluctuations in a respondent's natural environment. Building upon our pilot study findings, the current study will use a validated ESM approach to investigate momentary changes in aggression (proactive, reactive) and substance misuse (cigarettes/e-cigarettes, cannabis, and alcohol) among young adults with prior legal involvement. Approximately 50 young adults seeking social welfare support from the municipality of Rotterdam in the Netherlands will participate in a brief (1-2 minutes) daily survey, administered twice a day, five days a week, for 2-4 weeks. The survey will focus on aggression (proactive, reactive, and provocation) and substance use (craving, consumption) exhibited over the past hour. The primary goal of this study is to pinpoint specific moments when participants are more prone to engage in acts of aggression or substance misuse. By identifying critical periods of risk and the contextual factors preceding these maladaptive behaviors, we can focus future research efforts on developing more effective intervention strategies. In particular, we plan to utilize information from this study to target daily maladaptive behaviors persisting in this expanding population of antisocial young adults.

Anna Ciaunica, University of Lisbon

Title: One Step Closer to my Heart: Cardiac Phase is Coupled with Footsteps in Typical but not in Depersonalisation Individuals

Authors: Simon Knogler*, Alberto Colombo*, Ana Tajadura Jimenez, Alejandro Galvez Pol, Julien Lagarde*, Anna Ciaunica*

*Equal contributions

Abstract: Previous work showed that the bodily self is not fixed but constantly updated through dynamic sensory feedback, including sound feedback (Tajadura-Jiménez et al. 2012; 2015). Depersonalisation is a very common phenomenon that make people feel detached from their bodily self (Sierra & Berrios 1997). This study investigated the dynamic coupling between bodily movements from the inside the body (i.e. cardiac signals) with bodily actions in the world (e.g. walking) in 60 participants with high and low occurrences of Depersonalisation. We used a shoe-based sound device, the so-called 'MAGIC SHOES' which allow the dynamic modification of footstep sounds, as people walk (Tajadura-Jiménez et al. 2012; 2015). In parallel, we have recorded participants cardiac signals in real time, as well as gait biomechanics which was used as an implicit measure of changes in perceived body weight. We found that in the control condition, the proportion of Toe-Off (TO) events occurring during systole was significantly greater than chance level in the low DP group. The High DP group showed however no synchronization between gait events and cardiac phase. Moreover, in the High DP group, the proportion of both IC and TO events occurring during systole was significantly greater than chance in the Low Frequency sound condition. Our study reveals for the first time that the dynamic coupling between bodily movements from the inside (e.g. cardiac signals) and bodily actions in the world (i.e. footsteps) is altered in Depersonalisation, but not in typical individuals. Our results provide further evidence that people feeling detached from their bodies are literally out of sync with their inner body, i.e. heartbeats. Further work is needed to examine the neural mechanisms underlying the atypical interplay between bodily movements from the inside (i.e. heartbeats) and bodily actions in the world (i.e. footsteps) in Depersonalisation.

Francesco Bubbico, University of Chieti-Pescara

Title: Exploring Sensorimotor and Respiratory Synchronization Differences Between Schizophrenic Patients and Healthy Subjects

Authors: Francesco Bubbico, Andrea Zaccaro, Mauro Gianni Perrucci, Marcello Costantini & Francesca Ferri

Abstract: This study will investigate sensorimotor and respiratory synchronization abilities in schizophrenic and healthy subjects to elucidate their impact on social interactions. It will include 46 participants, equally divided between groups. The study will involve two primary tasks: a sensorimotor synchronization task where individuals will tap in accordance with a visually presented stimulus, and a respiratory synchronization task with a visual breathing signal. Both tasks will be conducted under conditions of high and low stimulus predictability. Additionally, the tasks will be performed under two social bias conditions: one where participants believe they are interacting with someone from their own group and one with the opposite group. Synchronization performance will be assessed in the sensorimotor task by measuring the time intervals between consecutive finger taps and the asynchronies, which are the mismatches between the initiation of each tap and the onset of the corresponding visual stimulus; in the respiratory task, through indices such as phase-locking, relative phase, and the percentage of in-phase occurrence. By exploring these dynamics, the study aims to expand the understanding of how schizophrenia affects interpersonal connections and the extent to which social perceptions modulate synchronization abilities. This research will highlight significant challenges in social interactions for individuals with schizophrenia, contributing to the discourse on epistemic injustice.

Francesca Della Penna, University of Chieti-Pescara

Title: The influence of respiratory phases on interoceptive and exteroceptive perception

Authors: Francesca della Penna, Andrea Zaccaro, Mauro Gianni Perrucci, Marcello Costantini & Francesca Ferri

Abstract: Recent literature about interoception suggests that interoceptive accuracy and its related neural correlates (e.g., the heartbeat evoked potential) are enhanced during exhalation, while inhalation optimizes the processing of exteroceptive information. We herein investigated the relationship between respiratory activity and the perception of anticipated interoceptive and exteroceptive stimuli, which were signaled by a visual cue (i.e., a white cross turning red). We tested whether and to what extent the presence of a cue would prompt participants to actively modulate their breathing to enhance task performance. Forty-one participants engaged in both an interoceptive and an exteroceptive task, while their respiratory and cardiac activity were recorded. The interoceptive task was the Heartbeat Discrimination Task, where participants were instructed to judge the simultaneity of a sequence of three tones with their heartbeat. In the exteroceptive task, participants were asked to detect a near-threshold tactile stimulation over their left index finger. This paradigm allowed us to determine whether participants actively align inhalation and exhalation to the expected (i.e., cued) exteroceptive and interoceptive trial onset, respectively. By applying Signal Detection Theory, we assessed task performance and discrimination indices. We observed a significantly better performance during exhalation compared to inhalation in both tasks, indicating a modulation of perceptual processing by the respiratory cycle. Moreover, circular statistics revealed strong phase-locking of respiration to the expected (i.e., cued) stimuli onset during both the interoceptive and exteroceptive tasks. Generally, participants showed a tendency to align inhalation with trial onset. Additional analysis, including measures like inter-trial coherence, is required to better understand the role of respiration as an active sensing mechanism, optimizing the perceptual processing of both the interoceptive and exteroceptive domains, and its contribution to the understanding of how bodily rhythms shape and optimize human perception.

Sabrina Iuliano, University of Campania "Luigi Vanvitelli"

Title: Aging and wellbeing: interaction between spatial memory, interoception and body representation

Authors: Iuliano, S., Nunziata, S., Iachini, T., Ruggiero, G.

Abstract: Ageing is characterised by the progressive decline in cognitive functions and the gradual reduction in motor/physical performance impacting on daily living activities (Basile & Sardella, 2020). In line with recent research, along with decline of spatial cognitive abilities (Barnes, 2015; Colombo et al., 2017; Lester et al., 2017; Ruggiero et al., 2018; Iachini et al., 2023), ageing negatively affects also the interoceptive awareness (Murphy et al., 2018; Khalsa et al., 2009). The underlying cause of these challenges is the progressive loss of integrity of at least three interconnected dimensions: the ability to match one's internal needs (interoception) with daily functional actions (bodily processes) while interacting with various social-emotional cues of the external environment (spatial representation). Here we want to investigate the link between interoception, spatial memory and daily functioning in young and old people to investigate this aspect. To do this, we will carry out neuropsychological tests (MMSE, MoCA), a modified version of the Ego/Allo task with stimuli of different emotional valence, the Body Perception Questionnaire for interoception (BPQ, Poli et al., 2021) and Short Form Health Survey SF-12 for daily functioning (Gandek et al., 1998).

Luana Amadini Genovese, Catholic University of the Sacred Heart

Title: "Chronic Pain and Body-Brain interaction: a systematic review"

Authors: Luana Amadini Genovese, Chiara Pupillo, Giuseppe Riva, Daniele di Lernia

Abstract: Chronic pain (CP) is defined as a persistent pain condition generally present more than three to six months and it can have a significant impact on a person's quality of life. CP can lead to changes in the brain's morphology and function, affecting the processing, sensitivity and integration of somatosensory and interoceptive signals. Additionally, CP can impact the function of the autonomic nervous and somatosensory systems, disrupting bodily regulation and perception at the peripheral level. These changes highlight CP as a multifaceted condition that involves complex interactions between physical, psychological and neural factors. Understanding this intricate body-brain interplay is essential for developing a comprehensive approach to managing chronic pain. As body-brain interaction refers to the communication and interconnection between the brain and the rest of the body, this interaction is fundamental for the regulation of the physiological and behavioural functions of the organism and it has a relevant, albeit not fully understood, role in CP. To better comprehend how CP influences the interplay between body perception and brain processes, we conducted a systematic review to investigate if CP can affect body-brain interaction measured by means of neural correlates of bodily perception processes. The eligibility criteria for including articles in the systematic are the diagnosis of chronic pain, pain present in the last three months, subjects older than 18 years, a sample of patients compared to a control sample. In addition, the selected articles must include at least a measurement of neural correlations, at least a metric of bodily processing (proprioceptive or interoceptive) and at least a measurement of body-brain interaction. Items that do not represent these criteria will be excluded. The extraction and screening procedure is in progress and will be completed by the time of the Summer School.

Basak Bayram, University of Chieti-Pescara

Title: Role of Stress in Cortical Processing of Cardiac Signals

Authors: Basak Bayram, Andrea Zaccaro, Mauro Gianni Perrucci, Mirko Pesce, Marcello Costantini & Francesca Ferri

Abstract: Stress is a multifaceted phenomenon involving various structures and functions that alter bidirectional communication along the body-brain axis (Craig, 2002). One way to measure cortical processing of cardiac signals is through Heartbeat Evoked Potentials (HEP), with modulations of HEP amplitude extensively studied through tasks requiring focused attention on heartbeats (Schandry, 1981). Recent research has shown that HEPs are modulated by respiratory phases, proposing ΔHEP, calculated by subtracting the mean amplitude of HEP during inspiration from expiration, as a physiological index of optimal cardiac interoception (Zaccaro et al., 2022). However, it remains unclear whether respiratory phases can optimize cardiac interoception under stress conditions, moreover, studies focused on stress and HEPs are scarce. The current study will utilize a within-subjects design with simultaneous EEG, ECG, and respiratory activity recordings, alongside salivary cortisol measurements, to investigate these interactions. Participants will undergo two sessions: a control and a stress condition. Stress will be induced through a challenging mental arithmetic task with feedback, intended to elicit cognitive and psychosocial stress (Dedovic et al., 2005). We hypothesize that stress will reduce respiratory phase-dependent HEP amplitude modulation (ΔHEP) and we expect to find alterations in HEP amplitude during stress condition compared to the control condition.

Maria Rosaria Pasciucco, University of Chieti-Pescara

Title: Predictive role of exteroceptive and interoceptive bodily processing to Active Aging

Authors: Maria Rosaria Pasciucco, Mauro Gianni Perrucci, Pierpaolo Croce, Gennaro Ruggiero, Marcello Costantini & Francesca Ferri

Abstract: Older adults typically manifest a relationship between changes in the body and changes in cognitive and daily life functioning. However, the current approach in aging science typically focuses on testing cognitive functions, mostly neglecting bodily factors. Our study investigated the bodily processes, particularly the aspects of exteroceptive and interoceptive bodily dimensions, to find which of these exteroceptive or interoceptive aspects are reliable predictors of deterioration in daily life functioning, particularly on emotional well-being and general well-being. We recruited 53 right-handed healthy participants (37 females), aged 20-89 years old, and they performed a battery of tasks and questionnaires that assessed the different dimensions. Exteroceptive representations involve the perception and integration of sensory information from outside the body and were evaluated through Body Image, Spatial Tactile Acuity, Body Structural Representation, Multisensory Integration, Multisensory Temporal Resolution, Peripersonal Space, Temporal Tactile Acuity and Sensorimotor Functions. Interoceptive representations involve information from inside the body and were evaluated across Interoceptive Accuracy, Interoceptive Sensibility and Interoceptive Awareness. Employing Partial Least Square Regression Analysis we found that both exteroceptive and interoceptive aspects are predictors of emotional and general well-being. The findings indicate that the main predictors of general well-being are the three aspects of the interoception, and the exteroceptive aspects regarding multisensory integration, as well body image, spatial tactile acuity and body structural representation. Regarding emotional well-being the main interoceptive predictors are interoceptive sensibility and awareness. The main exteroceptive predictors are most related to the aspect of both spatial and temporal tactile acuity, as well as body image. These findings contribute to the promotion of active aging, highlighting a comprehensive investigation and identification of the predictive role played by interoception and exteroception in bodily dimensions of the aging mind.

Aurelia Schirripa, "Sapienza" University of Rome

Title: Electroencephalography correlates of tactile cues integration with proprioceptive information for motor control

Authors: Aurelia Schirripa, Matteo Bianchi, Alessandro Moscatelli, Viviana Betti

Abstract: Studies exploring stationary hand positions have unveiled that cutaneous stimuli from object contact can induce the perceptual illusion of hand displacement, suggesting touch provides auxiliary proprioceptive feedback for action guidance. For instance, sliding a finger across ridged surfaces demonstrates how tactile cues integrate with proprioception to control motor actions. The neural mechanisms underlying multisensory integration within the somatosensory system and between sensorimotor regions across the two cerebral hemispheres remain incompletely understood. To accomplish these goals, we will create behavioral tasks that we will combine with high-density electroencephalography (EEG) to assess the brain mechanisms that underlie sensorimotor integration between limbs in healthy subjects, as well as their function in controlling movement. In these tasks, we will use a novel robotic device to decouple proprioceptive and tactile inputs while reaching. The tactile feedback will be delivered on the left hand, while the sliding movement will be performed with the right hand. The tactile feedback provided by the ridges in incongruent trial will not match the proprioceptive feedback of the right arm performing the sliding movement. We hypothesize to find frontal response with larger ERN and stronger theta response for incongruent cues. Inn incongruent trial we expect a greater beta suppression, typical of trial-and-error learning. Another cluster of interest will be Posterior Parietal Cortex, holding multiple representation of trajectories, it is also involved in involved in early stages of motor learning and motor adaptation, during which task execution strongly relies on external stimuli. According to our hypothesis beta activity is modulated also in this region. Lastly according to our hypothesis, we would find different activity for hMT+/V5 in the contrasting conditions. This area has a causal role in tactile direction processing, and strengthen the case when serving multimodal motion perception. We expect to find a modulation of beta band activity in hMT+/V5.

Serena Sdimami, University of Chieti-Pescara

Title: An interoceptive view into psychopathology: schizophrenia and interoceptive illusions

Authors: Eleonora Parrotta Serena Sdinami, Andrea Zaccaro, Mauro Gianni Perrucci, Marcello Costantini, Francesca Ferri

Abstract: Under new emerging views interoception is no longer seen as a merely sensory-driven, bottom-up process, but also as an active process in which the brain acts as a generator of inferences based on our expectations or beliefs, even when they are misleading, following a Bayesian account of hypothesis. Our recent studies observed that predictive processes indeed shape interoception, illusorily distorting heartbeat perception towards prior subjective beliefs, such that threat expectations suffice to induce a misperception of heartbeat frequency. These previous results prompt fascinating inquiries into how deceptive interoceptive experiences might intertwine with the understanding and management of our inner states, potentially contributing to dysfunctional conditions. The notion that psychopathology could stem from abnormal predictions isn't groundbreaking and hinges on the concept of atypical, evidence-resistant predictions despite evidence suggesting otherwise, explaining for example hallucinations or delusions in schizophrenia and related conditions. In light of this, the present study investigates whether this illusory misperception can be observed also among people affected by Schizophrenia. In fact, evidence exists that interoceptive processes seem compromised in this clinical population, which also shows decreased levels of interoceptive accuracy compared to healthy controls. Taken together, this evidence led us to hypothesize that given the patients' decreased interoceptive abilities, they would end up with an abundance of prediction errors when generating inferences about the external world. In time, this caused patients to rely less on what they internally perceive and more on external stimuli. We will present preliminary results on a small sample of patients and healthy controls.

Angelo Lucio Silvino, University of Campania "Luigi Vanvitelli"

Title: Psychophysiological reactions to multisensory environments

Authors: Angelo Lucio Silvino, Mariachiara Rapuano, Francesco Ruotolo, Gennaro Ruggiero, Tina Iachini

Abstract: Several studies have shown that contact with nature has a positive effect on people. However, we spend a considerable amount of time indoors (e.g., at home and at work). In this regard, little research has been done on the characteristics of the indoor environments that may promote our mental and physical well-being. Thirty-four participants (22 women; mean age = 22.5 years) were immersed in ten virtual scenarios resulting from the combination of five types of rooms with colors and furnishings reminiscent of natural or urban settings (i.e, comfort room: green/blue colors, soft materials; nature room: green, natural materials; comfort-nature room: yellow/green colors, high-quality materials; modern room: white/grey colors, high-quality materials; basic room: brownish colors, low-quality materials) with two outdoor scenarios: a natural environment with bird sounds and an urban environment with traffic noise. While immersed in these scenarios, participants indicated on a 9-point Likert scale (1 = not at all; 9 = extremely) how calm, excited, happy, nervous, tired, and sad they felt. In addition, their skin conductance (SC) was recorded. The results showed that participants rated Nature-like rooms more positively than Modern and Basic rooms. In contrast, Modern and Basic rooms induced more negative emotions. However, the results also showed that Modern and Basic rooms induced more positive emotions when combined with natural outdoor sights and sounds. Finally, higher levels of SC were recorded when participants were immersed in Modern and Basic rooms than in Nature-like rooms. Theoretically, the results support the idea that the perception of the environment in which we live is multisensory, integrating both indoor and outdoor environmental features. On an applied level, the results suggest that adding visual and/or acoustic elements reminiscent of nature to indoor environments may enhance people's mental and physical well-being.

Kati Kiiski, University of Eastern Finland and University of Applied Sciences of South-Eastern Finland

Title: Nature-based methods and structures as part of the Finnish social and health service system's range of services - One solution in the life of a person living with global challenges

Authors: Kati Kiiski

Abstract: Many of the human physical and mental health challenges probably stem from our alienation from our natural environment. Alienation from nature and health challenges are part of the wicked problems we live in the midst of. At the same time, our social and healthcare system is in crisis. There is some national and international research on the health and well-being effects of nature. The effects have been shown to be mostly positive. Harnessing the health and well-being effects of Finnish forest nature as part of the Finnish field of social and health services and increasing the well-being of the population has not yet been implemented on a large scale. However, the concept of planetary well-being and planetary health has emerged in Finland recently. Intervention studies investigating the health and well-being effects of nature have been ongoing for ten years. With the help of these, the applicability of the services from the point of view of individuals (and certain customer groups) has been investigated, and the experiences of the target persons (customers) with nature-based services have also been studied. More research is still needed on this whole to assess how Finnish (forest) nature can be suitable as an effective part of the Finnish social and health service system. At the same time as nature-based methods are being studied in practice for different disease groups, both preventively and therapeutically, it is worth considering how they will be introduced into the service system. In my own research, I intend to use the delphoi method of future research to find out how those working in the field or those deciding on best practice recommendations see the issue.

Ambre Lahlou, National School of Architecture of Nantes

Title: Neuroarchitecture. De la théorie à la pratique

Authors: Ambre Mimi-Lahlou, Léa Mosconi, Emmanuelle Ladet, Isabella Pasquallini, Anne Tuscher, Emma Villarem, Claire Daugeard, Alice Cabaret

Abstract: Designing and implementing projects with a user experience focus is central to architects' core mission. Neuroarchitecture, an emerging interdisciplinary field, empowers professionals by integrating cognitive neuroscience and environmental psychology. It aims to deepen architects' understanding of how the environment shapes users' experiences for better-suited space design. Despite global enthusiasm for neuroarchitecture in institutions, research labs, and consulting firms, its limited presence in architectural practices raises a critical question: Why does neuroarchitecture face challenges in integrating into architects' daily workflows while gaining ground elsewhere? To bridge this gap, there's a pressing need for administrative, legal, and financial frameworks. Framing this through the HMONP* qualification, this thesis explores integrating neuroscientific principles into architectural practice.

Mercedes Paino, University of Oviedo

Title: Environmental Predictors of Clinical High-Risk of Psychosis (CHRp) in Adolescence

Authors: Paino, Mercedes, Fernández, Fernández, Inma, González-Menéndez, Ana, & Roces-Montero, Cristina

Abstract: Few studies have attempted to analyze and understand the risk of psychosis in relation to environmental risks (ER). In our study, we evaluated a representative sample of 1,824 Spanish adolescents from the general population using different scales to thoroughly examine the potential interaction of Clinical high-risk of psychosis (CHRp) with various ER, including trauma, academic performance, migration, and socioeconomic status. Based on a three-track algorithm for identifying CHRp (which integrates symptoms from the main risk approaches—ultra-high risk, basic symptoms, and anomalous self-experiences—along with the presence of global functional deficits), 29.12% (n= 516) of the adolescents exhibited a moderate-to-high risk of psychosis. Regarding ER, 789 (51.27%) adolescents indicated that they had suffered previous trauma, and 606 (39.63%) reported that trauma caused high discomfort. Furthermore, 76 (4.88%) reported poor academic performance. A total of 92 (5.04%) adolescents were foreigners. Finally, 44 (2.84%) families were identified as having low socioeconomic status. The correlation data confirmed a significant association ($p < .001$) between higher CHRp and all ER anaylzed. Positive correlations were observed between CHRp and trauma, with the highest correlation found for distress associated with trauma ($r = 0.88$, $p < .001$). Furthemore, a significant positive correlation was found between CHRp and migration, while negative correlations were noted between CHRp and academic performance, as well as social status. The CHRp predictor model, calculated through multiple hierarchical regression analysis, indicated that ER emerged as significant predictors of high-risk psychosis, explaining 9% of the variance. Trauma was the primary environmental predictor for CHRp, followed by academic performance, migration, and socioeconomic status.

Understanding ER associated with psychotic spectrum disorders is key to improving the focus of therapeutic interventions. Targeting the reduction of ER faced by children, including trauma, low socioeconomic status, low academic achievement, and migration, is an appropriate preventive measure to reduce adolescent CHRp.

Domenico Voso, University of Chieti-Pescara

Title: Methods for brain-body networks, brain states, mobile Brain-Body Imaging: Brain-fingerprint correlates of the EEG response to TMS

Authors: Domenico Voso, Leo Tomasevic, Hartwig Siebner, Vittorio Pizzella, Laura Marzetti

Abstract: Brain-Imaging studies are often conceived with the main aim of investigating whether significant differences exist among experimental groups. While being a powerful approach, this methodological scheme faces the downside of neglecting inter-individual differences, which are instead a characterizing feature of the human brain [1] and might convey key information on why an experimental manipulation shows weak effects on a group level. With a Brain-Fingerprinting approach, the focus shifts on such inter-individual differences, with the primary intent of quantifying how prominent they are [2]. Thus, a fundamental Brain-Fingerprinting metric is the identifiability of a given neuroimaging feature. Importantly, it has been reported that identifiability metrics can shift given different experimental conditions [3]. In this study, the aim is to determine whether the identifiability of the EEG signal can be modulated by administering single-pulse, neuronavigated-Transcranial-Magnetic-Stimulation (nTMS) to the left Primary Motor Cortex (M1). Twelve healthy subjects were administered with 840 pulses divided into seven stimulation blocks. We found that identifiability (iDiff, [4]) was significantly higher post-TMS for Time-Frequency Power, Inter-Trial-Phase-Clustering and Functional Connectivity. We speculate that this finding might be reflected by increased Free Energy in the stimulated area [5], resulting in higher inter-individual variability of brain states, and, consequently, higher identifiability.

Giulia Pieramico, University of Chieti-Pescara

Title: Mapping FUNctional Connectivity in the Motor and Somatosensory Areas: FUN-mTMS

Authors: Giulia Pieramico, Roberto Guidotti, Victor H. Souza, Tuomas P. Mutanen, Domenico Voso, Risto J. Ilmoniemi, Gian Luca Romani, Vittorio Pizzella & Laura Marzetti

Abstract: Transcranial magnetic stimulation (TMS) is a non-invasive technique that influences brain networks by applying a focused electric field (E-field) through a single coil placed over the scalp (Vlachos et al., 2022). The choice of the location and orientation of the E-field in TMS experiments is crucial as it induces cortex-specific effects and is supposed to modulate brain network communication (Marzetti et al., 2023). Recently, the development of multi-locus TMS (mTMS) has provided a tool to precisely modify the E-field without repositioning the coil manually (Nieminen et al., 2022). This allows to study the effects of the stimulation on brain networks by systematically changing the parameters (Pieramico et al., 2023; Tervo et al., 2022). We investigated how the position and the orientation of the E-field during mTMS stimulation influence electroencephalographic (EEG) functional connectivity. Eight healthy participants underwent mTMS primarily targeting the left motor cortex (M1) and the left somatosensory cortex (S1) with a 5-coil mTMS system. The mTMS was used to modify the E-field by targeting 3 different positions on M1 and 3 different positions on S1 5 mm apart. EEG recordings were conducted with 64 electrodes to capture changes in functional connectivity modulated by the 5-coil mTMS pulses. The main goal was to predict stimulation origin by classifying post-stimulus functional connectivity across sites, utilizing six phase coupling metrics (Basti et al., 2022). Support Vector Machine (SVM) and Random Forest algorithms were used for classification. Results underscore the predictive potential of post-stimulus connectivity modulation in discerning various stimulated positions during mTMS. This is crucial for accurately interpreting TMS-induced modulations of brain networks.

Bike rental

- **Centro Vadini**, Vadini Center, a few steps from the Sea Lion Hotel. The cost of the bike is € 10.00 for half a day and €12.00 for the whole day (9 am/7 pm).

  Address: Via Aldo Moro, 14, 65015 Montesilvano PE

  Phone: 338 303 9201

Electric Scooter rental

Download the App here:

- **https://bitmobility.it/en/** (Pescara)
- **https://play.google.com/store/apps/details?id=com.helbiz.android&hl=it** (Montesilvano, for Android)
- **https://apps.apple.com/it/app/helbiz-micromobility-hub/id1438844293** (Montesilvano, for iPhone)

TAXI

Radio Taxi Pescara, Phone: 085 3515

Radio Taxi Montesilvano, Phone: 085 9210888

BUS

To move between the Sea Lion Hotel and Pescara center, you can use bus number 2/. The bus stop is just a few steps from the hotel. There is a bus every half an hour until 9:30 pm.

Restaurants and Bars

- “Lido il Chiosco”, Via Carlo Maresca, Traversa 1, 65015 Montesilvano PE Telefono: 339 435 6490
- “Pizzeria Civico 01”, Via Inghilterra, 1, 65015 Montesilvano PE Telefono: 085 219 1497
- “Pizzeria Carpe Diem”, Indirizzo: Via Aldo Moro, 22, 65015 Montesilvano PE Telefono: 085 219 0917
- “Ristorante Vinarrosto”, Via Inghilterra, 10, 65015 Montesilvano PE Telefono: 085 204 0334
- “Gelateria “Davide”, Via Inghilterra, 2, 65015 Montesilvano PE Telefono: 085 889 0524
- “Alikè Coffee & Drink”, Via Strasburgo, 3/5, 65015 Montesilvano PE Telefono: