



The Centre for Cognitive Neuroscience (CCNS) at the  
University of Salzburg

presents

the 8<sup>th</sup> Salzburg Mind – Brain Annual Meeting

SAMBA 2026

July 2.-3.

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# PROGRAM

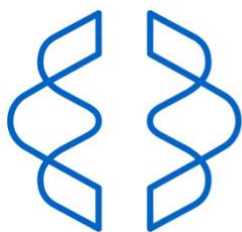
SALZBURG  
MIND BRAIN  
ANNUAL MEETING  
2026

Time	July 2	Time	July 3
08:15	Registration & Coffee		
08:40	Opening Remarks		
09:00	Talk 1: Joachim Groß The Dynamic Brain: From Structural Scaffolds to Embodied Rhythms Across the Lifespan	09:00	Talk 6: Andrea E. Martin From Trees to Dynamics: Rethinking Linguistic Structure in the Brain
10:00	Coffee	10:00	Coffee
10:30	Talk 2: Judit Gervain How prenatal language exposure lays the foundations for language acquisition	10:30	Talk 7: Stefan Rampp MEG for epilepsy surgery: From dipoles to connectivity
11:30	Short Break	11:30	Short Break
11:45	Talk 3: Nadine Dijkstra How generative brains distinguish imagination from reality	11:45	Talk 8: Marzia De Lucia Cardiac and auditory regularity processing in wakefulness, sleep and coma
12:45	Lunch Break	12:45	Lunch Break
14:15	Talk 4: Simon Jacob Neuronal inventory of a right- hemispheric language network in an individual with aphasia	14:15	Talk 9: Richard Gao Accelerating discovery of data- driven models and theories of neural dynamics
15:15	Coffee & Posters	15:15	Coffee & Posters
17:15	Talk 5: Ayelet Landau Rhythmic attention negotiates competition across the visual hierarchy	17:15	Talk 10: Bruno L. Giordano Characterizing natural sound representations with magnetoencephalography
			Closing Remarks
			Social Event

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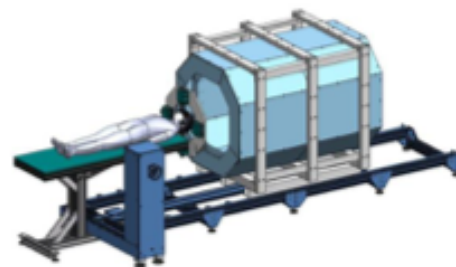
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# TALKS

## Talk 1:

### The Dynamic Brain: From Structural Scaffolds to Embodied Rhythms Across the Lifespan

**Joachim Groß**

University of Münster

Dynamic brain activity emerges from the interplay of multiple factors: the structural and neurochemical scaffolds that constrain regional dynamics, the rhythmic influences of bodily signals such as respiration and arousal, and the gradual reorganization of these processes across the human lifespan. In this talk, I will discuss how micro-architectural features—including cytoarchitecture, neuromodulatory receptor landscapes, and gene expression—provide a powerful blueprint for local brain activity. Building on this foundation, I will present evidence that slow bodily rhythms, particularly breathing and arousal fluctuations, rhythmically modulate cortical excitability, perception, and excitation-inhibition balance, and that these rhythms themselves interact. Finally, I will highlight how lifespan changes reshape these dynamics, with temporal autocorrelation emerging as a robust marker of brain aging. Together, these findings motivate a shift toward a unified framework of brain-body states, where neural activity is understood as nested trajectories across timescales—from fast oscillations to bodily rhythms to the slow progression of aging.



## Talk 2:

# How prenatal language exposure lays the foundations for language acquisition

## Judit Gervain

Padua Neuroscience Center, University of Padua, CNRS & Université Paris Descartes

This talk will present a series of NIRS and EEG experiments with newborn infants who how experience with speech heard in the womb already shapes the neural circuitry dedicated to speech and language processing. Prenatal experience consists mainly of prosody, as the womb acts as a low-pass filter, suppressing individual speech sounds. The talk argues that this early prosodic experience lays the foundations of subsequent language acquisition, as it helps infants chunk the speech stream into units that are relevant for the acquisition of syntax and the lexicon..



## Talk 3:

# How generative brains distinguish imagination from reality

## Nadine Dijkstra

Department of Imaging Neuroscience (the FIL), Institute of Neurology, University College London

How do we know that what we see is real and not just imagined? Our perception of reality is generative: to resolve ambiguous sensory input, our brain predicts the most likely interpretation using an internal model built on past experiences. This same top-down mechanism can be used to generate sensory signals in the absence of input to generate mental imagery. Mental imagery is used to support a wide range of cognitive processes such as memory, navigation and planning. While an efficient use of neural resources, the neural overlap between perception and imagery can cause confusions regarding the source of perceptual experiences under certain circumstances. During this talk, I will discuss our work on how the brain maintains the precarious balance between being able to generate high-fidelity imagery on the one hand while still maintaining a firm grip on reality on the other hand.



## Talk 4:

# Neuronal inventory of a right-hemispheric language network in an individual with aphasia

**Simon Jacob**

TUM University Hospital

Language constitutes one of the most formidable sensorimotor integration functions of the human brain. While the cortical regions in the human frontal, temporal and parietal lobe that comprise the language network have already been identified, there are vast gaps in our understanding of the neuronal mechanisms that govern how we verbalize thoughts, intentions and emotions. I will present recent efforts in my laboratory devoted to establishing a brain-computer interface with cellular resolution for patients with language disorders (aphasia) after stroke.



Using large-scale neurophysiological recordings from microelectrode arrays chronically implanted into right-hemispheric brain regions homotopic to the left language network, we are investigating how linguistic elements are encoded at the single-neuron level and how population-wide activity gives rise to temporal integration and combinatorial processes during language comprehension and production. The long-term goal of our transdisciplinary work is to explore neurotechnological approaches that leverage right-hemispheric cognitive resources for aphasia rehabilitation.

## Talk 5:

# Rhythmic attention negotiates competition across the visual hierarchy

## Ayelet Landau

University College London (UCL) / Hebrew University of Jerusalem

Navigating the environment involves engaging with multiple objects, each activating specific neuronal populations. When objects appear together, the respective neuronal populations compete. Classical attention theories suggest that selection involves biasing one population over another. Recent research shows that perception fluctuates over time. When a single object is processed over time a  $\sim 8$  Hz fluctuation seems to govern its perception. When attention is distributed over two different objects a 4 Hz fluctuation is measured, possibly due to the division of the 8 Hz rhythm between competing objects. In my talk I will explore these rhythmic phenomena, coined attentional sampling, across the visual hierarchy. I will argue that sampling is a selection mechanism that negotiates neuronal competition. It manifests as early as eye channels and extends to complex features higher in the visual hierarchy and potentially beyond the visual modality. Finally, I will discuss the cognitive significance of this mechanism and its potential neuronal implementation.



## Talk 6:

# From Trees to Dynamics: Rethinking Linguistic Structure in the Brain

### Andrea E. Martin

Max Planck Institute (MPI) for Psycholinguistics & Donders Centre for Cognitive Neuroimaging, Donders Institute, Radboud University



Human listeners and signers reliably recover discrete, structured interpretations from a continuous and highly ambiguous acoustic and visual signal. Explaining how neural systems transform this unfolding physical input into compositional linguistic and relational structures remains a central challenge for cognitive (neuro)science. Magnetoencephalography (MEG) provides a powerful window onto the temporal whole-brain dynamics that accompany this process. Much recent work has sought to identify correlates of linguistic structure directly in neural readouts, for example by linking oscillatory activity to particular linguistic units or hierarchical levels. While such approaches have revealed important aspects of the temporal organization of language processing, they can invite an overly literal interpretation in which linguistic structures—such as syntactic trees—are treated as candidate neural encodings. In this talk, I argue for a different perspective. Linguistic structures are formal descriptions of the relational computations that language users perform; the central question for neuroscience is how those computations are implemented in neural population dynamics unfolding in time. Importantly, this perspective strengthens—rather than weakens—the role of formal theories from linguistics and psycholinguistics in cognitive science and neuroscience. For example, theories of syntax and semantics specify the relational distinctions that must be made during processing and therefore provide essential constraints on mechanistic accounts of brain function. Across studies combining naturalistic spoken language comprehension paradigms, computational modeling, and analyses of cross-frequency neural dynamics, I describe how linguistic structure and statistical expectations jointly constrain evolving neural states across interacting timescales. I argue that progress in understanding brain computation will depend less on predictive model alignment and more on interpretable models of neural dynamics that can reveal how structured cognition emerges from biological systems.

## Talk 7:

# MEG for epilepsy surgery: From dipoles to connectivity

## Stefan Rampp

Department of Neurosurgery, Department of Neuroradiology, University Hospital Erlangen, Germany; Department of Neurosurgery, University Hospital Halle (Saale), Germany

One of the main clinical applications of magnetoencephalography (MEG) is localizing epileptic foci for planning invasive recordings and epilepsy surgery. A large body of evidence shows that including such MEG localizations in the resection leads to significantly better long-term postoperative seizure control. However, for patients with insufficient interictal epileptic discharges (IEDs), the diagnostic value of MEG based on conventional methods (i.e., dipole localization of IEDs) remains limited. Measures of resting-state connectivity may provide an alternative approach. This presentation will summarize the current evidence on the value of MEG in the preoperative evaluation of epilepsy surgery and present the results of our study of 1,000 patients over 28 years. Additionally, novel approaches to localizing the epileptic network will be discussed based on recent studies on network analysis compared to invasive recordings and epilepsy surgery.



## Talk 8:

# Cardiac and auditory regularity processing in wakefulness, sleep and coma

**Marzia De Lucia**

Brain-Body and Consciousness Lab, Lausanne University Hospital and University of Lausanne, Center for Biomedical Imaging, Switzerland

Repeated sensory inputs allow the brain to form predictions about upcoming events, as evidenced by electroencephalographic responses to deviant or omitted sounds in regular auditory sequences. Beyond external inputs, the brain continuously monitors internally generated visceral signals such as the heartbeat, which also exhibit intrinsic regularity and are processed largely implicitly to maintain physiological stability. Here I propose that bodily rhythms facilitate the processing of auditory regularities across different levels of consciousness. Using electroencephalography, I show that the brain responds to unexpected sound omissions embedded within auditory sequences synchronized with the ongoing heartbeat (cardio-audio regularity) during both wakefulness and sleep. Remarkably, similar neural responses are observed in comatose patients, particularly in those with favorable outcomes. These findings are complemented by modulations of cardiac activity following omissions in cardio-audio sequences across vigilance states in healthy individuals and in comatose patients with good prognosis..



## Talk 9:

# Accelerating discovery of data-driven models and theories of neural dynamics

**Richard Gao**

Goethe University Frankfurt, Institute of Computer Science

How does cognition emerge from the complex interaction of biological elements in the brain? Neural dynamics offers a potential bridge between structure and function, where population activity is shaped by a variety of circuit properties and harnessed for computations at multiple timescales. In dissecting these relationships, we are now amassing brain measurements at an unprecedented scale. But while artificial intelligence excels at uncovering associations in large datasets, how AI can complement and advance mechanistic theories of neural dynamics remains an open question.



In this talk, I outline how recent developments—in particular, probabilistic generative models and sequence models—can help link neural dynamics with brain structure and function. First, I discuss how simulation-based inference enables estimation of circuit properties from experimental recordings using a mechanistic model with interpretable parameters. Second, I detail our recent works using state space models and diffusion models to synthesize realistic field potential and spiking data. To close, I share how these approaches can be integrated for building tractable multi-scale models of brain dynamics to bridge neurobiology and neural computation.

## Talk 10:

# Characterizing natural sound representations with magnetoencephalography

**Bruno L. Giordano**

Institut de Neurosciences de la Timone (INT), CNRS  
and Aix Marseille Université



Everyday listening takes place in a rich acoustic world full of meaningful events (footsteps, tools, animals, machines etc.). Natural sounds are therefore a useful instrument for characterising how the brain links acoustic structure to the objects and actions that produce them. In earlier behavioural and 7T fMRI work, we showed that natural-sound organisation in perception and auditory cortex is captured particularly well by intermediate layers of sound-processing neural networks. This points to representations that are neither purely acoustic nor simply verbal labels, but sit between sound structure and meaning.

In this talk, I will focus on a new MEG dataset designed to follow this transformation in time. The main result is a clear progression from early acoustic representations (~100 ms) to sound-learned categorical representations (~250 ms), to sound-learned continuous semantics (> ~500 ms). MEG therefore makes it possible to describe how natural sounds move from acoustic detail to event meaning within the first second of listening.

I will then present two extensions of this result. First, information-decomposition analyses show that different MEG latencies model provide both shared and complementary information about computational model representations. This suggests that the brain does not simply pass from acoustics to meaning in a single sequence, but keeps integrating sound-driven representations over time. Second, causal CRNN modelling confirms that temporal integration matters: causal models that combine multiple temporal scales within a single recurrent architecture explain MEG responses better than isolated temporal scales treated separately.

The final part of the talk asks whether there is really one acoustic-to-semantic cascade for all sounds. Most analyses implicitly treat every sound as following the same route through the brain, but recognition should change that route. Sounds that are easy to identify can be rapidly linked to labels and sources, whereas ambiguous sounds should keep processing closer to the acoustic signal. This is what we find: well-identified sounds show faster access to sound-label similarity, while poorly identified sounds show more sustained sound-based representations. Together, these MEG results characterise the dynamics by which everyday sounds become meaningful auditory objects and events, and provide a basis for moving from isolated sounds to the richer case of real-life auditory scenes.

# POSTER ABSTRACTS

## 1 Long-Term Impact of Mild Traumatic Brain Injury in Athletes: A Multimodal Imaging Study Using MEG, DWI, fMRI and SNS

**Anna Elisabeth Bergauer<sup>1</sup>, Alexander Schorb<sup>2</sup>, Markus Klein<sup>3</sup>, Jürgen Herfert<sup>4</sup>, Martin Kronbichler<sup>1</sup>, Nathan Weisz<sup>1</sup>, Fabio Richlan<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria, <sup>2</sup>Paracelsus Medical University, Salzburg, Austria, <sup>3</sup>EC Red Bull Salzburg, Austria, <sup>4</sup>Red Bull Athletic Performance Center, Thalgau, Austria

Mild traumatic brain injury (mTBI) is a neurological event caused by an external mechanical force to the head. Athletes in contact sports are at risk for repeated mTBI which can lead to cognitive symptoms (e.g., memory deficits) and long-term adverse health outcomes such as persistent postconcussive symptoms or dementia. This risk is increased by the lack of objective biomarkers as CT and conventional MRI are blind to the microstructural and functional brain alterations upon mTBI. Moreover, research is challenged by the heterogenous nature of mTBI, comorbidities with psychiatric conditions (e.g., depression), and the absence of longitudinal data. This study addresses these challenges by including (1) a multimodal imaging including fMRI, DWI, and MEG (2) longitudinal neuropsychological data to link brain alterations with clinical symptoms and cognitive performance (3) 100 ice hockey players to increase generalizability (4) a novel online symptom monitoring tool (SNS) to track psychological change processes, supporting accurate diagnosis and symptom management. Overall, this study aims to contribute to the development of new biomarkers for mTBI to ensure athletes' long-term health.

## 2 How our priors and stimulus familiarity shape neural prediction of naturalistic dynamic input

**Ingmar Engbert Jacob de Vries<sup>1</sup>, Eva Berlot<sup>2</sup>, Christoph Huber-Huber<sup>1</sup>, Tiziano Causin<sup>1</sup>, Floris de Lange<sup>2</sup>, Moritz Wurm<sup>1</sup>**

<sup>1</sup>University of Trento, Italy, <sup>2</sup>Radboud University Nijmegen, Netherlands

EEG For adaptive behavior such as social interaction, our brain needs to continuously predict unfolding external events. While prediction theories propose such dynamic prediction, empirical evidence is mostly limited to static snapshots and indirect consequences of predictions. The dynamics of the predictive representations themselves remain unexplored. Here we apply dynamic representational similarity analysis (dRSA) to capture neural representations of unfolding events across hierarchical levels of processing (from perceptual to conceptual), by investigating the match between a temporally variable stimulus model at a given time-point and the neural representation across time. This gives us both the strength and latency of representation (e.g., whether a neural representation is predictive). We apply this approach to MEG data from several experiments involving naturalistic dynamic stimuli such as ballet videos and audiovisual movies. We find evidence for hierarchical prediction such that high-level features are predicted earlier in time while low-level features are predicted closer to real-time. In a second experiment we show that disrupting holistic priors by up-down inversion of ballet sequences, redirects predictions from high- to mid-level features, while disrupting kinematics priors eliminates prediction all together, while sharpening reactive post-event representations. In a third experiment we extend these findings in a naturalistic audiovisual free-viewing movie by showing earlier perceptual predictions compared to simple action sequences, and by showing that both neural predictions and anticipatory eye-movements emerge earlier with increased stimulus familiarity (i.e., second vs. first viewing). Together these results demonstrate how our priors and stimulus familiarity jointly shape our neural prediction of naturalistic dynamic input.

### 3 Evaluation of an ultra-high-frequency visual stimulation intervention on mild cognitive impairment and Alzheimer's Disease

**Julian Keil<sup>1</sup>, Maria Buthut<sup>1</sup>, Ravit Hadar<sup>1</sup>, Jana Fass<sup>2</sup>, Liam Doherty<sup>3</sup>, Jakob Litsch<sup>1</sup>, Nikolett Gajda<sup>1</sup>, Victor Hernandez-Urbina<sup>1</sup>, Fabian Queisner<sup>1</sup>, Markus Müschenich<sup>1</sup>, Surjo R. Soekadar<sup>1</sup>**

<sup>1</sup>Charité - Universitätsmedizin Berlin, Germany, <sup>2</sup>Medical School Berlin, Germany, <sup>3</sup>University of Potsdam, Germany

**Objectives:** Alzheimer's disease (AD) patients' cognitive functions decline. While newly developed disease-modifying drugs reduce the accumulation of amyloid-beta in the brain, their effect on cognitive functions is moderate. Starting from the neural mechanisms of memory promises more precise interventions. Here, Sharp-Wave-Ripples (SWRs) are important: SWR density correlates with learning and memory, and artificially induced SWRs improve memory. Non-invasive brain stimulation can safely induce SWRs.

**Methods:** The double-blind, placebo-controlled NIN-AD study (DRKS00036848) investigates the effect of ultra-high-frequency visual stimulation (UHV-stimulation) in AD patients. It comprises active or control stimulation for one hour daily for six months, applied at home using augmented-reality glasses. It comprises 120 Hz spatio-temporally organized flickering light stimulation, which is indistinguishable from the constant light control stimulation. The study focuses on tolerability and adherence to the stimulation protocol. It also evaluates the effect on memory, AD symptoms, sleep, general wellbeing, and caregiver assessment of daily functioning. Exploratory analyses comprise resting state EEG and fMRI assessment of brain structure and function, and blood and CSF AD biomarkers.

**Results:** Patient recruitment and data collection are ongoing, with an intermediate read-out after 3 months, a post-intervention read-out after 6 months and a follow-up read-out after 9 months. Results from the intermediate read-out indicate high tolerability and protocol adherence, and positive effects on subjective and caregiver-assessment of memory. Pilot experiments in epilepsy patients with electrodes implanted in the Hippocampus indicated the safety of the stimulation and its effectiveness on SWR induction.

## 4 Evolving Morphology, Increasing Synchronization: Auditory Processing Trajectories in High-density EEG Across the First Year of Life

**Eva Reisenberger<sup>1</sup>, Manuel Schabus<sup>1</sup>, Cristina Florea<sup>2</sup>, Monika Angerer<sup>1</sup>, Michaela Reimann-Ayiköz<sup>1</sup>, Jasmin Preiß<sup>1</sup>, Dietmar Roehm<sup>1</sup>, Dominik P. J. Heib<sup>1</sup>, Claudius Fazelnia<sup>2</sup>, Mohamed S. Ameen<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria, <sup>2</sup>Salzburger Landeskliniken, Austria

The first year of life is a crucial period for neurodevelopment during which sensory processing undergoes substantial refinement. In the present study, we tracked a large longitudinal cohort of 69 infants (32 female) from 2 weeks to 12 months of age using high-density electroencephalography (hdEEG). We combined auditory evoked potentials with oscillatory measures, including inter-trial phase coherence (ITPC), and time-frequency (TF), to investigate the change in amplitude and phase of auditory responses during the first year of life. As only the 2-week recordings contained sleep data, those data were sleep-staged to distinguish wake from sleep states. To match the arousal state at 6 months and 12 months we limited longitudinal analyses to wake-only data.

With age, evoked responses increased in amplitude and trial-to-trial variability decreased. Phase synchronization increased from 2 weeks to later stages in a broad low-frequency range (0-11 Hz). From 6 months to 12 months, however, phase synchronization decreased. We interpret this pattern as a developmental shift from strictly stimulus-locked timing to more flexible temporal integration during the second half year of life, in line with a perceptual narrowing in speech and music.

Overall, our results indicate that early auditory development is not strictly linear but reflects progressive reorganization of neural circuits. They also show that different neural measures follow distinct developmental trajectories and highlight the need for multi-dimensional, longitudinal assessments to capture the evolving neural architecture of early sensory processing.

## 5 Pupillary synchrony to natural speech in 6-month-old infants

**Mireia Marimon<sup>1</sup>, Alan Langus<sup>2</sup>**

<sup>1</sup>Ludwig-Maximilians-Universität in Munich, Germany, <sup>2</sup>University of Potsdam, Germany

During the first year, infants use cues such as syllabic and prosodic regularities to segment speech into word candidates (Johnson & Jusczyk, 2001), though how they learn these regularities remains debated. We hypothesize that tracking the speech temporal structure at syllabic and prosodic timescales plays a central role in these processes. Neural oscillations in the auditory cortex track the speech envelope at syllabic and prosodic timescales early in development, potentially guiding infants' attention to these cues. Because pupil size can also synchronize with auditory rhythms (Barczak et al., 2018), here we tested whether infants' pupils synchronize with natural speech at multiple timescales and how this ability relates to speech segmentation at 6 months. In a central fixation paradigm, German-learning infants (N = 70) heard passages of natural speech, each containing sentences with a nonce word (e.g., pahlen). At test, infants heard repeated isolated words (familiar or novel). Pupil size and looking times (LTs) were recorded. Results show that infants' pupils spontaneously synchronize with the speech envelope at prosodic and syllabic timescales during familiarization. At test, infants' LTs to novel vs. familiar trials revealed a significant cross-over interaction between synchronization in Delta (1-3Hz) and Theta (4-6Hz) frequency bands ( $B=0.15$ ,  $SE=0.04$ ,  $p<.01$ ). Specifically, higher synchrony at the syllabic rate (Theta, 4-6 Hz) was associated with a novelty preference at test, which has been linked to less cognitively demanding tasks (Hunter & Ames, 1988), and appears to make word segmentation easier for infants acquiring a morphologically rich language such as German..

## 6 Electromagnetism in a Restless Conductive CSF Medium

**Tzvetan Popov<sup>1</sup>**

<sup>1</sup>University of Zurich, Switzerland

Electroencephalography (EEG) and magnetoencephalography (MEG) are widely interpreted as direct, non-invasive measurements of neural population activity. This interpretation assumes that surrounding tissues, including cerebrospinal fluid (CSF), act as passive volume conductors that distort but do not contribute to signal generation. The present paper challenges that assumption with a series of conductive-fluid phantom experiments, structural magnetic resonance imaging, and in vivo EEG and MEG recordings in humans. Results indicate that mechanically driven conductive fluids can generate structured, oscillatory, and source-localizable electromagnetic signals resembling EEG in the absence of neural tissue and that interindividual differences in CSF volume systematically moderate signal amplitude. Notably, these effects extend to MEG, which is commonly assumed to be insensitive to volume-conductor properties. Consequently, electrophysiological characteristics traditionally interpreted as neural manifestations vary with changes in CSF. These effects are consistent with prior reports linking posture, sleep-related CSF dynamics, and physiological motion to measured brain signals. These results suggest a framework supporting the emergent properties of neural currents in a mechanically active volume conductor. It identifies a fundamental identifiability limit in EEG and MEG source interpretation and motivates electrophysiological models that explicitly incorporate fluid dynamics and mechanical phenomena. At the scales accessed by both invasive and non-invasive electrophysiology, electromagnetic and mechanical processes in the brain form a coupled system in which cause and effect cannot be uniquely assigned to either neural currents or fluid motion alone.

## 7 Decoding precise action plans during working memory maintenance

**Larissa Behnke<sup>1</sup>, Caterina Trentin<sup>2</sup>, Freek van Ede<sup>2</sup>, Heleen A. Slagter<sup>2</sup>, Christian N. L. Olivers<sup>2</sup>**

<sup>1</sup>University of Zurich, Switzerland, <sup>2</sup>Vrije Universiteit Amsterdam, Netherlands

Future actions are often prepared while task-relevant information is maintained in working memory (WM), yet it remains unclear whether and when specific action plans are initiated. Here we combined electroencephalography (EEG) with a gesture-based visual-motor WM task to test whether, and when, upcoming gestures can be decoded during WM maintenance. Participants (n=30) memorized two visual orientations and later reproduced their angle on a touch screen using one of two gestures: a sliding movement tracing the orientation of the memorized item with the index finger or a two-finger grip movement. The reported orientation and response gesture were cued during the delay.

Lateralized motor activity indicated activation of the prospective response hand immediately following the action cue during the WM delay. Linear decoding further showed that the specific upcoming gesture (slide vs. grip) could be predicted from EEG signal at probe onset and before participants initiated the movement, but this emerged after initial neural signatures associated with selection of the visual object and the prospective response hand. These findings indicate that fine-grained action plans held in WM are found in neural activity and suggests that memory representations are transformed from general motor plans to more specific action plans just-in-time before behaviour execution.

## 8 Traveling waves in the human brain support flexible storage of working memory

**Yifan Zeng<sup>1</sup>, Andrea Alamia<sup>2</sup>, Johannes Sarnthein<sup>3</sup>, Paul Sauseng<sup>1</sup>**

<sup>1</sup>University of Zurich, Switzerland, <sup>2</sup>Brain and Cognition Research Center, Université Toulouse III - Paul Sabatier, Université de Toulouse, France, <sup>3</sup>University Hospital of Zurich, Switzerland

Human working memory is a system that enables us to temporarily store and flexibly utilize information. It is thought that there are two distinct neural mechanisms by which information is retained in working memory: persisting firing of working memory-relevant neurons<sup>1</sup>, or information retention via short-term synaptic plasticity in the absence of ongoing neuronal firing<sup>2</sup>. However, both these mechanisms are disadvantageous when working memory contents are updated with novel information, leading to strong neural interference. As an alternative, here we propose how information can be flexibly held in working memory in the form of traveling waves. In an artificial neural network, we simulated traveling wave-like propagation by passing transient neural firing patterns, representing single items of information, across network layers. In comparison to sustained neural firing, we demonstrated that these transient traveling patterns result in minimal synaptic plasticity, thereby facilitating the easy updating of working memory without significant neural interference. In intracranial recordings from the human medial temporal cortex, we then identified such traveling wave patterns. They had a strict onset at encoding of information and persisted uniformly during maintenance and recall, well compatible with the activation pattern seen in the artificial neural network. Thus, our data from artificial neural networks and human intracranial brain recordings confirm that neural traveling waves might support information processing in working memory while minimizing interference during updating. This newly identified mechanism appears particularly relevant in brain regions known for their high level of plasticity, such as the medial temporal cortex..

## 9 Neural and Ocular Tracking of Music and the Influence of Individual Differences in Musicality and Hearing Status

**Theresa Maria Elisabeth Denecke<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria

Music is a fundamental aspect of human experience that unfolds over time and engages multiple sensory and cognitive processes. To explore the temporal patterns of auditory processing, the approach of neural tracking has been established in auditory research. Recent findings indicate that also ocular activity aligns with acoustic features of speech stimuli. This raises the question of whether this could also be the case for music. Therefore, a MEG study (N = 92) was conducted. EOG measured the ocular activity. The results of the neural tracking analysis strengthened the findings on neural music tracking and provided first evidence that ocular activity also shows a measurable relationship with acoustic features of the music stimuli. To gain further insight into the mechanisms and functionality of music tracking, two influential factors for auditory processing were assessed as well. For an explorative analysis (N = 12), Linear Mixed Models on the influence of musicality, measured with Edinburgh Lifetime Musical Experience Questionnaire, and hearing status, measured by pure-tone audiometry, on the prediction accuracy of TRF were computed. While no significant effects were observed for overall musicality scores, significant effects emerged for specific domains of musicality and their interaction with hearing status. Despite the small sample size and resulting limitations in interpretability, results suggest that neural and ocular tracking of music are modulated by individual differences in musicality and hearing ability.

## 10 Training Spatial Hearing in Cochlear Implant Users via Auditory-Tactile Stimulation

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While cochlear implants (CIs) restore access to sound and speech, spatial hearing remains severely limited. Without reliable spatial cues, CI users face not only safety risks but also reduced social interaction and communication in noisy environments. However, current rehabilitation programs rarely address spatial hearing, and real-world-based training approaches are largely missing. To address this gap, the present study establishes a laboratory-based audio-tactile spatial hearing training paradigm as a foundation for future daily-life rehabilitation.

We implement a Multimodal Repetition Suppression (MMRS) design, pairing spatially congruent auditory and tactile stimuli to reinforce spatial associations. Fourteen CI users completed five training sessions, each involving repeated audio-tactile sequences and auditory-only test trials across seven loudspeaker positions ( $-67.5^\circ$  to  $+67.5^\circ$ ). EEG recordings were obtained throughout, focusing on mismatch negativity (MMN) as an objective neural index of spatial prediction and learning.

Behavioral results showed consistent improvement in localization accuracy and reduced mean absolute error, accompanied by more linear response patterns across sessions. Corresponding EEG patterns suggest enhanced neural sensitivity to spatial deviations after training.

These findings demonstrate that audio-tactile training effectively enhances spatial hearing in CI users, with measurable neural correlates of learning. The paradigm establishes a controlled yet ecologically inspired framework toward real-world, home-based rehabilitation using tactile feedback as a practical multisensory scaffold for auditory spatial relearning.

## 11 Generalisation of Familiarity-Related Neural Patterns to Emotional Facial Expressions

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While emotional expressions are theorised to modulate face familiarity, their shared neural dynamics remain unclear. In this secondary analysis of openly available EEG data, we used cross-dataset multivariate pattern analysis (MVPA) to test whether neural representations of familiarity generalise across emotional expressions. Data was drawn from two previously published experiments: an emotion categorisation task, in which 24 participants completed a two-alternative forced-choice task on facial expressions (happy, angry, sad, neutral; 384 trials), and a familiarity task, in which 22 participants viewed personally familiar and unfamiliar faces (100 trial-unique images) alongside an orthogonal attention task.

Classifiers trained to distinguish familiar versus unfamiliar faces were cross-applied to emotional expression data, and vice versa, using re-labelling strategies (e.g., angry = familiar, neutral = unfamiliar). This approach enabled assessment of shared representational structure independent of task demands.

Results showed that angry expressions aligned most strongly with familiarity-related neural patterns, with sustained cross-classification accuracy emerging from approximately 200 ms post-stimulus and peaking over posterior electrodes (Cohen's  $d = 1.35$ ). Happy and sad expressions exhibited weaker and more transient associations within the 200-400 ms window, while neutral expressions consistently aligned with neural signatures of unfamiliarity.

These findings support behavioural accounts of threat prioritisation, suggesting that threat-related facial expressions recruit neural representations that overlap with familiarity processing. Overall, the results provide evidence for partially overlapping neural mechanisms underlying affective evaluation and identity processing in face perception.

## 12 Flexible Rhythm Production Abilities and Cortical Tracking of Speech

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Speech exhibits quasi-rhythmic regularities (e.g., syllabic events typically cluster around 3-5 Hz), allowing the brain to generate temporal predictions in support of speech segmentation via neural oscillatory entrainment. Individual differences in rhythm production, particularly the ability to synchronize speech with external auditory rhythms, predict speech perception performance. However, existing research has relied almost exclusively on isochronous rhythms (regular), which poorly capture the inherent temporal variability in natural speech.

This study introduces the concept of flexible rhythm production and proposes a comprehensive behavioral battery assessing three rhythm classes: (1) isochronous sequences, (2) anisochronous but structurally regular sequences drawn from musical rhythms, and (3) anisochronous speech-derived rhythms based on the amplitude envelopes and syllabic structure of natural utterances across multiple languages. Tasks are administered in both speech and finger-tapping modalities to disentangle domain-general rhythmic ability from effector-specific motor control.

The central hypothesis is that these three rhythm classes reflect partly distinct individual-difference dimensions: individuals who struggle with isochrony will likely struggle broadly, while those who master isochrony may still show variable anisochronous performance. Whether speech-derived rhythms are harder than musical ones (implying speech-specificity) or equivalently hard (implying anisochrony itself as the key factor) is treated as an open empirical question.

These behavioral measures will be related to MEG-based cortical tracking of continuous speech across three populations: native speakers, second-language learners, and post-stroke individuals. The goal is a novel framework linking rhythmic production flexibility to neural speech processing.

## 13 Behavioral and neuroanatomical effects of soccer heading training in virtual reality: A longitudinal fMRI case study

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Virtual reality (VR) technology has received considerable attention over the last few years, with applications in many performance domains including training of sports-related mental and motor skills. The exact psychological and neurobiological mechanisms underlying potential VR training effects in athletes, however, remain largely unknown.

The present longitudinal functional magnetic resonance imaging (fMRI) case study reports behavioral and neuroanatomical effects of VR soccer (football) heading training in a male adult amateur player. The study was conducted over 8 weeks, starting with a pre-test, followed by a 4-week VR training phase, during which weekly fMRI assessments and the first behavioral post-test were conducted. After an additional 4-week retention phase, the final fMRI assessment and the second behavioral post-test were conducted.

Substantial improvement in real-life heading performance was accompanied by both structural and functional neuroanatomical changes. The comparison of the T1-weighted images revealed an increase in GM volume in the left thalamus and an increase in WM volume in the bilateral cerebellum. Furthermore, the analysis of the surface images showed an increase in cortical thickness in the right insula, left inferior temporal gyrus, left parahippocampal gyrus, left lingual gyrus, left posterior cingulate cortex, and bilateral anterior cingulate and medial prefrontal cortex. The seed-based correlation analyses of the resting-state fMRI data revealed manifold increases in functional connectivity within and between important brain networks.

This study contributes to the growing literature on VR training in athletes and provides the world's first evidence on fundamental neurobiological mechanisms underlying neuroplasticity related to VR training effects in sports.

## 14 Characterizing Word Processing On The Individual Subject Level With Multi-echo fMRI

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Although language is central to human life, our understanding of the neural mechanisms involved remains limited. While group-level fMRI studies have identified a distributed language network, averaging participants can obscure meaningful inter-individual variability. Precision fMRI addresses this limitation by acquiring densely sampled, high-quality data within individuals, enabling reliable characterization of neural activity at the single-subject level. Here, we combine precision fMRI with multi-echo acquisition to investigate individual differences in word processing.

Twenty-one healthy right-handed native German speakers (19–31 years) completed a visual word discrimination task targeting phonological, orthographic, and semantic processing. MRI data were acquired over four sessions on a 3T Siemens Prisma scanner using multi-echo fMRI. Variability and reliability were quantified using similarity analysis and intraclass correlation coefficients (ICC) in PyReliMRI.

Beyond shared activation patterns, participants exhibited idiosyncratic activation profiles. Some regions reached significance at the group level but not consistently across individuals, whereas other regions showed robust subject-level activation without reaching group-level significance. Several left-hemispheric regions showed high within-subject reliability combined with high between-subject variability, indicating stable individual differences rather than measurement noise. Individual activation maps were characterized by smaller, spatially distinct clusters that often appeared as larger merged clusters in group analyses. Activation similarity was negatively associated with sentence reading comprehension.

These findings demonstrate subtle but reliable individual differences in the neural organization of word processing and suggest that group averaging may obscure meaningful aspects of functional organization. Further investigation of individual variability is needed to better understand the neural architecture of language.

## 15 Cortical tracking of speech across sensory modalities: studying the effects of music expertise and audiovisual integration with mTRF encoding models

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Musicians exhibit stronger sensitivity to timing information, which might underlie advantages in speech perception. Previous studies suggest that cortical tracking might be a crucial neural mechanism explaining such advantages. However, while most research focused on auditory-only perception, during everyday face-to-face communication timing processing is not limited to the auditory modality, as upper-limb movements behave as additional rhythmic oscillators temporally aligned to the speech. Therefore, increased timing sensitivity in musicians might affect 1) the processing of rhythmic visual cues such as hand movements (hereafter, “gestures”) and 2) the integration between auditory and visual information when they are temporally congruent. In this study, we explore these hypotheses by measuring cortical tracking of speech acoustics and gestures speed with multivariate Temporal Response Functions (mTRF) models. In a MEG experiment, musicians and non-musicians attended videos of individuals retelling cartoons in Audio-Visual (AV), Audio-only (A) and Visual-only (V) modality. Preliminary analyses show that mTRF weights, which approximate neural response amplitude, are sensitive to differences between modalities, with auditory and visual regressors eliciting higher amplitudes in AV than in A and V conditions, respectively. Moreover, comparing the prediction accuracy between a full AV model and partially permuted models, we were able to disentangle the contribution of each regressor to the model performance, confirming that visual information is more strongly encoded in AV condition, when it is integrated with speech, than in V condition. Overall, we suggest that mTRF modelling is a promising approach to study cortical tracking across modalities and its modulation by music expertise.

## 16 Neural correlates of spontaneous speech production: insights from whole-brain fMRI

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The vast majority of studies investigating the neural correlates of speech production planning have relied on highly controlled paradigms, which differ considerably from everyday, naturalistic language production. Here, we analysed an existing fMRI dataset in which participants (n=19) spontaneously recalled the contents of short movies to investigate which brain regions support different aspects of speech production planning. Using syntactic parsers, we derived four word-by-word predictors capturing a) the number of verbs in the sentence (propositional complexity), b) the number of phrasal nodes being opened at each word (syntactic structure building), c) the number of verbal dependencies being maintained simultaneously (linearisation), and d) the number of syllables within lexical noun phrases anchored to the phrase onset (phonological encoding). Each predictor was convolved with the HRF and entered as a parametric modulator of the response to word onset in a whole-brain model, alongside word frequency and lexical surprisal as control regressors. Results revealed that propositional complexity modulated brain responses in the bilateral precunei and temporo-parietal junctions. Syntactic structure building was associated with higher responses in the bilateral STS and inferior parietal gyri. The linearisation of verbal dependents was associated with increased responses in the posterior left MTG and left supramarginal gyrus. Finally, phonological encoding was associated with increased responses in the left precentral gyrus extending into the pars opercularis. Taken together, these results demonstrate that model-based approaches can track multiple distinct aspects of spontaneous speech production and provide the first comprehensive characterisation of the neural infrastructure that supports this process

## 17 Linking Human Auditory Representations and Deep Neural Networks Through Multiscale Temporal Processing

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Human auditory perception relies on the integration of acoustic information across multiple temporal scales. While deep neural networks trained for sound recognition have been shown to capture aspects of auditory cortical representations, the contribution of multiscale temporal processing to brain-model alignment remains poorly understood. Here, we investigated how temporal integration mechanisms shape the correspondence between sound-classification networks and human magnetoencephalography (MEG) representations. Twenty-one participants listened to 150 natural sounds while MEG activity was recorded. We compared these responses with representations extracted from a multistream convolutional recurrent neural network (CRNN) trained for environmental sound classification. The model processed log-mel spectrograms through parallel temporal streams with integration windows of 20, 40, and 80 ms. Time-resolved representational dissimilarity matrices (RDMs) were computed for both MEG responses and model activations. Brain-model correspondence was quantified using predictive representational similarity analysis with leave-one-participant-out cross-validation, yielding time-resolved cross-validated explained variance.

Several consistent patterns emerged. First, a causal model variant produced significantly stronger early alignment with MEG representations than a non-causal variant. Second, the integrated multistream model outperformed a combination of independently fitted single-stream predictors, indicating that joint temporal integration captures complementary representational structure relevant to cortical processing. Finally, layer-wise analyses revealed the strongest alignment within recurrent representations of the intermediate (40 ms) stream, suggesting a privileged role for intermediate temporal scales in shaping auditory representations.

These results suggest that multiscale temporal integration is a critical determinant of brain-model correspondence and highlight recurrent processing at intermediate timescales as a key component of representations that align with auditory dynamics.

## 18 EEG Microstate Dynamics Reveal Increased Attentional Network Activity Associated with Loneliness

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Loneliness is a growing public health concern with profound consequences for mental health; however, its neurophysiological basis remains incompletely understood. In this study, we used resting-state electroencephalography to identify neural signatures of perceived loneliness in young adults, stratifying participants into high, moderate, and low loneliness groups. Conventional power spectral density analyses yielded no significant intergroup differences. In contrast, dynamic microstate analysis revealed that individuals with a high level of loneliness exhibited an increased occurrence and spatial coverage of Microstate D, a neural configuration associated with the dorsal attention network. This pattern suggests increased attentional network engagement, consistent with continuous monitoring for potential social threats. This profile diverges from the cognitive withdrawal commonly observed in depression, indicating that loneliness is an active state of sustained attentional demand, rather than passive decline. These findings highlight the value of temporally resolved neural measures and identify Microstate D as a candidate biomarker for loneliness. Establishing objective, scalable markers may enable earlier detection of loneliness and targeted interventions, with implications for mitigating downstream mental health disorders in vulnerable populations.

## 19 Neural Sensitivity to Statistical Structure and Memory Encoding During Visual Statistical Learning

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Previous studies suggest that the N400 component is implicated in the online segmentation of visual statistical learning (SL). This study aims to examine whether the N400 also exhibits sensitivity to statistical structures and memory encoding in visual SL. Electroencephalography (EEG) was recorded while 30 young adults were exposed to a continuous stream of nonsense shapes and performed a judgment task using triplets with varying transitional probabilities (TPs). During familiarization phase, neural activity within the 300 to 450ms post-stimulus window revealed three key findings. First, N400 amplitude increased as a function of TP and its interaction with shape position, yielding a larger N400 for final shapes with high TPs compared to those with low TPs. Second, time-frequency power for final shapes differed significantly across TPs in all frequency bands. Third, distinct alterations in alpha and beta power occurred across shape positions. These findings indicate that N400 amplitudes and oscillatory power reflect sequence segmentation and memory encoding of statistical structures. We propose that the elevated N400 for high TP final shapes indexes the active retrieval and integration of completed cohort structures from episodic memory, while the concurrent modulation of alpha and beta oscillations serves to gate attention and stabilize these newly bound sequence representations against incoming sensory information.

## 20 Selecting by Enhancing, Suppressing, and Moving: A New Framework for Attention

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Selective attention allows us to navigate a world rich in sensory input by prioritizing relevant information over competing distractions. Yet, how the brain and body achieve this together remains poorly understood. Classic models of selective attention typically do not distinguish between mechanisms that enhance relevant targets and those suppressing irrelevant distractors. Furthermore, these models have largely focused on neural mechanisms while neglecting the role of bodily action. Here, a two-component neuromotor model is proposed that integrates two emerging trends to overcome these limitations. First, drawing on contemporary insights from behavioral and neuroscientific investigations, target enhancement and distractor suppression are functionally dissociable. This view receives support from experiments that separate target- versus distractor-processing and demonstrate their independence. Second, the model incorporates recent findings on the role of motor activity in attentional selection. These two components are linked by findings showing a tight coupling of alpha oscillatory modulations (~10 Hz) with oculomotor activity and head rotations during selective attention — evidence that attentional selection is not a purely neural phenomenon but is embedded in the dynamics of bodily movement. The resulting model provides a unified framework for understanding how the brain and body together select relevant input despite distraction. The model generates testable predictions about the co-modulation of neural activity and motor behavior in attention tasks.

## 21 Neuronavigated iTBS Treatment in Patients with Depression and OCD: Behavioural Outcomes and Structural Neuroplasticity

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**Background:** Intermittent theta-burst stimulation (iTBS) shows efficacy in treating major depressive disorder (MDD) and obsessive-compulsive disorder (OCD). However, identifying predictive neurobiological markers remains challenging. This ongoing study evaluates clinical changes, structural neuroplasticity, and functional alterations following neuronavigated iTBS. **Methods:** Patients with MDD or OCD completed pre- (T1) and post-treatment (T2) assessments (N=16 behavioural; pilot N=17 neuroimaging). Target localisation used personalised neuronavigation. Clinical outcomes (SPECTRA) were analysed via frequentist paired t-tests and Bayesian sequential analyses. Structural MRI data were examined using Voxel-Based Morphometry (VBM; contrast T2 >T1). DLPFC-sgACC functional connectivity analyses are ongoing. Single-subject follow-ups tracked long-term effects. **Results:** Behavioural analyses revealed significant improvements from T1 to T2. Depression scores markedly decreased ( $t(15) = 4.26, p < .001, d = 1.07$ ), backed by decisive Bayesian evidence ( $BF_{10} > 100$ ). Anxiety ( $t(15) = 2.82, p = .013, d = 0.71$ ) and internalising symptoms ( $t(15) = 3.19, p = .006, d = 0.80$ ) reduced significantly; sequential analyses indicate that accumulating evidence will likely yield significance across remaining symptom domains. Single-subject data demonstrated sustained clinical stability through 4 months post-treatment and comparable efficacy upon repeat treatment. VBM analyses revealed clusters of increased grey matter volume (T2>T1) aligning with literature-reported neuroplasticity. Functional analyses remain ongoing. **Conclusion:** Neuronavigated iTBS effectively alleviates core symptoms, supported by robust frequentist/Bayesian evidence, long-term single-subject stability, and macrostructural neuroplasticity. Integrating these findings with upcoming connectivity results will clarify how neuromodulation remodels frontostriatal and limbic circuits, advancing imaging-informed personalised strategies.

## 22 Linking Visual Gamma Oscillations to Oculomotor Variability Across Stimulus Contrast

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Neural oscillations are shaped by the cognitive demands imposed on the brain. Among these rhythms, visual gamma oscillations (30–90 Hz) occupy a central position in theories of perceptual and associative processing. Gamma activity recorded over occipital cortex has been linked to feature binding and perceptual integration, as well as displaying excitation in response to stimulus properties (e.g., contrast). Yet, despite extensive work on how stimulus properties such as contrast and spatial frequency shape gamma power and peak frequency, the mechanistic origin of this variability remains unresolved. One possibility which is rarely examined in human EEG, is that gamma modulation may partly reflect systematic changes in oculomotor behavior. Although it has been shown that microsaccades influence early visual responses and have been associated with gamma band activity in non-human primates, large scale evidence in human EEG recordings is lacking.

To address this gap, we will use dynamic, concentric gabor gratings presented at four contrast levels (25, 50, 75, and 100%) while recording EEG and eye-tracking simultaneously in a large sample of 50 participants. We will measure eye movements (microsaccadic rate and gaze velocity) and gamma oscillations (frequency and power) at each contrast level, employing linear mixed effects models to determine whether gamma modulations are partly driven by oculomotor variability.

Preliminary pilot data (N=10) show that increasing stimulus contrast is associated with reduced microsaccade rate, and a trend of increasing gamma power and peak frequency. These pilot findings support the working hypothesis that gamma-band variability partly reflects contrast-dependent oculomotor dynamics.

## 23 Mapping hippocampal structure along the anterior-posterior & medial-lateral axis: from heritable cognitive to plastic affective organisation

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Hippocampal structural specialization provides a physical scaffold to map gene-environment interdependence, given its high heritability and experience-dependent plasticity. Its anatomical geography constrains and drives diverse behavioral phenotypes, constituting a fundamental interface for human behaviour (cognition, emotion, and alertness). However, the majority of studies have focused on hippocampal volume, setting aside both its structural complexity and the associated functional and genetic variation. To address this gap, we mapped the structural complexity of healthy young adults by extracting thickness, gyrification, curvature, and a myelin proxy (T1w/T2w ratio) using Hippunfold's U-Net segmentation. Along the hippocampal anterior-posterior and medial-lateral axes, we examined: their group-level distributions, applied non-linear dimensionality reduction (gradients) to extract axes of intrinsic covariation, calculated heritability, and uncovered latent structural-behavioral associations using multivariate regularized canonical correlation analysis. Thickness and gyrification shared a medial structural pattern that was the most heritable, anchored the primary axis of structural coordination, and emerged from the latent dimension linking hippocampal structure to cognitive behaviour. The T1w/T2w ratio showed low heritability across the hippocampus, suggesting that hippocampal myelination may be primarily associated with environmental factors. Overall, the anterior-CA1 areas, characterised by the lowest T1w/T2w ratio values, were also most strongly associated with negative emotional experience. This lower myelin content likely imposes fewer physical constraints on circuit reorganization, maintaining a higher potential for experience-dependent plasticity. Together, these findings trace two hippocampal axes: a medial, heritable structure tied to cognition, captured by thickness and gyrification, and an anterior-CA1 territory potentially favoring plasticity and defined by low myelination and affective processing..

## 24 Brain, heart, and breath dynamics during brief mindfulness and relaxation interventions

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Mind–body interventions such as mindfulness and relaxation are widely used to support emotional and physiological regulation, but acute mechanisms of brief interventions remain insufficiently understood. It remains unclear how these practices differ across subjective, physiological, and neural systems, and whether these differences reflect distinct regulatory pathways. This study examined subjective relaxation, autonomic regulation, cardiorespiratory coordination, and neural responses in healthy adults.

In a within-subject MEG design, participants completed three randomized audio-guided conditions: a mindfulness-based body scan, guided safe-place imagery, and podcast control. MEG, ECG, respiration, and subjective relaxation ratings were collected. Physiological analyses included heart rate, heart rate variability, respiration rate, and heart–breath coupling indexing cardiorespiratory coordination. Neural processing of spoken audio was assessed by modelling how MEG activity followed moment-to-moment acoustic changes; root-mean-square temporal response function amplitude summarized neural response magnitude.

Both interventions increased subjective relaxation compared with podcast listening. Physiological responses showed a differentiated pattern: respiration rate and heart rate variability varied by condition, whereas heart rate did not. Heart–breath coupling was higher during intervention conditions and predicted greater relaxation increase, suggesting that coordinated cardiorespiratory regulation may capture responsiveness beyond single autonomic markers. Neural response magnitude to acoustic changes was stronger during podcast listening than safe-place relaxation, with body scan showing an intermediate pattern, potentially reflecting stronger externally oriented auditory processing and reduced stimulus-driven processing during imagery-based relaxation.

These findings suggest that brief mindfulness and relaxation interventions affect response systems in partly dissociable ways. Multimodal assessment may help identify mechanism-specific profiles relevant for future intervention selection.

## 25 Brain-body timing gates conscious access across sensory systems

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Conscious awareness fluctuates with the brain's internal state at the moment of perception, yet how these states are temporally coordinated remains unclear. Although such internal states are reflected in ongoing neural activity, their temporal structure may arise from intrinsic interactions between the brain and the body. To test this hypothesis, we simultaneously recorded neural, cardiac, and respiratory activity while participants detected auditory, tactile, or visual stimuli presented at perceptual threshold. Across sensory modalities, stimulus detection was preceded by transient bursts of alpha-band (8–13 Hz) activity localized to lateralized prefrontal and premotor regions. Crucially, these neural events were aligned with specific phases of the cardiac and respiratory cycles, revealing coordinated brain–body states at the time of perception. This cross-system coupling predicted whether sensory stimuli reached conscious awareness. Together, these findings show that brain–body synchrony acts as a temporal gate for conscious access across sensory systems.

## 26 The dynamic relationship between pupil dilation and neural surprise in natural language comprehension

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Predictive processing accounts hold that the brain continuously generates predictions and updates internal models from error signals, but it remains unclear whether prediction representation and model-updating reflect a single graded computation or computationally distinct operations implemented in dissociable systems. We recorded magnetoencephalography and pupillometry while participants listened to natural speech, quantifying word-by-word lexical surprise and semantic prediction error with GPT-2. Broadly speaking, lexical surprise was tracked in a predominantly graded fashion, whereas the response to semantic error was better captured by a rectified linear gating function - i.e., that responds only when the error exceeds a recent contextual baseline. There were also some interesting dissociations in the strength of these relative effects. The auditory cortex tracked lexical surprise in a graded, continuous manner, with later cortical stages reflecting semantic error. By contrast, tonic pupil diameter and source-localised brainstem responses were predominantly captured by a gated response to semantic error. A pupil-coupling analysis confirmed that this gating signature was statistically shared between pupil-linked arousal and brainstem-localised, but not cortical, responses. Together, these findings reveal a division of labour in which the cortex maintains a continuous, high-fidelity map of predictive information while a pupil-linked model-update system acts as a selective gate, engaged specifically by meaning-disrupting events that have crossed a threshold level of error. This asymmetry suggests that signals serving continuous parsing of prediction error and signals serving model revision may be computationally dissociated, with a range of implications for our understanding of the intrinsic interactions between mechanisms serving perception and learning.

## 27 Accelerated neural aging as a systems-level vulnerability for tinnitus

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Tinnitus, the perception of sound without an external source, affects 10-15% of individuals, yet its neural mechanisms remain poorly understood. Building on evidence that chronological age predicts tinnitus risk beyond hearing loss, we tested the hypothesis that accelerated neural aging increases susceptibility to tinnitus by integrating cross-sectional resting-state MEG with longitudinal structural imaging data. In a large MEG dataset, spectral parametrization revealed that age-neural relationships were amplified in the tinnitus group compared to age-, sex- & hearing-matched controls. Complementing these findings, prospective analyses using data from the UK Biobank showed that among participants without tinnitus at baseline, stronger age-related declines in white-matter density predicted later tinnitus onset. Collectively, these converging functional and structural findings support accelerated brain aging as a key risk factor for tinnitus.

## **28 As Young as You Feel? Linking Subjective Age to MEG-Derived Brain Age**

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Brain age refers to the estimation of an individual's biological brain age based on neurophysiological characteristics and provides a quantitative index of deviation from chronological age. This deviation, commonly termed the brain-age gap, has been proposed as a potential marker of individual differences in brain ageing, including patterns of preserved or accelerated neurobiological ageing. Within the Paracelsus 10,000 Study in Salzburg, large-scale magnetoencephalography data provide the opportunity to estimate brain age from functional neurophysiological measures. The present study investigates whether subjective age perception, assessed via questionnaire, is reflected in MEG-derived brain age. Specifically, it examines whether individuals who perceive themselves as younger or older than their chronological age show corresponding differences in their brain-age gap. By linking subjective ageing experience with an objective neurophysiological marker of brain ageing, this work aims to contribute to a better understanding of the relationship between self-perceived ageing and functional brain ageing.

## 29 Spatiospectral signatures of stomach-brain synchrony

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While cognitive neuroscience has increasingly recognized the brain-body connection, the temporal dynamics of how the stomach's intrinsic rhythm (~0.05 Hz) modulates human neural activity remain poorly understood. Leveraging concurrent high-resolution magnetoencephalography (MEG) and novel high-density electrogastrography (EGG) recordings from N = 30 participants at rest, we provide the first comprehensive spatiotemporal mapping of human gastric-brain coupling. Our circular-linear correlation approach revealed widespread, broadband phase-amplitude coupling between the gastric rhythm and spontaneous cortical oscillations across delta, theta, alpha, and beta bands. Using nonnegative matrix factorization, we identified distinct spatiospectral fingerprints that significantly overlap with the known fMRI-based gastric resting-state network. Crucially, we discovered a consistent preferred gastric phase for these modulations, i.e. during the transition between stomach waves, that was stable across brain regions, frequencies, and time. These findings suggest that the gastric rhythm - potentially in unison with other physiological signals - provides a stable, global temporal scaffold for large-scale oscillatory brain organization. By unravelling these spectral signatures, our results establish the stomach as a critical driver of the temporal coordination of human brain dynamics..

## 30 Ocular Speech Tracking during Continuous Speech Listening in Developmental Dyslexia

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Developmental dyslexia (DD) has been linked to atypical neural tracking of continuous speech, characterised by reduced flexibility in adapting neural dynamics to changes in speech intelligibility. While these effects have been demonstrated at the neural level, it remains unclear whether analogous alterations are present in ocular speech tracking – an attention-dependent systematic coupling of eye movements to the temporal dynamics of speech.

Here, we investigate ocular speech tracking in individuals with DD (N = 18) and typically developing controls (N = 26). Participants listened to continuous auditory narratives presented at three intelligibility levels, manipulated via noise vocoding. Using coherence analyses of electrooculography (EOG) signals and speech envelopes, we quantify frequency-specific coupling between oculomotor activity and auditory input.

We hypothesise that ocular speech tracking is preserved in individuals with DD in terms of overall coherence magnitude but shows reduced flexibility in adapting to changes in speech intelligibility, mirroring previously observed neural effects. This would indicate that impaired temporal adaptation in dyslexia is expressed not only in neural activity but also in oculomotor dynamics, raising the possibility that atypical oculomotor dynamics contribute to altered speech tracking in dyslexia and link eye movement behaviour to broader deficits in speech processing.

## 31 Hippocampal Developmental Change in Childhood and its Association with the Exposome

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Childhood environment plays a critical role in impacting the pace of brain development. The hippocampus is a uniquely plastic structure and a key node in distributed networks subsuming emotion and contextual processing. Previous studies verified associations between the environment and hippocampal development. However, they have relied on age-related mean differences and isolated exposures. Our objective was to elucidate how the environment in its totality – i.e., an exposome – is associated with individual rates of change of hippocampal macrostructural development. For this, we used T1-weighted imaging data from 828 participants across three time-points from the ABCD Study (age range 9 – 14 years), segmented with a novel unfolding approach implemented in HippUnfold. A normative model using Hierarchical Bayesian Regression with SHASH likelihood was fitted, and the resulting Z-scores were used to derive velocity metrics. Finally, a cumulative exposome measure was obtained, spanning socioeconomic, family, school, and neighborhood domains. Our preliminary results suggested a differential effect of the environment on hippocampal macrostructural changes, in which a more advantageous exposome at baseline predicted slower rates of change of posterior-central thickness ( $\beta = -0.51$ , pFDR = 0.045) and faster gyrification in the subiculum ( $\beta = 0.70$ , pFDR = 0.032). These findings seem to indicate the posterior hippocampus as a region of specific plasticity during development. Possible implications regarding a protracted or accelerated development of hippocampal macrostructure will be discussed in this work. In conclusion, we provide preliminary evidence that the pace of hippocampal development may be susceptible to environmental influences.

## 32 Benchmarking SQUID and OPM Magnetoencephalography with a Dry Phantom: Source Localization Accuracy and Its Dependence on Sensor Count

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Magnetoencephalography (MEG) noninvasively records the magnetic fields of neuronal activity using either established cryogenic SQUID sensors or emerging optically pumped magnetometers (OPMs), which need no cooling and can sit closer to the scalp. Human comparisons are confounded by physiology, so we benchmarked both technologies on a dry phantom emulating 50 equivalent current dipoles (ECDs), measured by both a SQUID (Kanazawa Institute of Technology) and OPM sensors system (HEDscan) in the same shielded room at NYU Abu Dhabi. Drive currents of 10 and 100  $\mu\text{A}$  varied signal-to-noise ratio; sources were reconstructed with the Sarvas formula and scored against CT-calibrated ECD positions. Placing OPMs closer to the source gave a peak signal 3-4 $\times$  larger than SQUID (6.6 vs 2.2 pT), yet OPM localization error was about three times larger:  $3.48 \pm 0.58$  mm versus  $1.07 \pm 0.17$  mm at 10  $\mu\text{A}$ , and 2.77 versus 0.74 mm at 100  $\mu\text{A}$ . Controlled analyses showed this gap was not explained by signal-to-noise ratio, channel count, or spatial coverage; a 90-channel SQUID subset still reached 1.56 mm, and only  $\sim 40$  SQUID channels were needed to match the 90-channel OPM accuracy (3.13 mm), implicating OPM sensor-array calibration as the dominant factor. A companion study resampling subsets of 30-90 of the 96 OPM sensors characterizes how accuracy improves and plateaus with array size, guiding cost-effective, incrementally expandable OPM-MEG. A dry phantom thus offers a reproducible, physiology-free benchmark for cross-technology comparison, identifying calibration, rather than noise or sensor count, as the key lever for improving OPM source localization.

### 33 Concordant and diverging cortical tracking signatures of objective and subjective hearing ability

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Pure-tone audiometry is the current clinical standard for assessing hearing ability, but audiometric thresholds only partly capture everyday listening experience. Self-reported hearing ability often covaries with audiometric status, yet listeners with similar audiometric thresholds can report markedly different listening experiences. This suggests that objective and subjective hearing may reflect partly shared, but also partly distinct, neural processes.

We tested this using MEG recordings from participants who passively listened to a continuous radio play. Objective hearing was quantified using pure-tone audiometry, while subjective hearing ability was assessed with the Speech, Spatial and Qualities of Hearing Scale. Neural tracking was estimated as parcel-wise temporal mutual information between source-localized cortical activity and a modeled inferior colliculus representation of the auditory stimulus. Resulting temporal mutual information was parameterized by peak height, peak latency, and peak width to characterize the strength and temporal profile of cortical tracking across the brain.

Audiometric hearing loss was associated with poorer self-reported hearing, but subjective hearing varied substantially among participants with comparable thresholds. Cortical tracking features were associated with both pure-tone thresholds and subjective hearing ability. These associations showed mostly concordant but also regionally divergent patterns, suggesting that subjective hearing is not merely a perceptual reflection of audiometric sensitivity.

Together, our findings indicate that objective and subjective hearing are reflected in partially overlapping but spatially dissociable cortical tracking signatures during naturalistic listening. More broadly, they suggest that naturalistic cortical tracking can reveal shared and distinct neural correlates of different dimensions of hearing ability.

## 34 Interaction of model size, context length and text genre on Turkish language models' prediction of human reading: An analysis of MultiEye Turkish data

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Surprisal theory predicts slower reading for less predictable words (Levy, 2008). Psychometric predictive power (PPP; Goodkind & Bicknell, 2018) tests this by measuring how much language-model (LM) surprisal improves prediction of human reading behavior. Kuribayashi et al. (2022) found that LMs can become more human-like when prior context is restricted, suggesting that full-context Transformers may use information readers do not always maintain online. We test whether this restricted-context effect extends to Turkish, an agglutinative SOV language, and whether it depends on model size, text genre, and comprehension accuracy.

## 35 What space-resolved MVPA can add to your M/EEG analysis: factors determining data-driven topographical EEG decoding of natural scenes, error processing and visual search

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Recent work has shown that multivariate pattern analysis (MVPA) can not only decode from the spatial pattern across M/EEG electrodes/ sensors but from the temporal pattern within sensors (i.e. “space-resolved” or sMVPA). It is not clear which experimental factors affect sMVPA accuracy, as the only two previous sMVPA studies varied greatly in design and analysis parameters.

Here we systematically kept other parameters the same while varying dataset, trial/fold number and algorithms. We used three very different publicly available datasets: i) our recent study in which participants viewed real world scenes through shutter glasses which generated large numbers of steady-state visual evoked potentials (SSVEPs) and from which we could decode, with near-ceiling accuracy and from single electrodes, which of 6 scenes people were viewing. ii) Error Related Negativity (ERN) during a flanker task iii) N2Pc in visual search. Decoding was reduced but still very high when we used far fewer (15 rather than 200) trials for decoding the naturalistic SSVEPs, with little effect of decoding algorithm (Pearson correlation versus Support Vector Classifiers). Surprisingly, we found similarly high decoding accuracies with naturalistic SSVEPs as with the ERN evoked by highly artificial flanker arrow stimuli. Decoding accuracy was reduced but still surprisingly spatially extensive in the N2Pc dataset in which the waveforms to be classified are highly similar. sMVPA decoding therefore does not require naturalistic stimuli and is relatively algorithm-insensitive, boosted by high trial numbers and waveform dissimilarity. sMVPA allows highly data-driven decoding, without first specifying cluster-size, direction, electrode or time-bin of effects.

## 36 Breaking the narrative: Effects of event structure and attention on neural predictions across visual hierarchies

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To make sense of this dynamic world, our brain uses learned causal regularities to predict upcoming events, such as dark clouds preceding a rainstorm. However, it remains unclear how disrupting causal structure affects neural representations across the visual hierarchy and whether this also requires attention. In a natural MEG experiment, 54 participants watched 9-minute-long movies played either forwards or backwards while attending or performing a distraction task. Reversing movies disrupted causal relationships without altering low-level input whereas manipulating attention tested whether updating these predictions depended on it.

We used dynamic Representational Similarity Analysis (dRSA), in which we compare time-varying stimulus models to neural data, revealing when and how strongly each model is represented. We tested models spanning low-, mid- and high-level features to locate where our manipulations influenced neural processing. Low-level visual features were represented at 100-200ms in early visual cortex and were enhanced by attention. Spatial coherence, approximating parvocellular LGN responses, showed the same attentional enhancement but also stronger representations for reversed movies. Mid-level body-kinematics models were only weakly represented in LOTC and showed no modulation, while high-level action representations in LOTC emerged at 100–400ms and were strongly enhanced by attention.

Together, these preliminary results suggest that disrupting causal structure modulates neural representations primarily at early stages, with stronger responses to reversed movies, potentially reflecting prediction error signals. Attention, by contrast, enhanced representations across the hierarchy, most strongly for action content in LOTC. Overall, attention and causal structure seem to act independently, modulating neural representations additively rather than interactively

## 37 Memorability-Driven Temporal Distortions in Episodic Memory: Behavioral and Neural Evidence

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Episodic memory does not merely preserve what happened where but also when – how far apart events felt in time. Previous studies have suggested that temporal distances between events in memory are “mapped” by the theta rhythm (~ 3-8 Hz). But does this mapping reflect objective time or rather the temporal structure of events as they were experienced? In our previous work, we showed that memorability – a high-dimensional stimulus property that has been shown to distort perceived duration – also alters temporal memory, biasing temporal distance judgments and imposing structure on continuous experience: transitions in memorability act as implicit boundaries, segmenting an ongoing sequence of images into distinct sub-events. Building on these findings, we asked 30 healthy participants to view image sequences with and without memorability transitions and provide temporal distance judgments while undergoing MEG recordings. Preliminary data suggest memorability-driven temporal distortions are captured by changes in evoked response amplitudes during encoding. Additionally, in line with the theta code hypothesis for temporal distances we predicted that theta power tracks subjective rather than objective distances, such that distortions experienced during encoding would be reflected in this code. Supporting this working hypothesis, we show a memorability-dependent modulation of theta power by temporal distance. Together these preliminary findings highlight the role of memorability context in the organization and retrieval of temporal memories supporting the view that the when of memory is not a passive readout of experienced time, but a reconstructive, context-dependent process.

## **38 Can oscillatory perception models accommodate the variation in natural sensory signals?**

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The brain generates temporal predictions about incoming input that shape perceptual processing. For example, in speech perception, oscillatory accounts propose that this process is supported by the alignment of neural oscillations with the temporal structure of speech, such that peaks of processing align with peaks in likely information. If we listen to someone speaking, on average, with syllables at 4 Hz, it is proposed that our brains oscillate at 4 Hz to optimise perception. These accounts have proven controversial, partly because it is unclear whether the level of variation in timing of natural signals would render an oscillatory mechanism adaptive for perception. To this end, the present project aimed to formally model this level of variation to determine the fit of different sampling models. Using naturalistic speech recordings from the Harvey Oral Narratives on Record (HONOR) corpus, we extract envelopes and estimate syllable onsets based on acoustic features of the speech signal. We then quantify the temporal distribution and variability of inter-syllabic intervals. To examine how naturalistic variability interacts with oscillatory sampling, we implement a computational model of a theta oscillator and compare it with a non-oscillatory predictive model, assessing how well each model captures the timing of syllabic structure. By relating the statistics of natural speech to the sampling properties of an oscillatory model, this study thereby determines the relative adaptive value of different models, with implications for our understanding of perception of our dynamic environment in speech and, by extension, other modalities.

## 39 Neural Dynamics of Respiratory Interoception

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Interoception encompasses both unconscious and conscious detection of bodily signals and is critical for maintaining homeostasis and enabling adaptive allostatic regulation. Among these, respiration stands out due to its malleability and its association with psychiatric conditions such as anxiety disorders. Respiratory interoception (respiroception) can be quantified using a dimensional framework in which lower levels reflect objective perceptual performance and higher ones capture metacognitive insight. This hierarchical approach, combined with behavioural modelling implemented in the respiratory resistance sensitivity task (RRST), provides a robust method for quantifying respiroceptive processing.

Thirty participants completed a MEG-compatible RRST alongside questionnaires assessing anxiety, depression, and interoceptive awareness. Behavioural data were analysed using a Bayesian psychophysical model to estimate perceptual and metacognitive dimensions. Source-level neural dynamics were examined within an AAL atlas-based cortical ROI network derived from prior (f)MRI-respiroception studies.

Multivariate pattern analysis (LDA-MVPA) applied to time-frequency representations reliably decoded restricted from free breaths, eliciting temporally and spectrally distinct neural signatures within the interoceptive network. Alpha and gamma frequency bands appear as interesting contributors in unravelling neural fingerprints of respiroception.

Overall, these preliminary findings suggest that respiratory interoception is supported by spatially and spectrally organized cortical and subcortical dynamics. Ongoing analyses aim to link the strength and timing of these discriminative neural patterns to behavioural sensitivity and precision. Further work will situate these results within a predictive-coding framework leveraging a hits versus misses decoding analysis. The integration of behavioural and neural markers holds translational promise, particularly for conditions characterised by altered respiratory interoception, such as anxiety disorders.

## 40 Investigating Respiratory Modulation Of Neural Oscillations During Multisensory Integration

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The brain continuously integrates exteroceptive signals from the environment with interoceptive rhythms generated within the body. Among these, respiration has emerged as a key modulator of sensory and cognitive processing. Multisensory integration - the non-linear combination of information across senses to reduce environmental uncertainty - relies on neural oscillations whose phase dynamics may be shaped by respiratory rhythms. This ongoing project investigates whether and how respiration influences the phase resetting of ongoing oscillations during multisensory processing. We build on prior behavioural evidence that reaction times vary systematically with respiratory phase and that multisensory gain, quantified via the race model inequality, appears to fluctuate across the respiratory cycle. 35 healthy participants performed a simple detection task with unimodal (auditory and tactile) and bimodal (audio-tactile) stimuli while respiratory and brain activity (EEG) were recorded. Behavioral analyses revealed faster responses to bimodal stimuli than unimodal stimuli, and multisensory integration was confirmed by a significant violation of the race model inequality. Building on this, the planned analysis will focus inter-trial phase coherence (ITPC) to test whether stimulus-driven phase alignment of cortical oscillations during multisensory integration is modulated by respiratory phase. We hypothesise that respiration acts as a slow carrier wave organising cortical excitability and establishing temporal windows within which multisensory integration is enhanced. By linking respiratory dynamics to oscillatory mechanisms of sensory processing this study will inform theoretical frameworks of body-extended, predictive, and multi-timescale multisensory integration, clarifying how bodily rhythms scaffold the brain's processing of the external world.

## 41 Effects of Propionic Acid Supplementation on Cortical Excitability and Neurovisceral Coupling in Multiple Sclerosis

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Multiple Sclerosis (MS) is characterized by neuroinflammation and metabolic dysregulation, including altered levels of the gut-derived short-chain fatty acid propionic acid (PA). In this longitudinal exploratory study, we investigated associations between PA supplementation, heart–brain synchronization, and cortical excitability in MS patients compared to healthy controls. To assess cortical excitation/inhibition (E/I) balance, we applied a hierarchical Bayesian model to the aperiodic exponent (1/f slope). At baseline, results suggested spatially heterogeneous effects in MS, with no evidence for a uniform global shift, but regional interaction terms indicating deviations in the Dorsal Stream Visual and Superior Parietal networks, and a negative shift in the Early Auditory network (95% HDI excluding zero). Longitudinal analyses provided preliminary evidence for region-specific changes in aperiodic dynamics associated with PA supplementation, although 95% credible intervals generally included zero, suggesting uncertainty in temporal effects. Complementary Heartbeat-Evoked Potential (HEP) analysis showed preserved evoked amplitudes and latencies, while ECG–MEG coherence analysis revealed reduced heart–brain coupling in MS patients ( $p = .027$ ), most pronounced in posterior sensory integration regions ( $p = .014$ ), with weaker effects in frontal regions ( $p = .081$ ). Overall, these findings are preliminary and exploratory in nature. They suggest altered neurovisceral coupling and region-specific cortical dynamics in MS, with potential modulation following PA supplementation.

## 42 Tracking Cross-Modal Fear Generalization with Multivariate MEG

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Fear learning in natural environments rarely depends on a single sensory channel. Threat-related cues can be detected rapidly through modality-specific sensory pathways, suggesting that sensory cortices may contribute to the fast processing and generalization of potential danger. Investigating whether fear-generalization gradients are shared across sensory modalities, or instead rely on modality-specific sensory representations, is critical for understanding the neural mechanisms underlying adaptive and dysfunctional fear learning. Here, we examine fear generalization across visual and auditory modalities using magnetoencephalography and multivariate pattern analysis.

Forty healthy subjects underwent a fear conditioning paradigm in which either a low frequency or a high frequency tone was aversively conditioned (CS+). Before and after the conditioning phase, we also presented seven generalization stimuli (GS) with frequencies logarithmically distributed between CS- and CS+. In addition, explicit ratings of these stimuli were assessed, and a stimulus discrimination task was performed before and after this paradigm to assess perceptual thresholds.

RDM based tuning-curve analysis tested whether neural representations were organized along the expected generalization gradient, with stronger dissimilarity for increasingly distant stimulus conditions. We showed a time-resolved tuning structure, indicating that MEG source patterns encoded graded relationships among conditioned and generalized stimuli across modalities. Subjects also showed generalization effects in their ratings of the GS stimuli: the more similar GS were to the aversively conditioned stimulus, the higher the ratings were in terms of fear elicited and the likelihood of the aversive stimulus occurring.

## 43 Tracking dynamic representations of predictions, sensory evidence, and prediction error during moving-object perception

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Predictive coding accounts propose that perception depends on comparing incoming sensory evidence with expectations. In many M/EEG paradigms, prediction error is studied by contrasting evoked responses to expected and unexpected static stimuli, leaving open how predicted stimuli, observed stimuli, and their mismatch are dynamically represented. Moving-object occlusion provides a dynamic test case: when an object disappears, its trajectory supports a prediction about where it should reappear and continue; when it becomes visible again, this prediction can be confirmed or violated.

We recorded MEG while participants viewed a dot moving along smooth curved trajectories. The dot was either always visible, temporarily occluded while continuing along the same path, or temporarily occluded while changing direction behind the occluder. Using dynamic representational similarity analysis, we tracked how strongly time-resolved MEG activity reflected observed position, expected continuation, and prediction-error models.

Preliminary analyses (N = 7) revealed reliable position-related structure during visible motion, lagging the stimulus by approximately 120–130 ms. In always-visible trials, position information was strongest early and weakened later, despite continuous input. In non-deviant occluded trials, position representations attenuated during occlusion and increased after reappearance, consistent with reinstatement when sensory evidence matched prediction. In deviant trials, post-occlusion activity aligned more strongly with the observed deviated path than with the expected continuation, suggesting rapid updating after mismatch. Prediction-error models showed weaker structure than observed-position models.

These preliminary findings suggest that dRSA can move beyond static stimuli expected-versus-unexpected contrasts by testing whether MEG representations follow predictions, incoming sensory evidence, or their mismatch over time.

## 44 Challenging "Baby Brain": Preliminary Findings from a Longitudinal Study of Memory in Pregnant and Non-Pregnant Women

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A substantial proportion of pregnant women report cognitive difficulties such as attention and memory problems – a phenomenon commonly referred to as "baby brain". Yet, objective evidence for pregnancy-related memory changes remains inconsistent. The present longitudinal study examined both subjective and objective memory performance across pregnancy and the postpartum period. A total of 50 participants (25 controls (M AGE = 29.2, SD AGE = 4.78), 25 pregnant women (M AGE = 29.8, SD AGE = 3.95)) were assessed at five time points over 12 months. Each time point comprised an in-lab session followed by ambulatory home assessments: an adaptation evening and night, followed by an experimental evening, night, and morning. Measures covered subjective memory complaints (Cognitive Failure Questionnaire, Metacognitive Prospective Memory Inventory) and objective tests of declarative memory (word-pairs, verbal fluency), working memory (n-back), prospective memory (intention task, actigraph button-press task), visuospatial memory (Corsi Block Tapping, card-pairs), and motor learning (Finger Tapping). Preliminary findings indicate that pregnant women reported significantly more everyday cognitive failures postpartum, yet showed no significant differences on any objective memory measure, suggesting a dissociation between subjective and objective memory experience. Notably, reduced vigilance (Psychomotor Vigilance Task) in the third trimester and postpartum suggests that attentional and motivational factors may partly account for the subjective perception of "baby brain." Our future EEG analyses may further clarify these effects, for instance by revealing whether preserved behavioural performance is accompanied by compensatory neural activity.

## 45 Pregnancy reshapes diurnal steroid rhythms and their association with sleep fragmentation – a longitudinal study

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Pregnancy is characterized by profound endocrine changes, yet the diurnal organization of steroid hormones and their associations with sleep fragmentation remain insufficiently understood. This longitudinal study (six months) examined diurnal salivary cortisol, estradiol and progesterone patterns across pregnancy. 23 women (MAGE = 30.13, SDAGE = 3.66) were assessed in early pregnancy ( $\leq 16$  gestational weeks), second and third trimester; 23 non-pregnant controls (MAGE = 29.04, SDAGE = 4.60) completed three time-matched assessments in the luteal phase. At each assessment period, 13 morning and evening saliva samples were collected, yielding 39 samples per participant. These were accompanied by six nights of ambulatory polysomnography in total; chronotype was assessed at baseline using a self-assessment questionnaire. Hormone concentrations increased across gestation but remained stable in controls. Cortisol showed a progressive attenuation of the evening-to-morning difference and cortisol awakening response across pregnancy. Estradiol displayed group-specific diurnal organization: with consistent morning peaks and evening declines in pregnant participants but weaker evening-oriented or flat profiles in controls. Progesterone increased across pregnancy but showed modest, inconsistent within-day variation. More sleep fragmentation (indexed by wake after sleep onset) was associated with a reduced cortisol awakening response and smaller overnight estradiol increases in controls, but not in pregnant participants. Chronotype was related to the cortisol awakening response across groups, with stronger morningness associated with a smaller response. Together, these findings indicate that pregnancy reshapes diurnal endocrine profiles and may weaken the association between sleep fragmentation and hormone patterns, suggesting a reduced sensitivity of endocrine rhythms to disrupted sleep during pregnancy.

## 46 Language familiarity and signal degradation modulate center frequency of coherence spectrum differentially: A cross-cultural approach

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Neural speech tracking has advanced our understanding of how the brain processes speech, yet it remains unclear how speech intelligibility modulates this tracking. In the present study, we manipulated speech intelligibility through two factors: language familiarity and signal degradation. We used a  $2 \times 2 \times 3$  mixed factorial design, with Population as a between-subjects factor, comprising native German and native Mandarin speakers; Language Familiarity as a within-subjects factor, comprising native and unfamiliar languages; and Degradation Level as a within-subjects factor, comprising original, 7-channel vocoded, and 3-channel vocoded speech. Participants listened to the same set of stimuli: clear or degraded audiobook segments from *A Little Princess* in German and Mandarin, ranging from 15 to 90 seconds in duration. After each segment, they selected, from two visually presented nouns, the last noun they had heard. Experiments were conducted in Salzburg and Taipei to ensure optimal control over language familiarity. Both populations were tested using identical magnetoencephalography (MEG) systems.

Behavioral results showed a significant interaction between language familiarity and degradation level, as well as a marginal three-way interaction among population, language familiarity, and degradation level. To characterize neural speech tracking, we parameterized the phase coherence spectra between speech envelopes and MEG signals, providing a detailed profile of speech–brain phase alignment. Analyses of the center frequency of the coherence spectrum revealed significant interactions between population and language familiarity, and between language familiarity and degradation level. Together, our findings suggest that different sources of speech intelligibility modulate neural speech tracking in distinct ways.

## 47 Neural signatures of coding and storing time intervals in working memory

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Working memory (WM) critically relies on temporal processing for the order and time intervals of cognitive information. However, the neural mechanisms underlying the representation and the maintenance of time intervals in WM remain largely unresolved. Previous work using an n-item delayed duration reproduction task suggested that durations can be stored as scalar magnitudes in WM (Herbst et al., 2025). Herein, participants were presented with sequences of duration consisting of either one or three empty temporal intervals (items), marked by brief tones. After a retention period, participants reproduced these items. We used this protocol with magnetoencephalography and contrasted brain activity as a function of the number of item(s) and of their durations. First, we observed that during the encoding of the temporal sequence, the amplitude of the evoked response to the last tone increased with the smaller number of durations in a sequence and longer sequence duration. Additionally, its amplitude predicted participants' performance in reproducing a single item of short time intervals. Second, we examined how WM load modulated oscillatory power during the retention interval. Our preliminary observations suggest that alpha (8-12 Hz) and beta (14-30 Hz) power are modulated by the number of items. Overall, as for other WM content, our findings suggest that evoked responses and oscillatory power serve as neural signatures of temporal information encoding and maintenance, respectively. We expect that this study will help further clarify the representation of duration in WM.

## 48 The Impact of Bedtime Procrastination and Pre-Sleep Digital Detox on Sleep Quality

**Sandra Strzoda<sup>1</sup>, Esther Kraus<sup>1</sup>, Johannes Lager<sup>1</sup>, Nomi Sihler<sup>1</sup>, Sebastian Baron<sup>1</sup>, Kerstin Hoedlmoser<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria

Bedtime procrastination is associated with poor sleep quality, and pre-sleep smartphone use may drive this effect by displacing time otherwise spent sleeping. However, whether restricting pre-sleep screen use can improve sleep quality remains an open question, with objective evidence particularly lacking.

We examined the sleep of 80 young adults ( $M = 22.40$  years,  $SD = 2.38$ , 66 females) over two weeks via heart-rate variability recorded by the Polar<sup>®</sup> sensor and scored into sleep stages by the Sleep<sup>2</sup>© app. During one of the two weeks, participants refrained from using digital technologies in the hour preceding sleep. The assignment was randomized, and compliance was monitored using screentime data or daily sleep logs. The sleep logs capturing subjective sleep quality and technology use were filled out in the morning and evening. Validated questionnaires assessing sleep quality, technology use, and well-being were administered weekly. Additionally, a subgroup of Android users ( $n = 32$ ) installed the Murmuras app for objective smartphone tracking.

In the digital detox week, objective sleep onset latency was significantly reduced compared to the control week. Additionally, higher levels of bedtime procrastination significantly predicted later sleep onset time, lower objective total sleep time, and lower objective sleep efficiency, despite no significant differences in pre-sleep smartphone use.

Our findings indicate that a one-hour pre-sleep digital-detox is sufficient to reduce sleep onset latency, highlighting the practical relevance of limiting pre-sleep screen use. However, individuals high in bedtime procrastination continued to show insufficient sleep, suggesting they may require a specifically targeted intervention.

## 49 Sound identifiability modulates acoustic-to-semantic transformations in MEG responses to natural sounds

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<sup>1</sup>Institut de Neurosciences de la Timone, Aix-Marseille University, France, <sup>2</sup>Institut de Neurosciences des Systèmes, Marseille Public University Hospital System, France, <sup>3</sup>Computer Science and Systems Laboratory, University of Toulon, Marseille, France, <sup>4</sup>Maastricht University, Netherlands

Natural sounds vary in how reliably they can be mapped onto recognisable sources, from instantly identifiable to persistently ambiguous. This variability provides a principled test of whether acoustic-to-semantic transformations in the brain depend on the reliability of mapping acoustic input onto learned sound-source representations. We recorded MEG responses to 150 natural sounds (21 participants), and combined representational similarity analysis (cross-validated variance partitioning) of MEG responses (crossnobis) with computational-model embeddings (acoustics; deep neural networks learning categorical and continuous semantic embeddings from sound; text-based semantic models), and independent behavioural measures of sound and text-label similarity, and of sound identifiability. Across sounds, MEG responses followed a sound-to-meaning cascade: early acoustic representations (~100ms) were followed by categorical (~250ms) and continuous (~500ms) semantic representations, with text-based semantics predicting little variance. Behavioural models showed a sustained MEG representation of perceived similarity and a weaker, transient contribution of sound identifiability. An analysis split by identifiability revealed diverging representations: well identified sounds showed early acoustic (~250ms) and sound-label similarity (<500ms), whereas poorly identified sounds showed sustained acoustic and sound similarity representation with little evidence for text-based coding. These results suggest that identifiability biases sound processing toward rapid label access for recognisable sounds and prolonged sound-based analysis for ambiguous sounds.

## 50 The brain predicts the next word: Parafoveal processing in Arabic word recognition

**David Paul Melcher<sup>1</sup>, Michele Deodato<sup>1</sup>, Gianluca Marsicano<sup>1</sup>**

<sup>1</sup>New York University Abu Dhabi, New York University, United Arab Emirates

The brain uses both current and previously viewed information to make predictions about what we will see next. When reading or looking around a scene, we use saccade eye movements to look at the next word or object ("target") based on a glimpse of that target from extra-foveal vision ("preview"). We studied the preview benefit of validly predicting the identity of a target word across an eye movement. Through a combined use of EEG and gaze-contingent eye tracking, participants with a range of expertise in the Arabic language made a saccade to words that appeared in either their right or left parafoveal visual field. In valid preview trials, the same target word was presented during the preview and after the saccade, while in the invalid condition, the saccade target was a number string that turned into a word during the saccade. The valid preview dramatically reduced the fixation-related EEG evoked response to the word target after the saccade. Interestingly, both univariate and multivariate analyses revealed much earlier preview effects than previously reported for words in many other languages. Individual decoding performance correlated with participant reading scores. These results demonstrate that a parafoveal preview can influence relatively early aspects of post-saccadic word processing in Arabic, with implications for both normal reading and dyslexia for Arabic readers.

## 51 Mutual Information Reveals Frequency-Specific Processing of Pleasant and Unpleasant Music

**Alejandro Espino-Payá<sup>1</sup>**

<sup>1</sup>University of Münster, Germany

Music elicits powerful affective responses, yet the acoustic and neural mechanisms underlying musical pleasantness remain poorly understood. Here, we investigated how the structure of acoustic features relates to neural encoding of pleasant and unpleasant music. Thirty-nine participants listened passively to musical fragments while their brain activity was recorded using magnetoencephalography (MEG). For each 8-second fragment, we extracted four acoustic features sampled at 100 Hz; the envelope, its derivative, spectral flux, and its derivative. We then computed the power spectral density (PSD) of each feature for two purposes. First, using the Hilbert transform and peak detection, we quantified the number of oscillatory peaks within canonical frequency bands (delta, theta, alpha, beta and gamma) for pleasant and unpleasant stimuli. Second, we estimated Gaussian Mutual Information (GMI) between the acoustic features and the MEG signals to quantify the shared information between music and brain activity, capturing both linear and nonlinear dependencies.

Multivariate mutual information across all four features revealed significant clusters predominantly in the right and left auditory cortices: in the delta band for the unpleasant > pleasant contrast, and in the theta and alpha bands for the pleasant > unpleasant contrast. Critically, these neural clusters emerged in the same frequency bands where the number of acoustic peaks differed significantly between conditions. These findings suggest that the density of acoustic peaks within a given frequency band drives the amount of information shared between musical stimuli and neural responses, providing a candidate mechanism linking acoustic temporal structure to the affective processing of music.

## 52 Multilingualism and spatial grids: insights into neuro-cognitive reserve underlying language learning

**Sevil Maghsadghagh<sup>1</sup>, Olga Kepinska<sup>2</sup>, Marcia Bécu<sup>3</sup>, Irene Balboni<sup>4</sup>, Alessandra Rampinini<sup>4</sup>, Christian F. Doeller<sup>3,5</sup>, Narly Golestani<sup>1,4</sup>**

<sup>1</sup>University of Vienna, Austria, <sup>2</sup>Aix-Marseille University, France, <sup>3</sup>Norwegian University of Science and Technology, Trondheim, Norway, <sup>4</sup>University of Geneva, Switzerland, <sup>5</sup>Max Planck Institute for Human Cognitive and Brain Sciences, Max Planck Society, Leipzig, Germany

Bilingualism has been associated with structural and functional brain differences (Hervais-Adelman et al., 2018; Voits et al., 2022), episodic memory advantages (Golshani et al., 2024) and neural reserve (Venugopal et al., 2024). The entorhinal cortex (EC), part of the declarative memory system involved in language learning and processing (Ullman, 2004), generates grid-like activity—a hexadirectional modulation of fMRI BOLD signal during spatial navigation (Doeller et al., 2010). EC is among the earliest regions affected in Alzheimer's disease (Braak & Del Tredici, 2011). Grid-like EC activity has also been observed during semantic processing (Viganò et al., 2021), suggesting that multilingual language experience—managing multiple linguistic mappings—may strengthen entorhinal function and structure.

In 107 healthy young adults, we examined whether (a) multilingual language experience, quantified using a proficiency-weighted composite score (LEAP-Q; Marian et al., 2007), and (b) language aptitude — assessed using phonological, grammatical, and rote learning measures—are associated with grid-like EC activation and EC volume. Participants performed a virtual navigation task during fMRI (Kunz et al., 2015). Functional and structural data were analyzed using GridCAT (Stangl et al., 2017), and FreeSurfer (Fischl, 2012), respectively.

Multilingual experience was positively associated with grid-like activation in bilateral EC and with right EC volume, controlling for age, sex, education, and navigation performance. Language aptitude was not related to either measure. These findings provide the first evidence that multilingual language experience is associated with stronger entorhinal function and structure, consistent with prior evidence for multilingualism-related experience-dependent plasticity and neural reserve.

## 53 Neural decoding across core language dimensions during naturalistic speech comprehension: from word form to pragmatics

**Riccardo Venturini<sup>1</sup>, Cosimo Iaia<sup>2</sup>, Paolo Canal<sup>1</sup>, Federico Frau<sup>1</sup>, Luca Bischetti<sup>1</sup>, Marco Tettamanti<sup>3</sup>, Valentina Bambini<sup>1</sup>, Alessandro Tavano<sup>2</sup>**

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In this study, we aimed to decode the information content of the EEG signal to predict eight theoretically motivated language dimensions, ranging from word form to discourse-pragmatic levels, including word class, syntactic operations and positions, conceptual semantics, distributional semantics and lexical-pragmatic features.

Thirty-four participants (20 females; age =  $23.6 \pm 2.1$ ) listened to an audio recording of the tale "Il Drago dalle sette teste" while EEG was recorded. Continuous preprocessed data were segmented into epochs time-locked to word offset (from  $-400$  to  $1200$  ms). We fitted a back-to-back regression model (King et al., 2020) to estimate each feature representation in the EEG signal at each time point. Group-level significance was assessed using cluster-based permutation tests (one-tailed,  $n = 5000$ ,  $\alpha = .001$ ).

The first seven dimensions, from word form to the lexical-pragmatic level, were significantly decoded (clusters spanning from  $-84$  ms to the end of the epoch, all  $p < .001$ ), whereas the discourse-pragmatic level was not reliably decodable. See Figure (<https://tinyurl.com/B2B-word-offset>).

These findings demonstrate that multivariate predictive modelling can decode multiple fine-grained linguistic dimensions from EEG, replicating previous work (Gwilliams et al., 2025), with higher-order representations exhibiting more extended neural decodability windows than lower-level features. Overall, our findings support substantial parallel processing during language comprehension. Interestingly, conceptual semantic and lexical-pragmatic information were also decodable and overlapped with the temporal window of word class features, suggesting that higher-order linguistic representations may be active concurrently with lower-level ones. The null result for discourse-pragmatic decoding likely reflects inherent limitations of word-level analyses.

## 54 Eyes in the Loop: Ocular and Neural Interplay in Auditory Speech Processing

**Veronika Holler<sup>1,2</sup>, Annika Etzler<sup>1</sup>, Karolina Ignatiadis<sup>2</sup>, Fabian Schmidt<sup>1</sup>, Thomas Hartmann<sup>1</sup>, Anne Hauswald<sup>1</sup>, Gianpaolo Demarchi<sup>1</sup>, Nathan Weisz<sup>1,3</sup>**

<sup>1</sup>University of Salzburg, Austria, <sup>2</sup>MED-EL (Austria), Innsbruck, Austria, <sup>3</sup>Christian Doppler Klinik, Salzburg, Austria

“Ocular Speech Tracking” (OST) is a phenomenon describing the alignment between a heard audio envelope and a listener’s eye movements. Previous studies provided evidence of this mechanism and revealed links to attention and the degree of speech understanding. In the present study, we investigated how age and OST are related and to develop a deeper understanding of the relationship between OST and the longer-established Neural Speech Tracking (NST); the latter referring to an alignment of neural activity with heard speech. Both phenomena were investigated using Temporal Response Functions (TRFs), in a dataset containing MEG and eye-tracking data from a dual-speaker experiment of 114 subjects between the ages of 18 and 79.

We found no significant main effect for age on OST. However, we replicated the effect of attention: tracking was pronounced for the attended speaker in a dual speaker condition compared to a single speaker or an unattended speaker. To investigate the relation of ocular and neural activity, we further compared a TRF model for NST with the envelope as a predictor to a model incorporating both, envelope and the eye movements. Including eye movements increased prediction accuracies, with the affected brain regions varying as a function of age and speaker scenario.

Our findings support a facilitative role of the oculomotor system in speech processing beyond visually-guided functions like lip reading and attention. Future research on this process may yield new insights into speech processing and inform the development of targeted rehabilitation strategies.

## 55 Dancing Eyes: Oculomotor tracking of polyphonic music reflects attention and musical expectation (preliminary)

**Annika Etzler<sup>1</sup>, Thomas Hartmann<sup>1</sup>, Fabian Schmidt<sup>1</sup>, Anne Hauswald<sup>1</sup>, Nathan Weisz<sup>1</sup>**

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Recent speech research suggests that the oculomotor system is involved in attention and segregation of competing auditory sources. Music, however, differs fundamentally from speech in that listeners integrate multiple sound sources into a coherent percept that can be greater than the sum of its parts. Evidence for oculomotor involvement during music listening remains limited to findings such as blink synchronization to musical beats and pupil diameter changes with tonal regularity. However, currently there is no evidence that eye movements systematically track auditory features of music. In this study, 26 participants listened to polyphonic musical excerpts performed by a cello and/or bassoon, presented individually or simultaneously, with selective attention directed to one instrument in dual-instrument trials. MEG and eye-tracking data were recorded during fixation of a central cross. Temporal response functions (TRFs) using spectral flux and note onsets as predictors revealed significant ocular music tracking (OMT) across instruments and conditions. OMT was strongest during single-instrument presentations. In dual-instrument trials, prediction accuracy for bassoon stimuli was higher when attended than when ignored, mirroring effects in competing speech. No comparable attention effect was observed for cello stimuli. To investigate whether predictive processes contribute to OMT, we used IDyOM, a variable-order Markov model of musical expectation, to derive note-wise entropy and surprise estimates. Including these measures as additional regressors significantly improved prediction accuracy relative to shuffled controls. These findings suggest oculomotor activity during music listening reflects not only low-level acoustic features but also selective attention and probabilistic expectations derived from statistical regularities in music.

## 56 Phase-Dependent EEG Decoding of Sustained Visual Information

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Traditional visual processing research often emphasizes brief stimulus presentations, limiting investigation to the initial encoding stages of visual information. In this regard, studies have reported many contributions of neural oscillations on perception and visual encoding. For example, pre-stimulus power and phase of alpha oscillations (8–12 Hz) have been shown to influence neural and behavioral responses to brief visual stimuli, although their role in maintaining visual information remains unclear.

In this study, we recorded EEG from participants viewing sustained (2-second) Gabor stimuli with varying orientations (left vs. right) and spatial frequencies (low vs. high). Neural representation were strongest in the first 500–1000 ms, despite the stimuli persisting beyond this period and participant not reporting any visual fading.

This raises the question of how is visual information stored and maintained into consciousness beyond this initial period. To examine oscillatory contributions to visual maintenance, we implemented a novel decoding approach targeting the 1000–2000 ms time window. Specifically, EEG decoding of stimulus spatial frequency was conducted separately for data points corresponding to different phases of alpha oscillations at each channel location. Strikingly, we found that decoding accuracy varied with the phase of alpha oscillations at frontal and occipito-parietal channels, suggesting that visual information is periodically reactivated in different parts of the brain.

Our phase-specific decoding method underscores the potential of leveraging oscillatory dynamics to study information processing in the brain. These findings provide compelling evidence on the role of alpha oscillations in the maintenance of visual information, highlighting their importance in sustained visual processing.

## 57 Spontaneous alpha oscillations as distinct bursting and traveling waves in the human brain

**Raphaël Bordas<sup>1</sup>, David M. Alexander<sup>2</sup>, Virginie van Wassenhove<sup>1</sup>**

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Alpha oscillations (8-12 Hz) are a hallmark of electrical brain activity recorded in humans. They have been linked to numerous perceptual and cognitive functions, despite their generative mechanisms remaining unknown. To better characterize neural oscillations in general, recent literature has highlighted two phenomena: transient bursts of oscillatory activity and traveling waves across the cortex. With the working hypothesis that such spatiotemporal descriptions would help disentangle the different types of alpha activity, we investigated their spatiotemporal dynamics during resting-state using 56 MEG recordings. We asked whether traveling waves and bursts are two sides of the same coin, that is, whether bursts are temporal snapshots of the passing of a traveling wave at a given location in space. First, we show that macroscale traveling waves spontaneously occur for 100 to 300 milliseconds, at a rate of 2 Hz. Spatial patterns include planar patterns on the lateral or anterior-posterior axis and spiral waves. In contrast, bursts are three to four times longer (from 300ms to 1s) and located in the parietal sensors. Consequently, we observe only partial overlap in time and space between bursts and traveling waves in parietal sensors. Finally, we demonstrate that the two phenomena interact minimally and most likely reflect distinct functional processes. Traveling waves do not generate bursts in parietal sensors. Thus, future work should take into account the distinction between temporal and spatial dynamics of alpha activity to avoid conflating different networks and/or neural rhythms.

## 58 Rapid label-referent mapping with vocoded speech in young infants

**Amanda Saksida**<sup>1,2</sup>

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**Background.** From birth on, human auditory cortex tracks the speech amplitude envelope modulation. Speech temporal structure correlates with speech perception in infants and speech comprehension in adults. The relative importance of speech envelope for speech comprehension can be shown with vocoded speech. Young infants can discriminate vocoded speech, but it is not clear whether they perceive it as speech and use it to acquire language.

**Methods.** 6- to 9-mo German-learning infants (N=24) participated in a label-referent mapping pupillometry experiment consisting of 20 trials. Each trial consisted of familiarization (2 object-label pairs) and test: 2 Same and 2 Switch pairs (familiarization objects and labels switched). Visual stimuli: 8 abstract Tetris-like objects. Auditory stimuli: 8 disyllabic nonce words, either natural speech or vocoded (synthesized from 2, 4, 8 or 16 narrowband frequencies).

**Results.** Cluster-based permutation tests over the pupillary response at test revealed a significant interaction between Channel (Speech/2ch/4ch/8ch/16ch) and Trial Type (Same/Switch) in the 1886—2675ms post-word window (TSUM=64.42,  $P < .01$ ) (Figure 1), with a significant difference between Same and Switch trials with natural speech and 16-channel vocoded speech, but not with fewer channels.

**Discussion.** Infants can rapidly map labels to visual objects after only a limited exposure to natural as well as vocoded speech. However, this ability deteriorates as the number of frequency bands is reduced. In normal hearing, speech envelope cues may, therefore, play a smaller role in speech comprehension in young infants than in adults.

## 59 Levels of Inner Speech – An Investigation of Oscillatory Dynamics

**Viktoria Schmitzer<sup>1</sup>, Jutta L. Mueller<sup>1</sup>**

<sup>1</sup>University of Vienna, Austria

Inner speech has been hypothesized to exist on different representational levels corresponding to the processing steps of overt speech production. Such levels are broadly a semantic level, a phonological level, and an articulatory level. Yet, these levels have not been sufficiently supported by neurophysiological evidence.

The LISP project aims to induce these different forms of internal verbalization by means of a working memory paradigm and uses time-frequency data obtained through EEG to differentiate between them. Furthermore, interindividual differences are investigated through questionnaires about participants' propensity for inner speech and visual imagery.

Here, I present data from the phonological inner speech condition and two visual control conditions. The phonological level of inner speech is characterized by higher power in the alpha and beta bands compared to the visual control condition during the encoding and maintenance periods. Furthermore, this power difference appears to be modulated by the general working memory capacity as well as the propensity for inner speech and visual imagery, as measured through the Internal Representations Questionnaire (IRQ).

## 60 The Literature Basis as a Missing Layer of Research Transparency: A Proof of Concept

**Tanja Gebhart<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria

Scientific publications routinely document hypotheses, methods, results, and references. Yet the empirical process by which a literature basis is assembled often remains largely undocumented. While bibliographies reveal which sources were ultimately cited, they provide little information about search strategies, relevance decisions, discarded papers, or potential blind spots that shaped the final literature selection.

This limitation becomes increasingly relevant as scientific literature continues to grow and AI-assisted discovery tools become part of everyday research practice. Different tools, prompts, and search strategies may lead researchers to different literature bases, while the decision-making process behind these selections often remains invisible.

This contribution introduces the concept of literature basis transparency and explores whether empirical literature search should become a more transparent and reproducible component of scientific practice. Three transparency mechanisms are proposed:

- (1) a Research Transparency Statement summarizing search sources, thematic structures, and review decisions,
- (2) a Research Logbook documenting how a literature basis developed over time, and
- (3) a “Research Fingerprint” – a unique identifier used to unambiguously link to the logbook and make it retrievable anytime.

Using a literature search in developmental dyslexia as a demonstration case, these concepts are illustrated through the TAO.TAO framework. The proposed approach aims to make literature selection processes more inspectable, discussable, and reproducible, while supporting transparency, supervision, and open-science practices.

The broader methodological question is whether literature selection should be treated with the same transparency standards that are routinely applied to data collection, analysis, and reporting.

## 61 Phase-Dependent EEG Decoding of Sustained Visual Information

**Nima Noury<sup>1</sup>**

<sup>1</sup>Universitätsklinikum Tübingen, Germany

Transcranial electric stimulation (tES) is a promising technique to non-invasively modulate human brain activity. However, stimulation artifacts in EEG and MEG recordings severely hinder the study of its online effects. Approach. Here, we introduce a new approach to account for these artifacts. The approach rests on two key ideas. First, we focus on interactions of tES with intrinsic brain activity, which are absent for tES artifacts. Second, rather than removing artifacts, we compare composite signals that share similar artifacts but potentially differ in the interaction of tES with intrinsic brain activity. We follow a simple logic: if tES does not interact with intrinsic brain activity, then neural activity during simultaneous sensory stimulation and tES should equal the linear superposition of the neural effects of each applied alone. Any deviation from this prediction provides evidence for a neural interaction. Main results. We tested this approach in a proof-of-principle MEG study, applying 10 Hz transcranial alternating current stimulation (tACS) during rest and during a 10 Hz visual flicker. We compared neural activity during simultaneous stimulation with that predicted by the linear superposition of flicker and tACS alone and found a phase-dependent interaction between tACS and flicker-evoked brain activity. Significance. Our work establishes a novel approach to investigate online effects of tES and suggests a state-dependent interaction of tACS with human brain activity.

## 62 Multimodal Assessment of Fatigue and Fatigability with EEG and Physiology

**Patrick Neff<sup>1</sup>, Nick Sommerhalder<sup>1</sup>**

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AlphaFatigue and fatigability are related but distinct constructs, referring respectively to subjective feelings of exhaustion and measurable performance decline over time. While fatigue has been reported in tinnitus (and other clinical populations), objective markers of fatigability remain poorly characterized. We developed a multimodal paradigm to identify candidate behavioral and electrophysiological markers before application in clinical research.

Healthy young adults completed two counterbalanced laboratory sessions: a cognitively demanding fatiguing session and a passive movie/control session. Before and after each session, participants underwent resting-state EEG and visual and auditory alertness tasks. Subjective fatigue ratings were collected repeatedly throughout the experiment. Continuous EEG, eye tracking, and physiological measures were recorded.

Preliminary analyses indicate a significantly stronger increase in subjective fatigue during the active compared to the passive session. Behaviorally, reaction times increased following the fatiguing session but remained stable or improved following the control session. In the visual alertness task, fatigue was associated with reduced fronto-central N2 amplitudes. Importantly, individual ERP changes were associated with changes in reaction time, suggesting sensitivity to objective fatigability. In contrast, auditory ERP effects were less consistently related to behavioral performance. Resting-state EEG showed only modest fatigue-related alterations.

These findings suggest that fatigue-related changes are detectable across subjective, behavioral, and electrophysiological domains, but that objective and subjective measures may capture partially distinct aspects of fatigue. The identified markers will be evaluated in a subsequent comparison of clinical hearing populations.

## 63 Supramodal Neural Correlates of Consciousness

**Rebecca Abt<sup>1</sup>**

<sup>1</sup>University of Salzburg, Austria

Most studies about conscious perception focus on a single sensory modality. We extend this perspective across the senses to a framework of supramodal neural correlates of consciousness. The participants detected visual, auditory or tactile stimuli at individual perceptual thresholds, while functional magnetic resonance imaging (fMRI) or magnetoencephalography (MEG) data was recorded. Our methodological approach combines the strengths of fMRI and MEG, exploiting both excellent spatial resolution as well as superior temporal precision, by fusing the methods using representational similarity analysis. In the temporal domain, our results show that neural activity associated with sensory processing per modality precedes generalized activity patterns across the senses. In the spatial domain, sensory-specific activation was observed in sensory areas contralateral to the stimulated side, but generalized supramodal activity patterns were found in frontal and parietal regions predominantly ipsilateral to stimulation. These findings suggest the involvement of a fronto-parietal network in the transition from modality-specific sensory processing to integrative supramodal conscious perception.

## 64 Entrainment Echoes in Cerebellar Electroencephalography (cEEG)

**Costanza Carlotta Cerrano<sup>1</sup>, Florence Rémy-El Boustani<sup>1</sup>, Benedikt Zoefel<sup>1</sup>**

<sup>1</sup>Université de Toulouse, France

Recent research has demonstrated an involvement of the cerebellum in speech processing. In particular, source-localized magnetoencephalography (MEG) data revealed sustained rhythmic activity in the cerebellum after rhythmically presented speech, a phenomenon that was termed an “entrainment echo”. Cerebellar entrainment echoes appeared after the offset of the rhythmic stimulus, when temporal expectation, induced by the stimulus rhythm, was violated. These echoes therefore seemed to reflect updates of temporal predictions in speech processing, in line with accumulating evidence for the cerebellum’s prominent role for such functions.

In this study, we tested whether entrainment echoes can be measured with a cerebellar electroencephalography (cEEG) montage, comprising 64 standard (10/20) electrode positions, and 15 sub-occipital and upper cervical locations presumed to capture cerebellar activity. 23 healthy participants listened to monosyllabic words presented in sequences at 3Hz or 7Hz, and interrupted by silent periods where entrainment echoes were measured. Neural entrainment and its echo were assessed through rate-specific response (RSR) measures developed previously.

In line with previous work, we found rate-specific responses that were strongest over frontocentral EEG electrodes during rhythmic speech sequences. Importantly, this sound-driven response was followed by entrainment echoes that were visible and statistically reliable in “cerebellar” EEG channels but not in those typically associated with auditory processing.

Although future analyses will need to confirm a cerebellar origin of these cEEG echoes, our findings suggest that cEEG can capture a neural signature of temporal predictions in speech processing and highlight its potential for investigating the cerebellar contribution to speech and auditory rhythm processing.

## Information

The SAMBA-Meeting takes place at the ***Faculty of Natural and Lifesciences (NAWI)***

University of Salzburg  
NAWI  
Hellbrunnerstraße 34  
5020 Salzburg, Austria

## WLAN

### Eduroam

**Benutzername:** v1122566@sbg.ac.at

**Passwort:** Salzburg\_26

## How to get to the venue?

### By car

Motorway A10 exit Salzburg Süd/Anif (in the direction Salzburg Zentrum). Go along *Alpenstraße* for about 6 km. Turn left in the *Friedensstraße*. Turn right in the *Hellbrunner Straße* after about 500 m

Parking areas at or nearby the venue (with costs):

- Parkplatz Akademiestraße (5-minute-walk)
- Tiefgarage Zentrum Herrnau (Alpenstrass 48, 3-minute-walk)

### Public transport

Bus tickets can be purchased at kiosks (so called "Trafik"), within the SalzburgVerkehr App, or vending machines. To find the perfect connections via public transport in Salzburg please go to [salzburg-verkehr.at/en](https://salzburg-verkehr.at/en).

Bus stations near the venue:

- Faistauergasse (6-minute-walk)
- Michael-Pacher-Straße (directly in front of the NAWI, only bus line 22)

### From the main train station

Take the bus line 3 (*in the direction of Salzburg Süd*) until *Faistauergasse* (14 min, 8 intermediate stops). The NAWI is ~550 m walking distance.

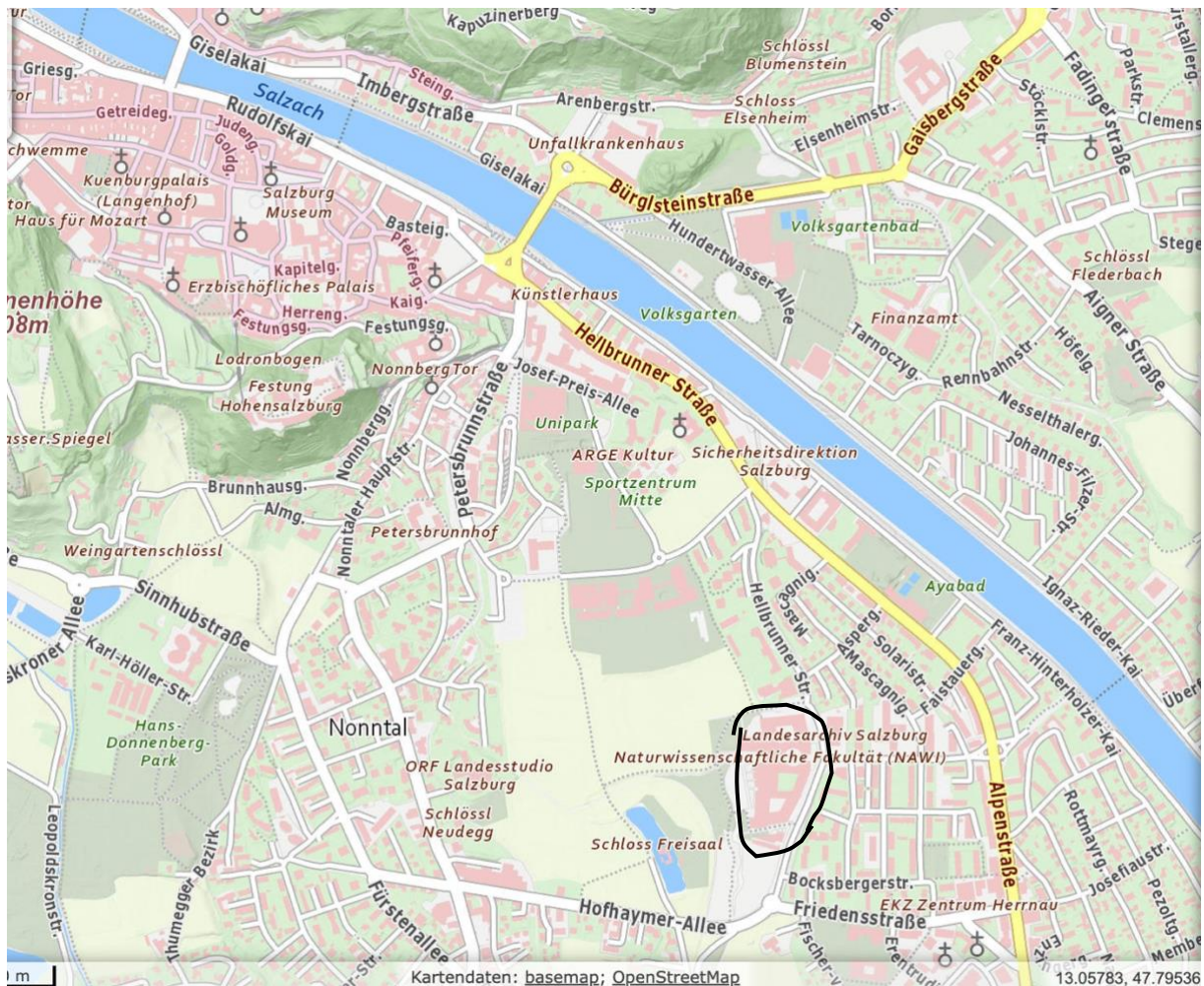
### From the airport

**Option 1:** Take the bus line 10 (in the direction of Sam) until Ferdinand-Hanusch-Platz (17 min, 10 intermediate stops). Then take bus line 3 or 8 (in the direction of Salzburg Süd) until Faistauergasse (6 min, 4 intermediate stop). The NAWI is in ~550m walking distance.

**Option 2:** Take the bus line 2 (in the direction of Obergnigl) until Salzburg Aighof LKH West (11 min, 6 intermediate stops). Then take bus line 8 (in the direction of Salzburg Süd) until Faistauergasse (16 min, 10 intermediate stops). The NAWI is in ~550m walking distance.

## Local Supply

The venue is very close to the city center, which offers lots of opportunities.



## Nearby spots for lunch

- Mensa (directly at NAWI)
- Zentrum Herrnau (Alpenstraße 48, 5020 Salzburg):
- Raschhofer Herrnau
- Resch (Bakery)

- MyIndigo
- La Cantinetta

## Bars / Restaurants

### Some places we recommend for having a good Austrian meal:

- [Bärenwirt](#) (city centre)
- [Kastners Schenke](#) (city centre)
- [Restaurant Stieglkeller](#) (city centre)
- [Raschhofer Herrnau](#) (10-minute-walk from the venue)
- [Pauli Stubm](#)
- [Zum Zirkelwirt](#) (10-minute-walk from the venue)
- [Imlauer Sky Bar & Restaurant](#) (25-minute-walk from the venue)
- [Gasthof Überfuhr](#) (25-minute-walk from the venue)
- [Stadtalm](#) (30-minute-walk from the venue)

### To have a drink after the meeting we recommend:

- [Times Bar](#)
- [The Dubliner Irish Pub](#)
- [Celtic Spirit](#)
- [Alchimiste Belge](#)
- [Whiskey Museum](#)
- [Darwin's](#)
- [Schnaitl Bier + Bar](#)
- [Mentor's Bar](#)
- [Glückfall Café – Bar](#)
- [Wein & Co](#)

## Hotels / Hostels

Salzburg offers several accommodations. Some of them are listed below. You may also be interested in Airbnb.

- [Via Roma](#)
- [Arcotel Castellani](#)
- [Motel One Alpenstraße](#)
- [Austria Classic Hotel Hölle](#)
- [A&O Salzburg Hauptbahnhof](#)
- [Eduard-Heinrich Haus](#) (hostel)

## Poster prints

If you need to print your poster directly in Salzburg, you can do it in one of the local copy shops. We recommend contacting the copy shop before your arrival and ask for the exact conditions and prices.

- University of Salzburg Printcenter ([printcenter@sbg.ac.at](mailto:printcenter@sbg.ac.at))
- Colibri ([nonntal@colibri-print.at](mailto:nonntal@colibri-print.at))
- Copypoint ([office@copypoint.at](mailto:office@copypoint.at))

# Social event

## WHEN:

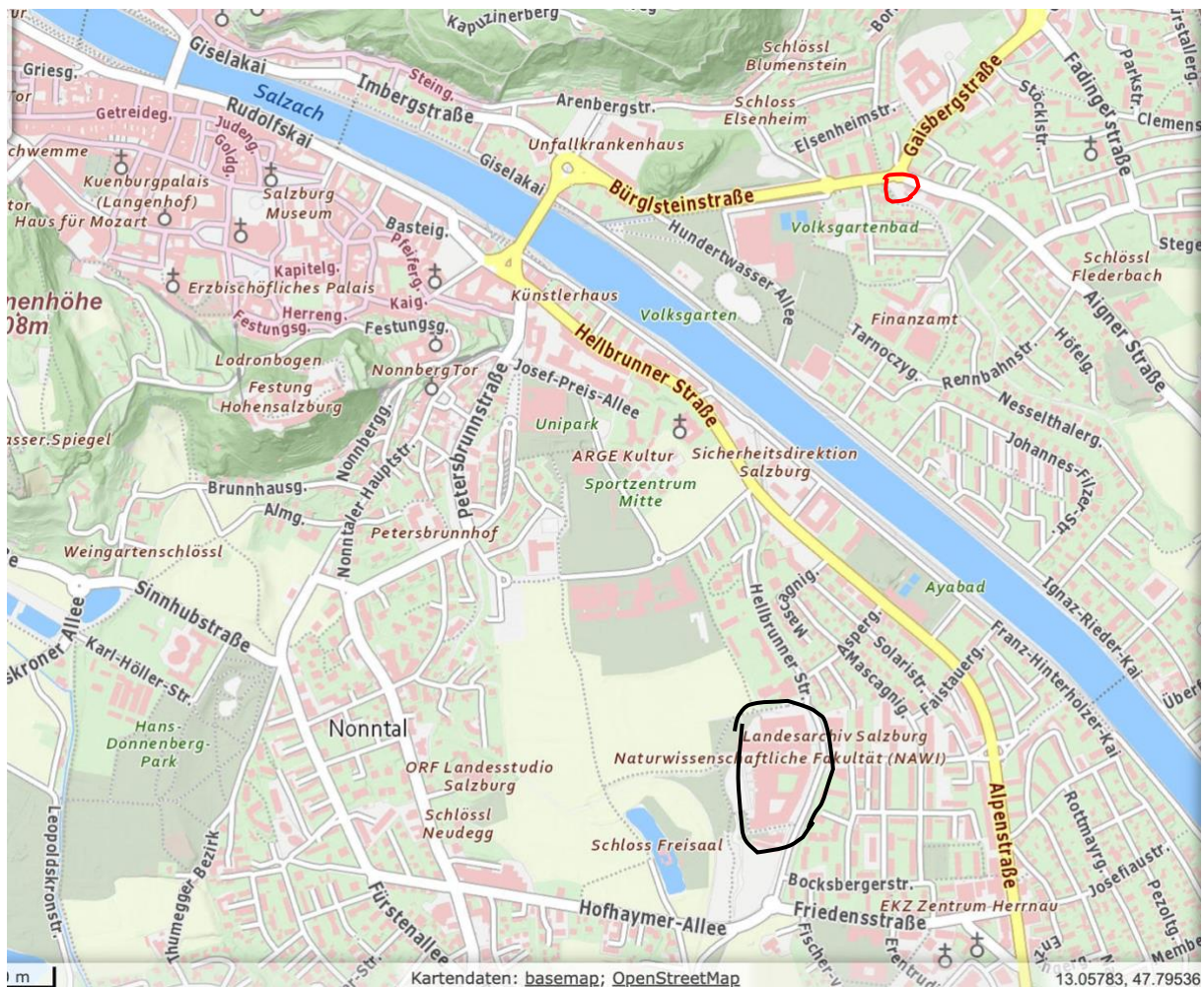
Friday, July 3rd 2026, starting at 7:00 pm

## WHERE:

“Steinlechner”

Aigner Str. 4

5020 Salzburg, Austria



## WHAT DO I GET?

A three course menu and three drinks.

**Please bring your name badge and your ticket with you!**

You will need to give your ticket to the staff at “Steinlechner”.

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