SALZBURG MIND BRAIN ANNUAL MEETING 2023

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

the 6th Salzburg Mind – Brain Annual Meeting
SAMBA 2023

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PROGRAM

SALZBURG MIND BRAIN ANNUAL MEETING

Time	July 13	Time	July 14
08:15	Registration & Coffee		
08:40	Opening Remarks		
09:00	Talk 1: Bryan Strange Memory for the exceptional and exceptional human memory	09:00	Talk 6: Rosanne Rademaker Flexible formats and loci of visual working memory?
10:00	Coffee	10:00	Coffee
10:30	Talk 2: Stephanie Forkel Brain variability and its impact on language functions	10:30	Talk 7: Katharina Schmack Hallucinating mice, dopamine and immunity – towards mechanistic treatment targets for psychosis
11:30	Short Break	11:30	Short Break
11:45	Talk 3: James Bonaiuto Noninvasive dissection of sensorimotor cortical circuits using high precision MEG	11:45	Talk 8: Roland Fleming Learning to See Stuff: Modelling Human Perception with Unsupervised Deep Learning
12:45	Lunch Break	12:45	Lunch Break
14:15	Talk 4: Ole Jensen An oscillatory pipelining mechanism supporting visual exploration and reading	14:15	Talk 9: Isabella Wagner Mapping memories that last: Neural patterns that promote durable memory formation
15:15	Coffee & Posters	15:15	Coffee & Posters
17:15	Talk 5: Maria Wimber Tracking the reconstruction of visual memories in human brain and behaviour	17:15	Talk 10: Markus Ullsperger Multiplexed Performance Monitoring Signals in the EEG in health and mental disorders
		18:15	Closing Remarks
		19:00	Social event

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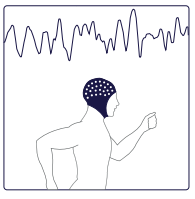
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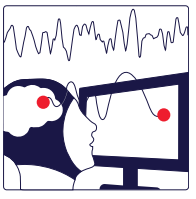
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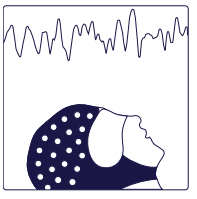
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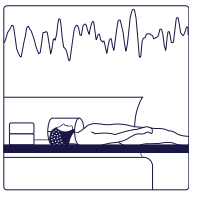
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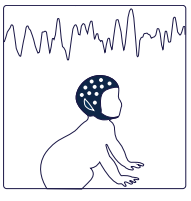
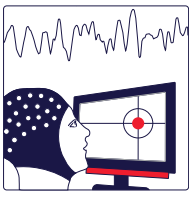

Developmental EEG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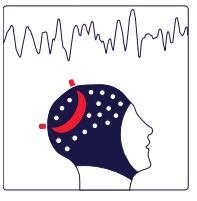
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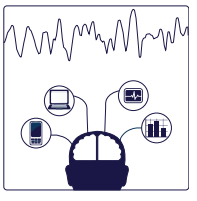
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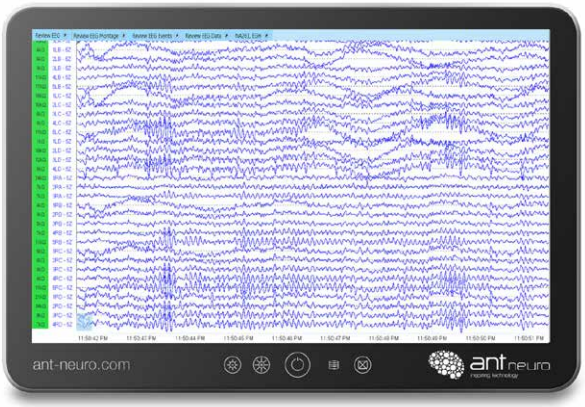
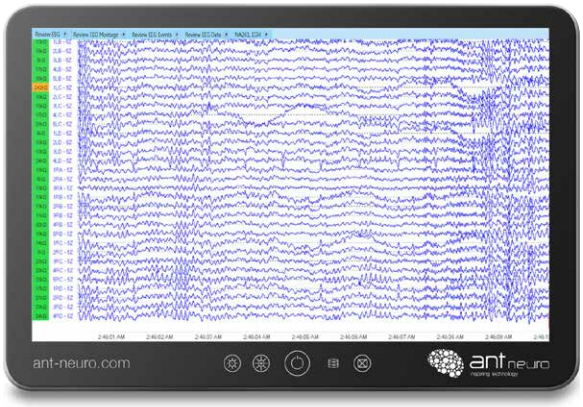


5 minutes
after the net appliction

3 hours
after the net appliction



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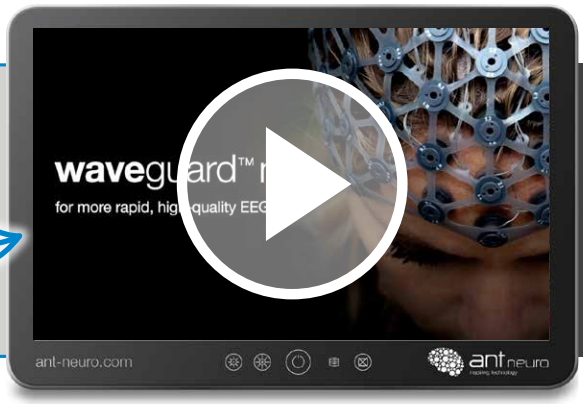

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TALKS

Talk 1:

Memory for the exceptional and exceptional human memory

Bryan Strange

Universidad Politécnica de Madrid- Spain

We tend to remember exceptional events over the mundane ones. Understanding how we form and retrieve long-term memories for important or salient events is relevant for combating the rapidly growing incidence of pathologies associated with memory dysfunction. I will present behavioural, neuroimaging and human intracranial recording data demonstrating how different human brain circuits couple with the hippocampus to bring about enhanced memory for salient events, focusing on memory advantage for emotionally aversive stimuli and stimuli paired with voluntary movement. I will explain how an understanding of the neurobiological mechanisms underlying novelty-evoked episodic memory enhancement has led us to discover the memory enhancing effect of deep-brain stimulation of the human nucleus accumbens. Lastly, I will present findings from a large cohort of “Superagers”, individuals over 80 years old but with memory performance equal to people in their 50s, and reveal which factors might protect against age-related memory loss.

Talk 2:

Brain variability and its impact on language functions

Stephanie Forkel

Radboud University

Our brain's immense power is derived from the complex networks between brain areas. The delicate complexity of these connections is the backbone of functions as we know them. Functions emerge from the interaction between brain areas. Modern neurosciences have built a sophisticated picture of how our brains work based on the stunning anatomical work conducted by previous generations. This talk will look at the emergent properties of the connected brain in health and neurological diseases.

Talk 3:

Noninvasive dissection of sensorimotor cortical circuits using high precision MEG

James Bonaiuto

Institut des Sciences Cognitives, CNRS

Understanding the dynamics of cortical circuits is fundamental for unraveling the brain's information processing mechanisms. Recent advancements in magnetoencephalography (MEG) recording and analysis techniques have revolutionized the non-invasive study of cortical circuit dynamics in human subjects. In this talk, I will explore the capabilities of high precision MEG, which has been successfully employed to validate long-standing theories regarding the dominance of frequency-specific neural activity across cortical layers in the visual and sensorimotor cortices, estimate the orientation of cortical columns, and infer the temporal dynamics of laminar activity during event-related neural fields. I will also present our ongoing research that combines these techniques with computational modeling to investigate the generation of beta bursts in the sensorimotor cortex. By focusing on neural field potentials rather than time-frequency activity, we unveil a diverse range of burst waveform shapes, suggesting that sensorimotor beta bursts are not homogeneous events, but rather reflect distinct computational processes. The non-invasive and global nature of high precision MEG and its ability to provide detailed insights into the laminar dynamics of cortical circuits offer promising avenues for bridging the gap between circuit-level understanding in animal models and large-scale brain networks in humans.

Talk 4:

An oscillatory pipelining mechanism supporting visual exploration and reading

Ole Jensen

University of Birmingham

When we explore a visual scene or read, we make saccades every 250 milliseconds. It takes about 100 milliseconds to prepare and execute each saccade, leaving less than 150 milliseconds for the visual system to identify the object or word we are fixating at and prepare for the next saccade. To uncover the fast neuronal mechanisms that support natural reading, we combined MEG with a new technique called rapid invisible frequency tagging and multivariate pattern analysis to investigate how we process upcoming words before we saccade to them. We found that we process upcoming words at both the lexical and semantic levels, and the depth of this processing predicts the individual reading speed. We also discovered that saccades are locked to the phase of ongoing alpha oscillations, which supports the coordination of visual and saccadic activity during reading. These findings provide support for an oscillatory pipelining mechanism that supports natural vision.

Talk 5:

Tracking the reconstruction of visual memories in human brain and behaviour

Maria Wimber

University of Glasgow

How does the human brain recreate vivid mental images of past events? The talk will give an overview of our work investigating how memory reconstruction dynamically unfolds in time, using pattern analysis of electrophysiological and fMRI data as well as behavioural reaction time analyses. The results highlight two prominent characteristics of memory recall. First, when the hippocampus reactivates a previously stored visual memory, the information flow in neocortex tends to follow a reverse feature processing hierarchy compared to initial perception, starting with the reconstruction of high-level conceptual image features and ending with low-level perceptual detail. We also find consistent evidence for a representational shift towards conceptual features ("semanticisation") over longer consolidation periods and with repeated, active recall. Second, memory reactivation is rhythmic, as visible in brain and behaviour, in line with models suggesting that the hippocampal theta rhythm orchestrates the timing of memory reactivation relative to incoming sensory input. Our most recent findings demonstrate that phase coding along the theta rhythm can help segregate overlapping, competing memories. Together, these findings emphasise the dynamic and reconstructive nature of our memories.

Talk 6:

Flexible formats and loci of visual working memory?

Rosanne Rademaker

Ernst Strüngmann Institute / Max Planck Society

Neural correlates of visual working memory have been found in early visual, parietal, and prefrontal regions. These findings have spurred fruitful debate over how and where in the brain memories might be represented. Here, I will present data from multiple experiments to demonstrate how a focus on behavioral requirements can unveil a more comprehensive understanding of the visual working memory system. Specifically, items in working memory must be maintained in a highly robust manner, resilient to interference. At the same time, storage mechanisms must preserve a high degree of flexibility in case of changing behavioral goals. Several examples will be explored in which visual memory representations are shown to undergo transformations, and even shift their cortical locus alongside their coding format based on specifics of the task.

Talk 7:

Hallucinating mice, dopamine and immunity – towards mechanistic treatment targets for psychosis

Katharina Schmack

Francis Crick Institute & University College London

Psychosis is a sign of severe brain disorders including schizophrenia and is characterised by disturbances of perception such as hallucinations. These are subjective phenomena that have traditionally been difficult to study biologically.

We recently established a new behavioural-computational approach to capture hallucination-like perception in humans and mice. Hallucination-like perception increased after hallucinogenic manipulations in mice and correlated with self-reported hallucinations in humans. Using optical imaging, optogenetics and pharmacology in behaving mice, we found evidence for a causal role of striatal dopamine in psychosis-like perception. Finally, computational modelling showed that hallucination-like perception occurred when expectations about upcoming stimuli were high.

Our results suggest that hallucination-like perception can serve as a translational marker of hallucinations across humans and mice, and provide circuit-level evidence for the long-standing dopamine hypothesis of psychosis. We propose that increased striatal dopamine biases perception to rely more on expectations, signalled by cortical inputs, as compared to sensory evidence, signalled by thalamic inputs, thereby producing hallucinations.

In our current work, we investigate neural and immunological upstream regulators of these psychosis-relevant neural circuit mechanisms. Thereby, we hope to identify new biological targets for the treatment of schizophrenia, and to understand how the brain generates perception.

Talk 8:

Learning to See Stuff: Modelling Human Perception with Unsupervised Deep Learning

Roland Fleming

Giessen University

Humans are very good at visually recognizing materials and inferring their properties. Without touching surfaces, we can usually tell what they would feel like, and we enjoy vivid visual intuitions about how they typically behave. This is impressive because the retinal image that the visual system receives as input is the result of complex interactions between many physical processes. Somehow the brain has to disentangle these different factors. I will present some work in which we show that an unsupervised neural network trained on images of surfaces spontaneously learns to disentangle reflectance, lighting and shape. We find that the network not only predicts the broad successes of human gloss perception, but also the specific pattern of errors that humans exhibit on an image-by-image basis. I will argue this has important implications for thinking about vision more broadly.

Talk 9:

Mapping memories that last: Neural patterns that promote durable memory formation

Isabella Wagner

University of Vienna

Why are certain memories more enduring than others? I will discuss my team's endeavor to chart the neural pathways that facilitate lasting memories using behavioral methods, functional magnetic resonance imaging (fMRI), and techniques that enable the tracking of dynamic fluctuations in brain connectivity and neural representations. To start with, I will delve into the distinct neural markers that underpin the longevity of memories when individuals are initially learning new material. Subsequently, I will explore the interplay between the hippocampus, thalamus, and neocortex after learning, and how activities such as exercise or memory training enhance memory retention. Finally, I will provide an outline of our recent work on the association between eye movements and grid-like codes in the entorhinal cortex, as well as the impact of visual sampling on hippocampal memory representations. Collectively, our efforts strive to map out medial temporal lobe function and memory durability from multiple perspectives, seeking to comprehend the underlying mechanisms that are altered in the aging process and neurodegenerative disease.

Talk 10:

Multiplexed Performance Monitoring Signals in the EEG in health and mental disorders

Markus Ullsperger

University of Magdeburg

Photo: © Jana Duennhaupt

Performance monitoring is essential for successful goal-directed behavior. An important aspect is the utilization of feedback on action outcomes in uncertain environments to make inferences on action-outcome contingencies and to learn and update action values. After a brief introduction of the neuroimaging and EEG correlates of performance monitoring in humans I will focus on feedback-related EEG dynamics. I will present data on the representation of reward prediction errors, learning rate, surprise and other variables guiding future decisions in the feedback-locked EEG. In a series of probabilistic learning experiments we found that variables influencing the update of stimulus and action values are represented in a latency range between 200 and 700 ms in a multiplexed fashion. Multivariate pattern analysis and regression approaches show that feedback-locked EEG activity can be used to predict subsequent behavioral adjustments and future decisions. In the last part of my presentation I will present data from patients with schizophrenia and major depressive disorder, respectively. Both patient groups show deficits in probabilistic learning. A transdiagnostic finding is that both groups show a reduced dynamics (i.e., decay) of the learning rate with learning progress rendering them more susceptible to misleading probabilistic feedback. These behavioral deficits are accompanied by specific changes in the feedback-locked EEG dynamics.

POSTER ABSTRACTS

1 Behavioral and neuroanatomical effects of virtual reality soccer training in an amateur player

Fabio Richlan[1]

[1]University of Salzburg, Austria

Virtual reality (VR) technology has received considerable attention over the last few years, with applications including training of sports-related mental and motor skills. The present longitudinal MRI study reports behavioral and neuroanatomical effects of VR soccer heading training in an amateur player (male; age = 37 years).

The study was conducted over a period of eight weeks, with a four-week training phase followed by a four-week retention phase. VR training was conducted with an Oculus Quest 2 headset (Meta Platforms) and was done for four weeks from Monday to Saturday. Each daily training session lasted 30 minutes. High-resolution structural T1-weighted MRI was acquired with a Siemens Prisma 3 Tesla scanner. For preprocessing and statistical analysis, SPM12 software was used running in a MATLAB environment.

Substantial improvement in real-life heading performance (juggling, heading strength and precision) was accompanied by neuroanatomical changes. The comparison of the smoothed, modulated, normalized GM images revealed an increase in GM volume in the left thalamus. In addition, the comparison of the WM images revealed an increase in WM volume in the bilateral cerebellum. The signal intensity values (arbitrary units) show a continuous increase from T0 to T4 with a stable retention effect after 4 weeks without training (T8).

Taken together, the results point towards both stable behavioral and neuroanatomical effects of a four-week VR soccer heading training. With this longitudinal MRI study, we contribute to the growing literature on VR training in general and the scarce evidence on fundamental neurobiological mechanisms underlying potential training effects.

2 Beta band rhythms influence reaction times

Elie Rassi[1]

[1]Radboud University Nijmegen, Netherlands

Despite their involvement in many cognitive functions, beta oscillations are among the least understood brain rhythms. Reports on whether the functional role of beta is primarily inhibitory or excitatory have been contradictory. Our framework attempts to reconcile these findings and proposes that several beta rhythms co-exist at different frequencies. Beta frequency shifts and their potential influence on behavior have thus far received little attention. In this human magnetoencephalography experiment, we asked whether changes in beta power or frequency in auditory cortex and motor cortex influence behavior (reaction times) during an auditory sweep discrimination task. We found that in motor cortex, increased beta power slowed down responses, while in auditory cortex, increased beta frequency slowed down responses. We further characterized beta as transient burst events with distinct spectro-temporal profiles influencing reaction times. Finally, we found that increased motor-to-auditory beta connectivity also slowed down responses. In sum, beta power, frequency, bursting properties, cortical focus, and connectivity profile all influenced behavioral outcomes. Our results imply that the study of beta oscillations requires caution as beta dynamics are multifaceted phenomena, and that several dynamics must be taken into account to reconcile mixed findings in the literature.

3 Predictive neural representations of unfolding actions revealed by dynamic RSA

Ingmar de Vries[1], Floris de Lange[1], Moritz Wurm[2]

[1]Radboud University Nijmegen, Netherlands, [2]University of Trento, Italy

In dynamic environments (e.g., traffic or sports), our brain is faced with a continuous stream of changing sensory input. Effective and prompt behavior requires our brain to predict unfolding external dynamics. While theories propose such dynamic prediction, empirical evidence is limited to static snapshots and indirect consequences of predictions. We developed a dynamic extension to representational similarity analysis (dynamic RSA) that uses temporally variable models to capture neural representations of unfolding events across hierarchical levels of processing (from perceptual to conceptual). This approach allows investigating the match between a stimulus model at a given time-point and the neural representation at the same or different time-points (i.e., earlier, or later). Across two experiments we applied dynamic RSA to source-reconstructed magnetoencephalography (MEG) data of healthy human subjects and demonstrate both lagged and predictive neural representations of observed actions. In the first experiment, we reveal predictions across timescales matching hierarchical levels of processing, such that high-level conceptual stimulus features are predicted earlier in time, while low-level perceptual features are predicted closer in time to the actual sensory input. In the second experiment, we manipulate prior stimulus knowledge at two levels by either inversion (up-down) or temporal piecewise scrambling of action videos and demonstrate how stimulus familiarity modulates the temporal forecast window across hierarchical levels. To conclude, by quantifying the temporal forecast window of the brain, this new approach shows how neural representations – from perceptual to conceptual – are predictive in nature, and thereby support understanding and navigation of our ever-changing world.

4 Neural network mechanisms underlying post-decision biases

Klaus Wimmer[1], Miguel Donderis[1], Jose M. Esnaola-Acebes[1], Bharath C. Talluri[2], Tobias Donner[3], Alex Roxin[1]

[1]Centre de Recerca Matemàtica, CERCA Institution, Barcelona, Spain, [2]National Institutes of Health, United States Department of Health and Human Services, Government of the United States of America, Bethesda, United States, [3]University Medical Center Hamburg-Eppendorf, Universität Hamburg, Germany

Perception is influenced by past choices. In combined discrimination-estimation experiments a categorical choice leads to two biases, a choice-dependent confirmation bias in the continuous stimulus estimate, and a decrease in the sensitivity to subsequent sensory evidence. To shed light on the neural mechanisms that give rise to these post-decision biases, we develop a neural network model. We leverage our recent results on the integration of continuous sensory evidence in a bump attractor network. By modulating the bump amplitude through a change in the global excitatory input to the network, we have observed qualitatively distinct temporal integration regimes, including early, uniform and late temporal weighting. We embed this integration circuit in a hierarchical three-area network such that it receives stimulus information through a low-level sensory circuit and sends integrated stimulus evidence to a top-level decision circuit that signals the categorical choice. Both the categorical choice as well as the stimulus estimate rely on the accumulated evidence in the integration circuit. To model post-decision biases, we include top-down feedback signals from the decision circuit. The feedback to the integration circuit is non-specific and reduces the sensitivity to subsequent stimuli by increasing the bump amplitude as described above. The feedback to the sensory circuit is selective, akin to feature-based attention, and gives rise to a confirmation bias through a choice-dependent modulation of the sensory inputs. Our network model provides a comprehensive and experimentally testable computational framework to study the neural mechanisms underlying stimulus estimation and perceptual categorization and their interaction.

5 Spatially organized flicker can evoke high-frequency responses above 100Hz in visual cortex

Julian Keil[1], Hanni Kiiski[2], Liam Doherty[3], Victor Hernandez-Urbina[3], Hamed Bahmani[4]

[1]Kiel University, Germany, [2]University of Potsdam, Germany, [3]Ababax Health GmbH, Berlin, Germany, [4]Bernstein Center for Computational Neuroscience Tübingen, National Bernstein Network Computational Neuroscience, Germany

Flickering visual stimulation targeting the entire visual field can evoke steady-state visual evoked potentials (SSVEPs), and these SSVEPs could potentially boost perception and information absorption. Here, we aimed at extending previous findings to evoke SSVEPs above 100Hz. We hypothesized that sequentially targeting selected neighboring retinal cells allows evoking high-frequency responses in the synchronized summed activity across the visual cortex. By selectively and sequentially targeting neighboring retinal cells with high-frequency flickering light, each cell was only stimulated every 10ms, but neighboring cells were stimulated at a lag of 8.33ms, 6.06ms, 5.55ms, and 5.26ms (i.e., 120, 165, 180 and 190Hz), for 60 trials of 2s, while we recorded 64-channel EEG from 10 participants. In line with our hypothesis, we measured spatially selective SSVEPs for 165Hz stimulation with an occipital topography, localized in the visual cortex. For the first time, we show that it is possible to evoke high-frequency SSVEPs above 100Hz across the visual cortex by using a spatially selective noninvasive visual brain stimulation. This critically extends previous findings of an upper limit of SSVEPs of 100Hz using full-field stimulation. Spatially selective noninvasive visual stimulation could potentially be used as a tool to artificially mimic naturally occurring high-frequency oscillations during stimulus processing, attentional information selection, and memory. This opens the possibility of targeted therapeutic interventions based on high-frequency visual stimulation.

6 Neural speech tracking benefit of lip movements predicts behavioral deterioration when the speaker's mouth is occluded

Patrick Reisinger[1], Marlies Gillis[2], Nina Suess[1], Jonas Vanthornhout[2], Chandra Leon Haider[1], Thomas Hartmann[1], Anne Hauswald[1], Konrad Schwarz[3], Tom Francart[1], Nathan Weisz[1]

[1]University of Salzburg, Austria, [2]KU Leuven, Belgium, [3]MED-EL (Austria), Innsbruck, Austria

Observing lip movements of a speaker is known to facilitate speech understanding, especially in challenging listening situations. Converging evidence from neuroscientific studies shows enhanced processing of audiovisual stimuli. However, the interindividual variability of this visual benefit and its consequences on behavior are unknown. Here, we analyzed source-localized magnetoencephalographic (MEG) responses from normal-hearing participants listening to audiovisual speech with or without an additional distractor speaker. Using temporal response functions (TRFs), we show that neural responses to lip movements are, in general, enhanced when speech is challenging. After conducting a crucial control for speech acoustics, we show that lip movements effectively contribute to higher neural speech tracking, particularly when a distractor speaker is present. However, the extent of this visual benefit varied greatly among participants. Probing the behavioral relevance, we show that individuals who benefit more from lip movement information in terms of neural speech tracking, show a stronger drop in performance and an increase in perceived difficulty when the mouth is occluded by a surgical face mask. By contrast, no effect was found when the mouth was not occluded. We provide novel insights on how the benefit of lip movements in terms of neural speech tracking varies among individuals. Furthermore, we reveal its behavioral relevance by demonstrating negative consequences for behavior when visual speech is absent. Our results also offer potential implications for future objective assessments of audiovisual speech perception.

7 An intact oculomotor neural circuit in congenital blindness

Cemal Koba[1]

[1]Sano Center for Computational Medicine, Krakow, Poland

In the past three decades, multiple studies revealed that congenital blindness is associated with functional and structural reorganization in early visual areas and its interaction with other neural systems. Among the most reproducible findings is the weaker connectivity between the visual and sensorimotor cortices, which in sighted individuals plays a role in eye-motor coordination. Here we demonstrate an important exception to this reorganization phenomena: we find that in congenitally blind individuals (as for normally sighted ones), spontaneous, non-controlled eye movements correlate with connectivity between visual and sensorimotor cortices. Furthermore, using time-lagged regression, we show that eye movements drive activity in the visual cortex, which subsequently drives sensorimotor activity. Remarkably, this phenomenon persists even though blind participants often exhibit unsynchronized eye movements and cannot sense or regulate their eye positions. These findings provide evidence of a preserved, "non-functional" connectivity in congenitally blind individuals and reveal a firm, hard-wired constraint on connectivity that remains immune to any reorganization phenomena produced by lack of visual experience and oculomotor control.

8 Machine Listening for high-throughput psychoacoustic experimentation

Patrick Connolly[1]

[1]MED-EL (Austria), Innsbruck, Austria

Cochlear implants (CI) are neuroprosthetic devices that can restore hearing in profound deafness. On the software side, CIs have a large number of parameters that can be modified. The default set of parameters are set by the sound coding strategy, and these are tuned to the individual needs of the user at fitting sessions.

The default parameters have been selected, for the most part, through hypothesis-driven psychoacoustic experimentation. These experiments are time and resource consuming, and tedious for participants. Given that the parametric space is vast, there is no guarantee that the current default parameters provide the optimal performance (rather than being a local maximum of performance).

The recent development of highly accurate machine learning-based transcription provides us with a potential tool to complement existing methods. to search the parametric space for undiscovered "islands of performance" which may serve as the basis for future coding strategies.

Machine listening (ML) experiments have several advantages: they can be conducted faster than real-time (up to 47X with the latest methods) and continuously (machines do not tire), they can be conducted in parallel (arbitrary scalability), and the listeners are not subject to learning effects (the same or similar stimuli can be repeated).

In this preliminary study, we assess the characteristics of one ML framework based on a recent encoder-decoder transformer model with 244M parameters. We then use it to test a real-world hypothesis which would be difficult to test with human listeners.

9 Investigating the role of human beta oscillations in working memory while controlling for the potential influence of non-sinusoidal rhythms at lower frequencies

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Human working memory is associated with significant modulations in oscillatory activity. Modulations in the beta frequency range (15–40 Hz) are especially difficult to interpret because they could be artifactually produced by (more prominent) oscillations in lower frequencies that show non-sinusoidal properties. In this study, we investigate beta oscillations during working memory while controlling for the possible influence of lower frequency rhythms. We collected electroencephalography (EEG) data in 31 participants who performed a spatial working-memory task with two levels of cognitive load. In order to rule out the possibility that observed beta activity was affected by non-sinusoidalities of lower frequency rhythms, we developed an algorithm that detects transient beta oscillations that do not coincide with (more prominent) lower frequency rhythms in time and space. Using this algorithm, we show that the amplitude and duration of beta bursts decrease with memory load and during memory manipulation, while their peak frequency and rate increase. In addition, interindividual differences in performance were significantly associated with beta burst rates. Together, our results show that beta rhythms are functionally modulated during working memory and that these changes cannot be attributed to lower frequency rhythms with non-sinusoidal properties.

10 Beyond Hearing Loss: Ageing as a Tinnitus Risk Factor

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Background: Tinnitus affects ten to 15 percent of the population, but its underlying causes are not yet fully understood. Hearing loss has been established as the most important risk factor. Ageing is also known to accompany increased prevalence, however, the risk is normally seen in context with (age-related) hearing loss. Whether ageing per se is a risk factor has not yet been established. We specifically focused on the effect of ageing and the relationship between age, hearing loss, and tinnitus.

Methods: We used two samples for our analyses. The first, exploratory analyses, comprised 2249 Austrian individuals. The second included data from 16008 people, drawn from a publicly available dataset (NHANES). We used logistic regressions to investigate the effect of age on tinnitus.

Results: In both samples, ageing per se was found to be a significant predictor of tinnitus. In the more decisive NHANES sample, there was an additional interaction effect between age and hearing loss.

Conclusion: Expanding previous findings of hearing loss as the main risk factor for tinnitus, we established ageing as a risk factor in its own right. Underlying mechanisms remain unclear, and this work calls for urgent research efforts to link biological ageing processes, hearing loss, and tinnitus. We therefore suggest a novel working hypothesis that integrates these aspects from an ageing brain viewpoint.

11 Investigating the temporal dynamics of top-down attention during single- versus dual-color search

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Lately, a number of psychophysical studies on human visual perception and attention demonstrated rhythmic fluctuations in the time course of behavioral performance from around 4 to 14 Hz, matching the timescale of ongoing oscillatory brain activity. Further, studies reported that the speed of these fluctuations decreases by half during the monitoring of two versus one attended locations or objects. Critically, attention is often top-down directed through templates of task-relevant features held in visual working memory (VWM). Sensory input is then compared to the templates until a match is achieved. Prior research from our lab showed that while holding two target features in VWM, discrimination performance exhibits a temporal profile of ~ 4 Hz per feature. Presently, however, it is unknown whether the simultaneous monitoring of two versus one feature templates during visual search leads to a similar rhythmic performance fluctuation.

To elucidate this issue, we ran a visual search protocol with single- and dual-color search conditions. Participants encoded either one or two new colors on every trial and subsequently searched for the target among three distractors. By testing search performance based on VWM contents at 100 different time points after encoding, we estimated the time course of template-based performance separately for both conditions.

Our findings provide novel insight into the temporal dynamics of VWM representations and, together with previous work from our lab, suggesting a cyclic re-activation of task-relevant features. Particularly, results from the present study shed light on current beliefs regarding a simultaneous operation of multiple templates guiding search.

12 Gut microbial impact on neural plasticity and visual perceptual learning

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Neural plasticity describes the brain's ability to change as a result of experience and is crucial for learning. It is closely tied to the concentration of excitatory (glutamate) and inhibitory (gamma-aminobutyric acid, GABA) neurotransmitters in the brain. Recent animal studies highlighted the gut microbiome and its contribution to neural plasticity, but whether this translates to humans is unknown. Here, we study the impact of the human gut microbiome on neural plasticity and visual perceptual learning. Eighty healthy participants (age: 18-35 years, 50% female) will complete a visual perceptual learning task while undergoing magnetic resonance imaging (MRI). To measure learning-related changes in neural plasticity, we will assess neurotransmitter concentrations of glutamate and GABA in the primary visual cortex, using MRI spectroscopy, before and after the task. Individual gut microbiome diversity and the quantity of specific metabolite-producing bacteria associated with neural plasticity (such as short-chain fatty acids) will be derived from stool samples. We expect performance in the visual perceptual learning task to scale with increased glutamate and reduced GABA concentrations post-task (compared to baseline). Furthermore, larger task-related changes in neurotransmitter concentrations should be accompanied by higher gut microbial diversity and increased quantities of SCFA-producing bacteria across participants. Findings will be the first to tackle whether the human gut microbiome impacts neural plasticity. Data collection and analysis are ongoing and preliminary results will be presented.

13 Transition frequency from theta to alpha band: automatic computation and applications to patients affected by Dementia with Lewy Body

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Dementia with Lewy bodies (DLB) is the one of most common causes of degenerative dementia in older people together with Alzheimer's disease and Parkinson diseases and its diagnosis can be sometimes difficult. Thus, along with the use of traditional biomarkers such as clinical, biochemical, genetic and neuroimaging ones, features extracted from EEG, a method that records electrical activity of the brain, are nowadays also commonly used to study DLB [1] because of EEG low cost and non-invasiveness.
Recently, the theta-to-alpha brain transition frequency (TF) turned out to be another possible and useful biomarker [2]: indeed, it was proved that TF positively correlates with the Mini-Mental State Examination (MMSE), which measures cognitive impairment. In order to compute TF, the new proposed technique, called Transfreq, exploits only a resting state recording. We will show here results referred to an analysis performed by using Transfreq on a dataset of patients affected by DLB and healthy controls. In particular we will show (i) the distribution of TF and other spectral features in this dataset and how these features clearly show a shift of the dominant posterior rhythm on slower frequencies for DLB subjects; (ii) analysis on signal location distribution by considering channels that record theta and alpha activity.

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14 Impact of individual head movement patterns on the detection of morphometric abnormalities in Schizophrenia

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BACKGROUND: Patients with schizophrenia (SCZ) show alterations in gray matter volume compared with healthy volunteers (HV). Head motion during MRI scans affects morphometric estimates obtained from structural images, so morphometric differences between cases and controls could be affected by artifacts potentially attributable to motion. Our study tested this hypothesis in two independent cohorts

MATERIALS AND METHODS: We used the structural images of 1088 individuals: 485 HV-134 SCZ from the Lieber Institute for Brain Development (LIBD) and 405 HV-64 SCZ from the University of Bari (UNIBA). For each individual, we extracted 24 movement parameters from functional images of a working memory task and we conducted a principal component analysis (PCA) using these data. In each cohort, we performed two voxel-based morphometry analyses (VBM) to study the morphometric differences between groups (pFWE<0.05). Maps stripped from motion effects were overlaid to identify significant clusters reproducible in the two cohorts.

RESULTS: VBM adjusted for 4 movement components showed a 24% reduction in differences between HV and SCZ (pFWE<0.05) of LIBD. In UNIBA cohort, VBM adjusted for 4 movement components revealed a 94% reduction in differences between groups (pFWE<0.05). In both cohorts, the difference in left insular volume (SCZ<HV) was not associated with movement.

CONCLUSIONS: The head movement influences gray matter estimates and differences between HV and SCZ. The results show lower insular volume in SCZ, previously associated in the literature with age of onset and disease duration. This innovative approach could help to better understand between-groups differences in gray matter volumes.

15 Long-term memory retrieval benefits for selected items in working memory

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While different theoretical models suggest there is an information exchange between working memory (WM) and long-term memory (LTM), it is not clear whether existing LTM engrams can be weakened or influenced by manipulations within WM. The current study seeks to address this question via electroencephalogram. We designed a task, in which subjects first learnt associations between objects and their presentation position (top, bottom, left, or right). In a following WM task containing a retro-cue design, these objects, bound to the same locations from the encoding phase, re-occurred. One-third of them were consistently presented in the cued condition, another one-third in the non-cued condition, while the rest was never repeated during the WM task. Finally, during the retrieval phase, subjects were centrally presented with the same objects, and they had to retrieve the associated locations. Behavioral results indicated that subjects were fastest and most accurate in retrieving the locations associated with cued objects, which were placed in the focus of attention during the WM task. In turn, behavioral measures were comparable between the objects assigned to the non-cued condition, thus inhibited during the WM task and those not presented at all (control condition). Behavioral results were also supported by a differential modulation of the left-parietal old-new effect between conditions, with the highest amplitude for the target condition and lower, but comparable effects for the non-target and control condition. Overall, this shows that attending to a particular information within WM can strengthen an existing LTM engram and benefit later retrieval processes.

16 Cochlear implantation for single-sided deafness improves speech perception in both CI and non-CI ears: A longitudinal EEG study

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Former studies have shown that individuals with a cochlear implant (CI) for treating single-sided deafness (SSD) have experienced improved speech perception in noise after implantation. However, it is not clear how neural speech representation of speech comprehension changes over time.

In this longitudinal EEG study, we measured the neural activity in response to various degraded spoken words monaurally presented to CI and non-CI ears in 10 single-sided CI users and 10 age- and sex-matched individuals with normal hearing. Subjective comprehension ratings of each word were also recorded. The data of single-sided CI participants were collected at four time points: pre-CI implantation, 3, 6, and 12 months after implantation. We conducted representational similarity analysis (RSA) on the EEG data to depict single-sided CI users' improvement in characteristics of temporal dynamics and representational patterns in both CI and non-CI ears.

After implantation, speech comprehension performance of the degraded words improved over time in both ears of single-sided CI users. Moreover, in CI users' non-CI ears, increased similarity showed around 600-1000 ms after stimulus onset, coinciding with the peak of decoding accuracy of spoken-word comprehension. Time-generalized RSA analysis correlated with healthy control data partly confirmed this improvement over time. The present study implies that auditory cortical speech processing after CI implantation gradually normalizes towards normal functioning within months. The CI benefits not only the CI ear but also the non-CI ear. These novel findings highlight the feasibility of tracking neural recovery after auditory input restoration by advanced multivariate analysis methods like RSA.

17 Are pupil size and neural alpha power similarly sensitive to reward prospect under demanding listening conditions?

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Pupil size and neural alpha oscillatory power are often used to indicate cognitive demand, but it is unclear how much these metrics covary with an individual's motivational state. Here we test whether pupillometry and alpha power are sensitive to both listening demand and motivational state. Participants performed an auditory gap-detection task while pupil size or magnetoencephalogram (MEG) were recorded. Task difficulty and a listener's motivational state were orthogonally manipulated through changes in gap duration and monetary-reward prospect, respectively. While participants' performance decreases with task difficulty, reward prospect enhances performance under hard listening conditions. Pupil size increases with both task difficulty and higher reward prospect. Importantly the reward-prospect effect is largest under difficult listening condition. Moreover, larger pre-gap pupil size is associated with faster response times on a within-participant level. In contrast, neural alpha power shows no effects of reward-prospect. Of relevance to the utility of pupillometry in audiology and translational neuroscience, pupil size indexes higher motivational state especially under demanding listening. However, we could not find a similar response of neural alpha power. These results add to the mounting evidence, that pupil size and alpha power are not two interchangeable physiological indices of cognitive investment.

18 No free lunch in language prediction – Limitation of cognitive resources reduces the impact of surprisal on multiple time scales

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In everyday communication, we seemingly effortlessly predict upcoming language. However, it remains unclear to what extent the formation of predictions taxes cognitive resources supported by domain-general neural networks.

Our study set out to investigate the involvement of those resources in natural language prediction on multiple time scales, ranging from words to paragraphs, using a dual-task reading paradigm in an online study. Specifically, we asked whether higher cognitive load affects the generation and utilisation of language predictions.

N=74 healthy participants (mean age: 33.6±11.6, range: 18-60 years) read short newspaper articles, presented word by word in varying font colours. This self-paced reading task was either performed in isolation (2 blocks) or paired with a competing n-back task (1-back or 2-back, 2 blocks each) on the words' font colour. We measured word-level reading speed and block-level reading comprehension as well as n-back performance. To quantify word predictability, we generated surprisal scores on four distinct time scales (i.e., context lengths) for each word using GPT-2.

As expected, reading speed was faster for more predictable words, and decreased with increasing cognitive load. Importantly, across time scales, the surprisal effect on reading speed was modulated by the respective cognitive load condition: Higher cognitive load weakened the beneficial effect of higher predictability on reading speed, particularly evident at shorter time scales.

Our findings suggest that language prediction relies on cognitive resources supported by domain-general neural networks. Furthermore, when these resources are limited, the formation or utilisation of language predictions might be diminished or not employed at all.

19 Violating internalized rules affects prediction processes in musicians

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In their seminal article from 2019, Demarchi et al., introduced a method to analyze prediction processes. In a nutshell, they used Multivariate-Pattern-Analysis (MVPA) to measure the similarity between MEG recorded cortical activity during anticipation of a predictable sound and during its actual perception. The rational is, that if the similarity is sufficiently high, this would confirm the hypothesis put forward by predictive coding frameworks that prediction activity should be in fact very similar to activity caused by perception.

Predictability is induced in these experiments by presenting a highly ordered sequence of 4 tones which leads to rapid internalization of this rule. In the current study, we expanded the paradigm by evoking a rule that is internalized depending on musicality. The tones would either create a perfect A major chord or slightly detuned version of it. The hypothesis was that higher musicality, measured by the Goldsmith Musical Sophistication Index (GOLD-MSI) would correspond to better internalization of this rule and thus would have an influence on these prediction processes.

Using musicality as a factor in a linear model estimating prediction related activity as in the Demarchi et al. 2019 study, we indeed found that the slope of the musicality factor was outside of the 94% HDI and thus significantly lower than 0 at 125ms to 75ms before the onset of the stimuli.

This confirms our initial hypothesis that internalized rules have an impact on prediction related activity that can be measured with the MEG.

20 EEG correlates of visual compensation in age-related hearing loss

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Background: Auditory deprivation is associated with compensatory plasticity that modifies connections within the visual cortex and also repurposes auditory cortical neurons to respond to visual stimuli. These changes may underpin improvements for visual abilities in deafness such as motion discrimination and visual localization. However, visual plasticity remains less understood in cases of partial or incomplete hearing loss, such as age-related hearing loss (ARHL), where auditory cortices still receive some auditory input. While evidence of visual compensation has been observed in ARHL, it is unclear whether cortical activation to visual stimuli is dependent on stimulus type. This study aimed to determine if, in ARHL, visually evoked potentials (VEPs) were modified depending on whether the stimulus was relevant to speech perception.

Methods: Participants aged 40 to 80 underwent hearing and speech-in-noise listening tests. 64-channel EEG was recorded while participants viewed 250 repetitions of speech-related or speech-irrelevant stimuli. The speech-related stimuli included alternating frames of two Preston Blair visemes to mimic a single-syllable utterance. The speech-irrelevant stimuli consisted of a radially modulated circle-star pattern that gives rise to apparent motion.

Results: After accounting for age differences, results suggested that worse speech-in-noise listening was correlated to longer VEPs latencies for the verbal stimulus, but no correlations in VEPs amplitude or latency were found for the non-verbal stimulus.

Conclusion: These results suggest that visual brain responses are modified in ARHL and depend on relevance of the stimulus for speech communication.

21 Tracking sleep dynamics via aperiodic activity - an (i)EEG study

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The electrophysiological signal decays as a function of increasing frequency. In electroencephalography (EEG), the slope of this decay, i.e. the spectral slope, has been shown to discriminate between sleep stages. However, previous approaches that analysed aperiodic activity during sleep had two main methodological concerns: (a) low temporal resolution and (b) very simplified estimation models that poorly reflect the underlying signal.

In this study, we explored the influence of changing the model parameters for estimating aperiodic activity in intracranial EEG (iEEG) as well as surface EEG, on its ability to differentiate between sleep stages. Thereafter, we used the new models to track sleep dynamics in a time-resolved fashion. For EEG, we used a dataset of high-density EEG recordings of 17 healthy humans during a full night of sleep. For iEEG, we used sleep data from the MNI Open iEEG Atlas. The parametrization of neural data was done using the specparam toolbox.

We show that switching from the narrowband frequency range (30-45Hz) that has been usually used in sleep literature to a broader frequency range improves the model performance. Further, using a more complex estimation model that incorporates the knee frequency, i.e., the frequency at which the slope of the power spectrum changes, provides a better reflection of the underlying signal with the knee frequency performing better at differentiating sleep stages as compared the the spectral slope.

Our findings highlights several guidelines for the estimation of aperiodic activity in neural data for a better representation and description of the electrophysiological signal.

22 Effects of satiety and participants' expectation on their performance

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Some research suggests that being hungry negatively impacts concentration. However, intermittent fasting, a deliberate practice of abstaining from eating, shows potential cognitive benefits in certain studies. This contradiction might be solvable by considering how individuals perceive food abstinence—as a missed meal or a health-benefitting choice. Individuals expecting improved performance from fasting versus anticipating cognitive decline due to hunger may behave differently.

To test the interaction between hunger and expectations, we conducted an online study using a 2-by-2 design. Half of the participants completed the study after breakfast and lunch (satiated), the other half without (hungry). Participants were either made to expect hunger to enhance concentration or satiety to enhance concentration. These expectations were induced by presenting participants with relevant vignettes phrased in terms of recent research findings. Cognitive performance was assessed using a Simon Task.

We did not find reaction time differences. However, there were significant main effects of satiety (coeff satiated = -0.17, SE = 0.06, p = .006) and expectations (coeff "satiated is good" = -0.15, SE = 0.05, p = .006) on accuracy. These main effects were qualified by a significant interaction between the conditions (coeff = 0.33, SE = 0.08, p < .001). Thus, participants in congruent conditions (e.g. being hungry and expecting positive effects from being hungry) performed better than those in incongruent conditions.

Our study demonstrates that participants' expectations regarding effects of hunger on concentration are reflected in their actual behaviour. This finding underscores the importance of considering participants' expectations when designing intervention studies.

23 Mobile and real world EEG with LCD glasses

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Movement is fundamental to the functioning of the brain, but imaging the human brain during movement is typically neglected. The overall goal of this research is to develop a method for studying the brain during natural exploration of real world environments and during social interaction.

Mobile EEG is a promising solution, but analysis is difficult due to artefacts in the data caused by movement. Here we use modified LCD glasses to provide high frequency visual flicker to produce “steady state visually evoked potentials” (SSVEPs). The high signal to noise ratio allows a clean signal to be recovered despite movement artefacts. Participants do not need to be seated looking at a screen as the actual visual scene is the visual input. This allows real world neuroscience in naturalistic settings with a minimalistic setup; small numbers of electrodes and small mobile EEG headsets can be used.

Here we present data from a selection of experiments where we demonstrate this method with participants walking and standing outside the lab and making eye movements during naturalistic social interaction combined with eye-tracking. Different visual scenes can be accurately distinguished with SSVEPs from a short amount of data (approx. 5 seconds), demonstrating that this method has greater decoding accuracy than traditional resting EEG or ERP approaches. Decoding accuracy is frequency specific with certain flicker frequencies, for example the alpha band, resulting in greater information about the visual scene. This is potentially due to an interaction with the preferred frequency of endogenous neural oscillations.

More information: www.jamesdowsett.com

24 Oscillatory signatures of the interplay between working memory, attention, and multisensory processing

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In this study, participants performed an audiovisual delayed-match-to-sample task. They were presented with one or two audiovisual memory objects, consisting of concurrently presented tones (varying in frequency) and teardrop stimuli (varying in orientation). Following a delay, participants compared the currently task-relevant features of an audiovisual probe stimulus to the encoded memory items. That is, depending on the block, participants were asked to attend to the auditory features (attend-auditory condition), to the visual features (attend-visual condition), or to both features (conjunction condition). Critically, conditions only differed by task instruction, while the physical stimulus sequence remained the same. Behavioral data analyses showed that when the task-irrelevant feature of the probe was incongruent (e.g., tone A and orientation B at encoding in the attend-auditory condition, but tone A and orientation C as a probe), a decrease in accuracy was evident. This congruency effect suggests that the task-irrelevant features were integrated and encoded into working memory to some degree. EEG analyses showed sustained, modality-specific modulations of alpha power dynamics in a cluster of parieto-occipital and frontal electrodes during encoding and maintenance. Cluster-based permutation tests revealed a relative increase in alpha power in attend-auditory blocks compared to attend-visual and conjunction blocks. Further, a relative increase in alpha power was evident in conjunction compared to attend-visual blocks. This could suggest that attending to auditory or audio-visual features in working memory requires a greater degree of “shielding” than attending to visual information. Altogether, the results shed light on the interplay of working memory, attention, and multisensory processing.

25 EEG correlates of learning from static and self-generated repeated movements

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Mastering a motor task may take several hours of training but learning the rudiments of a movement to accomplish a task can be done in a handful of attempts. The ability to synchronize one's actions with an external source is necessary for that learning In turn the ability to synchronize may depend on the interaction between the movement display that has to be copied and the physical and mental limitations of the "student". This interaction can also determine the perceived agency of the "teacher". The effect of the display on leaning a movement can be tested by manipulating the ease of synchronization.

Adult participants are tested by having them repeat multiple movements multiple times from a 3D avatar presented on screen. For each movement the avatar either statically repeats the movement (playing back the same recorded motion), each repetition is replaced by efforts of another human (playing back different tokens of the same motion), or the repetition efforts of the participant (playing back the participants last attempt of repetition). EEG and full body motion capture are recorded. Synchrony between movement-movement and EEG-EEG and movement-EEG are measured using cross-correlation, wavelet cross-coherence.

Preliminary results show that while synchrony (measured between repetitions) in movement increases in all cases the largest increase is with self-generated movements, while the largest changes in EEG synchrony are in the case of static repetition.

26 Entorhinal grid-like codes map visual space during memory formation

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Eye movements, such as saccades, allow us to sample the visual world which in turn shapes memory. Recent work in animals and humans has shown that saccades are related to the activity of spatial cells in the entorhinal cortex, including grid cells or associated grid-like codes. It is unclear however, whether grid-like codes are relevant to memory formation in humans. Here, we asked whether entorhinal grid-like codes are associated with saccades as human participants studied visually presented scene photographs. In two separate experiments (N1 = 32 and N2 = 50), participants viewed scene images while undergoing functional magnetic resonance imaging (fMRI) and continuous monitoring of eye gaze. To determine memory performance, participants of both experiments completed a recognition memory task immediately after study (experiments 1+2), as well as one week after (experiment 2). Results consistently revealed significant grid-like codes in the entorhinal cortex when participants produced saccades to study the scene images. Entorhinal grid-like codes positively scaled with activation in the frontal eye fields and inferior temporal cortex. Notably, we found that increased recognition memory performance was associated with lower entorhinal grid-like codes across participants. These results reinforce the notion that entorhinal grid-like codes contribute to oculomotor and visuo-spatial processing during human memory formation.

27 The trans-saccadic preview effect reflects active vision rather than adaptation

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Our eyes move about three times per second which divides apparently continuous vision into rather discrete snapshots. These spatiotemporal dynamics imply that we never see something completely new: There is always an extrafoveal preview of upcoming foveal input which impacts on foveal processing. Preview effects can be found in task performance, eye-movement behavior, and fixation-related neural responses. Here, we further investigate the fixation-related neural preview effect with concurrent magnetoencephalography (MEG) and eye-tracking in order to find out whether the preview effect can be explained by simple neural adaptation or whether an additional neural mechanism related to actively executing a saccade is required for this effect. To differentiate between these possible explanations, we designed three viewing conditions: active viewing involving a saccade to an object, passive replay with the eyes of the participant fixed and the preview object moving to the center of the screen, and a post-saccadic blank condition which served to further distinguish among subtypes of adaptation. We found an earlier preview effect in the active saccade condition compared to the passive replay condition and no preview effect in the post-saccadic blank condition. Moreover, the preview effects in the different viewing conditions had very different topographies. Our results suggest that the neural preview effect does not arise from adaptation alone but requires an additional neural mechanism that is tightly linked to saccade execution and, therefore, to active vision.

28 Age-Related Variability in Memory Formation: An EEG Study on Ongoing and Stimulus-Related Alpha Power

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Aging is often associated with cognitive decline and memory impairment. However, the neural mechanisms underlying memory formation and the factors contributing to impeded memory are still unknown. Previous research has primarily focused on memory formation through remembered versus forgotten comparisons, lacking the ability to capture the incremental nature of learning. Moreover, investigations have primarily examined event-related desynchronisation (ERD) of alpha power, neglecting the potential influence of ongoing, prestimulus alpha activity.

To address these gaps, we employed a sequence learning paradigm, in which subjects learn a fixed sequence of visual stimuli over repeated observations. Critically, it allowed us to track the pre- and poststimulus alpha power modulations during the incremental process of learning.

Behavioral results revealed that young subjects learned significantly faster than older subjects, in line with expected age-related cognitive decline. Neurophysiological data showed that prestimulus alpha increased with sequence knowledge. Crucially, alpha ERD was modulated by prestimulus activity. Successful learning was characterized by low prestimulus alpha and small ERD, whereas non-learning was characterized by high prestimulus alpha and large ERD. Interestingly, older subjects showed higher prestimulus alpha power and weaker modulations of alpha power during the task, suggesting potential age-related alterations in inhibitory mechanisms and lower capacity for information processing compared to their younger counterparts.

These findings shed light on the age-related differences in memory formation and provide insights into ongoing and stimulus-related alpha power dynamics during learning. Further exploration of these mechanisms may contribute to the development of targeted interventions to enhance memory performance in older adults.

29 In-phase Focal Theta-tACS Over Fronto-parietal Brain Areas Improves Verbal Working Memory Only When Task Demands Are High

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Correlational research supports the importance of theta phase coherence for efficient information transfer within long-range neural networks, such as between human frontal and parietal brain areas for working memory processing. Studies using tACS even provided a causal link of fronto-parietal theta coherence and working memory, demonstrating a modulation of working memory performance depending on whether synchronous or asynchronous tACS at theta frequency was delivered. Recent work, however, suggests that such phase-dependent tACS effects might require populations with deficits or tasks with a high level of cognitive demand. In this study, we investigated whether phase-dependent tACS effects on behavioral performance are facilitated by the right level of cognitive challenge in young neurotypical adults - depending on an individual's cognitive capacity, as measured by digit span performance, and the cognitive demand in a Sternberg working memory task. Our data showed that for task conditions with higher cognitive demands (Load 10), working memory performance was improved during In-phase focal tACS at theta frequency over fronto-parietal brain areas, compared to no stimulation in a sham condition. This was not the case for task conditions with lower cognitive demands (Load 4 or Load 8). The stimulation effect, however, did not depend on individual cognitive capacity in this sample of young neurotypical adults with a digit span of 4 to 9 items. Yet, this indicates that in-phase electric brain stimulation can potentially be used not only for compensating cognitive deficits, but even for increasing peak performance in young, neurotypical adults when cognitive demands are high enough.

30 Neurophysiological correlates of somatosensory tinnitus modulation

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Background

Tinnitus is the subjective perception of a sound without a physical sound source. Neuronal activity in various brain areas contribute to its generation. Research has highlighted somatosensory processes associated with tinnitus. We here investigate if differences in tinnitus perception mediated by the somatosensory system are reflected in brain oscillations.

Methods

24 tinnitus patients performed relaxing versus straining exercises with their jaw (blocked design, randomized order). After each condition, participants' brain activity was measured with Magnetoencephalography. Participants rated tinnitus loudness and unpleasantness on a visual analogue scale. Brain activity was contrasted for the strained versus relaxed state on sensor level using a cluster-based permutation test. Derived significant clusters were projected to source space using a beamformer approach. Furthermore, connectivity between somatosensory and auditory brain areas will be analysed using Phase Transfer Entropy.

Results

For the strained compared to the relaxed condition we found that participants experienced their tinnitus louder and more unpleasant ($p<.05$). Furthermore, we found a significant positive cluster in the frequency range of 32-46 Hz and a significant negative cluster for 7-14 Hz on sensor level (both $p<.05$). According to source analysis, the gamma power increase showed up mainly in right secondary auditory cortex, while alpha power reduction peaked in left somatosensory and motor cortex

Discussion

We here show that tinnitus perception is reduced by relaxing exercises. Furthermore, tinnitus loudness reduction is accompanied by reduced auditory gamma power and increased somatosensory-motor alpha power. These results point to a functional role of the cortical somatosensory-motor system in maintaining tinnitus.

31 Manifestation of vision through cortico-ocular coupling

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Steady fixation is considered a necessary requirement in cognitive experiments that involve visual stimuli. It is the absence of macroscopic oculomotor events that is thought to ensure the validity of the interpretation of the acquired data in relation to the cognitive construct studied. That is, a putative relationship between eye movement control and the brain's response to visual stimulation is not considered per definition. The present report explores the extent to which visual signals may be related to eye movements through an analysis of cortico-ocular coherence, akin to established observations in the motor system.

We re-examined simultaneously acquired magnetoencephalographic and eye tracking data in the context of an inward moving grating experiment. During visual stimulation, gaze was directed towards central fixation – as instructed. We processed the horizontal eye gaze position data in order to be able to use it as a proxy for the EMG of the extraocular muscles. We first subtracted a median filtered version of the eye tracker signal, to remove saccades. This was followed by high pass filtering (cutoff frequency at 40 Hz, windowed sync FIR filter), and rectification. Sensor level coherence analysis revealed two spectral peaks in the delta/theta frequency range (2-7 Hz), and alpha/beta frequency range (10-16 Hz). Source localization identified involvement of bilateral early visual cortical areas, bilateral cerebellum and possibly the superior colliculus

The results are discussed in light of the conjecture that coherence between subsaccadic movements and cortical rhythms is a manifestation of an efferent oculomotor process supporting active vision.

32 Co-varying eye movements and power modulations of alpha oscillations during working memory: a pi-lot study

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A common assumption in Cognitive Neuroscience is that, under well controlled experimental conditions, brain rhythms vary with task-specific cognitive demands and reflect the neural support of the cognitive operation performed. Power modulations of alpha oscillations are consistently related to working memory (WM). There is an inconsistency in the literature regarding the direction of this association between alpha power and WM load. Some findings suggest an increase while others suggest a decrease in alpha power with an increase in WM load.

Building upon the premise that the brain continuously monitors oculomotor action, the present proposal suggests that different gaze patterns during commonly used WM tasks (i.e. Sternberg and N-back) predict variations in alpha power. Specifically, pilot data (N=10) are reported where participants performed both task types. Differences in alpha power with WM varied with variability in oculomotor action: the higher the variability the stronger the decrease in alpha power and vice versa.

The results are discussed in light of the conjecture that the variation of alpha power with WM load - or more generally, power modulations - appear correlated with the cognitive task at hand, while in fact they evolved primarily to support oculomotor control.

33 Multi-sensory closed-loop stimulation to improve memory in humans: experimental design

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Hippocampal theta oscillations are considered a critical substrate for episodic memory formation. The hippocampus has been suggested to bind together a wide range of to-be-encoded multisensory information through ongoing theta oscillations. In line with this, recent studies have demonstrated that entraining theta oscillations through 4Hz audio-visual stimulation can enhance memory performance in human subjects. However, this "one-size-fits-all" approach neglects the individual variability in brain activity and may inaccurately estimate the optimal encoding state of each subject, thus leading to variability in the results. Indeed, it is known that brain activity varies across individuals and within the same individual over time, raising the question of whether memory encoding could benefit from individualised stimulation parameters.

Therefore, this study aims to test whether real-time cryogenic-MEG signal analysis combined with the adaptive alignment of stimulation parameters to the subjects' ongoing brain activity, can consistently enhance the entrainment effects on the memory performance of each participant. Specifically, the hippocampal signal will be extracted from the data using source modelling (beamforming), and the estimated Individual Theta Frequency (ITF) will be used to modulate the flickering rate of the sensory stimuli (audio and video) on a trial-by-trial basis.

The results will contribute to our understanding of the role of theta oscillations in memory, with implications for the potential development of novel interventions for memory enhancement.

34 Revisiting the orthographic prediction error for a better understanding of efficient visual word recognition

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Recent evidence suggests that readers optimize low-level visual information following the principles of predictive coding. Based on a transparent neurocognitive model, we postulated that readers remove redundant visual signals to focus on the informative aspects of the percept, i.e., the orthographic prediction error (oPE). Here we test alternative oPE implementations by assuming all-or-nothing signaling units based on multiple thresholds (i.e., output modality of a neuron). Further, we tested if readers signal predictions from one or multiple neuronal units. For model evaluation, we compared statistical model fits of the new oPEs with each other and against the original formulation based on behavioral and electrophysiological data (EEG at 230, 430 ms). We found the highest model fit for the oPE with a 50% threshold integrating multiple prediction units for behavior and the late EEG data. The early EEG data was still explained best by the original hypothesis. Thus, the new formulation is adequate for late but not early neuronal signals indicating that the prediction error representation, which likely implements lexical access, changes over time.

35 Does Contrast affect both Gamma Oscillations and Ocular Movements? A pilot study

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In cognitive neuroscience, it is generally assumed that brain rhythms reflect the neural processes involved in the cognitive operation demanded by the experiment task. This assumption has led to various theories about the role of gamma oscillation patterns, which range from fundamental functions such as facilitating effective neural communication to higher-order cognitive functions like memory and attention. However, it remains unclear why occipital gamma variation primarily depends on stimuli properties like contrast.

It has been observed that black and white gratings most consistently elicit occipital gamma activity. The perception of these gratings is enabled by miniature eye movements across the contrast border. Given that the brain continuously monitors oculomotor action, it may be crucial to take these eye movements into account when investigating gamma.

This study proposes that differences in grating contrast lead to variations in both gamma and eye movement properties. Specifically, it is expected that high-contrast gratings will elicit gamma oscillations with higher frequency but lower power compared to low-contrast gratings. Additionally, it is predicted that eye movement properties are dependent on the grating contrast condition, although no specific direction of this relationship is proposed. In support of these hypotheses, preliminary analyses of pilot data are reported.

A dependence of both eye movements and occipital gamma on grating contrast suggests that gamma might be related to oculomotor control. Therefore, this study may offer an alternative explanation for the apparent correlation between gamma modulation and cognitive tasks and help develop a comprehensive theory about the function of gamma oscillations.

36 Investigating High-Level Visual Cortex Preferences through Neural Network Training on Large Neuroimaging Data

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Convolutional neural networks (CNNs) pretrained for object recognition tasks are now widely compared to and associated with ventral stream responses to visual stimuli. However, pretrained networks carry biases introduced by their training dataset and task objective. Recent advances in large-scale visual neuroimaging datasets offer an opportunity to train modern CNNs directly on human neuroimaging data, overcoming these biases. In this study, we used the Natural Scenes Dataset - an expansive functional MRI dataset capturing photo responses - to identify a suitable neural network architecture (among ResNet50, VGG and others) for predicting responses in individual high-level visual cortex regions. Through careful optimization, we trained high-performing voxel-wise encoding models using the same architectures end-to-end, that is with the stimulus image as input and BOLD activity as output, as such remaining hypothesis-agnostic. Treating these brain-optimized networks as in-silico models of visual cortex regions, we conducted a sensitivity analysis using millions of images to reveal expected preferences of FFA for faces, PPA and RSC for places, and EBA for body parts. Using unbiased feature visualisation methods which expand the search space to non-naturalistic images, our findings also uncovered novel abstract selectivity for these areas. These results demonstrate the feasibility of training common neural network architectures on currently available large neuroimaging datasets and provide valuable insights into the representations underlying human vision.

37 The neural basis of Face Identity Recognition in macaques with fMRI frequency-tagging

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Monkeys appear particularly proficient at recognizing gaze, head orientation and facial expressions. However, their ability to perform face identity recognition beyond image-based discrimination similarly to humans is questionable. Having recently validated a powerful frequency-tagging fMRI face localizer in non-human primates, here we extend this approach to target the neural basis of monkeys' recognition of facial identities. FMRI recordings were performed in two macaques. Natural images of a single unfamiliar identity were presented within a rapid 6Hz stream in two conditions: (1) with the same image across low-level changes only, or (2) different image changes additionally. Every 9s during a 243s run, 7 natural different unfamiliar identities were introduced in bursts. Analyses were performed in the Fourier domain where individual face discrimination responses were objectively identified and quantified, at the peak of the identity change frequency. In all the regions defined with our functional frequency-tagging localizer, image-based individual face discrimination responses were found in both monkeys for condition 1, whereas responses were negligible in condition 2, for both human and monkey faces. In contrast, preliminary evidence from four human subjects tested in the same paradigm indicates robust individual discrimination effects across both conditions in their core face-selective ventral regions and exhibits large inversion effects, restricted to conspecific faces. This extension of the frequency-tagging fMRI approach provides the first evidence of fMRI adaptation to different face identities in non-human primates. However, contrary to humans, this effect appears to be essentially restricted to image-based discrimination, with no significant advantage for conspecific faces.

38 Curiosity induced by stimulus uncertainty modulates attention control

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A common assumption in lab-based tasks is that any behaviour not in alignment with the stated goal indicates a failure of top-down control. But, what if people attend to such cues out of curiosity - a concurrent motivation in most humans? We examined if curiosity leads to greater processing of irrelevant information in a version of the Posner cueing paradigm which is typically used to study spatial attention control. Participants (n = 30) were presented with an abrupt-onset cue followed by a single letter target (E or H). The letter target was followed by either a mask at the target location (low uncertainty/curiosity) or masks at all four locations in the display (high uncertainty/curiosity). We recorded EEG and measured event-related potentials time locked with target onset. Results showed significant differences in the N2 component at frontocentral electrode sites. Further analysis was conducted using the Residue Iteration Decomposition Method (RIDE) to overcome the limitations of conventional stimulus-locked ERP analyses by adjusting for trial-to-trial latency variability. RIDE also decomposes stimulus-locked EEG data into three separate component clusters associated with distinct levels of processing: stimulus (s), central (c) and response (r) components. RIDE analyses showed a larger N2 amplitude in the high uncertainty condition compared to the low uncertainty condition in the s-cluster. A larger P300 was also observed for the high uncertainty condition compared to the low uncertainty condition in the c-cluster. These novel results reveal the neural basis of the effects of curiosity on attention and cognitive control.

39 Improving early diagnosis of neurodegenerative diseases using MEG-based machine learning in the BioFIND dataset

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There is an ever-growing need for developing treatments for Alzheimer's disease (AD). Electrophysiological biomarkers could help achieve earlier diagnosis of AD and other dementias.

In this study, we explored spectral magnetoencephalography (MEG) metrics and machine learning approaches for AD detection. We assessed the capacity of MEG to distinguish between patients with mild cognitive impairment (MCI) and healthy controls, and between stable MCI and patients who later developed AD dementia.

We analyzed 323 resting-state MEG recordings from the BioFIND dataset (Vaghari et al., 2021), including 157 MCI patients and 166 healthy controls. 64 MCI patients evolved to AD dementia while 53 remained stable. We computed spectral power and covariance matrices using Morlet wavelets (Hipp et al 2012, Nat Neuro). We further analyzed classification performance of MEG metrics using models based on Riemannian Geometry (Sabbagh et al 2020, NeuroImage).

Baseline analyses of spectral power suggested a widespread increase of brain activity in lower frequencies (1-6Hz). This was most pronounced in parietal, temporal and occipital regions of the sensor array. AD converters showed a focal pattern of reduced spectral power in higher frequencies (> 12Hz) in parieto-occipital regions compared to non-converters. Effects remained significant after adjusting on confounds (site, sex, motion, education). Compared to baseline log-power features, the Riemannian features performed better to discriminate between MCI and controls when using the covariance matrices on frequencies ranging from 0.5Hz to 64 Hz (AUC = 0.82).

Our results suggest that covariance-based features can bring additional value beyond classical spectral features.

40 Transferability of auditory spatial adaptation to threat-related perceptual biases

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Humans localize incoming sounds by identifying their specific spectral shapes, which are formed by the listener-specific pinna geometry, depend on sound-source location, and are captured by head-related transfer functions (HRTFs). Interestingly, the human auditory system can adapt surprisingly well to changes in spectral cues, e.g. to changes in pinna geometry or asymmetric hearing loss. We here present the outline for a study that aims to (1) investigate whether listeners can be trained to estimate sound directions filtered with novel, physically implausible spectral-shape cues and (2) whether they can generalize this newly acquired knowledge about novel spectral-shape cues to distance perception and movement discrimination. Training consists of a supervised learning procedure implemented in VR, spread over multiple days. We assess learning effects by comparing localization performance with native and novel cues before (pre-) and after (post-) training. To demonstrate generalizability, participants perform a looming bias (LB) task pre- and post-training. There, looming or receding sounds, filtered with native or novel HRTFs, are, in 40% of trials, followed by an auditory target. Participants indicate target detection via a button press. Electroencephalogramm (EEG), Eyetracking (ET) and Skin-Conductance-Response (SCR) data is collected during pre- and post-test sessions. We hypothesize that participants initially perform poorly with novel cues at the pre-test level, meaning slower reaction times (RTs) overall and a reduced RT bias towards looming sounds accompanied by diminished ERP component, pupil dilation and SCR amplitude LB markers. Due to the extensive training, we expect performance and LB markers to recover at the post-test.

41 Age-related changes in “cortical” 1/f dynamics are linked to cardiac activity

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The power of electrophysiologically measured cortical activity decays 1/fX. The slope of this decay (i.e. the spectral exponent) is modulated by various factors such as age, cognitive states or psychiatric/neurological disorders. Interestingly, a mostly parallel line of research has also uncovered similar effects for the spectral slope in the electrocardiogram (ECG). This raises the question whether these bodywide changes in spectral slopes are (in-)dependent. Focusing on well-established age-related changes in spectral slopes we analyzed a total of 1282 recordings of magnetoencephalography (MEG) resting state measurements with concurrent ECG in an age-diverse sample. We show that the aperiodic signal recorded using surface electrodes/sensors originates from multiple physiological sources. In particular, significant parts of age-related changes in aperiodic activity normally interpreted to be of neural origin can be explained by cardiac activity. Moreover, our results suggest that changes (flattening/steepening) of the spectral slope with age are dependent on the recording site and investigated frequency range. Our results highlight the complexity of aperiodic activity while raising concerns when interpreting aperiodic activity as “cortical” without considering physiological influences.

42 Speech tracking in eye movements

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Watching the movements of a speaker's lips are recognized to aid in comprehending speech, and studies have demonstrated that this advantage is also reflected in the brain. Recent evidence has shown that eye movements can also track speech features and follow auditory sounds. However, the extent to which these eye movements drive speech tracking in motor cortices remains unclear. In this study, we investigated the eye movements of 60 participants while observing silent videos of intelligible and unintelligible lip movements of a speaker. We recorded whole-head magnetoencephalography (MEG) and electrooculogram (EOG). Usually, the EOG is used to reject eye artifacts in brain data. But in including the EOG in the analysis, we found that low-frequency speech tracking in the eye movements was higher in the intelligible compared to the unintelligible condition. Furthermore, this partially explains the higher cortical speech tracking in motor areas for intelligible compared to unintelligible speech. Our results suggest that EOG can provide valuable information about eye movements and offer a new approach to including them in brain research. This study sheds light on the functional role of eyes in auditory processing and raises important questions for future research in auditory neuroscience.

43 Alpha band sensor and source activity modulations by noxious heat stimulation delivered in the thenar eminence.

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Oscillatory alpha activity (6-12 Hz) may be related to pain processing. Resting-state alpha power distinguishes chronic pain patients from healthy controls (HC), and ongoing pre-stimulus alpha activity modulates the amplitude of contact-heat evoked potentials (CHEPs). However, alpha band modulation by noxious thermal stimuli and its cortical sources remain unclear. Here, we assessed oscillatory brain activity locked to short noxious heat pulses delivered to the thenar eminence in 59 chronic pain patients (mean age: 49 ± 7.98, 78% females) and 41 HC (mean age: 33 ± 7.9, 73% females). Independent Components (IC) decomposition of EEG data yielded 9 IC clusters based on dipole location. Independent samples t-tests with 500 permutations run on data at the sensor level showed greater upper alpha band power (9-13 Hz, p. $\leq$ .01 uncorrected) between 590 and 650 ms for patients than HC at Cz. Similarly, significantly larger alpha power for patients than HC (all p. $\leq$ .01 uncorrected) was found for the event-related alpha activity of 4 IC clusters: i) between 400 and 450 ms after stimulation onset at anterior cingulate (Brodmann Area 24), posterior portion of the left (BA 41) and anterior portion of the right (BA 22) superior temporal gyrus; and (ii) in later time windows (>600 ms) at the anterior portion of right superior temporal gyrus and left thalamus. These results corroborate that alpha activity at regions like anterior cingulate cortex and temporal gyrus is modulated by noxious stimuli and extend the evidence of the role of alpha activity in pain processing.

44 #EEGManyPipelines: mapping the multiverse of EEG analysis procedures and their impact on EEG results

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Analysis of electroencephalographic (EEG) data is marked by a large variability in the analytic approaches researchers might pursue to test the same research question. Although a few recent studies addressed the question of the impact of potential EEG analytic decisions, it remains unclear how variable real-life practices are and how they affect the result. To answer this question, we launched the EEGManyPipelines project the large-scale, community-driven project that aims to investigate the robustness of EEG findings across different analysis approaches performed by different analyst teams. To achieve this goal, we sent an EEG dataset together with a set of 8 hypotheses to more than 300 expert teams that signed up for the project. Teams were asked to test these hypotheses using analysis procedures as representative as possible to their usual analysis pipeline. 168 teams, encompassing 396 individual researchers from 37 countries, successfully completed the task and shared data including a self-report form on the analytic decisions taken, scripts, and pre-processed EEG data. Here, we show preliminary results documenting the extent of variability of analysis procedures "in the wild" based on how these analyses were reported and on how they were actually implemented in code. Likewise, our data also show that this multiverse of analysis pipelines yields substantial variability in the results. We expect that mapping this garden of forking paths of EEG analyses will inform recommendations for best practice guidelines, thereby enhancing the robustness of published EEG findings.

45 Fact or fiction? Putting theoretical models about trauma-related dissociation to the test

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Dissociation is a mental phenomenon frequently experienced during and after traumatic experiences. Several well-known theoretical models propose that it is triggered by specific trauma-characteristics, that it exhibits an inverted U-shaped relationship with behavioral, physiological, and experiential arousal-responses (i.e., positive relationships at low- and negative relationships at high-dissociation levels), and that it plays a role in the development and maintenance of posttraumatic stress disorder (PTSD). Here, we review the current state of evidence for these long-held theoretical assumptions, taking into account recent findings from our and other labs including two trauma-analogue studies in healthy participants and two clinical studies in individuals with PTSD, and highlight directions for future work.

46 The brain distinguishes random from predictable syllables during implicit statistical learning. Is this also true for the "sleeping" brain?

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The brain has a remarkable ability to rapidly extract the underlying rules of seemingly random information. To what extent, however, does this depend on the brain's consciousness level? The purpose of the present study is to determine whether predictive neural signals can be found in the sleeping human brain. 18 participants implicitly learned the grammatical rules underlying a set of syllables and were subsequently re-exposed to the same stimuli during overnight sleep, while Electro/Magnetoencephalography was recorded. Here, we present Event-related, Time-Frequency as well as decoding results during statistical learning in wakefulness. The amplitudes of the random and predictable auditory stimuli could not be differentiated. However, there was higher theta power at 100-300 ms after a stimulus that allowed for predicting the next upcoming one (i.e., the predicting stimulus), in combination with a reduction of alpha power prior to the presentation of a predictable stimulus (at -500 to -300 ms.). In addition, there were above chance across time decoding accuracies for stimulus predictability suggesting that the brain distinguishes random from predictable syllables. Interestingly, the stimulus properties of random syllables were decodable for longer, compared to the predictable ones. We found no evidence of pre-activations of the predictable syllables, as examined with the time generalisation method. Future analysis focuses on exploring these effects during sleep.

47 Pre-Stimulus Heartbeat Evoked Potentials predict P300 and reaction time in an auditory Oddball Task: real or spurious effect?

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Introduction. Heartbeat-evoked potentials (HEP) refer to the brain's response to one's own heartbeat, and are thought to reflect the brain's ability to monitor and regulate cardiovascular function. Previous studies have shown that HEP amplitudes could be modulated by the attentional shift from external to internal stimuli. In this framework, we aimed to investigate whether HEP amplitudes relate to electrophysiological activity and task performance in an Auditory-Oddball-Task, hypothesizing that pre-stimulus HEP amplitude would be inversely related to P300 task-evoked response and reaction time.

Methods. We analyze a large dataset of EEG + ECG recordings acquired in the LIFE-adult-study (N= 1796, mean age 70, SD = 4.6 years). Participants performed a 15-minute Auditory-Oddball-task. Event-related responses (ERP) were calculated and categorized based on P300 amplitude and reaction time (RT). We identified HEPs in the pre-stimulus time and sorted them into two categories, based on high/low P300 amplitude and fast/slow RT.

Results. We observed the hypothesized inverse relationship between HEP and task-evoked P300 amplitude as well as reaction time. However, control analyzes using resting state data and a pseudotrial correction procedure suggest that this association may be spurious.

Discussion. While our findings initially supported the hypothesized differences in pre-stimulus HEPs when categorized by task-evoked P300 amplitude or RT, these differences disappeared when employing a pseudotrial correction. Although we cannot exclude the possibility that pre-stimulus HEPs relate to task-evoked ERPs and performance in auditory oddball tasks, we present compelling alternative explanations that can account for the observed effects.

48 Short-latency somatosensory evoked potentials, alpha oscillations and excitability: linked via back-propagating membrane potentials?

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Neural activity is remarkably variable: Even for the very same stimulus, the brain´s response differs from moment to moment. This has been attributed to changes of brain states that shape the way a given sensory input is processed. Specifically, such brain states have been linked to the instantaneous excitability of primary sensory cortices. At the same time, it remains an open question how stimulus features (e.g., intensity) and neural states (e.g., excitability) are reflected in evoked brain responses: Are larger amplitudes necessarily associated with a stronger percept of a stimulus? In a series of three somatosensory stimulation paradigms in humans, we examined the interplay and spatiotemporal organization of two markers of cortical excitability, pre-stimulus oscillatory activity in the alpha band (8-13 Hz) and initial, feedforward excitatory post-synaptic currents inferred from short-latency somatosensory evoked potentials (SEP) in the EEG – as well as their association with the subjectively perceived stimulus intensity. Fluctuations of neural excitability shaped the perceived stimulus intensity already during the very first cortical response (at ~20ms) yet demonstrating opposite neural signatures as compared to the effect of presented stimulus intensity. We reconcile this seeming discrepancy by an excitability-dependent modulation of electro-chemical membrane gradients linking neural states and responses, which calls for reconsidering conventional interpretations of brain response magnitudes in stimulus intensity encoding. Moreover, these observations open a new perspective on bottom-up generated EEG responses: Most likely, they reflect membrane depolarizations that propagate *back* towards the apical dendrites, thus travelling towards top-down modulation zones rather than in feedforward direction.

49 Heart brain interactions and their relation to spontaneous beta activity are affected in Parkinson's disease

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Parkinson's disease (PD) is associated with impaired interoception, but the neuronal basis of this deficit remains unclear. We investigated whether the impairment could be reflected in the heartbeat evoked potential (HEP), a marker for cardiac interoception. We also examined the role of spontaneous brain state represented by beta burst dynamics, in shaping interoception in healthy and pathological brains.

Using data from the population-based LIFE-Adult dataset, we analyzed two visits (Baseline and Follow-up) of participants. Our analysis included three groups: healthy controls (HC_all: N=1462), prodromal PD (N=6), and PD (N=17). Using resting-state EEG measurements (20 minutes with 32-channel), our findings first demonstrate that PD development is accompanied by an attenuation of HEP longitudinally (in prodromal PD group). In addition, in healthy controls, higher beta power during the prestimulus window corresponded to greater HEP magnitude over the bilateral centro-parietal region ($p=0.002$). Besides, the timing and duration of beta bursts influenced HEP in the healthy group – the longer and closer of the beta bursts, the greater the magnitude of HEP. However, these effects were not observed in the PD group.

These results suggest that there may be a distinct role of transient beta activity in the perception of external stimuli versus internal bodily signals. Furthermore, the flexibility of brain response to the heartbeat appears to be disrupted in PD. Our study provides initial evidence of the influence of spontaneous brain activity on interoception and the central neuronal correlates of abnormal heart-brain interactions in PD.

50 Unveiling Neural Dynamics Timescales via Multiscale Entropy Analysis in MEG Patient Data

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The intricate and dynamic nature of the human brain requires advanced experimental and analytical approaches to comprehend the underlying mechanisms and unravel the complexities of neural processes. In this context, Magnetoencephalography (MEG) offers a unique opportunity to capture the spatiotemporal dynamics of neural activity with excellent temporal resolution.

Several tools have been recently introduced to quantify the irregularity and complexity of neural time series data across multiple time scales and frequencies. Among them are the Fitting Oscillations & One Over F (Fooof), the Irregular-Resampling Auto-Spectral Analysis (IRASA), and Multiscale Entropy (MSE). In particular, MSE is a powerful signal processing technique that assesses the signal's entropy over different temporal scales, providing a comprehensive evaluation of the dynamics and information content of the neural processes under investigation.

As a first study, we explore the potential clinical applications of MSE analysis in MEG data, particularly in the context of neurological disorders and psychiatric conditions. By comparing the MSE measures derived from healthy controls with those of tinnitus patients, we aim to identify potential signs or alterations in neural dynamics that may contribute to the pathophysiology of this disorders. Subsequently, we apply a variant of MSE (known as "modified" MSE) to elucidate the temporal dynamics of signal complexity in a sensory processing task, involving the same groups of healthy subjects and patients.

Our findings could offer new insights into the neural underpinnings of these abnormalities and underscore the potential of MSE as a tool for clinical diagnosis and monitoring. This research represents one step towards a more nuanced understanding of brain dynamics in health and disease, with potential implications for the development of novel therapeutic strategies.

51 Hemispheric asymmetries in auditory cortex reflect discriminative responses to temporal details or summary statistics of stationary sounds

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The processing of stationary sounds relies on both local features and compact representations. As local information is compressed into summary statistics, abstract representations emerge. While local features and summary statistics are associated with different neural oscillatory profiles, it is unknown whether the brain is endowed with distinct neural architectures overseeing such computations. We employed a validated protocol to localize cortical correlates of local and summary representations and recorded the MEG of participants exposed to triplets of synthetic sound textures systematically varying for either local details or summary statistics. Sounds also varied for the amount of information they encompassed (sound duration), specifically short (40ms) or long (478ms). Results revealed distinct activation patterns for local features and summary statistics changes occurring at short or long duration. Such activations diverged in magnitude, spatiotemporal distribution, and hemispheric lateralization. For short sounds, a change in local features predominantly activated auditory regions in the right hemisphere. By contrast, higher activations in bilateral frontotemporal regions were observed for long sounds when summary statistics, compared to local features, changed. The right auditory cortex was more engaged by changes in local features or summary statistics depending on sound duration, short or long, respectively. Conversely, frontal auditory-related regions in the left hemisphere responded specifically to changes in summary statistics at increasing sound duration. These findings provide insights into the neural mechanisms underlying the computation of local and summary acoustic information and highlight the involvement of distinct cortical pathways and hemispheric lateralization in auditory processing at different temporal resolutions.

52 Effects of adaptive computer-based auditory cognitive training: A neuroscientific approach.

Julian Ockelmann[1], Maren Stropahl[2], Sigrid Scherpiet[2], Nathalie Giroud[1]

[1]University of Zurich, Switzerland, [2]Phonak (Switzerland), Stäfa, Switzerland

Speech perception in background noise poses a difficult task for older adults, even for those with hearing aids or normal pure-tone thresholds. Thus, factors beyond just peripheral hearing integrity seem to contribute to these speech-in-noise (SiN) understanding difficulties in older adults. Due to impacting hearing-relevant cognitive skills, age-related cognitive decline is thought to be one such factor. Auditory cognitive training (ACT) has been shown to successfully tackle these cognitive deficiencies. However, only little work has been done on ACT-induced changes in neural speech processing with most reports being based on small sample sizes and no active control groups. Accordingly, our experimental framework investigates short- and long-term effects of ACT regarding behavioural, cortical, and subcortical components of speech processing in a large sample of older adults with sensorineural hearing loss (≥ 65 years; N=80). We employ a 4-week training, 2-month follow-up, and pre-post four-group design with two active control groups. Groups categorically differ in the use/non-use of hearing aids. Neural data is acquired using electroencephalography during a SiN understanding- and a syllable detection paradigm. Neural measures include the N1-P2 complex, parietal alpha power, auditory brainstem responses, and afferent connectivity from midbrain to cortex. We expect improved behavioral performance, increased parietal alpha power as listening effort decreases, alongside decreases in both N1-P2 magnitudes and wave V latency. Ultimately, our study is set to provide ample and novel insight on neural and behavioral effects of ACT for older adults with hearing loss. Preliminary data is expected by August.

53 Waves GPS: Simulation, Detection and Analysis of Cortical Traveling Waves

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Oscillatory activity has been found to form traveling waves within and across cortical regions. Finding and characterizing those spatio-temporally consistent patterns in data recorded with invasive as well as non-invasive techniques requires multiple consecutive, but sometimes interchangeable processing and analysis steps. The current literature on cortical traveling waves lacks a clear consensus of which methods can and should be applied in specific situations. To help navigate the methodological landscape, we introduce Waves GPS, a modular simulation and analysis tool implementing a range of methods to detect, describe and statistically evaluate traveling waves. The accompanying simulation module allows researchers to model different types of neurophysiologically plausible waves, embedded in realistic background conditions, to generate synthetic data and model experimental outcomes in silico. To validate the Waves GPS analysis pipelines, we analyzed electro- and magneto-encephalography data (N=19), concurrently recorded while participants performed a visual task. We then used the recovered wave parameters to simulate data with a known ground truth. Finally, we subjected those simulations to the same pipelines to derive objective benchmark analyses of naturalistic traveling wave patterns. We find strong evidence of traveling waves in real data with all tested pipelines, but show substantial differences in the rate at which different methodological approaches are capable of recovering them from simulations, demonstrating the importance of tailoring analyses to expected outcomes prior to processing real data.

54 Can intrinsic network configurations predict working memory gating?

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Computational models and neurophysiological data propose that the flexible coordination between distractor-resistant maintenance and updating of working memory contents is governed by a 'gating mechanism': While maintenance of information is mainly implemented in the prefrontal cortex, updating of information is signaled by phasic increases in dopamine in the striatum.

In the PFC, persistent maintenance of WM contents is fostered via recurrent excitatory networks and global feedback inhibition. The inherent ratio of one's excitatory and inhibitory connections may thus predispose certain malfunctions in the processes that should be balanced. However, the exact interplay of excitatory and inhibitory signals to navigate maintenance and selective updating remains elusive.

Long-Range Temporal Correlations (LRTC) in ongoing oscillations during rest have been demonstrated to characterize the intrinsic balance of inhibitory and excitatory connections within a neural network and emerge when neuronal systems operate at a near-critical state. Furthermore, near critical system dynamics were associated with optimal information processing. In addition, it has been shown that 1/f slope of the power spectral density (PSD) reflects the ratio between excitatory and inhibitory inputs in the respective network.

In this study, we aim to test whether these two measures of intrinsic network configuration relate to working memory gating. To this end, we [1] collected resting-state EEG to extract 1/f slope and LRTC, and [2] task EEG to capture brain activity of the gating process, and relate these to each other. We further collected data on several proxies of dopamine (transmission) and examined how these influence the observed relationships.

55 Neural attentional-filtering does not predict two-year change in attentive listening in aging adults

Sarah Tune[1], Jonas Obleser[1]

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Preserved communication abilities promote social well-being and healthy aging. While sensory acuity deteriorates with age and age-related hearing loss, an age-independent support mechanism for communication arises from attention-guided neural filtering of relevant sensory information in auditory cortex. Yet, how longitudinally stable is this brain–behaviour link? And, more generally, has neural filtering any potency in predicting interindividual differences in future changes in behavioural functioning?

We here tracked N=105 individuals neurally and behaviourally over approximately two years (age-varying cohort of 39–82 yrs). First, despite the expected decline in sensory acuity, listening-task performance proved remarkably stable. Second, when looking into each measurement time point separately (T1, T2), neural and behavioural metrics were correlated with each other. However, neither neural filtering at T1 nor its two-year change allowed us to predict an individual's behavioural two-year change, under a combination of modelling strategies.

Our results cast doubt on the translational potential of attention-guided neural filtering metrics as predictors of longitudinal change in listening performance over middle to older adulthood. Instead, behavioural performance as captured typically in audiology and neural filtering ability follow independent developmental trajectories associated with significant inter-individual variability.

56 Sustained effects of prior collaboration with a robot on the allocation of attention toward social signals

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Our prior experiences and expectations about the world shape how we perceive it. Accordingly, it would not be surprising if we perceive robots differently based on our prior expectations. Still, little work has investigated how priors influence the perception of robot social signals (i.e., mutual gaze with a robot). Here, we investigated the impact of prior social framing on processing robot social signals as measured by the alpha (8-12 Hz) frequency band. As a first step, participants categorized the color of a cube (yellow or blue) by either working together with a robot, or working with the robot as a passive actor. More related to our manipulation, both groups of participants completed the experiment again while we measured EEG activity. We explored the sustained effects of prior collaboration with a robot on the allocation of attention toward the robot's social cues, as reflected in modulations of alpha-band activity. Preliminary analyses revealed differences in the alpha-band activity based on prior experience, suggesting that prior exposure to a collaborative context might influence the neural correlates of the allocation of attention toward a robot's gaze. Understanding whether being engaged in a collaborative state could affect the processing of social signals delivered by a robot in a sustained vein can contribute to optimizing human-robot interactions and informing the design of collaborative systems.

57 Theta Synchronization as a Neural Marker of flexible (re-)use of socio-cognitive mechanisms for a new category of (artificial) interaction partners

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Previous research has demonstrated that artificial agents, including robots, can elicit higher-order socio-cognitive mechanisms comparable to those observed in interactions with humans. This suggests a flexible reuse of socio-cognitive processes, such as mentalizing, which originally evolved for human-human interactions (Wykowska, 2020). In this study, our aim was to identify neural markers associated with this flexible utilization of socio-cognitive mechanisms, with a specific focus on fronto-parietal theta synchronization, known to underlie cognitive flexibility (Fries, 2005).

We analyzed EEG data from two experiments previously ran in our facilities (Bossi et al., 2020; Roselli et al., submitted) in which participants completed the intentional stance (IST) test, a measure of their inclination to adopt the intentional stance towards robots. The test was designed by Marchesi and colleagues (2019) based on Daniel Dennet theories (1971). To obtain an intra-brain synchronization value, we used the imaginary part of coherence that allows to measure functional connectivity using neurophysiological data (Nolte et al., 2004). Our findings revealed a significant correlation between participants' IST scores, reflecting their likelihood of adopting the intentional stance towards robots, and higher theta synchronization values. Specifically, participants with higher IST scores exhibited greater long-range synchronization in the theta band. These results suggest that long-range theta synchronization may serve as a neural marker of socio-cognitive processes that can be flexibly applied to non-human agents, such as robots.

59 Reliability of functional connectivity and person identification based on resting-state EEG

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Functional connectivity (FC) has become a major neuroscientific tool to characterize coordinated interaction between functionally specialized brain areas. With its high temporal resolution, EEG enables to investigate functional connections on the timescale of the underlying physiological mechanisms. Functional networks based on EEG have been shown to contain individual-specific patterns, potentially enabling EEG-based person identification. The present study focuses on the within-subject reliability and between-subject similarity of FC networks as measured with resting-state EEG rhythms (0.5-80 Hz) on a large sample of young healthy adults (N = 201; mean age = 22.9 +/- 1.1). It was tested whether spatial leakage and its correction significantly influences the within-subject reliability and between-subject similarity of FC networks calculated based on source-reconstructed signals. FC measures corrected for spatial leakage showed much lower within-subject reliability and identification performance than their uncorrected counterparts. However, it was found that the imaging kernel matrices used in source reconstruction significantly contributed to the higher reliability and better identification performance for FC measures not corrected for spatial leakage over corrected measures. The results suggest that spatial leakage correction requires different strategies for studies focusing on a large-scale description of the neural activity of the brain and for studies focusing on person identification.

60 Prediction tendency, eye movements, and attention in a unified framework of neural speech tracking

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Auditory speech comprehension is a multi-faceted process in which attention, prediction, and sensorimotor integration (via active sensing) interact with or complement each other. Although different conceptual models that focus on one of these aspects exist, we still lack a unified understanding of their role in speech processing. Here, we replicated and extended two recently published studies from our lab to investigate the influence of prediction tendency on ocular and neural tracking of attended speech. We propose that selective attention guides ocular speech tracking, which in turn mediates neural encoding of speech. In contrast, individual prediction tendency and its relation to neural speech tracking seem to be largely independent of attention. Importantly, prediction tendency and ocular speech tracking seem to be unrelated. With the current work, we propose a framework that aims to bridge the gaps between attention, prediction, and active (ocular) sensing in order to contribute to a holistic understanding of neural speech processing.

61 Eye movements track prioritized auditory features in selective attention to natural speech

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[1]University of Salzburg, Austria, [2]Paracelsus Medical University, Salzburg, Austria, [3]MED-EL (Austria), Innsbruck, Austria, [4]University of Konstanz, Germany, [5]University of Zurich, Switzerland, [6]University College London, University of London, United Kingdom

Over the last decades, cognitive neuroscience has identified a distributed set of brain regions that are critical for attention - one of the key principles of adaptive behavior. A strong anatomical overlap with brain regions critical for oculomotor processes suggests a joint network for attention and eye movements. However, the role of this shared network in complex, naturalistic environments remains understudied. Here, we investigated eye movements in relation to (un)attended sentences of natural speech in simultaneously recorded eye tracking and magnetoencephalographic (MEG) data. Using temporal response functions (TRF), we show that eye gaze tracks acoustic features (envelope and acoustic onsets) of attended speech, a phenomenon we termed ocular speech tracking. Ocular speech envelope tracking even differentiates a target from a distractor in a multi speaker context and is further related to intelligibility. Moreover, we provide evidence for its contribution to neural differences in speech processing, emphasizing the necessity to consider oculomotor activity in future research and in the interpretation of neural differences in auditory cognition. Our results extend previous findings of a joint network of attention and eye movement control as well as motor theories of speech. They provide valuable new directions for research into the neurobiological mechanisms of the phenomenon, its dependence on learning and plasticity, and its functional implications in social communication.

62 'What' and 'Where' pathways within prefrontal cortex govern top-down attentional control through their differential connectivity fingerprints

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The frontal eye field (FEF) and inferior frontal junction (IFJ) within prefrontal cortex, are supposed to encode spatial versus non-spatial (such as feature- or object-based) representations, respectively. However, it remains unclear whether this distinct functional segregation is also reflected in the underlying anatomical and functional connectivity patterns of these two structures.

We hypothesized that FEF is predominantly connected with spatiotopically-organized regions in the dorsal ('where') stream, whereas IFJ has predominant connectivity with the ventral ('what') stream.

After accurately inferring the localization of these regions in stereotaxic space using activation likelihood estimation (ALE), meta-analytic connectivity modeling (MACM) revealed differential coactivations in frontal, parietal and temporal cortices, consistent with our hypothesis. Further, we investigated probabilistic tractography using 3T-diffusion-MRI data, tracking streamlines to the dorsal and ventral visual streams. We found preferential white-matter connectivity between FEF and the visual dorsal stream, and between IFJ and the ventral stream. Finally, we tested for the functional coupling of FEF/IFJ with the dorsal versus ventral stream, analyzing temporally high-resolving resting-state magnetoencephalography (MEG) recordings in various frequency bands. Here, FEF has predominant power- and phase-coupling with the parietal lobe in the beta band, while IFJa has predominant coupling with inferior temporal cortex in delta and gamma oscillations.

We conclude that both the anatomical and functional connectivity fingerprints of FEF/IFJ are congruent with each brain region's function. The contrasting connectivity patterns of FEF and IFJ not only align with their respective functional roles in spatial vs. non-spatial attention but also suggest a dorsal versus ventral path within PFC.

63 Children and adults rely on different heuristics for estimation of durations

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Time is a uniquely human yet culturally ubiquitous concept acquired over childhood and provides an underlying dimension for episodic memory and estimating durations. Because time, unlike distance, lacks a sensory representation, we hypothesized that subjects at different ages attribute different meanings to it when comparing durations; pre-kindergarten children compare the density of events, while adults use the concept of observer-independent absolute time. We asked groups of pre-kindergarteners, school-age children, and adults to compare the durations of an "eventful" and "uneventful" video, both 1-minute long but durations unknown to subjects. In addition, participants were asked to express the duration of both videos non-verbally with simple hand gestures. Statistical analysis has revealed highly polarized temporal biases in each group, where pre-kindergarteners estimated the duration of the eventful video as "longer." In contrast, the school-age group of children and adults claimed the same about the uneventful video. The tendency to represent temporal durations with a horizontal hand gesture was evident among all three groups, with an increasing prevalence with age. These results support the hypothesis that pre-kindergarten-age children use heuristics to estimate time, and they convert from availability to sampling heuristics between pre-kindergarten and school age.

64 tACS effects on entrainment to speech: (i) the cocktail party and (ii) the echo

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The importance of stimulus-aligned neural activity (neural entrainment) for speech perception becomes increasingly clear. This is partly due to studies using transcranial alternating current stimulation (tACS) to manipulate entrainment and thus reveal its causal role for speech processing. We present two studies that confirm such a role:

(i) In the first study, we tested the role of entrainment in a multi-speaker scenario. We used tACS to independently manipulate entrainment to target and distracting speech streams. We found that the tACS-induced manipulation of entrainment to both target and distracting speech modulated performance in a speech perception task, with no reliable differences between the two. Our results imply that neural entrainment to both target and distracting speech causally contributes to perception in multi-speaker scenarios.

(ii) In a second study, we tested whether tACS entrains endogenous neural oscillations as typically assumed. Recently, van Bree et al. (2021) showed that tACS produces rhythmic effects on speech perception that outlast the rhythmic stimulation, a hallmark of entrained neural oscillations. We expanded this paradigm by recording participants' EEG immediately after tACS. In this way, we were able to measure cortical oscillations underlying these "entrainment echoes" previously observed in behavioral responses. We found a 3 Hz response in the EEG that outlasts tACS applied at the same frequency, suggesting entrained endogenous oscillations. We also propose an analysis method to further investigate the dispersal of tACS entrainment effects over time.

65 Auditory entrainment and alpha oscillations undergo slow periodic fluctuations at similar time scales

Florian Kasten[1], Benedikt Zoefel[1]

[1]Brain and Cognition Research Center, Université Toulouse III - Paul Sabatier, Université de Toulouse, France

The brain constantly fluctuates between different processing modes. These brain-states can be characterized at different temporal scales and serve various different functions. In the auditory system, previous work in non-human primates indicates that neural processing may switch between an “external” attentional mode that prioritizes processing of sensory input, and an “internal” mode during which sensory information is ignored. While the former is characterized by reduced activity in the α-frequency band and strong entrainment to (rhythmic) auditory stimuli, the latter exhibits a higher amount of α-activity and reduced entrainment.

The current study aims to test if fluctuations in auditory sustained attention to continuous, rhythmic speech can be traced in human scalp EEG. Twenty-two participants were asked to listen to 5-min streams of degraded, rhythmic speech at 3 Hz and detect rare deviants from the rhythm. We extracted ongoing entrainment and α-oscillations (8-12 Hz) during the task by computing inter-trial-coherence and spectral power across 5-sec sliding windows. Our results reveal that both entrainment and α-oscillations exhibit similar regular fluctuations at ~0.07 Hz, although other components at different time-scales were also identified. Interestingly, this rate changed when a global change in brain-state was induced experimentally by instructing participants to perform the task with closed eyes.

Our results confirm previous findings in animal models of rhythmic attentional fluctuations and may pave the way for interventional approaches to improve auditory sustained attention.

66 Neural responses to unattended but not attended acoustic targets depend on the phase of neural oscillations

Troby Ka-Yan Lui[1], Benedikt Zoefel[1]

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Previous research has shown that the detection of visual targets depends on the phase of neural oscillations at ~7-10 Hz, even if these targets are temporarily unpredictable. This "attentional sampling" was stronger for attended than for unattended targets. Surprisingly, equivalent studies in the auditory domain found this phasic modulation to be absent for the detection of attended acoustic targets. We here hypothesize that this difference reflects the fact that typical auditory (but not visual) information changes rapidly in time: As an unpredictable target occurs at a random phase of the attentional rhythm, its processing can be suppressed if it occurs at the low-excitability phase of the oscillation. This rhythmic "information loss" is more critical if typical information disappears rapidly like in audition. An important prediction that results from this hypothesis is that auditory rhythms should be restored if expected events are irrelevant and a possible suppression at the low-excitability phase can be tolerated. We tested this prediction by asking participants to detect a pure tone embedded in noise while ignoring another. We found that the phase of neural oscillations at 8-10 Hz predicted the neural response to the ignored but not the attended tone. These results suggest that in the ever-changing auditory environment, our auditory system may reduce rhythmic neural processes when they might hinder the successful encoding of task-relevant information and rely on neural rhythms for the sampling of unattended, potentially irrelevant events.

Information

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

University of Salzburg
NAWI
Hellbrunnerstraße 34
5020 Salzburg, Austria

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"), vending machines or if you directly ask the bus driver (which is a little more expensive). To find the perfect connections via public transport in Salzburg please go to 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.

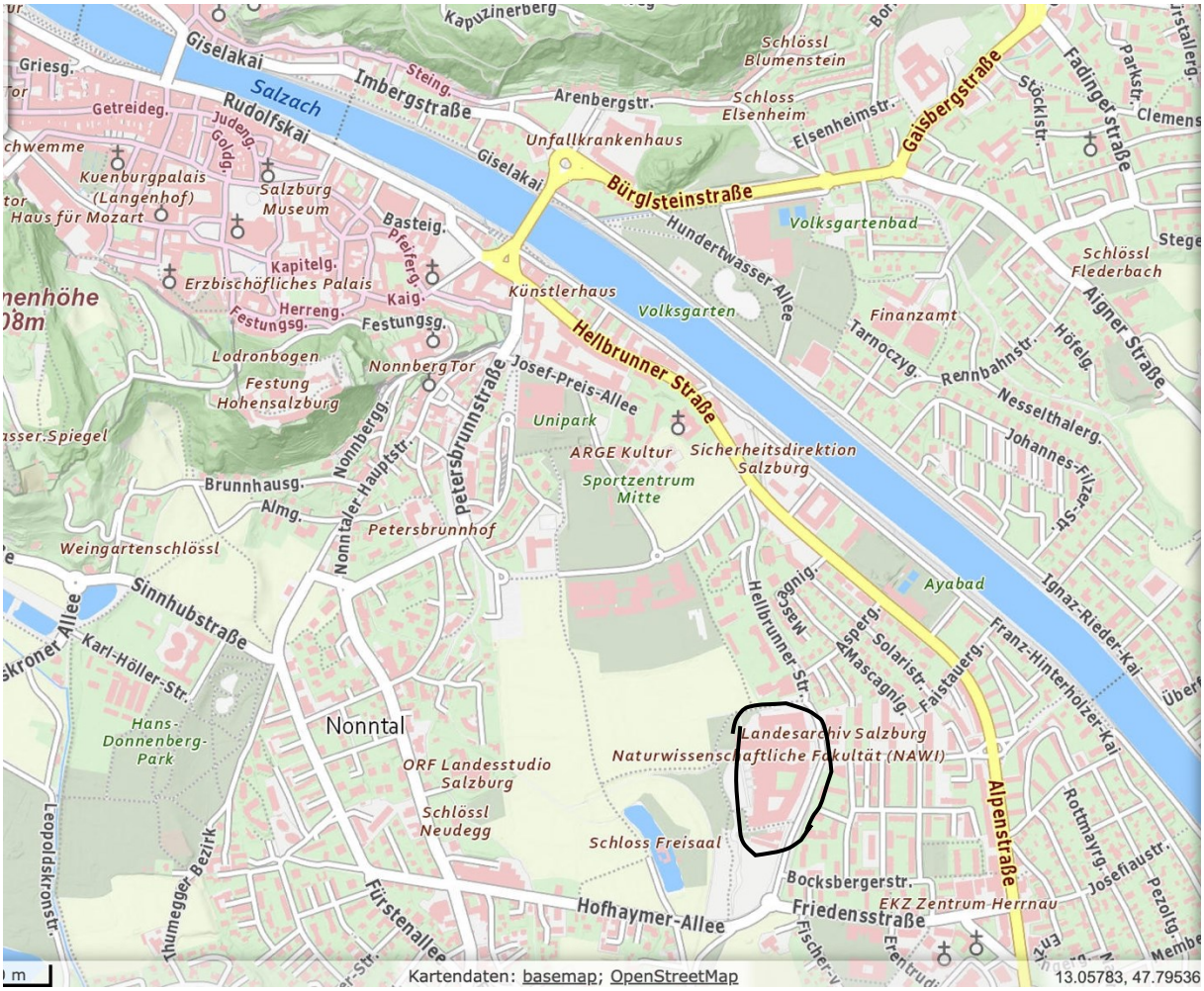
From the airport

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 Aiglhof 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 (directely 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
- Glüxfall 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)
- Colibri (nonntal@colibri-print.at)
- Copyprint (office@copypoint.at)

Social event

WHEN:

Friday, July 14t^{h} 2023, starting at 7:00 pm

WHERE:

“Urbankeller”

Schallmooser Hauptstraße 50

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 “Urbankeller”.

WI-FI AND LINKS

You can use the following credentials for WiFi at the venue:

SSID: eduroam
User: v1100597
PW: SAMBA_2023

Find us online at:

University of Salzburg

SAMBA

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Salzburg Brain Dynamics Lab

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