

Planned study

Clinic

#1 - NATURAL SPEECH COMPREHENSION IN DISORDERS OF CONSCIOUSNESS

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Unresponsive patients who suffered a Traumatic Brain Injury may still be aware despite lacking behavioural responses. Speech-specific brain activity is considered a good prognostic marker for recovery in patients with Disorders of Consciousness. However, identifying awareness through brain activity still requires standardisation and integration with behavioural assessments to enhance the diagnosis and prognosis of these patients. This study aims to identify Electroencephalography signatures of speech comprehension in healthy participants by examining how their brain tracks the acoustic and semantic features of speech while listening to different continuous natural speech conditions. Specifically contrasting native versus foreign speech, meaningful versus nonsensical

Jabberwocky-like speech, and engaging versus neutral speech. We will use linear models and Artificial Intelligence algorithms to predict speech comprehension, and the stimulus condition that best reflects comprehension will serve as a sensitive tool for future testing in patients. It is expected that the predictive power of the acoustic and semantic models will be stronger for engaging narratives, indicating stronger entrainment to intelligible, meaningful and engaging speech. The research may lead to the development of an Electroencephalography and Artificial Intelligence bedside tool to assess when an unresponsive patient understands speech, thereby improving clinical decision-making and patient outcomes.

Planned study

Clinic

#2 – **MAPPING EXCITATION/INHIBITION NON-INVASIVELY IN EARLY ALZHEIMER'S DISEASE**

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Alzheimer's disease (AD) is the most prevalent cause of dementia, affecting over 46 million people worldwide. Beyond amyloid and tau pathology, converging evidence highlights network dysfunction driven by an imbalance in excitation and inhibition (E/I). Hyperexcitability, GABAergic hypofunction, and hypersynchronization have been observed in preclinical and clinical stages of AD, but until recently, E/I could not be measured non-invasively in humans. Advances in magnetoencephalography (MEG) now allow estimation of E/I proxies via the aperiodic component of the power spectrum, with recent studies reporting alterations in at-risk and early AD populations. However, the relationship between these proxies and underlying neurochemical architecture remains poorly understood.

We will investigate MEG-derived E/I alterations in a large cohort (N = 579) spanning the AD continuum, including healthy controls, individuals with family history of AD, subjective

cognitive decline, mild cognitive impairment, and AD. Resting-state MEG data will be source-reconstructed and E/I proxies derived from the aperiodic exponent across 100 cortical parcels. These measures will be compared against normative glutamatergic and GABAergic receptor maps from PET studies. We will test whether macroscale neurotransmitter distributions predict the spatial organization of MEG-derived E/I proxies in healthy participants, and whether this coupling is disrupted in at-risk and clinical groups.

We expect to observe progressive increases in E/I ratios reflecting hyperexcitability, alongside decreasing correspondence between MEG-derived measures and normative neurotransmitter maps with advancing disease. This study will provide a novel mechanistic link between non-invasive E/I biomarkers and underlying neurochemistry, offering a promising tool for early detection and risk stratification in AD.

Planned study

Clinic

#3 – ALTERED CORTICAL PROCESSING OF VESTIBULAR INFORMATION IN CHRONIC VESTIBULAR DISORDERS

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Some patients with chronic dizziness and balance disorders report sensations of drunkenness, unsteadiness, and/or hypersensitivity to motion, despite normal or near-normal vestibular sensor function. Neuroscientific models suggest that these symptoms may arise from misinterpretation of vestibular signals and altered central processing of vestibular information.

We have validated a method to assess cortical processing of vestibular inputs using vestibular evoked potentials (vEPs) recorded with electroencephalography (Kobliska, 2023 ; Todd et al., 2014). This technique enables reliable evaluation of the amplitude and latency of cortical responses to sound-evoked otolithic vestibular stimulation.

In this planned study, we will apply this approach to compare 40 patients with chronic vestibular complaints, including Persistent Postural-Perceptual Dizziness (PPPD), with 40 age- and sex-matched healthy controls. We hypothesize that vEP amplitudes will be larger in patients than in controls, reflecting altered cortical processing of vestibular information. Such findings would support the view that symptoms in chronic vestibular disorders are not solely related to peripheral dysfunction, but also to central processing mechanisms.

This work may contribute to a better understanding of the neural basis of chronic dizziness and could help identify reliable biomarkers for future diagnosis and treatment monitoring in functional vestibular disorders.

Planned study

Clinic

#4 – THE PROCESSING OF BODY DRIVEN CONFLICTS IN ANOREXIA NERVOSA: AN EEG STUDY

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Conflict and error monitoring are crucial for cognitive control and may be impaired in psychiatric disorders, including Anorexia Nervosa (AN). Indeed, individuals suffering from AN can show impairments in processing conflicting body-related representations and adapting behavioural adjustments following errors. Although recent studies suggest that patients with AN are emotionally and perceptually sensitive to the processing of body-related stimuli, the neurophysiological mechanisms underlying their performance monitoring remain underexplored. The N2, error-related negativity (ERN), and mid-frontal theta activity (MFθ) are key electrocortical markers of conflict and error processing. While recent evidence indicates altered patterns of these signals during the processing of neutral conflicts, it remains unclear whether encoding of conflicting body-related stimuli is also affected by the body representation distortion that characterizes AN symptomatology.

This study investigates the neural signatures of performance monitoring in AN by examining

both event-related potentials and oscillatory activity during exposure to conflicting body stimuli. We will recruit 24 female AN patients and 24 healthy controls. Participants will complete a Body-Flanker task, involving congruent and incongruent trials, with underweight and overweight body silhouettes presented in both upright and inverted orientations. EEG will be recorded with a 64-channel system and analysed in both the time and frequency domains. Behavioural and neural measures will be subjected to 2×2×2 mixed ANOVAs. Additionally, EEG and behavioural indices will be correlated with psychometric scores.

We hypothesize impaired performance monitoring and altered neural responses to conflicting body stimuli in AN patients. The results may provide novel insights into the neurocognitive mechanisms underlying body representation in AN, with potential therapeutic implications.

Planned study

Cognition

#5 – TACTILE REINSTATEMENT IN EPISODIC MEMORY RECALL

- **Benito, L (1)** | (1) *Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Barcelona, Spain*

Episodic memory, the capacity to remember past experiences, contributes to the construction of the sense of self. Remembering past episodes involves the reactivation of neural activity present during encoding, a phenomenon known as reinstatement, observed both in cortical and subcortical regions. Cortical reinstatement has been shown in the visual and auditory domains, and more recently in pain and motor processing. However, how body ownership and other self-related aspects shape memory encoding and reinstatement remains under investigation. Within this framework, tactile reinstatement is still unexplored. Touch is a key modality through which we experience the body as our own and interact with the environment. Investigating tactile reinstatement is therefore essential to understand embodied memory. It can reveal whether, and if so, how, sensory traces anchored to the body contribute to the re-experience of past events.

This project will test whether tactile stimuli are reinstated during memory recall similarly to other modalities. We will examine its modality specificity, temporal dynamics, and relation to the subjective experience of recollection through an EEG experiment. Participants will encode images paired with either a tactile vibration or an auditory stimulus delivered at specific frequencies, eliciting steady-state responses in the corresponding sensory cortices. After one hour, participants will complete a recognition task with a mix of old and new images. Tactile reinstatement will be assessed by power increases in the frequency band associated with vibrotactile stimulation. We will also evaluate whether the degree of reinstatement correlates with subjective confidence in memory. Comparison with the auditory condition will allow us to determine the specificity of reinstatement to the sensory context experienced during encoding.

Planned study

Cognition

#6 – DIFFERENCES IN PROCESSING SPATIAL PREPOSITIONS BETWEEN YOUNGER AND OLDER ADULTS: AN MEG STUDY

- **Hidalgo Chagoya, JR (1), Cui, H (1), Højlund, A (1, 2), Wallentin, M (1, 2, 3)**

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Rationale: Spatial prepositions are closed-class linguistic items that encode spatial relations or locations of objects. Behavioral studies have shown that both the naming and comprehension of spatial relations are negatively affected by aging. This deterioration in spatial relation processing has been associated more with a decline in visuospatial abilities than with a decline in non-spatial verbal performance. As visuospatial processing has been linked to parietal areas in the brain, we expect to observe differences in parietal cortex activity between younger adults and older adults, during spatial language processing around 400 ms, as measured by MEG. This study aims to inform our understanding of the neural underpinnings of processing spatial prepositions across different age groups as well as any related cognitive decline in typical aging.

Method and materials: Two participant groups will be recruited, all meeting the general inclusion criteria of being right-handed, having Danish as their first language, and having no

neurological or psychiatric conditions. The first group will consist of 30 younger adults (aged 18–30), while the second group will include 30 older adults (aged 50+), matching in years of education and sex.

All participants will complete an initial background questionnaire and a behavioral battery. They will then perform the Spatial Preposition Verification Task (SPVT) during MEG recording. In this task, participants judge (true/false) whether a picture featuring two objects accurately depicts the spatial relation described by a previously presented preposition. The SPVT includes two types of spatial prepositions, with a control condition consisting of an object recognition task using the same visual stimuli. Finally, participants will undergo a T1-weighted MRI scan.

For data analysis, we will use beamforming for source reconstruction. Classification tests will then be implemented per time point across conditions and groups.

Planned study

Cognition

#7 – TOWARD UNDERSTANDING EQUINE ATTENTION: A PRE-STUDY USING EEG AND THE ODDBALL PARADIGM

• **Ilmer, I (1)** | (1) *Doctoral School in the Social Sciences, Jagiellonian University, Cracow, Poland;* (2) *Centre for Cognitive Science, Jagiellonian University, Cracow, Poland*

Horses are social mammals with strong flight responses, making them a unique model for studying attention in non-human species. Although horses have a long history of close interaction with humans, the neural basis of equine attention remains underexplored. Previous equine electrophysiological (EEG) research has focused on pathology, stress, anaesthesia, or sleep using frequency analyses, but to date, only one small study has examined event-related potentials (ERPs).

This planned study aims to investigate the neural correlates of visual attention in horses using a passive visual oddball paradigm. Its objectives are to identify ERP components analogous to human N2 and P3, and to examine perceptual lateralisation in response to spatially distributed stimuli. Fifty horses will be tested across two conditions combining centralised or spatially dispersed visual stimuli, with each condition including two different visual stimuli (standards and deviants) presented at fixed intervals.

Since the study will be conducted in accordance with the highest ethical standards, all horses will be selected based on health and temperament, habituated to EEG equipment, and tested in controlled stalls to minimise stress. EEG and synchronised video recordings will be collected, with ERP amplitude and latency analysed using established preprocessing methods and software tools.

Identifying N2- and P3-like components will extend neuroscientific methods to horses, enabling precise study of attention and perception, revealing spatially driven neural differences, and providing a foundation for comparative cognitive neuroscience. Understanding equine attention is also critical for animal welfare and human safety, as unexpected stimuli often trigger flight responses. Equally importantly, this study will support further comparative research contributing to a deeper understanding of human cognition.

Planned study

Cognition

#8 – EEG SPECTRAL FEATURES AS INDICATORS OF BRAIN RESPONSES TO THE URBAN ENVIRONMENT

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Neurourbanism is an emerging field that investigates how urban environments influence mental health. This research area has gained momentum in recent years due to the availability of wearable devices, enabling experimentation in real-world settings or highly ecological environments such as virtual reality (VR). The unique advantage of wearable technologies, including mobile EEG, fNIRS, EDA, and ECG sensors, is their ability to capture objective physiological data outside the laboratory, pushing the boundaries of neuroscience. To use wearable technologies effectively, preliminary laboratory research on the urban features most relevant to mental health is essential. One of the most informative EEG measures in neurourbanism is spectral features (SF), which demonstrate consistent associations with stress in multiple studies. This is important, as features of the urban environment, such as building height, street width, greenery, sky visibility, and crowding, can

modulate stress. In our forthcoming study, participants will evaluate pictures of urban environments varying in these features and will have EEG recorded in typical laboratory settings. The experimental design consists of a 2x2 block structure, manipulating building height (high vs. low) and street width (wide vs. narrow), while additional features such as greenery, visible sky, and vehicle presence are also present. Following statistical analyses of SF, we will apply machine learning (ML) methods to examine to what extent the type of stimuli can be predicted based on the extracted features. Different feature selection algorithms will be implemented, and the prediction accuracy will serve as an indicator of the underlying connection between the SF and specific stimulus characteristics. The aim of this study is to extract and conceptualize relevant urban stressor features using objective physiological measures, providing a foundation for mobile and VR research in ecologically valid environments.

Planned study

Cognition

#9 – AHA! IN THE BRAIN: THE NEURAL MARKERS OF INSIGHT PROBLEM-SOLVING

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An “Aha! moment” corresponds to the moment the solution to a problem suddenly pops into consciousness. The phenomenological experience of the “Aha! moment” is characterized by a feeling of suddenness and pleasure and by an increased confidence in the solution. On a neural level, insight problem-solving has been shown to be different from an analytical step-by-step problem-solving. In this study, we plan to use a multi-step puzzle to further investigate the difference between insight and analytical problem-solving at each step of the solving processes. We plan to record participants’ neural activity with an EEG, as well

as the heart rate and skin conductance of the participants. Through an analysis of the event related potentials after the response and time frequency before finding the answers, we expect to find the markers associated with insight in the frontal, parietal, and occipital lobes for insight solutions. In accordance with the previous literature, we also expect an increased heart rate for analytical problem-solving and a greater skin conductance for insight problem-solving. We also hypothesize that we will be able to find the neural markers of insights within the different steps of the puzzle, even when the solution is ultimately found analytically.

Planned study

Cognition

#10 – THE EFFECTS OF SUBCORTICAL NEURAL ENCODING ON SECOND LANGUAGE PHONETIC LEARNING

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During speech perception, salient phonetic information is extracted from the acoustic stream. This process is subject to individual differences, as listeners vary in how categorical they are in distinguishing between phonemes, and in what acoustic cues they use for this purpose (Kapnoula, 2016). Recent findings reveal that individual differences in the neural encoding of speech underlies this variability (Ou and Yu, 2021).

Languages differ in how they distinguish phonological contrasts acoustically. While English voiced and voiceless stops feature short vs. long positive Voice Onset Time (VOT) durations, in French they display negative vs. short positive VOT durations, respectively. As French voiceless stops overlap with English voiced stops in terms of VOT, English natives learning French must retune their existing perceptual categories to the durational parameters of the target language.

Individuals vary in how successful they are at retuning during learning (Yamada and Zatorre,

1992). We hypothesise that individual differences in how acoustic-phonetic input is encoded subcortically and cortically, as measured with EEG, can significantly impact, and thus predict, success in second-language perceptual learning.

We propose a pretest-training-posttest study with English learners of the French word-initial voicing stop contrast. During pre- and posttest, 40 American English subjects will be tested on their perception of the French contrast via a Visual Analogue Scaling (VAS) task, and their scalp-recorded electrophysiological activity will be collected during passive listening to series of syllables containing the target sounds. Between pre- and posttest, subjects will be trained to differentiate the contrast in 8 sessions of high-variability online phonetic training (Melnik and Peperkamp, 2021). 40 French listeners will follow the same protocol, but they will complete a non-linguistic training paradigm to mirror the procedure followed by the English cohort.

Planned study

Cognition

#11 – TOWARDS A PROTOCOL TO FIND NEUROPHYSIOLOGICAL MARKERS OF COLLABORATION

• **Meunier, J (1), Rimbert, S (1, 2), Prouzeau, A (3), Lotte, F (1, 2)** | (1) *Inria center at the university of Bordeaux, France*; (2) *LaBRI, Talence, France*; (3) *Université Paris-Saclay, CNRS, Inria, France*

Workspace awareness is the real-time understanding of the activity of collaborators within a shared workspace (Dourish et al. 1992 ; Gutwin et al. 2002). As highlighted by Prouzeau and Rimbert (2024), while existing tools can track observable actions, they struggle to capture underlying cognitive processes behind the actions, known as collaborative coupling [4]. To study such collaborative cognitive processes, hyperscanning, a method that use passive Brain-Computer Interface (BCI) to simultaneously monitor neural activity across multiple brains using electroencephalography (EEG), can be used to highlight synchrony indices in the signal (Toppi et al., 2016; Aruon et al., 2024; Ramirez-Moreno et al., 2023).

We plan to study neurophysiological markers of collaboration through a first experiment based on a validated task: a path-finding task with constraints regularly used to study collaborative coupling (Inkpen et al., 2023; Prouzeau et al., 2017). In this task, each collaborator will have to

navigate a path from one point to another, ensuring that their routes intersect only at two specific points. This task allows addressing complex aspects of collaboration such as coordination and decision-making (McGrath, 1984) and to study different levels of collaboration. For instance, using this task, Prouzeau et al. (2017) found that using two screens compared to one shared screen lowered the level of collaboration between the two participants. Inspired by this, we propose two conditions: a high-collaboration condition using a shared screen and a low-collaboration condition with separate screens and rooms, where only a cursor provides information about the collaborator. Additionally, as explored through formal specification (Dan Pan et al., 2018), we could introduce miscommunication to create a third condition, reflecting a misalignment in the collaboration. We aim to find EEG patterns, specific for each condition.

Planned study

Cognition

#12 – MINDS IN CONFLICT: EXPLORING COGNITIVE IMPACTS AND TRAUMA TRANSMISSION IN THE COLOMBIAN INTERNAL ARMED CONFLICT

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There is a gap in the literature regarding the cognitive impact of conflict on war-affected populations (victims and perpetrators). The Colombian Internal Armed Conflict (CIAC) provides a distinct context for such research. Findings indicate a high prevalence of Post-Traumatic Stress Disorder (PTSD) among victims and ex-combatants (perpetrators) of the CIAC. Studies using electroencephalography (EEG) have shown that trauma and PTSD result in heightened bottom-up processing, impaired inhibition, and reduced top-down control. However, these findings have not been replicated in individuals affected by the CIAC. Furthermore, research suggests parental trauma and PTSD lead to an increased sensitivity to PTSD, known as intergenerational trauma

transmission (ITT). Although there is preliminary evidence indicating ITT for processing biases, more research is required. To address these gaps, the current project will work with victims, ex-combatants, and their offspring to explore alterations in cognitive processes resulting from CIAC exposure and ITT. We will record brain activity with EEG across six tasks focusing on either emotional processing or non-emotional processing. We expect previously found biases in trauma-exposed and PTSD patient populations to be replicated as well as more severe impairments in victims compared to ex-combatants for emotional processing. We hypothesize similar but milder biases will be observed in offspring as in their CIAC-exposed parents.

Planned study

Cognition

#13 – NEURAL CORRELATES OF HUMANNESS PERCEPTION IN SPEECH

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The growing presence of computer-generated speech in everyday life is driving us to study how listeners perceive synthetic voices. Recently, we found that text-to-speech (TTS) generated voices were perceived as sounding less human than recordings of human voices. This raises the question of whether TTS voices are processed differently from human voices and whether such differences can be measured in the brain. Previous studies have found associations between alpha band power and the voice quality of TTS-generated voices (Maki et al., 2018; Parmonangan et al., 2019). Here we propose a different approach to investigate the neural correlates of humanness perception, using a representational similarity analysis to relate multi-channel brain activity data with behavioral measures. This method was recently applied by Lavan et al. (2024) and revealed neural

correlates of voice identity cues, of physical traits such as gender and age as well as social traits such as attractiveness and trustworthiness. We hypothesize that the humanness of a voice might be another voice identity trait with its own neural correlates. To this end, we will record EEG from participants listening to sentences spoken by several human and TTS-generated voices while performing a 1-back task to keep their attention maintained. In a second session, participants will rate each stimulus on a 1-100 scale for how human the voice sounds to them. We will correlate EEG recordings with behavioral ratings using a representational similarity analysis to determine if there is a neural correlate of humanness and, most importantly, when in time neural activity significantly correlates with the humanness perception.

Planned study

#14 - MEDITATION-BASED NEUROFEEDBACK FOR THE INCREASE OF FRONTAL ALPHA ASYMMETRY SCORES AND REDUCTION OF MALADAPTIVE AVOIDANCE IN HIGH-TRAIT ANXIETY

• **Percolla, E, (1), Pfeiffer, M, (1), Ziebell, P, (1,2), Kübler, A, (1) | (1) Psychology I - Intervention Psychology, Julius-Maximilians-Universität Würzburg, Würzburg, Germany; (2) Psychology V - Differential Psychology, Julius-Maximilians-Universität Würzburg, Würzburg, Germany**

This study investigates whether individuals with elevated trait anxiety and maladaptive avoidance can learn to increase frontal alpha asymmetry (FAA) scores through meditation-based neurofeedback. Participants will be screened online, and eligible individuals will be invited to the laboratory. During the first session, they will complete behavioral assessments and perform an emotion-eliciting task to establish baseline FAA scores. Participants will then be randomly assigned to either a control group (waiting-list paradigm) or one of two intervention groups: explicit or implicit neurofeedback.

Intervention groups will complete five training sessions. Each session begins with recorded audio instructions, followed by a 30-minute training consisting of four blocks: two 5-minute

meditation blocks and two 5-minute meditation-based neurofeedback blocks, with short breaks in between. After the final session, all groups will repeat the behavioral and neurophysiological assessments conducted at baseline. We expect both intervention groups to show increased FAA across training sessions. At the pre-post level, we hypothesize higher FAA scores during the emotion-eliciting task, alongside reduced negative affect and avoidance scores on behavioral measures.

This study aims to advance understanding of the neurophysiological and behavioral mechanisms underlying maladaptive avoidance in subclinical anxiety. The findings may contribute to the development of cost-effective, targeted interventions for the prevention of more severe anxiety-related disorders.

Collected data study

Clinic

#15 – **DOPAMINERGIC MODULATION OF SPATIO-SPECTRAL EEG DYNAMICS DURING BCI LEARNING: A DOUBLE-BLIND ANALYSIS**

• **De Poi, E (1, 2), Grigoryan, KA (1), Vidaurre, C (3, 4, 5), Kapralov, N (1, 6), Sehm, B (1), Nikulin, N (1*), Villringer, A (1*)** | (1) Neurology Department, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany; (2) International Max Planck Research School on Cognitive NeuroImaging (IMPRS CoNI), Leipzig, Germany; (3) Basque Center on Cognition, Brain and Language, Basque Excellence Research Centre (BERC), San Sebastian, Spain; (4) IKERBASQUE, Basque Foundation for Science, Bilbao, Spain; (5) Machine Learning Dp, TU-Berlin, Berlin, Germany; (6) International Max Planck Research School NeuroCom, Leipzig, Germany | *Share senior authorship

Background:

Stroke, a leading cause of long-term disability, leaves many survivors with persistent motor impairments, highlighting the need for more effective rehabilitation. While conventional therapies offer limited recovery, Brain-Computer Interface (BCI), a promising alternative, translates brain activity into device commands, bypassing damaged neuromuscular pathways and fostering neuroplasticity. However, BCI adoption is hindered by "BCI inefficiency", a phenomenon where 15% to 30% of users fail to achieve reliable control, often due to weak sensorimotor rhythms and cognitive factors.

Aim:

To address this, our study explores a novel strategy: combining BCI training with dopaminergic modulation. We investigate whether levodopa, a dopamine precursor, can enhance BCI learning by leveraging dopamine's effect on neuroplasticity and motor performance.

Methods:

In a double-blind, between-subjects design, 22 healthy participants were randomly assigned to either levodopa or placebo group. For 6 days, they underwent daily 1-hour motor imagery BCI sessions with RecoveriX (g.tec), receiving their assigned substance 30 minutes prior.

Expected results:

We hypothesize that levodopa will enhance BCI learning by modulating key neurophysiological markers of motor imagery, such as event-related desynchronization and synchronization (ERD, ERS) and Signal to Noise Ratio (SNR). We expect these neural changes to correlate directly with BCI accuracy. We will also analyze the effect of levodopa on functional connectivity; however given the existing body of conflicting longitudinal research, we anticipate a potentially complex relationship with BCI learning.

Significance:

By improving BCI learning speed and accuracy, this strategy could make the technology more accessible and effective for stroke survivors and other patients with severe motor impairments.

Collected data study

Cognition

#16 – DEVELOPMENTAL DIFFERENCES IN AUDITORY DURATION DISCRIMINATION: DISENTANGLING TIMING, PITCH, AND EXECUTIVE CONTRIBUTIONS

- **Arlaud, S (1), Noreika, V (1) |** (1) SBBS, Queen Mary University of London

This study investigates developmental differences in perceptual timing among participants across different age groups through three distinct sessions: a neuropsychological assessment, a behavioral task session, and an EEG session. The duration discrimination task, supplemented by a pitch discrimination task, serves as the primary focus to discern potential age-related variations in auditory processing and executive functions. Specifically, variability in thresholds among younger participants in the duration discrimination task may indicate not only changes in perceptual timing sensitivity but also developmental maturation of underlying cognitive processes such as working memory, sustained attention, decision making, and motor control. The pitch discrimination task is designed to control for these possibilities. Behavioral effects observed solely in the duration discrimination task would suggest maturation of perceptual timing, while effects observed in both

tasks, alongside a positive correlation between them, would indicate the influence of general auditory maturation and/or executive functions on developmental changes in duration discrimination.

Machine Learning methods and UMAP analysis were employed serving the aim to examine how EEG data differentiate between standard and deviant classes, as well as with respect to gender and age. Additionally, a General Mixed Linear Model has been utilized to investigate the significance of age differences in targeted brain areas highlighted through spatial temporal cluster permutation analysis. Finally, SHAP (SHapley Additive exPlanations) was employed to interpret model predictions, allowing for a comparison of differences across classes and pairwise models. This multifaceted approach promises to provide further understanding of developmental differences in perceptual timing as well as their neural correlates.

Collected data study

Cognition

#17 – IN UTERO DETECTION OF FETAL BRAIN RESPONSES TO LIGHT USING OPM-MEG

• **Capparini, C (1), Langford, Z (1), Wens, V (1), Ferez, M (1), De Tiège, X (1), Bertels, J (1)** | (1) *Laboratoire de Neuroanatomie et Neuroimagerie translationnelles (LN2T), Université libre de Bruxelles, Bruxelles, Belgium*

In the last trimester of pregnancy, the human fetus already exhibits a remarkable ability to process external sensory inputs, including light and sound. Investigating the neural basis of this fetal perceptual ability has traditionally relied on cryogenic magnetoencephalography (MEG). However, the widespread adoption of fetal MEG has been hindered by the high cost and scarcity of cryogenic systems suited to pregnant participants, which remain confined to a couple of specialized research centres worldwide. In this work, we adapted a cryogen-free MEG system based on optically pumped magnetometers (OPM-MEG) to demonstrate the possibility to record brain activity in response to visual stimulation already in utero. The OPM sensors are lightweight and wearable, making them an ideal candidate for flexible and scalable MEG applications. At present, 16 pregnant women in their third trimester (32-36 weeks of gestation)

participated to this study. The procedure includes an ultrasound before and after the OPM acquisition to determine fetal head position and orientation. For the OPM acquisition, sensors are organized onto an adaptable abdominal belt. We record fetal brain activity in response to 500 ms LED flashes presented at two locations over the maternal abdomen (180 trials per location), according to the fetal head position in the womb. Data collection is still ongoing. Preliminary results reveal great intersubject variability in detecting a visual evoked response, especially depending on fetal head position and head-sensors distance. Additional results will be presented at the meeting. Establishing the feasibility of OPM-MEG to record brain responses before birth would enable non-invasive and scalable studies across developmental stages.

Collected data study

Cognition

#18 – PUBERTY-RELATED ELECTROPHYSIOLOGICAL CHANGES UNDERLYING SPEECH PERCEPTION IN NOISE: A STUDY OF ADOLESCENT FUNCTIONAL CONNECTIVITY AND CORTICAL TRACKING OF SPEECH

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Adolescence is a period of heightened neuroplasticity underlying the improvement of cognitive and perceptual skills required to succeed in complex social environments. Among these, the ability to perceive speech signals in the presence of noise is crucial in teenagers' daily-life interactions. The neurobiological underpinnings of speech perception in noise (SIN) protracted development remain poorly understood, but likely stem from changes at the endocrine and neural levels. As part of the SensationHL pubertal development cohort collection, this study investigates the effects of puberty on the electrophysiological changes underlying auditory and cognitive development supporting SIN.

We will present cross-sectional data from a set of participants, who are part of a two-years longitudinal cohort providing measures of pubertal stage, hormonal levels, cognitive functions and SIN. Multimodal neuroimaging including single-voxel spectroscopy, diffusion imaging, and high-density

electroencephalography to evaluate neurotransmitters concentrations, structural and functional connectivity, cortical tracking of speech in noise and oddball-evoked responses. From such data, we aim at inferring upon the mechanisms of neuroplasticity involved in adolescent neurobehavioral development.

We focus on preliminary HDEEG results from our first time-point data collection. We expect developmental changes in functional connectivity, cortical tracking of speech in noise and oddball-evoked responses to correlate with pubertal stage progression. Moreover, we predict an association between improvement in complex auditory skills, cognition, and puberty-associated electrophysiological maturation.

Our results will be discussed with respect to the neurobiology of adolescent development. Moreover, they hold potential for practical implications: the emphasis on SIN addresses a real-world challenge with effects on academic performance and social interactions during this sensitive developmental phase.

Collected data study

Cognition

#19 – PRIMING DISOBEDIENCE

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Milgram's obedience experiments highlighted the influence of situational and social factors on behaviour. Caspar (2021) introduced a novel paradigm devoid of cover stories, adaptable to neuroscientific methods, focusing on disobedience research. Their findings revealed that awareness of Milgram's experiment isn't the primary determinant of participants' decisions to (dis)obey, despite explicit mentions during the experiment. This led us to explore whether priming (dis)obedience could impact behaviour and specific neural aspects.

Conducting a neuro-behavioural between-subject study, we will explicitly prime (dis)obedience in participants. The second study aims to prime disobedience either implicitly or explicitly. These studies collectively address the research question: 'Can we prime prosocial disobedience?'. Each study will involve approximately 80 participants or 40 pairs (working with dyads), employing the same

paradigm as introduced by Caspar (2021). While results are pending, we anticipate observing effects in both brain activity and behavioural responses due to the priming of disobedience. We will take a closer look at the actual rate of disobedience, feeling of Responsibility, Empathy and Sense of Agency, as well as ERP components and specific brain waves on the EEG. This research contributes to my PhD's overarching theme: an exploration of neurocognitive processes and disobedience to immoral orders, providing insights and potential interventions to enhance resistance. Understanding these dynamics provides valuable insights for navigating moral dilemmas and developing interventions to enhance prosocial resistance. By unravelling the intricacies of priming effects on behaviour and neural responses, this study contributes to our understanding of human decision-making in morally challenging contexts with real-world applications.

Collected data study

Cognition

#20 – INVESTIGATING INTRA-USER VARIABILITY IN BCI: A MULTI-SESSION, MULTI-CONTEXT EXPERIMENTAL PROTOCOL

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BCI performance is significantly affected by inter-subject variability—differences across users—and intra-subject variability—fluctuations in the same user over time (Saha & Baumert, 2020). EEG signals and BCI performance fluctuate due to the interaction of several potential sources of variability including context, time of day, as well as user engagement and fatigue (Grosse-Wentrup & Schölkopf, 2013; Dehais et al., 2019; Benaroch et al., 2021; Roy et al., 2022). While machine learning helps mitigate these effects, an understanding of the specific variability factors affecting BCI performance and EEG features remains limited.

We designed an experimental protocol to measure, understand and model the variabilities affecting BCIs. 20 healthy participants, each completed 6 sessions, scheduled on different days, alternating between mornings and afternoons. Sessions begin with baseline recordings, followed by 6 runs: 2 acquisition runs with sham feedback and 4 training runs with

online feedback. Each run includes 3 mental tasks in random order: motor imagery, mental subtraction and word association. Participants perform the tasks using two distinct contexts: Graz, a low-stimulating context and Brain Hero, a highly-stimulating context with background noise. After each run, participants completed multiple questionnaires, assessing their psychological states (e.g., alertness, fatigue) and user experience (e.g., interest, engagement).

We aim to perform a series of analyses to investigate how intra-subject variability affects EEG features and BCI performance by: (i) correlating these measures with variability factors (context, time of day, fatigue/attention; (ii) analyzing the evolution of their spatial and time-frequency features (ERD/ERS) across sessions, contexts, times of day, and mental states (e.g., mental fatigue); (iii) identifying EEG subspaces most sensitive to intra-subject variability, in order to develop predictive multivariate models.

Collected data study

Cognition

#21 – THE NEURAL CORRELATES OF INTERNAL AND EXTERNAL COGNITIVE DOMAINS

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Previous research has investigated the neural distinction between internal and external cognitive domains using tasks that contrast self-referential processes with externally-oriented judgments, primarily through fMRI studies employing color preference paradigms. To investigate the temporal dynamics and neural sources distinguishing internal versus external cognitive domains, we conducted a study using a color preference task with MEG. We employed event-related analysis and source localization

techniques to identify the spatiotemporal patterns of brain activity that differentiate between internally-oriented (preference-based) and externally-oriented (similarity-based) cognitive processes. This MEG approach allows us to characterise both the timing and cortical sources of neural activity underlying the distinction between internal and external cognitive domains, extending beyond the spatial resolution provided by previous fMRI investigations.

Collected data study

Cognition

#22 - TWO PATHS TO MENTAL FATIGUE: EFFECTS OF COGNITIVE UNDERLOAD AND OVERLOAD ON MENTAL FATIGUE AND INHIBITORY CONTROL

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Mental fatigue impairs inhibitory control, a key executive function involved in suppressing impulsive responses and resolving conflicts, which is critical for effective decision-making and behavioural regulation. Yet, subtle differences in inhibitory brain function arising from prolonged underload (non-adaptive, non-executive task) versus overload (adaptive, executive task) remain underexplored. The present study investigated the differential effects of prolonged underload and overload on mental fatigue and inhibitory control. Participants attended two laboratory sessions, each involving completion of a distinct fatigue-inducing task, preceded and followed by a set of computer-based ERP evaluation tests (Flanker and Go/No-Go tasks). Subjective ratings of

workload, fatigue, sleepiness, and boredom were collected alongside electroencephalographic (EEG) and electrocardiographic (ECG) signals to capture psychophysiological markers of mental fatigue. Perceived fatigue increased similarly during underload and overload. However, underload induced greater sleepiness and boredom, whereas overload elicited higher perceived workload. Behavioural and psychophysiological analyses are ongoing. These findings are expected to advance understanding of how different cognitive demands modulate inhibitory function under fatigue and to inform strategies for mitigating fatigue-related performance impairments in both low- and high-demand environments.

Collected data study

Cognition

#23 – LEARNED SEMANTIC ASSOCIATIONS FROM REAL-WORLD EVENTS CO-OCCURRENCES INFLUENCE THE AUDITORY PERCEPTIONS OF NATURALISTIC SOUNDS SCENES. A PILOT STUDY

• **Marinato, G (1), Ferreyra, C (1), Esposito, M (2), Plegat, M (1), Formisano, E (2), Giordano, BL (1)** | (1) *Institut de Neurosciences de la Timone, CNRS, Aix-Marseille Univ., Marseille, France*; (2) *Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands*

Humans naturally integrate acoustic details with higher-level contextual knowledge when interpreting the rich acoustical structures encountered in daily life. While prior research has suggested that statistical regularities influence our auditory perception through predictions, internalized schemas and attention (Southwell et al., 2017; Woods & McDermott, 2018), our focus shift instead on the semantic role (Giordano et al., 2023) of the contextual regularities.

Specifically, we explore how the typical co-occurrence of sounds (e.g., birdsong with rustling leaves, traffic noise with car horns), may influence our representation and understanding of the auditory scenes.

To investigate whether such co-occurrence statistics shape neural responses to complex sound mixtures, we considered a large-scale corpus of machine-generated descriptions of real-world scenes (Auto-ACD; Sun et al., 2023) to build semantic models of sound-event relationships, including both Word2Vec

embeddings and frequency-based co-occurrence statistics. We tested these models against magnetoencephalography (MEG) data, recorded while participants listened to 10 seconds long, naturalistic sound scenes, comprising common environmental and man-made sounds.

For each sliding time window of the sensor-level MEG signal, we computed representational dissimilarity matrices (RDMs), and assessed their alignment with model-based predictions using representational similarity analysis (RSA).

Our study helps framing the research on top-down and bottom-up processes in auditory scenes perception, exploring how even relatively abstract semantic models can partially explain brain activity patterns of listeners. Future work should explore more refined semantic structures, task-driven modulations, and the integration of multimodal context to deepen our understanding of real-world sound processing in the human brain.

Collected data study

Cognition

#24 – FROM PERCEPTION TO DECISION : EMERGENCE AND VARIATION OF CONFIDENCE DURING DECISION MAKING

• **Mathieu, L (1, 2, 3), Somon, B (1), Mazoyer, P (3), De Grancey, F (3), Drougard, N (2), Sarrazin, JC (1)** | (1) ONERA, Salon de Provence, France; (2) ISAE SUPAERO, Toulouse, France; (3) THALES, Toulouse, France

Trust is central in human-AI teaming. In order to understand how trust towards automated systems emerges, confidence at individual level needs to be deepened. While the emergence of confidence can be regarded as inherent to the decision-making process using metacognition and accumulation evidence theories, its variation can be regarded as a temporal variable whose dynamics change over time and that can be studied through learning theories. Here, we aim to identify cognitive markers of confidence, at different levels of descriptions, and assess the effect of learning on confidence evaluation during decision making. To this end, participants performed a perceptual decision-making task of varying difficulty to account for evidence accumulation, confidence in their own decision and prediction emerging from implicit learning on task difficulty (with feedback on their performance). Subjective, behavioral and electroencephalographic measures were recorded during the task. We focus on an event related potential component: the Central

Parietal Positivity (CPP), an accumulating evidence variable that predicts confidence. Building on the interpretation of the CPP as an index of evidence accumulation, we further investigate this process using the Drift Diffusion Model (DDM) to unravel the dynamics of decision making. We also examine the relationship between these variables as well as metacognitive computations and learning effect. Manipulating task difficulty resulted in two distinct conditions, with participants showing better performance (higher accuracy, d' and meta d') and confidence rate in the easy condition compared to the hard one. Further analyses are expected to highlight CPP features and DDM parameters as well as an improvement of metacognitive reliability through implicit learning. Eventually, the identified markers can be transposed to a supervision task in which an operator rates his confidence towards system decisions, improving our understanding of trust in AI.

Collected data study

Cognition

#25 – NEUTRALITY DOESN'T EXIST. AN EEG STUDY OF MICRO-VALENCE

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Introduction:

As noted by Zajonc, "We do not just see 'a house': we see 'a handsome house', 'an ugly house', or a 'pretentious house'". All perceptions are colored by their valence (positivity or negativity). According to recent theories this valence would play an important role in conscious perception (Cleeremans & Tallon-Baudry, 2022, Barrett & Bar, 2009) and could drive our subsequent behaviors (Shenhav, 2024). This suggests the omnipresence of valence. Even a priori neutral experience would have a valence or a micro-valence (Lebrecht, 2012; Mentec et al., under review). Our study aimed at understanding the

(dis)similarities between the neural correlates of macro- and micro-valences.

Methods:

Fifty participants took part in an EEG study. Pictures of everyday objects and affective loaded pictures were presented. Participants were asked to passively look at the pictures or to rate explicitly their valences depending on the block. ERPs analyses and multi-variate pattern analyses will be conducted to test the (dis)similarities between macro- and micro-valences processing. Moreover, the passive condition will allow us to test the automaticity of valence evaluation as in Lebreton (2009) for both macro- and micro-valences.

Collected data study

Cognition

#26 – "CARDIAC CYCLE, REACHING MOVEMENTS AND MOTOR IMAGERY" (CARMi)

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Background: The human brain integrates sensory information with internal physiological signals, particularly cardiovascular activity (Azzalini et al., 2019). Research shows that cardiac timing influences cognition, with perceptual abilities enhanced during diastole, while motor cortex excitability and action is facilitated during systole (Birren et al., 1963; Al et al., 2023; Kunzendorf et al., 2022). Previous studies examined basic motor tasks, leaving gaps in our understanding of cardiac influences on complex movements and motor learning.

Objective: This study examines relationships between cardiac timing and motor performance during complex reaching sequences, investigating how heart phase affects reaction times, movement accuracy, and motor learning across different conditions.

Design and Methods: We conducted a secondary analysis of existing behavioural and electrocardiographic data from 60 participants (30 females, 30 males, aged 18-35 years) completing a force field adaptation paradigm

(Gippert et al., 2025). Participants were randomized into three groups: active (executing sequential reaches), motor imagery (imagining movement before execution), and control (single reach execution). Cardiac phase was analyzed as binary categories (systole/diastole) and continuous circular variables. Linear and generalized mixed-effects models examine relationships between cardiac timing, reaction times, and movement error dynamics.

Expected Outcomes: We hypothesize that movement initiation timing relative to cardiac phase will influence reaction speed and accuracy, with potential differences between execution and imagery conditions. We predict entrainment between cardiac rhythms and motor cues throughout motor learning. Exploratory analyses will examine central brain processes, captured with EEG, leading to the expected effects.

Significance: Findings will advance the understanding of cardiovascular-motor system interactions in naturalistic contexts.

Collected data study

Cognition

#27 – BETA DYNAMICS AND CORTICOSPINAL EXCITABILITY DURING MOVEMENT PREPARATION

- **Patnaik, M (1), Denyer, R (1), Sulcova, D (2), Lambert, J (1), Duque, J (1) |**

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Transcranial Magnetic Stimulation (TMS) is a powerful non-invasive method to probe corticospinal (CS) excitability in humans. When applied over primary motor cortex (M1), TMS elicits motor-evoked potentials (MEPs) that index the state of the CS pathway. Many studies show a paradoxical preparatory suppression of CS excitability: during action preparation, MEP amplitudes decrease relative to baseline, not only in task-irrelevant muscles but also in those about to be recruited. Although robust, the neural mechanisms driving this suppression remain unclear. Neural oscillations provide a promising candidate. Beta rhythms (13–30 Hz) over sensorimotor cortex are tightly linked to motor preparation and execution. Beta power typically decreases (event-related desynchronization, ERD) during preparation, remains suppressed during movement, and rebounds after termination. Yet, the relationship between beta dynamics and preparatory suppression has not been systematically

examined. Here, we test whether the strength and timing of beta oscillations explain variability in preparatory suppression. We combine suprathreshold single-pulse TMS (120% rMT) over left M1 with concurrent EEG while participants perform a visuomotor instructed-delay reaction time task requiring left or right index finger abduction. TMS pulses are delivered either between the preparatory cue and imperative signal or during inter-trial intervals (baseline). EEG is analyzed with time–frequency methods to quantify beta modulation, and MEPs are expressed relative to baseline. Data from 11 right-handed participants have been collected so far, with recruitment ongoing. We hypothesize that stronger beta ERD will correspond to deeper CS suppression in irrelevant muscles, while beta rebound reflects release of suppression in selected effectors. By linking oscillatory markers of motor preparation with CS output, this work aims to clarify the functional role of beta rhythms in action control.

Collected data study

Cognition

#28 – ELECTROPHYSIOLOGY AND MEMORY CONSOLIDATION ACROSS DIFFERENT POST-ENCODING ACTIVITIES: AN EEG STUDY

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Humans spend a substantial part of their time awake in so-called offline states, where they are less responsive to the demands of their immediate surroundings. A possible benefit of this frequent disengagement could be increased memory consolidation during such offline states. One established method to study these states in humans involves instructing participants to rest for a few minutes while remaining awake – commonly referred to as wakeful rest. It has been shown in typical wakeful rest studies that participants remember more previously presented information when they engage in wakeful rest, as compared to a cognitively demanding task subsequent to information presentation. By measuring electrophysiological activity (EEG) during the interval following information presentation, we can identify neurophysiological substrates related to memory consolidation and elucidate the wakeful rest effect.

Thus, in our study, we recruited 30 healthy older participants ($M = 69.07$, $SD = 8.61$), presented

them with short prose passages, and for 12 minutes following the story presentation they were tasked with either (1) resting with closed eyes while remaining awake, (2) relaxing with their eyes closed while counting their breath (3) or engaging in cognitively demanding tasks. We employed a repeated measures design, with each participant experiencing all post-encoding conditions. Condition order was counterbalanced across participants. We measured EEG of the participants throughout the whole experiment.

Initial findings show that memory performance of the participants is independent of their post-encoding activity. However, neurophysiological activity during the post encoding interval is related to memory performance.

Those initial results could be a first step in developing new treatments for memory impaired populations, e.g., by using the neural correlates of memory consolidation as targets for neuromodulation techniques.

Collected data study

Cognition

#29 – RESTING-STATE EEG GAMMA OSCILLATIONS AS BIOMARKERS FOR MEMORY PERFORMANCE

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Associative memory, a critical element of social cognition, is frequently compromised in the prodromal phases of dementia, including Alzheimer's disease.

Gamma oscillations (γ , 30-120 Hz) are integral to advanced cognitive processes, such as multisensory integration (Senkowski et al., 2009) and the consolidation of memory (Hanslmayr et al., 2016), serving as a fundamental mechanism in neural communication.

This study aimed to determine if resting-state EEG spectral power could predict performance in associative memory tasks.

24 young adults participated in 2 rsEEG recordings and tests assessing working memory (WM), immediate recall (IR), and delayed recall (DR). Spectral power was analysed with linear regressions, with memory indices as dependent variables.

For high-gamma (h- γ , 51-100 Hz), the models showed significant associations with both immediate (IR, $p = .023$) and delayed recall (DR, $p = .021$). Frontal and temporal h- γ activity

exhibited statistically significant positive correlations with recall performance, as indicated by IR ($\beta = 0.95$, $p = .013$) and DR ($\beta = 1.14$, $p = .006$). Central and posterior h- γ activity demonstrated statistically significant negative correlations with recall performance (IR: $\beta = -2.26$, $p = .036$; DR: $\beta = -1.13$, $p = .016$).

Theta power showed a trend toward significance for IR ($p = .096$). Posterior theta (θ) was positively associated with IR ($\beta = 1.51$, $p = .013$), while frontal θ was negatively ($\beta = -1.73$, $p = .018$). For low-gamma (l- γ , 30-49 Hz), we found a trend for DR ($p = .076$), with temporal l- γ positively predicting performance ($\beta = 1.06$, $p = .019$).

Spontaneous γ activity in specific brain regions supports multimodal memory processes. Frontal/temporal h- γ supports encoding and retrieval, while posterior θ and temporal l- γ contribute to recall. Thus, resting EEG gamma activity appears to be a promising biomarker for associative memory (Griffiths & Jensen, 2023) and a potential tool for the early detection of cognitive decline.

Collected data study

Cognition

#30 – SENSE OF AGENCY. TO ADAPT OR NOT ADAPT. "HOW" IS THE QUESTION

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The sense of agency (SoA) is the feeling of control over one's actions and outcomes. For simple actions, both a prospective component, which relies on action preparation, and a retrospective component, which relies on the comparison between predicted and actual sensory feedback, contribute to SoA. In addition, SoA has been shown to adapt to the environment. Yet the contribution of these neural substrates to SoA has been scarcely studied.

The present study aims at 1) disentangling the neural correlates of the prospective and retrospective components of the SoA 2) investigating the neural markers of SoA adaptation. For this, we developed an algorithm aimed at presenting to participants a consequence shortly before they complete an action and recorded MEG signal. During an image recognition task (800 trials), participants were instructed to press a button upon identifying an image to trigger its offset. Based on each participant's recent behavior in the task, the image offset was scheduled 42–142 ms

before the predicted button press. Participants report on each trial their SoA over the image offset.

Preliminary results (N=21) show that participants' button press was successfully anticipated in $31 \pm 11\%$ of trials (range 12–55%). Throughout the task, the participants felt agent over images offset occurring earlier and earlier relative to their button press, suggesting an increase of SoA. Preliminary MEG analyses revealed distinct univariate activity patterns of the prospective and retrospective component of the SoA (resp. before and after the image offset) and significant decoding of the retrospective component.

At the behavioral level, we confirmed our previous online study showing that participants progressively feel agency over events occurring before their action. At the neural level, we expect to clarify the prospective vs. retrospective contributions as well as the adaptation of SoA, which may be differentially impaired across neuropsychiatric conditions.

Collected data study

Cognition

#31 – TOUCH IN CONFLICT: ENHANCING MOVEMENT CONTROL WITH TACTILE EXTERNAL CUES

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Touch bridges perception and action by combining exteroception, which provides information about the environment (e.g. texture), with interoception, which monitors bodily states (e.g. movement direction), to guide our interactions with the world. However, in a visuomotor task with conflicting visual and somatosensory input (mirror paradigm), the processing of somatosensory information compromises movement control. In this context, interoceptive touch increases the sensory conflict, disrupting performance. Given the brain's ability to prioritize relevant sensory cues, we explored whether adding an external spatial component to touch could reduce the effect of interoceptive touch. Seventeen adults traced the contour of a white-textured 2D shape on a smooth black surface (interoceptive and exteroceptive-spatial cues) with their index finger, receiving either direct or mirror-reversed visual feedback. A control group (n=17) traced a

white shape with the same texture as the black surrounding surface (interoceptive cues). We hypothesized that spatial exteroceptive cues would improve tracing accuracy with mirror-reversed vision. Indeed, finger kinematics revealed significantly greater tracing accuracy when spatial exteroceptive cues were present compared to when only interoceptive touch was available. EEG source analyses showed distinct sensorimotor strategies. The presence of spatial exteroceptive cues significantly increased the activity of the sensorimotor cortex while tracing with mirror compared to direct vision. Conversely, in the absence of spatial exteroceptive cues, the visual cortex showed significantly increased activity, suggesting enhanced reliance on visual information. Our results suggest that the presence of external tactile information, congruent with environmental visual input (here the shape), can reduce sensory conflict and enhance movement control.

Collected data study

Methods

#32 – RELIABLE ESTIMATION OF REPRESENTATIONAL DISSIMILARITY MATRICES ON MAGNETOENCEPHALOGRAPHY DATA

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Reliable estimation of representational dissimilarity matrices (RDMs) with practical temporal and spatial resolution from neuroimaging modalities, such as magnetoencephalography (MEG), remains an open challenge. While certain MEG data processing practices, like noise covariance estimation, are beneficial for RDM computation, others can introduce unexpected effects. This study investigates the estimation of sensor-level and source-level RDMs using a dataset where participants listened repeatedly to a diverse set of natural sounds. We systematically explored the effects of various noise covariance methods, beamformer source localization parameters, and additional MEG-analysis options (e.g., baseline correction), on time-varying RDM statistics. Given the challenges of estimating noise covariance on source-localized MEG data, we explored the use of beamformer weights to

estimate a whitening matrix for the source-level noise. Our analysis revealed that a noise whitening matrix based on the Ledoit-Wolf estimator yielded the best cross-validated squared Mahalanobis RDM statistics at the sensor level, but not necessarily at the source level. Furthermore, we found that the rank of the data and noise covariance matrices is a highly sensitive parameter for source-level RDMs. In contrast, cross-validated correlation RDMs proved to be robust across different parameter configurations and noise covariance estimators. We also observed that baseline correction introduces unexpected biases in the time-varying mean and variance of the RDMs. Our analyses highlight key challenges and propose potential solutions for the reliable computation of representational dissimilarity matrices from MEG.

Collected data study

Methods

#33 – RESCUING EEG SIGNAL QUALITY WHEN DRY ELECTRODES GET THIRSTY

• **Huang, Y (1), Michela, A (1), Colangelo, C (1), Ros, T (1)** | (1) *NeuroTuning Laboratory, Department of Clinical Neurosciences, University of Geneva, Geneva, Switzerland*

With the rapid advancement of clinical neuroscience and Brain-Computer Interfaces (BCIs), there is an increasing demand for convenient, patient-friendly EEG acquisition methods suitable for diverse environments, including home-based settings. Traditional gel-based EEG systems, while reliable, are often cumbersome and time-consuming, whereas dry electrode systems tend to suffer from elevated noise levels.

In this study, we investigate whether wetting the hair with water can enhance EEG signal quality in dry electrode systems by improving scalp electrode conductivity.

To this end, we recruited 22 healthy participants and compared their resting-state (RS) EEG activity across three experimental conditions (dry, wet, and gel) within a single-session design. Specifically, we analyzed electrode impedance,

spectral power (SP), and functional connectivity (FC). Our results show that wetting the hair significantly reduces electrode impedance and improves both SP and FC measures relative to dry electrode application. While gel remains the gold standard, our findings indicate that water-wetted hair represents an intermediate condition between dry and gel, more closely resembling gel performance than dry.

Although this method does not fully match the signal quality of traditional gel-based systems, it represents a promising compromise, enhancing EEG data quality under suboptimal conditions. This approach offers a practical and non-invasive means to improve EEG signal integrity, ultimately increasing the reliability and usability of EEG-based applications in real-world, user-friendly contexts.

Collected data study

Methods

#34 – ROLE OF ORBITOFRONTAL OSCILLATIONS IN EFFORT-BASED DECISIONS: INSIGHTS FROM THE COMBINATION OF TACS, EEG, AND COMPUTATIONAL MODELING

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Animals, including humans, must constantly decide whether to engage (or not) in physical efforts to reach rewarding goals. This key process – usually referred to as effort-based decision-making – has been linked to a key fronto-striatal network, encompassing the orbitofrontal cortex (OFC), the supplementary motor area (SMA), the dorsal anterior cingulate cortex (dACC), and the ventral striatum. Previous research has demonstrated that activity in these structures is preferentially modulated by either reward magnitude (OFC), prospective effort (SMA) or both (dACC and ventral striatum). Interestingly, reward valuation in the OFC has been linked to oscillatory responses in specific frequency bands, including the theta (4 to 8 Hz)

and beta (15 to 35 Hz) bands. However, these studies were correlational, and the causal role of OFC oscillatory activity in effort-based decisions, if any, remains untested. To address this gap, we recruited 20 healthy participants in a randomized, double-blind, sham-controlled study. Participants had to perform an effort-based decision-making task, with concurrent high-density transcranial alternating current stimulation in three different conditions (sham, theta stimulation at 6 Hz, and beta stimulation at 20 Hz). To investigate the impact of stimulation on neural activity, both task-based and resting-state electroencephalography measurements were acquired before and after stimulation. EEG data processing is currently ongoing.

Collected data study

Methods

#35 - **HARMONIZING GAMMA: THE EFFECTS OF 40 HZ AND 60 HZ AUDITORY AND TRANSCRANIAL STIMULATION ON ENTRAINMENT**

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Gamma waves (30–120 Hz) are critical for numerous cognitive processes and are frequently disrupted in many neuropsychiatric disorders (Guntekin et al., 2023). Transcranial alternating current stimulation (tACS) and auditory stimulation (rAS) have gained attention for non-invasively modulate brain activity by delivering rhythmic current over the scalp (Manippa et al., 2022; 2024). Despite their potential, little is known about how different frequencies and stimulation sources influence neural entrainment in healthy adults. The aim of this work is to investigate narrow-band gamma entrainment after 5 minutes of 40 Hz and 60 Hz sinusoidal waveform rAS and temporal tACS. Twenty-four healthy young adults completed two experimental days, one with rAS and one with tACS. Within each day, participants received both 40 Hz and 60 Hz stimulations in a counterbalanced order. Resting-state EEG with eyes closed was recorded before and after each stimulation. ANOVA 2 (rAS vs tACS) $\times$ 19

(electrodes) in the 40Hz narrow band yielded no significant main and interaction effects. However, the one sample t-tests showed negative entrainment in P₄ and a positive one in Fp₁ for the rAS; while positive entrainment was observed in Fz after tACS. Conversely, in the 60Hz narrow band, ANOVA 2 $\times$ 19 yielded only a significant stimulation main effect ($p = 0.031$). The one sample t-tests showed a positive one in P₈ and F₃ for the rAS; while a negative entrainment in C₄, Cz, and P₃ was observed after the tACS. These findings emphasize the distinct patterns of gamma entrainment due to slow (40Hz) and fast (60Hz) auditory and electric stimulation. While 40Hz stimulation generates a frontal positive entrainment regardless of the stimulation source (Han et al., 2023; Helfrich et al., 2014). Conversely, while 60Hz rAS positively entrains fast gamma activity, tACS induces a desynchronization, likely due to the difficulty of electrically driving higher frequencies (Krause et al., 2022).

Collected data study

Methods

#36 – **LOCAL NEURAL CIRCUIT DYNAMICS EVOKED BY TMS REVEALED USING THE HUMAN NEOCORTICAL NEUROSOLVER (HNN) BIOPHYSICAL NEURAL MODELING SOFTWARE**

• **Sliva, DD (1), Gao, J (1), Tajchman, (1) & Jones, SR (1)** | (1) Jones Lab, Brown University, Providence, USA

Transcranial magnetic stimulation (TMS) is a non-invasive method for probing and modulating cortical activity, and has been increasingly adopted as an efficacious treatment for neuropsychiatric disorders. While prior studies have simulated effects of TMS-induced electrical fields on single neurons, it remains unclear how TMS drives complex interactions of cells at the local neural circuit level, and how these dynamic interactions relate to clinical outcomes. Our lab has developed an open-source neural modeling software called the Human Neocortical Neurosolver (HNN) that can uniquely address these challenges by revealing the neural circuit-level generators of the EEG-measured evoked response to TMS.

HNN is a biophysically principled neocortical column model, enabling one-to-one comparison between simulated primary current dipole signals and source localized EEG in equal units (nAm). A high level of biophysical detail facilitates multiscale interpretation of the neural origins of recorded signals, including layer- and

cell-specific spiking activity, that can be used to further develop and test model-derived predictions.

Single biphasic pulses of TMS (spTMS) were delivered to the left primary somatosensory cortex (SI) with concurrent EEG. Evoked responses were source localized to a 10mm region (constrained to SI) of maximum activation within 100ms post-TMS using MNE-Python. HNN was then used to interpret the cell- and circuit-level mechanisms generating estimated source waveforms.

Our model predicts that spTMS drives an initial transient burst of inhibitory cell spiking followed by a more prolonged pattern of inhibitory and excitatory activity that is consistent with invasive animal recordings, producing a simulated waveform in close agreement to recorded data. Such model predictions provide a framework to probe patient responses and/or optimize TMS protocols to further advance treatment for neuropsychiatric disorders.

Collected data study

Methods

#37 – EEG SPECTRAL CORRELATES OF ADAPTIVE CREATIVITY: PRELIMINARY RESULTS AND A NOVEL PIPELINE FOR REPRODUCIBLE ANALYSIS

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Adaptive creativity is central to rehabilitation after disability or trauma, with mental imagery offering a potential means to enhance it (Smith et al. 1995). Motor visual and kinesthetic imagery represent two distinct strategies, yet their relative effectiveness for enhancing creative processes remains unclear. EEG studies have shown that alpha-band activity is involved in creative processes, with different alpha patterns reflecting idea generation versus elaboration (Rominger et al., 2018, 2020).

A preliminary EEG dataset was collected to explore the impact of these two forms of mental imagery on figural creativity. Participants completed blocks of trials in which they engaged either in motor visual imagery, kinesthetic imagery, or a control condition prior to performing a creative drawing task. To rigorously analyze the EEG signals, we developed a reusable pipeline in MNE-Python (<https://mne.tools/stable/credit.html>) allowing the exploration of the spatio-spectral content

and the comparison of experimental conditions using robust statistical approach. We used Linear Mixed-Effects (LME) modeling to capture both condition-level effects and inter-subject variability in combination with a well establish non-parametric method to correct for multiple comparison: the cluster-based permutation (Maris and Oostenveld 2007). This allowed to identify cluster of significance between the experimental conditions. Finally, the pipeline was deployed on a High-Performance Computing (HPC) architecture, enabling parallel processing of multi-participant data and accelerating large-scale analyses.

Here, we present the results of the preliminary study and introduce the developed pipeline, which combines LME modeling with cluster-based permutation testing to provide a robust, reproducible approach for investigating the spectral neural basis of adaptive creativity and guiding imagery-based cognitive rehabilitation.

Analysed data study

Clinic

#38 - CHANGES IN EEG BETA FUNCTIONAL CONNECTIVITY DURING NARRATIVE LISTENING REFLECT LINGUISTIC-PRAGMATIC IMPAIRMENT IN SCHIZOPHRENIA

• Frau, F (1)*, Venturini, R (1)*, Canal, P (1), Aubonnet, R (2), Agostoni, G (3), Arcara, G (4), Cavallaro, R (3), Di Lorenzo, G (2), Bosia, M. (3), Bambini, V (1)
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Language difficulties are a hallmark feature of schizophrenia, especially affecting higher-level pragmatic abilities, and are linked to alterations within the language network. Yet, little is known about functional connectivity (FC) mechanisms underlying pragmatic difficulties in this population. Here, we aimed to link FC within the language network to the pragmatic skills (assessed using the APACS Test) of 49 participants with schizophrenia, who were engaged in a 5-minute-long narrative passive-listening task during EEG recording. Signal underwent an automated pre-processing pipeline (summarized here: <https://tinyurl.com/4k5vdxfc>), followed by the extraction of phase-based static connectivity matrices from source-level oscillations in α , low- β , high- β , low- γ , and high- γ frequency bands across 39 ROIs, reflecting the language network for discourse processing. Participants were divided into three groups based on whether they had pragmatic impairment (mild or severe) or not. Group differences in FC were tested using

permutation tests across ROIs and frequency bands, followed by hierarchical regression models, testing for the role of clinical and cognitive covariates on the FC edges that significantly varied between groups. We observed significantly decreased FC in low- β between left temporo-parietal and right fronto-temporal regions and increased FC between homologous contralateral superior temporal regions in the contrast between severely impaired and unimpaired patients. The group factor was always significant and contributed more to the models' fit than the clinical and cognitive covariates. Here, we show that during narrative listening, β oscillations in the language network vary with pragmatic abilities in schizophrenia. These results align with the hypothesis that altered β oscillations reflect disrupted predictive mechanisms that might underlie language disorganization in this population, highlighting potential implications for linguistic-pragmatic remediation.

Analysed data study

Clinic

#39 – INFORMATION PROCESSING AND SENSORY PLASTICITY DEFICITS IN GAMBLING DISORDER ASSESSED USING MISMATCH NEGATIVITY AUDITORY ODDBALL AND VISUAL LTP ERP PARADIGMS

• **Kleine, P (1), Gurney, M (1), Spriggs, M (1), Nutt, D (1), Erritzoe, D (1), Zafar, R(1), Godfrey, K (1)** | (1) *Centre for Psychedelic Research, Imperial College London, UK*

Gambling Disorder (GD) is a behavioural addiction with an increasing global burden. GD pathology includes reward processing and impulsivity impairments, indicating executive function deficits. However, knowledge of the underlying neurobiological mechanisms of GD remains limited. Improved identification of the neural substrates of GD may help develop novel therapeutics for the treatment of GD.

Mechanisms of auditory information processing and visual Hebbian plasticity were investigated in GD patients (n=15) and age-matched healthy controls (HC) (n=12) using auditory oddball mismatch negativity (AO) and visual long-term potentiation (vLTP) ERP paradigms. For each paradigm, the mean amplitude of difference-wave ERP components was compared in GD and HC using a likelihood ratio test (LRT) mixed-effects model and post-hoc estimated marginal means.

Independent LRT and follow up post-hoc analyses revealed significant reductions in AO P₃ (324 – 398ms) (FDR corrected) and trend-level

reductions in AO MMN (194 – 300ms) (uncorrected) component mean amplitude in GD, compared to HC, across multiple electrodes, indicating attentional information processing deficits in GD. Additionally, trend-level reductions in vLTP P₂ (166 – 246ms) component mean (uncorrected) in GD compared to HC indicate preliminary evidence of impaired capacity for Hebbian plasticity processes in GD. Relationships with gambling-related symptomatology were assessed using LRT mixed-effects models. Gambling severity (PGSI) showed a positive association with MMN mean amplitude in GD (FDR corrected).

These findings indicate neurophysiological dysfunctions in auditory information processing and visual Hebbian plasticity processes in GD patients. The association between MMN amplitude and gambling severity indicate a potential objective neurophysiological marker of gambling-related symptom severity, though replication in larger samples is required.

Analysed data study

Cognition

#40 – PERFECTIONISM AND FEEDBACK PROCESSING ACROSS COGNITIVE TASKS

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Feedback plays a fundamental role in guiding behavior and supporting adaptive decision-making. Yet, the extent to which individual differences shape neural responses to feedback remains unclear. The present research investigated associations between selected personality traits and electrophysiological markers of feedback processing, focusing mainly on the feedback-related negativity (FRN/RewP). Across two studies, a large sample of participants completed three experimental paradigms commonly used to probe performance monitoring: a modified Go/No-Go task, the Monetary Incentive Delay task, and the Flanker task, while their neural activity was recorded with EEG. Mixed-effects regression models were used to test the influence of

feedback valence, task context, and individual differences such as perfectionism.

The findings showed robust neural sensitivity to negative versus positive feedback, with the magnitude of this effect varying across tasks. In particular, feedback-related activity was most pronounced in the Go/No-Go task, while it was attenuated in the Monetary Incentive Delay task. Across both studies, individual differences in perfectionism did not reliably predict variations in feedback-related ERP components.

Together, these results highlight the role of task context in shaping feedback processing at the neural level, while suggesting limited influence of perfectionism on electrophysiological markers of feedback sensitivity.

Analysed data study

Cognition

#41 – INVESTIGATING THE ELECTROPHYSIOLOGY OF ICONIC MEMORY THROUGH PARTIAL REPORT

• **Bonfanti, D (1), Mele, S (1), Bertacco, E (1), Mazzi, C (1), Savazzi, S (1) | (1)**

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A precise characterization of the electrophysiology of iconic memory is still lacking, especially regarding the processes associated with stimulus storage, and their separation from post-perceptual ones. This study aims to fill this gap by using a partial report paradigm.

We collected data from 23 participants while recording EEG. Stimuli lasted 100 ms and consisted of six letters, symmetrically spread in a circular fashion around a fixation cross. After stimulus presentation, a specific acoustic cue instructed participants to report either the stimulus's left or right side. Participants completed 600 trials, divided into ten blocks of 60 trials each.

An ERP analysis revealed differences between the "Report Right" and "Report Left" conditions over ipsilateral parieto-occipital electrodes in the time window 850-1100 ms. Moreover, we found three components that were negatively correlated with accuracy: the P3 component at

338 ms, the temporo-occipital positivity at 730 ms, and the parieto-occipital positivity at 1060 ms. We also found a positive correlation between the 1060 ms parieto-occipital positivity and swap errors, and a positive correlation between the P3 component and the temporo-occipital positivity at 730 ms.

Electrophysiological differences emerged only late, from 850 to 1100 ms, which is in accordance with the iconic memory framework: while early conscious content is identical, different reporting conditions modulate exclusively post-perceptual processes. Moreover, the ERP correlations with accuracy show that information encoding for subsequent retrieval starts around 300 ms. In addition, the correlation between the P3 and the 730-ms peaks hints at two different processes – encoding and retrieval, respectively. The correlation of the 1060 ms peak with intrusion errors, finally, suggests that this component's activity might represent a filter for uncued letters.

Analysed data study

Cognition

#42 – NEURAL SPEECH TRACKING IN YOUNG COCHLEAR IMPLANTED ADULTS

• **Collesei, F (1), Fantoni, M (1,2), Iob, E (1), Federici, A (1), Bottari, D (1) |**
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Language acquisition relies on critical periods in early development when the brain is especially receptive to linguistic input. For typically hearing children, auditory exposure during this time is crucial for the maturation of neural systems that support speech perception and comprehension. In the case of congenital deafness, hearing may be restored through cochlear implantation, yet this intervention typically occurs no earlier than one year of age, following a period of auditory deprivation. This study explores whether young adults who were congenitally deaf but received early cochlear implants (CIs) process naturalistic speech similarly to their typically hearing peers at the neural level. To investigate this, EEG data were recorded from two demographically matched groups of young adults: 12 early-implanted CI users and 12 typically hearing controls. CI users received pre-surgery and post-surgery rehabilitation. Participants listened to short narratives presented in two formats

(audio-only, A and audiovisual, AV) and answered comprehension questions. Neural synchronization with the speech envelope was assessed at the individual level by measuring Temporal Response Functions (TRFs). Both groups exhibited clear TRFs in response to speech in both A and AV contexts. Notably, neural tracking was enhanced in the AV condition relative to the A condition for both groups, indicating that visual cues facilitate speech processing in both populations. CI users demonstrated significantly higher TRF amplitudes, potentially reflecting greater neural effort during speech tracking (all $p < 0.05$, cluster-corrected). Consistent with this interpretation, CI users achieved lower comprehension scores compared to their hearing peers ($p < 0.05$). These findings suggest that congenital deaf individuals who receive early implantation and pre- and post-surgery rehabilitation can develop efficient neural tracking of natural speech.

Analysed data study

Cognition

#43 – DO FRONTAL ALPHA ASYMMETRY (FAA) AND TEMPERAMENT SHAPE 9-MONTH-OLD INFANT SOCIO-EMOTIONAL STRESS REGULATION? A FACE-TO-FACE STILL-FACE STUDY

• **Cremaschi, G (1), Capelli, E (2) , Pili, MP (2), Torterolo, ELM (2), Riva, V (3), Billeci, L (4), Merazzi, D (5), Ghirardello, S (6) , Provenzi, L (1, 2) |** (1) *Developmental Psychobiology Lab, IRCCS Mondino Foundation, Pavia, Italy;* (2) *Department of Brain and Behavioral Sciences, University of Pavia, Italy;* (3) *Child Psychopathology Unit, Scientific Institute, IRCCS Eugenio Medea, Bosisio Parini, Italy;* (4) *National Research Council, Institute of Clinical Physiology, Pisa, Italy;* (5) *Mother's and Infant's Department, Valduce Hospital, Como, Italy;* (6) *Neonatal Intensive Care Unit, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy*

The present study investigated the interplay between behavioral, neurophysiological, and temperamental factors in 9-month-old infants exposed to the Still-Face Procedure (SFP), a well-established method to observe early social stress regulation. We examined whether frontal alpha asymmetry (FAA), measured via EEG during the Still-Face episode, and maternal reports of negative affectivity, assessed through the Infant Behavior Questionnaire–Revised (IBQ-R), were associated with infants' gaze aversion, conceptualized as a behavioral index of social stress regulation. Sixty-six 9-month-old infants participated in the SFP while continuous EEG was recorded. Infant gaze aversion behaviors were micro-analytically coded during the Still-Face episode to capture subtle regulatory responses. Mothers completed the IBQ-R, and the Negative Affectivity composite was extracted. FAA was calculated as the natural log difference in alpha power (6–9 Hz) between

right (F4) and left (F3) frontal sites, with lower values reflecting greater right-frontal activation, a pattern linked to withdrawal tendencies. Analyses revealed that only in infants with lower levels of temperamental negative affectivity, the use of more gaze aversion was associated with higher FAA levels. Infants that responded to perturbation with high negative emotionality showed increased FAA in the reunion episode, suggesting a more approach-oriented neurophysiological profile in the context of social stress. No significant associations emerged for other IBQ-R dimensions. These findings underscore the importance of considering individual differences in early affective dispositions when interpreting infants' behavioral and neural responses to social stress. Integrating EEG-based markers such as FAA with observational and parent-reported data offers a promising approach to understanding the mechanisms of early emotion regulation.

Analysed data study

Cognition

#44 – PRE-ATTENTIVE PROCESSING OF LEXICAL PITCH ACCENTS IN SOUTH SWEDISH: EVIDENCE FROM MISMATCH NEGATIVITY

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Lexical pitch accents are among the least studied tonal structures. Previous studies have investigated the neural representation of lexical tones. However, less is known about how lexical pitch accents in languages like Swedish and Norwegian are processed in the brain. In the present study, we used the electroencephalographic mismatch negativity (MMN) paradigm to sample the brain activity among South Swedish speakers passively listening to a minimal pair of words that only

contrasts in word accent. An identity MMN was calculated to show the automatic phonological processing void of acoustic information. Source localization indicated involvement of the left superior temporal gyrus and inferior parietal lobe. A conjunction analysis narrowed down the core results to the inferior parietal lobe. The brain thus seems to represent Swedish lexical pitch accents similarly to other lexical tones like Mandarin word tones.

Analysed data study

Cognition

#45 – NEURAL SYNCHRONIZATION WITH AUDIOVISUAL SPEECH DEPENDS ON A SENSITIVE PERIOD

• **Fantoni, M (1, 2), Federici, A (1), Camponogara, I (3), Handjaras, G (2), Pintonello, S (2), Nava, E (6), Bianchi, B (7), Debener, S (8), Orzan, E (2), Bottari, D (1)** | (1) *MoMiLab, IMT School for Advanced Studies, Lucca, Italy*; (2) *IRCCS materno infantile Burlo Garofolo, Trieste, Italy*; (3) *Zayed University, Abu Dhabi, United Arab Emirates*; (4) *Centro Interdipartimentale Mente/Cervello – CIMEC, University of Trento*; (5) *Centro Interuniversitario di Ricerca “Cognizione Linguaggio e Sordità” – CIRCLoS, University of Trento, Italy*; (6) *University of Milan Bicocca, Milan, Italy*; (7) *IRCCS Azienda ospedaliero-universitaria Meyer, Florence, Italy*; (8) *University of Oldenburg, Oldenburg, Germany*

Language acquisition relies on biological predispositions and exposure to appropriate sensory inputs at specific time windows. Behavioral studies indicate that the temporary lack of auditory inputs in the first year of life can alter the integration of audiovisual speech cues after hearing is restored with cochlear implants. Yet, the extent to which the functional development of neural circuits underlying such ability depends on postnatal sensitive periods remains uncertain. Here, we investigated neural synchronization with continuous auditory (A) and audiovisual (AV) speech in cochlear-implanted (CI) children with congenital (CD; N=20) or acquired deafness (AD; N=20) and in hearing control children (HC; N=35). The CD and AD groups differed in their exposure to functional hearing during the first year of life. We analyzed neural synchronization with the speech envelope and lip movements using uni- and multivariate encoding models of EEG data. Our findings revealed that neural synchronization with speech sounds was

significantly enhanced in the presence of AV speech vs. A speech in HC and AD groups. At short timescales (~0–100 ms), indicative of early auditory processing, the temporal response function to speech was markedly earlier when visual cues were available. This facilitatory effect was absent in the CD children. In agreement with existing literature, neural tracking of lip movements was more evident in children with CIs than in HC, with occipital activation between 0–60 ms. Behavioral data revealed that AV speech similarly improved comprehension scores in AD and CD groups compared to A speech, with a greater visual gain for the CD. Auditory deprivation in the first year hampers the development neural development for audiovisual speech integration, indicating a sensitive period where A (and AV) input is critical. This study identifies neural biomarkers of divergent developmental trajectories in CI children, offering insights for tailored rehabilitation.

Analysed data study

Cognition

#46 – HOW EARLY LIFE SENSORY EXPERIENCE AFFECTS CORTICAL PHONEME TRACKING

• **Federici, A (1), Fantoni, M (1), Battaglini, C (1, 2), Collesei, F (1), Handjaras, G (1), Orzan, E (3), Bianchi, B (4), Di Liberto, GM (5, 6), Bottari, D (1)** | (1) MoMiLab, IMT School for Advanced Studies Lucca, Italy; (2) Neurolinguistics and Experimental Pragmatics (NEP) Lab, University School for Advanced Studies IUSS Pavia, Italy; (3) IRCCS Materno Infantile Burlo Garofolo, Trieste, Italy; (4) IRCCS Meyer, Azienda Ospedaliero-Universitaria Meyer, Firenze, Italy; (5) ADAPT Centre, School of Computer Science and Statistics, Trinity College, The University of Dublin, Ireland; (6) Trinity College Institute of Neuroscience, Trinity College, The University of Dublin, Ireland

Native phoneme categories are typically established in the first year of life, guided by statistical distribution of speech sounds in the environment. But what happens when auditory experience is absent during this sensitive period? In cases of congenital deafness (CD), infants rely exclusively on visual speech cues and cannot distinguish minimal pairs of consonants that differ solely in acoustic features, such as /b/ and /p/. To test whether early auditory experience is required for encoding acoustic phonemic features, we recorded EEG responses to continuous speech in 37 hearing children (HC) and 38 children whose auditory function was restored with cochlear implants, half with CD and half with acquired deafness (AD). Only CD participants were auditory deprived during the first year of life.

We applied multivariate temporal response function modelling to predict individual EEG responses from hierarchically structured speech features: acoustic envelope, phoneme onsets,

and, selectively for visually indistinguishable consonant pairs, voicing (voiced or voiceless). Successful encoding was quantified as the additional EEG predictive gain obtained by including each phonemic predictor (phoneme onset and voicing) hierarchically in the models. In all groups, phoneme onset information improved prediction, indicating that this low-level phonemic feature is encoded independently of early auditory experience. By contrast, voicing was affected by early auditory deprivation: it improved prediction in HC and AD, but not in CD children, who showed significantly reduced voicing gain compared to AD peers.

These findings revealed that while basic timing-related phonemic information is encoded independently of the exposure to auditory input, the encoding of features that define phoneme categories critically depends on sensory experience during a sensitive period.

Analysed data study

Cognition

#47 - NEURAL ADAPTATION IN RESPONSE TO NOVEL STATISTICAL REGULARITIES IN SPATIAL SENSORIMOTOR INTEGRATIONS

• **Girondini, M (1), Bertoni, T (2), Boffi, P (1), Serino, A (3), Gallace, A (1) |**

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From early in life, humans learn to recognize statistical regularities—such as cause-and-effect relationships—through interactions with their environment. These sensorimotor experiences, whether active or passive, are typically multisensory and shaped by distinct spatiotemporal features. Yet, it remains unclear how humans adapt to novel spatial configurations during body–environment interactions.

To investigate this, we used virtual reality (VR) to artificially alter the motor–somatosensory loop. Our training protocol redirected tactile feedback from the right hand to either the contralateral left foot (CF training) or the ipsilateral right foot (IF training). Before and after training, we recorded somatosensory-evoked potentials (SEPs) from the hand (via the median nerve) and foot (via the tibial nerve) while participants

passively observed a virtual ball approaching the hand. Resting-state frequency analyses were also conducted.

The results revealed no significant changes in hand-level responses, although the CF group showed a trend toward reduced N140 amplitudes after training. By contrast, SEP responses at the tibial nerve level were altered in the CF but not the IF group, with CF training modulating early potentials (70–110 ms) in both contralateral and ipsilateral sensorimotor cortices. Resting-state analyses further showed a reduction in low-beta oscillatory power in the CF group.

Together, these findings highlight the rapid adaptability of the human sensorimotor system, driven by the statistical regularities that structure body–environment interactions.

Analysed data study

Cognition

#48 – ENHANCED SOMATOSENSORY PROCESSING DURING THE PLANNING OF ARM MOVEMENTS UNDER GRAVITATIONAL FORCE: AN EEG STUDY

• **Godines, A (1), Mouchnino, L (1, 2, 3), Gaveau, J (4), Blouin, J (1, 2)** | (1) Aix-Marseille Université, CNRS, Centre de Recherche en Psychologie et Neurosciences, UMR 7077, Marseille, France; (2) Aix-Marseille Université, CNRS, Institut des Sciences du Mouvement Etienne-Jules Marey, UMR 7287, Marseille, France; (3) Institut Universitaire de France; (4) Cognition, Action, et Plasticité Sensorimotrice, UMR 1093, Dijon, France

The effect of gravitational force varies considerably during ongoing arm movement, depending on the arm's orientation relative to the vertical axis of gravity. This variation is most pronounced during vertical movements and negligible during horizontal movements. Considering the gravitational force during rapid arm movements most likely relies on the integration of gravity-related sensory inputs from the movement planning stage (proprioceptive, visual, and vestibular). This study specifically investigated if proprioceptive feedback from the arm contributes, and if this contribution is greater for non-horizontal movements. Based on the premise that the cortical sensitivity increases with task-relevant sensory feedback, we hypothesized that the somatosensory cortex's response to vibration-induced stimulation of the shoulder muscles during movement planning

would be greater for non-horizontal movements. With their right arm fully extended and initially pointing straight-head at shoulder level, participants ($n=18$; 9F, 9M; mean age: 21 ± 3.92 years) produced rapid arm movements to targets in different directions (vertical up and down, 45° up and down, horizontal) upon illumination. All targets required 45° shoulder movements. Kinematic and EEG data were recorded. The 200 ms-vibration of the anterior deltoid started 100 ms after target onset (i.e., 270 ± 30 ms before movement initiation). Source analyses of the EEG signals showed significantly greater somatosensory cortical response for both vertical up and down directions compared to horizontal ($p < 0.05$), with a trend towards significance ($p = 0.08$) for diagonal up. This suggests that arm muscle proprioception is a key signal for the brain to account for effects of gravity on movements.

Analysed data study

Cognition

#49 – INTRUSIVE /ɛ/ IN SPANISH L1-ENGLISH L2 SPEAKERS: DISCREPANCY BETWEEN NEUROPHYSIOLOGICAL (MMN) AND BEHAVIOURAL RESPONSES TO L2 PHONOTACTICS

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We investigated the relationship between production and perception of L2 phonotactic constraints in Spanish L1-English L2 sequential bilinguals. De Leeuw et al. (2021) found that Spanish-English bilinguals made more mistakes than English monolinguals in same-different discrimination for non-words pairs (e.g. [spi-espi]). Surprisingly, no correlation was found between perception and production accuracy. To further examine this lack of production-perception link, our study employed an oddball paradigm. In this task, 17 Spanish L1-English L2 bilinguals and 21 English monolinguals listened to blocks of isolated standard and deviant non-words (e.g. [sma] vs [ɛsma]). As a behavioural perception measure, participants pressed a button when they heard a deviant trial (e.g., an [ɛsC] against a background of [sC], or vice versa). Concurrently, EEG recordings captured a neurophysiological measure of perception (ERP). For production, participants read aloud three customized short texts containing [sC] clusters in English.

The behavioural results were in line with de Leeuw et al. (2021): bilinguals were generally less accurate than monolinguals in both perception and production, yet no correlation emerged between the two, with some bilinguals showing high production but low perception accuracy. In contrast, a cluster-based permutation analysis of the ERP data revealed comparable perception accuracy across groups, as both showed similar MMN responses to the deviant stimuli.

The absence of group differences in the neurophysiological data suggests bilinguals' lower behavioural perception accuracy may reflect decision- or task-related factors, rather than a difficulty in perceiving the contrast.

Ref: de Leeuw, E., Stockall, L., Lazaridou Chatzigoga, D. & Gorba Masip, C. (2021) Illusory vowels in Spanish–English sequential bilinguals: Evidence that accurate L2 perception is neither necessary nor sufficient for accurate L2 production. *Second Language Research*, 37 (4), 587–618.

Analysed data study

Cognition

#50 – TRANSIENT REBOUND OF ATTENTION FOLLOWING BRIEF SPEECH DISRUPTIONS

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In everyday classrooms, learning is often disrupted by brief and unexpected comments or noises. These events are highly salient and capture attention, but it remains unclear whether their influence lingers or whether attention rapidly recovers. Most evidence on auditory distraction comes from oddball tasks with simple sounds, which demonstrate robust orienting responses but provide limited insight into real-world listening.

We addressed this gap by asking two questions: (1) What are the immediate neural and physiological responses to brief, semantically meaningful speech disruptions? (2) Do such disruptions leave lingering effects on attention and speech processing, or does the system quickly recover?

Participants (N = 60) watched a 20-minute educational lecture in an ecologically valid classroom-like setting, while neural activity (EEG) and skin conductance (GSR) were recorded. The lecture was divided into ~90-s segments, half of which contained short speech

comments starting with the Hebrew interjection “Wai” (akin to “Aw” in English), played from a lateral loudspeaker to mimic realistic classroom-like disruptions.

Results showed robust immediate responses to disruptions with common event-related potentials (ERP) components (P₅₀, N₁, P₂–P₃, N₄) and strong skin-conductance increases confirmed bottom-up orienting. At the moment of disruption, attentional markers were reduced, reflected in suppressed speech tracking and decreased alpha power. Crucially, these effects were short-lived. Within seconds, speech tracking, oscillatory measures, and Inter-subject correlations all rebounded, indicating rapid re-engagement of top-down control.

Together, these findings show that brief, naturalistic speech disruptions strongly engage bottom-up systems but do not cause lasting impairment. Instead, the brain demonstrates a transient and healthy rebound from disruption, highlighting the resilience and flexibility of attention in ecologically valid learning contexts.

Analysed data study

Cognition

#51 – INVESTIGATING THE EFFECT OF INFANT-DIRECTED SPEECH ON INFANTS' ATTENTION FOR AND LEARNING OF NOVEL WORDS

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Infant-directed speech (IDS) is the register typically used to address infants, and it differs from adult-directed speech (ADS) across several dimensions. Infants consistently prefer IDS, and while it has been argued to support language learning, the underlying mechanism remains unclear. Two possible explanations are IDS' simplified linguistic properties (Kalashnikova & Burnham, 2018; Kuhl et al., 1997), or its attention-grabbing characteristics (Nencheva & Lew-Williams, 2022). Previous studies have typically presented infants with stimuli in IDS and then tested learning for these stimuli, confounding the effects of their linguistic properties and attention capture on learning.

This study investigated whether IDS enhances infants' attention for and learning of subsequent linguistic input. In an initial training phase, we presented 9-month-old monolingual infants ($n = 37$) with cueing sentences in IDS or ADS, followed by word-object associations in a neutral register. Attention allocation was measured via

theta oscillatory power (3-5 Hz) during a short anticipation phase between cueing sentence and stimulus. During the test phase, learning was assessed via N400 amplitude differences for congruent vs. incongruent word-object pairs.

We found no systematic effect of speech register on theta power, but theta power significantly predicted the size of N400 differences in ADS. In the IDS condition, this effect was weakened. This indicates more automated processing of IDS, whereas ADS required active attention allocation to enable learning. These results match previous findings of increased attention and effects on learning for ADS vs. IDS (Schreiner et al., 2016; Peykarjou et al., 2024). Exploratory analyses will investigate the change in theta power over time, as well as the relationship between cortical tracking of the stimuli and theta power. This is especially relevant to further illuminate the relationship between language processing and attention during IDS/ADS input.

Analysed data study

Cognition

#52 – SENTENTIAL STRUCTURE MODULATES MEG RESPONSES IN NATURAL STORY COMPREHENSION

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Understanding language requires segmenting a continuous signal into units corresponding to different meanings: objects in noun phrases (NPs, e.g. a small dog), events / predicates in verb phrases (VPs, e.g. kick a ball), and sentences (modeling whole situations, like A small dog wanted to kick a ball). These units correspond to ways in which meaning is built with grammar. We hypothesized that the temporal neural signal should be sensitive to boundaries between these units. Prior literature found an effect of the quantity of nodes merged into a phrase (Nelson et al., 2017).

We analyze magnetoencephalography (MEG) data from Armeni & Schoffelen (2022), where three participants listened to ~10 hours of naturalistic audiobook narration. Using temporal response functions (TRFs), we test whether the inclusion of linguistic boundary information improves predictions of neural responses beyond what can be explained by acoustic and

low-level linguistic features (speech envelope, word onset and word frequency).

Preliminary results show that sentence boundaries significantly improve TRF cross-validation performance ($t=-7.269$, $p<.001$), particularly in bilateral temporal regions and the left supramarginal gyrus. In contrast, noun and verb phrase boundaries did not significantly enhance model performance.

Our findings suggest that lower-level grammatical units such as phrasal boundaries may not influence brain activity, at least not in the narrow time-frame analyzed (from -100ms to 600ms) - so meaning building of objects/events may lack a distinct neural response. This contrasts with Nelson et al.'s (2017) results, but our boundary measures capture something different, such as the building of a specific meaning (object/event/situation).

Analysed data study

Cognition

#53 – TEMPORAL DYNAMICS OF NATURAL SOUNDS REPRESENTATION IN THE HUMAN BRAIN

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Transforming natural sounds into knowledge of the auditory environment requires converting acoustic signals into semantic representations, but these processes are rarely modelled together. Moreover, extensive model comparison approaches have not been applied to time-resolved methods such as magnetoencephalography (MEG; De Lucia et al., 2010; Lowe et al., 2023), leaving the computational nature of dynamic cerebral representations unclear. While convolutional neural networks (CNNs) have been shown to best predict perceptual and fMRI representations (Giordano et al., 2023), their ability to account for dynamic cerebral responses to natural sounds remains unexplored.

We addressed these gaps by predicting MEG responses to natural sounds with three classes of models: acoustic, text-based semantic, and sound-processing CNNs. Specifically, we tested two CNNs differing only in training objective (Esposito et al., 2024): CatDNN, trained on sound-event categories, and SemDNN, trained

on continuous semantic embeddings (Word2Vec).

CNNs predicted brain responses more accurately than acoustic and text-based semantic models, especially in the right hemisphere. For acoustics, early MEG predictions were driven by Cochleagram and MTF (fine-grained acoustic features), while an Auditory Dimensions model (pitch, loudness, brightness, periodicity, roughness) dominated later latencies (800–1000 ms), suggesting higher-level processes in post-primary regions (right PT, STG). CNN analyses showed that early layers of both networks predicted responses around 250 ms, with CatDNN slightly superior. Later SemDNN layers best predicted responses at 500–800 ms, suggesting a switch from categorical to continuous semantic representations, with left-hemisphere predominance (HG, STG/STS).

Our results provide a temporally resolved computational account of natural sound representation, highlighting how CNNs reveal basic structural aspects of auditory semantics in the human brain.

Analysed data study

Cognition

#54 – DECODING VOICE IDENTITY IN AUDITORY WORKING MEMORY: AN MEG STUDY

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Auditory working memory (AWM) is critical for the temporary maintenance of sensory information, particularly in real-world communication contexts. Compared with visual working memory, the encoding of auditory features in working memory and their neural representation have remained less explored. As previous work has suggested that sounds are stored in working memory as objects including both task-relevant and -irrelevant features, we investigated whether we can decode both types of features from magnetoencephalography (MEG) signals during the delay phase of a working memory task. Stimuli were spoken syllables that differed both in perceived spatial location and voice identity (i.e., specific combinations of timbre and pitch). Participants were instructed to memorize voice identity (the

relevant feature), while location (the irrelevant feature) could be ignored. The task required a match non-match decision about a probe sound whose irrelevant feature could either be identical to or differ from the memorized stimulus. Behavioral results demonstrated an effect of irrelevant location on voice identity recall. Multivariate pattern analyses revealed that both task-relevant and -irrelevant features were decodable during the encoding phase. During delay, analyses provided some evidence for above-chance classification. In conclusion, both our behavioral and MEG data suggest that location information is encoded alongside voice identity, with delay-phase analyses hinting at persistent neural representation of both features.

Analysed data study

Methods

#55 – AN MEG SIGNAL PROCESSING PIPELINE TO CATCH DEEP SOURCES ACTIVITY MODULATED BY AN EMOTIONAL COGNITIVE TASK

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Magnetoencephalography (MEG) is a neuroimaging technique that offers excellent temporal and spatial precision, making it a valuable tool to study human cognition. However, while cortical sources activity estimation from MEG recordings is highly efficient nowadays, the estimation of deep sources remains challenging. This can be attributed to several factors, including the comparatively small amplitude of the signal in relation to that of the cortical sources. The present work aims to propose signal processing methods allowing to detect deep sources in MEG. We analysed an MEG dataset in which deep sources are expected to be at play in one condition but not another, to test whether our signal processing pipeline can account for subcortical activities modulated by a cognitive task. We analysed previously collected data from C. Lallement et al (2025): the task involved the presentation of IAPS images of neutral or strongly negative emotional valence, with the latter being hypothesised to activate the deep

neural regions involved in negative emotion processing such as the amygdala, the right insula, and the anterior cingulate cortex. Analyses have been run on 27 participants. The sensors-level signal is first decomposed into 50 components using Second Order Blind Identification. A time-frequency spectrum is computed for each component, and the power in the frequency band of interest is calculated at each time point. We then perform a linear regression of each component power in the frequency band of interest on the protocol, with an added contrast between neutral and negative picture. We then visualise the topography of significant components linked to negative pictures presentation. This allows to establish whether significant components topographies correspond to that of typical deep sources. The results are encouraging as components that have been significantly linked to negative images, in contrast to neutral ones, do show typical deep source topographies.

Analysed data study

Methods

#56 – CLASSIFICATION OF MENTAL WORKLOAD SPATIAL EFFECTS USING RIEMANNIAN MANIFOLD

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This study investigates the use of Riemannian geometry to classify mental workload from an EEG dataset collected in an aeronautical context. The analysis, based on EEG data recorded from 16 participants performing a Simon task, aimed to differentiate low and high workload conditions. Using covariance matrices

and a Minimum Distance to Mean (MDM) classifier, the results demonstrate spatial effects of mental workload irrespective of the investigated spectral domain. This demonstrates that spatial information is distributed evenly across all explored frequency bands.

Analysed data study

Methods

#57 – PRESERVING HARMONIC STRUCTURE IN FPVS-ODDBALL: A TWO-DIMENSIONAL CLUSTER-BASED PERMUTATION APPROACH

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The fast periodic visual stimulation oddball paradigm (FPVS-oddball), which combines multi-input frequency tagging with an oddball design, is a powerful electroencephalography (EEG) technique, for probing cognitive function. Traditionally, analysis collapses steady-state responses across harmonics into composite measures, which improves responses detection, but discards valuable information about the harmonic composition of responses. Here, we apply a two-dimensional (sensor x harmonic) permutation test, incorporating a novel free harmonic clustering procedure, that allows clustering across sensors and harmonics, thereby preserving harmonic-related information. Using datasets on object recognition (real vs pseudo-objects) and line

orientation discrimination, we show that the two-dimensional approach detects condition specific differences in the spatial and harmonic distribution of responses, that are missed by a one-dimensional (sensor only) test of composite responses. For object recognition, real objects elicited stronger left- and right-lateralised oddball responses at higher harmonics, consistent with additional semantic processing. For orientation discrimination, large versus small deviations elicited distinct harmonic-specific activation patterns, reflecting qualitatively different processing. These results demonstrate that two-dimensional cluster-based permutation testing allows sensitivity to the spatial and harmonic distribution of FPVS-oddball responses.

Analysed data study

Methods

#58 – A NEW FULLY AUTOMATED AND DATA-DRIVEN PIPELINE FOR ELECTRO-GASTROGRAPHY DATA ANALYSIS

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Electrogastrography (EGG) is a technique for recording electrical activity of the stomach using surface electrodes. In recent years, there has been growing interest in integrating stomach physiology, as measured via EGG, into psychological sciences. However, EGG signals have historically been challenging to analyze due to the weak electrical activity of the stomach at the body surface and the presence of numerous motion and electronic artifacts.

We present a new, rigorous, and data-driven pipeline for analyzing EGG data. This pipeline is based on a recent time-frequency representation (TFR) technique called the Superlet transform, which provides significantly improved time and frequency resolution compared to traditional TFR methods such as wavelet transform or Short-Time Fourier Transform.

Leveraging the enhanced time resolution of this technique and the fact that motion artifacts are highly energetic and localized in time, the pipeline can reliably identify artifact-

contaminated recordings using an entropy measure (Tsallis entropy) of the signal's instantaneous energy as a weighted frequency marginal of the Superlet TFR. Once artifacted segments are detected, they are removed through a combination of local Tukey fence analysis, Robust Random Cut Forest, and Connectivity-Based Outlier Factor algorithms.

After artifact removal, both classical EGG metrics—such as dominant frequency and power—and novel features exploring both frequency and time dimensions are extracted to construct a characteristic EGG fingerprint for each recording channel and participant.

Additionally, the presence of reliable oscillatory dynamics in the signal—indicative of structured physiological activity rather than stochastic noise—is assessed through Monte Carlo surrogate testing using AR(1,q) noise models.

The full pipeline has been evaluated using EGG recordings with controlled artifact contamination and resting-state signals from healthy participants, showing robust results.

Analysed data study

Methods

#59 – EVALUATING AND IMPROVING THE EXTRACTION OF MEG AND/OR EEG ACTIVITY FROM BRAIN AREAS OF INTEREST USING CROSS-TALK FUNCTION

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Neuroimaging studies often analyze and interpret results by referring to specific areas of the brain defined according to various parcellations based on anatomical, cyto-architectural, functional, and/or connectivity-based criteria. In MEG and EEG (M/EEG) analyses, it can be convenient to extract time series of activity that originates from such regions of interest (ROIs). Results of the subsequent analyses (e.g., connectivity) are then attributed to the selected ROIs.

Due to the spread of electric and magnetic fields, M/EEG recordings contain a mixture of activity of all sources within the brain. Commonly used approaches for extraction of ROI activity only partially alleviate this problem, and field spread remains a challenge even on the level of ROI time series. Because of the remaining field spread (RFS), extracted time series capture activity not only from the target ROI but also from other (not necessarily neighboring) ROIs. The amount of RFS can strongly affect the

validity of interpretations: with more RFS, the extracted time series becomes less representative of the target ROI. Unfortunately, both the amount and the pattern of RFS are generally not known.

In this study, we use cross-talk function (CTF) to analyze contributions of all sources within the brain to the extracted signal, thereby quantifying the degree of RFS. We show how CTF is related to the extraction of ROI activity and estimation of inter-regional connectivity. We observe that effects of RFS on the extraction of ROI activity are non-uniform, with deeper ROIs being more prone to capturing activity from ROIs that are closer to recording sensors. Finally, we show that CTF can be used to optimize the extraction of ROI activity but caution is required to avoid overfitting, especially if only a template head model is available for the analysis. Overall, our results illustrate how CTF can be used as a diagnostic tool for quantifying the RFS and optimizing the extraction of ROI activity.

Analysed data study

Methods

#60 – NO REPLAY DETECTABLE BY TDLM IN POST-ENCODING RESTING STATE

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We investigated, using temporally delayed linear modelling (TDLM) and magnetoencephalography (MEG), whether items associated with an underlying graph structure are replayed during a post-learning resting state. In these same data, we have previously provided evidence for replay during on-line (non-rest) memory retrieval. Despite successful decoding of brain activity during a localizer task, and contrary to predictions, we did not detect evidence for replay during a post-learning resting state. To better understand this, we performed a hybrid simulation analysis in which we inserted synthetic replay events into a control resting state recorded prior to the actual experiment. This simulation revealed that replay detection using our current pipeline requires extremely high replay densities to reach significance (>1

replay sequence per second, with “replay” defined as a sequence of reactivations within a certain time lag). Furthermore, when scaling the number of replay events with a behavioural measure we were unable to experimentally induce a strong correlation between sequenceness and this measure. We infer that even if replay was present at plausible rates in our resting state dataset we would lack statistical power to detect it with TDLM. We discuss ways for optimizing the analysis approach and how to find boundary conditions under which TDLM can be expected to detect replay successfully. We conclude that solving these methodological constraints is likely to be crucial to optimise measuring replay non-invasively using MEG in humans.

Analysed data study

Methods

#61 – MEGQC: A STANDARDIZED AND SCALABLE PIPELINE FOR MEG DATA QUALITY CONTROL

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Magnetoencephalography (MEG) recordings are highly susceptible to noise and artifacts originating from environmental sources, physiological processes, and technical issues, all of which compromise data quality and interpretability. Current MEG quality control (QC) methods largely rely on manual and subjective procedures, reducing reproducibility and complicating data sharing. To address these challenges, we introduce MEGqc, an automated, open-source, and BIDS-compatible pipeline designed to provide standardized and scalable assessment of raw MEG signal quality.

MEGqc, developed in Python, leverages popular libraries such as MNE-Python, NumPy, and Plotly to compute established QC metrics, including signal variability (e.g., standard deviation, peak-to-peak amplitude), spectral noise (e.g., power-line interference), high-frequency muscle activity, and physiological

artifacts from eye movements and cardiac activity. When available, head movement is also quantified. All metrics are saved as machine-readable BIDS derivatives and summarized in interactive HTML reports.

MEGqc efficiently identifies poor-quality recordings and integrates seamlessly into existing neuroimaging workflows, demonstrated through successful application on large datasets such as CamCAN (>600 subjects), promoting data transparency and reproducibility. Its modular architecture, user-friendly graphical interface, and parallel processing capabilities support effective QC in both small laboratories and large-scale consortia. MEGqc thus facilitates informed decision-making for data inclusion and enhances the quality of datasets used for advanced analyses, including machine learning.

Analysed data study

Methods

#62 – FUNCTIONAL NETWORK ANALYSIS OF EEG DATA FOR CAPTURING TRANSITIONS BETWEEN PERCEPTUAL STATES IN OBJECT RECOGNITION

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Functional networks (FNs) provide a useful toolset for the analysis of brain activity. In these networks, the edge weights are defined based on functional connectivity measures, one example being scaled correlation analysis (SCA). This method allows identifying neuronal synchronizations happening between two distinct sites of recordings, with temporal delays and across multiple timescales as well. Here we use SCA to extract FNs from an EEG experiment with 10 participants engaged in free visual exploration objects presented as lattices of deformed dots. To examine how brain networks change after the “Eureka” moment of recognition, we adopted a method introduced in our recent work: instead of averaging FN edge weights across trials, we compute and statistically analyze their distributions. Our approach provides a more robust way of studying FNs, avoiding the risk of information loss in the averaging process. It also lead to the discovery of a dynamic yet stable network architecture consistent across datasets: a mostly

bimodal edge weight distribution (EWD) with few strong o-lag correlations (that we call a backbone) and many weaker links at various time delays. In this study, we extract FNs around stimulus onset and before subject response, separately for seen and unseen conditions to distinguish the perceptual states. Using the pre-stimulus period as baseline and Cliff’s delta as effect size metric, we statistically compare EWDs. Because the distributions are bimodal, positive and negative modes are compared separately. We find no major differences between conditions in EWD changes immediately after stimulus onset. The differences are more pronounced before the response: on average, occipital and frontal scalp regions show greater change in their interaction patterns when object recognition is successful. Further investigation of the roles of correlated and anticorrelated interactions may clarify the contribution of dynamic network architecture to cognition.

Analysed data study

Methods

#63 – FAST AND RELIABLE DETECTION OF THE FUNCTIONAL ACTIVATION OF MT AND V6 DURING COHERENT MOTION PROCESSING WITH EEG

• **Petrizzo, I (1), Piazza, M (1), Morrone, MC(2), Buiatti, M (1)** | (1) Center for Mind/Brain Sciences, University of Trento, Rovereto, Italy; (2) Department of Translational Research on New Technologies in Medicine and Surgery, University of Pisa, Pisa, Italy

In the adult brain the perception of coherent visual motion (optic flow) activates a network of regions, in particular V5 (MT) and V6, which are part of the dorsal stream. These regions are already active in infants, well before the full development of V1, possibly due to the evolutionary relevance of detecting approaching stimuli or navigating in space. An alteration in the development of the visual dorsal stream and its functions, including motion perception, seems to be a key characteristic of children with Learning Disabilities (LD), an account known as the “dorsal stream vulnerability theory”. According to this view, the early functional integrity of the dorsal stream could be considered as a predictive biomarker of LD. To date, however, most studies on the neural underpinnings of optic flow used fMRI, a method

practically unsuitable for studying pediatric populations. Here we tested whether we could reliably use electroencephalography (EEG) for the same aim. We designed a frequency-tagging paradigm alternating flow and random motion stimuli and tested it on adult participants. The results revealed a robust EEG response to coherent motion, detectable at the single subject level within just 6 minutes of recordings. Source reconstruction using EEG-anatomy co-registration and individual structural MR scans confirmed that the cortical areas underlying the EEG activation included V5(MT) and V6. These results set the methodological standard for future studies on pediatric/clinical populations aimed at investigating the neurophysiological underpinning of coherent motion perception.

Analysed data study

Methods

#64 – EXPLICIT MODELING OF SUBJECT DEPENDENCY IN BCI DECODING

• **Romani, M (1), Paissan, F (1), Fossa, A (1), Farella, E (1)** | (1) *E3DA, Fondazione Bruno Kessler, Trento, Italy; University of Trento, Trento, Italy*

Brain-computer interfaces (BCIs) suffer from high inter-subject variability and limited labeled data, often requiring lengthy calibration phases. In this work, we propose an end-to-end approach for modeling subject dependency using lightweight CNNs. Our method addresses data imbalance, over-fitting, and hyper-parameter sensitivity, and evaluates two conditioning strategies for adapting pre-trained

models to unseen subjects with minimal calibration data. We benchmark three lightweight architectures suitable for efficient deployment on constrained hardware on a time-modulated ERPs classification task. Preliminary results demonstrate improved generalization and data-efficient calibration, paving the way for scalable subject-adaptive BCI

Analysed data study

Methods

#65 – A REPRODUCIBLE WORKFLOW TO EVALUATE M/EEG FEATURES (PERIODIC, APERIODIC, AND COMPLEXITY) FOR PREDICTING POST-STROKE FUNCTIONAL OUTCOMES

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Background. We present a transparent, comparable workflow for HD-EEG (EGI Geodesic 256) in patients with right-hemisphere stroke. An ad-hoc QC/cleaning pipeline handles very noisy resting-state data and yields usable features: periodic (delta, theta), aperiodic (exponent, offset), and complexity (Lempel–Ziv, Higuchi).

Methods. For each feature family and five bilateral ROIs (frontal, central, temporal, parietal, occipital; L/R), we train cross-validated models and report out-of-fold R^2 and MAE/RMSE (accuracy/ F_1 when applicable). Analyses run in CoCo Pipe, a Python framework that unifies signal processing with traditional ML and deep learning. We used Random-Forest and reproducible notebooks export per-fold/overall metrics, aggregate results, and generate targeted figures (best-by-family, best-ROI-per-feature, hemisphere summary).

Research questions. (1) Do To EEG features (theta, delta, exponent/offset, Lempel–Ziv, Higuchi) predict Barthel, FIM, and effectiveness,

and which features are most informative? (2) Do Age, Etiology, and Onset-to-EEG time influence these relationships?

Preliminary results. The workflow enables fair comparison across feature families, pinpoints—per feature—the most predictive ROI, and summarizes hemispheric trends (e.g., possible contralateral advantages for selected aperiodic metrics; parietal/temporal contributions for complexity indices). The figures provide concise, clinically interpretable guidance for prioritizing feature–ROI combinations.

Conclusions. We deliver an end-to-end, modular, reproducible workflow that foregrounds spatial specificity and lateralization and rescues biomarkers from very noisy HD-EEG. Given the univariate design and modest sample, findings are preliminary; ongoing work includes multivariate models, covariate interactions (Age/Etiology/Onset-to-EEG), external validation, and deeper integration with clinical variables.

Analysed data study

Methods

#66 – A NEURAL OSCILLATIONS ENCODE CONTEXT-BASED INFORMATIVENESS DURING NATURALISTIC FREE VIEWING

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Humans move their eyes several times per second. Observers predict where the most informative visual information is likely to be found, and move their eyes accordingly. An important determinant of the informativeness of individual fixated patches is the scene context in which they occur. It is yet unknown whether this type of context-based informativeness is encoded by (visual) cortex, and if it is, how?

A recent study in non-human primates found that primary visual cortex firing rates decrease with the predictability of high-level image features, while gamma synchronization increases with the predictability of low-level image features. However, it remains unclear whether these neural signatures, observed during passive fixated viewing, generalize to

human observers and unconstrained free-viewing behavior.

We developed a novel analysis pipeline combining large-sample, head-fixed magnetoencephalography, eye tracking with free viewing, and a generative deep neural network model. This approach allows us to quantify the context-based informativeness of each fixation during naturalistic image viewing and explore the corresponding neural correlates. Our results show that the informativeness of the current fixation is positively associated with theta/alpha activity across posterior cortex. This demonstrates that contextual predictability is rapidly and transiently encoded by early visual cortex during free viewing.