CuttingEEGX

Poster book

COGNITION

#1 - THE IMPACT OF COGNITIVE RESERVE ON NEURAL EFFICIENCY AND COGNITIVE DECLINE IN MULTIPLE SCLEROSIS: A FOCUS ON A2 GLOBAL POWER

• **Anagnostopoulou, A (1, 2), Karagianni, M ①, Tsoukaki, N ①, Melanitis, N ③, Chatzichristos, C (3, 4), Liozidou, A (5,6), Nikolaidis, I ⑦, Poghosyan, V ⑧, Grigoriadis, N ⑨, Bamidis, PD ①, Styliadis, C ① |** *① Aristotle University of Thessaloniki, Medical Physics and Digital Innovation Laboratory, Thessaloniki, Greece; ② Aristotle University of Thessaloniki, Department of Electrical and Computer Engineering, Thessaloniki, Greece; ③ Innovation & Incubation Center KU Leuven, AINIGMA Technologies, Leuven, Belgium; ④ KU Leuven, Department of Electrical Engineering, STADIUS Center for Dynamical Systems, Signal Processing and Data Analytics, Leuven, Belgium; ⑤ Scientific College of Greece, Laboratory of Cognitive Neuroscience and Clinical Neuropsychology, Athens, Greece; ⑥ Henry Dunant Hospital Center, Department of Clinical Neuropsychology, Neurology Department, Athens, Greece; ⑦ Hippokration General Hospital Thessaloniki, Neurology Department, Thessaloniki, Greece; ⑧ National Neuroscience Institute, King Fahad Medical City, Department of Neurophysiology, Riyadh, Saudi Arabia; ⑨ Aristotle University of Thessaloniki, Multiple Sclerosis Center, 2nd Department of Neurology, Thessaloniki, Greece*

Cognitive reserve (CR), shaped by education, occupation, and leisure activities, may explain why some people with Multiple Sclerosis (PwMS) experience more cognitive deficits than others. CR is a brain mechanism that represents its ability to maintain cognitive function despite accumulated pathology. This study investigates the cognitive and neurophysiological correlates of CR in PwMS and its role in the relationship between brain function and cognition. 62 PwMS (12 males; 42±12 years old; 14±3 years of education; 43 RRMS) and 47 healthy controls (HC; 14 males; 38 ±12 years old, 18±3 years of education) completed cognitive assessments, including the CR Index questionnaire (CRIq). Cognitive scores were z-scored and averaged into composite scores for memory, information processing speed, attention, and executive functions. Participants also underwent resting-state EEG to estimate global relative power (GRP) in the delta (1-4 Hz), theta (4-7 Hz), alpha1 (a1; 7.5-10), and alpha2 (a2; 10.5-13 Hz) bands. Compared to HC, PwMS performed worse in all cognitive domains, had lower CR levels ($p<0.001$), and showed reduced a2 GRP ($p<0.05$). CRIq in PwMS was correlated with memory ($\beta=0.404$, $p=0.026$), influenced by education ($\beta=0.374$, $p=0.003$) and leisure activities ($\beta=0.27$, $p=0.047$), and with a2 GRP ($\beta=0.435$, $p=0.025$), driven by leisure activities ($\beta=0.295$, $p=0.046$). Mediation analysis using the SPSS PROCESS MACRO model 4, showed no direct relationship between a2 GRP and memory ($c' = -0.19$, $p=0.783$), but with CRIq as a mediator, a2 GRP significantly affected memory (ab=0.702, 95%, C.I.: 0.113, 1.525). These findings suggest that CR plays a protective role against MS-related brain changes, with higher CR levels linked to better memory performance. The association between CR and a2 GRP indicates that PwMS with higher CR utilize more efficient neural resources, reflected in sustained memory performance and more efficient brain function.

Online

#2 - P3-LIKE AND BETA-BAND RESPONSES TO TEMPO PROCESSING

• **Bayram, B ①, Pellegrini, V ①, Meijer, D ②, Spierings, M ③, ④, Baumgartner, R ②, Pomper, U ① |** *① Department of Cognition, Emotion, and Methods in Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria, ② Austrian Academy of Sciences, Acoustics Research Institute, Vienna, Austria ③ Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria ④ Department of Behavioral Biology, Leiden University, Leiden, Netherlands*

Predicting the timing of external stimuli is a key function in sensory processing. Sudden changes in the environment often render prior information invalid. In such cases, observers should update beliefs and establish new priors using current sensory evidence. Our current EEG experiment investigates the behavioral and neural patterns associated with auditory temporal discrimination in a noisy and dynamically changing environment. Participants listened to a sequence of sounds with varying stimulus onset asynchronies, in which each sound had a 1/5 chance of being a change point at which the temporal pattern changed from acceleration to deceleration or vice versa. At the end of each sequence, they indicated whether the final sound was part of an accelerating or decelerating pattern. As a different number of sounds was presented in each trial, participants were expected to constantly update their temporal estimations. Behavioral data from 26 participants revealed higher accuracy in detecting decelerations compared to accelerations, with improved performance as more sounds in the same tempo pattern were presented. EEG analysis showed distinct neural responses associated with tempo processing: a prominent ERP difference in the range of P2 and P3 components was observed during tempo shifts, with larger amplitudes for acceleration versus deceleration conditions. Additionally, beta-band (13-30 Hz) activity exhibited greater suppression during decelerations compared to accelerations. These findings suggest that both ERP and oscillatory responses play critical roles in updating temporal predictions in dynamically changing auditory environments.

Online

#3 - NEURAL PHASE SYNCHRONIZATION TO FAMILIAR AND UNFAMILIAR ACCENTS: INVESTIGATING THE ROLE OF ACCENT IN SPEECH PROCESSING

• **Czepiel, A.M. ①, Bradley, H. ②, Vanden Bosch der Nederlanden, C.M. ①, Johnson, E.K. ② |** *① Language, Attention, Music and Audition Lab, University of Toronto at Mississauga, Canada ② Child Language and Speech Studies Lab, University of Toronto at Mississauga, Canada*

The brain is constantly trying to make sense of incoming auditory information, such as speech. One way the brain might do this is by aligning oscillations (phase synchronising or neural tracking) to important moments in the stimulus. Importantly, neural tracking of speech at different frequencies parses different aspects like phonemes, words, and phrases. While stronger neural tracking is thought to be higher with better speech comprehension, more recent evidence suggests it is stronger when speech is less intelligible. Based on previous research showing speech is more difficult to process when heard in an unfamiliar than familiar accent, the current preregistered study tested if neural tracking of speech is higher when speech is easier (familiar accent) or harder (unfamiliar accent) to process. English-speaking adults (n=34) from the Greater Toronto Area (Canada) heard English sentences in a familiar (Canadian) and

unfamiliar (Mandarin) accents. Neural activity was continuously recorded with a 32-channel BrainVision system. EEG (preprocessed offline with EEGLAB and Fieldtrip) and amplitude envelope was transformed into the frequency domain. Coherence was extracted from the cross-spectral densities between EEG and envelope for each accent condition across frequencies up to 40 Hz. We found a significant familiar/unfamiliar accent difference in gamma (30-40 Hz) and upper mu (10-12 Hz) bands, with stronger coherence in the familiar than unfamiliar accent. As the gamma band is associated with phoneme-level process, this increased coherence likely reflects more efficient phoneme processing to more easily recognise and segment speech into meaningful units. As high mu is linked to sensorimotor processes, like speech perception & production, stronger coherence here suggests that familiarity enhances sensorimotor during speech comprehension. Our results suggest that neural tracking reflects speech processing ease, though at a frequency-specific level.

Online

#4 - RESILIENCE AND VULNERABILITY OF NEURAL SPEECH TRACKING AFTER HEARING RESTORATION

• **Federici, A ①, Fantoni, M ①, Pavani, F (2, 3), Handjaras, G ①, Bednaya, E ①, Martinelli, A (1, 4), Berto, M ①, Trabalzini, F ⑤, Ricciardi, E ①, Nava, E ⑥, Orzan, E ⑦, Bianchi, B ⑤ and Bottari, D ① |** *1. MoMiLab, IMT School for Advanced Studies Lucca, Italy; 2. Centro Interdipartimentale Mente/Cervello – CIMEC, University of Trento, Italy; 3. Centro Interuniversitario di Ricerca "Cognizione Linguaggio e Sordità" – CIRCLeS; University of Trento, Italy; 4. IRCCS Fondazione Stella Maris, Pisa, Italy; 5. IRCCS Meyer, Azienda Ospedaliero-Universitaria Meyer, Firenze, Italy; 6. University of Milano-Bicocca, Milano, Italy; 7. IRCCS Materno Infantile Burlo Garofolo, Trieste, Italy.*

Infants are born with biological biases that favour language acquisition. One is the auditory system's ability to track the envelope of continuous speech. However, the extent to which neural speech tracking relies on auditory experience remains unclear. We measured neural speech tracking in children with or without access to functional hearing in the first year of life after they received cochlear implants (CIs) for hearing restoration, as well as in hearing-controls (HC). Neural speech tracking in children with CIs was unaffected by the absence of perinatal auditory experience. Regardless of deafness onset, CI users and HC exhibited a similar neural tracking magnitude at short timescales ~50–130ms of brain activity. However, this neural tracking phase was delayed in CI users, and its timing depended on the age of hearing restoration. Conversely, at longer timescales (~130–260ms), speech tracking was substantially dampened in CI participants, thereby accounting for their speech comprehension deficits. Speech tracking in HC listening to vocoded-speech suggested that differences between HC and CI children could not merely be explained by the degraded acoustic stimulation. These findings highlight the resilience of sensory components and the vulnerability of higher levels of speech processing to the lack of perinatal auditory experience.

Online

#5 - HYPERSCANNING PSYCHOTHERAPY

• **Hinrichs, N ① |** ① *Research Group Cognition and Plasticity, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany*

A protocol to study mental health intervention using dual-electroencephalography (EEG), audio-visual recordings, and behavioural and lexical analysis, dubbed HyPsy, is presented; its purpose is to yield biomarkers of intersubjective alliance, hallmark predictor of success in psychotherapeutic outcome. Preparatory steps for data collection are described, such as setup preparation, experiment design, and piloting. The theoretical context within which the protocol emerges is summarised, as are the kinds of research questions that it intends to address.

Online + On site

#6 - EXPLORING THE LANGUAGE NETWORK: NEURAL OSCILLATIONS AT THE SINGLE-TRIAL LEVEL

• **Huybrechts, M ①, Pongos, A (2, 3), Shain, C ②, Lipkin, B ②, Siegelman, M (2, 4), Wens, V ⑤, Sjøgård, M ⑤, Pantazis, D ②, Blank, I (2, 6), Goldman, S ⑤, De Tiège, X ⑤, Bruffaerts, R (1, 2) |** ① *Experimental Neurobiology Unit, University of Antwerp, Antwerp, Belgium;* ② *Brain and Cognitive Sciences Department, Massachusetts Institute of Technology, Cambridge, USA;* ③ *Department of Bioengineering, UC Berkeley-UCSF, Berkeley, USA;* ④ *Department of Psychology, Columbia University, New York, USA;* ⑤ *ULB Neuroscience Institute, Universite libre de Bruxelles, Brussels, Belgium;* ⑥ *Department of Psychology, University of California Los Angeles, Los Angeles, USA*

Frequency band activity levels may offer insight into the different neurobiological processes supporting real-time language comprehension. For instance, higher frequency bands such as gamma oscillations have been linked to the prediction of upcoming words during sentence reading, while lower frequency bands may be involved in word retrieval and the integration of meaning across the sentence. Such effects have mostly been studied by group analysis of separate frequency bands across multiple participants. Given the growing body of evidence documenting interindividual differences in the functional neuroanatomy of the language network, we here investigated the stability of single sentence analysis using magnetoencephalography. Forty-two participants (half tested in English, half in Dutch) performed a well-known sentence reading paradigm. The single trial analysis robustly demonstrates that the theta, alpha and beta band contribute to similar processing aspects of sentence reading. In addition, it opens the door for future work that relates the content of singular trials to their frequency band activation levels.

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#7 - HOW IS THE READINESS POTENTIAL IMPACTED BY PERIPERSONAL SPACE, REPORT INSTRUCTION AND ACTION OUTCOME?

• **Gaiqing Kong ①, Bastien Barlerin ①, Luke Miller ③, Clément Desoche (1, 2), Romeo Salemme (1, 2), Francesco Pavani ④, Marine Vernet ①, Alessandro Farnè (1, 2)** | ① *Impact team of the Lyon Neuroscience Research Centre INSERM U1028 CNRS UMR5292, Lyon, France ② Neuro-Immersion, Lyon Neuroscience Research Centre (CRNL), INSERM 1028 - CNRS UMR5292, University Claude Bernard Lyon 1, Lyon, France ③ Donders Institute for Brain, Cognition and Behaviour; Radboud University; Nijmegen, the Netherlands ④ Center for Mind/Brain Sciences - CIMeC, University of Trento, Trento, Italy*

This study investigates the effects of peripersonal space, attentional focus, and anticipated action outcomes on the Readiness Potential (RP) during voluntary movements, through a virtual reality adaptation of the Libet clock paradigm, recording EEG and EMG data. Our findings indicate that spatial proximity tended to, increase the RP amplitudes and the likelihood of earlier-initiated and longer-lasting movements in conditions without reporting requirements or in decision-reporting conditions lacking action consequences. Furthermore, when the Libet clock is near, actions are perceived as occurring earlier relative to the actual action timing, suggesting a spatial influence on the temporal perception of action execution. Importantly, regardless of spatial positioning, an attentional focus on early timing (i.e., on the decision, in the absence of subsequent action outcomes) showed an increased early RP and a decreased late RP slope, indicating a more pronounced preparatory neural state when focusing on intention timing. The results also verifies that temporal estimations of action-decision and action execution are modulated by the presence of action outcomes, demonstrating temporal binding effects with an increased late RP slope. Our study provides a unique addition to the body of RP research, underscoring a multifaceted interaction among spatial, cognitive, and sensorimotor elements. The findings suggest that the RP is not a mere neural precursor of movement preparation, but also sensitive and adaptive to external spatial environmental factors and internal higher cognitive processes which could shape the neural dynamics preceding voluntary movements.

Online

#8 - THETA-GAMMA INTERACTIONS IN THE HUMAN AUDITORY CORTEX ARE DRIVEN BY THE ACOUSTIC INPUT, BUT THEY ARE A MECHANISM FOR SPEECH PERCEPTION

• **López-Madrona, VJ (1,2), Giroud, J ③, Mercier, M ①, Trébuchon, A (1,4) Morillon, B ①** | ① *Aix-Marseille Université, INSERM, INS, Institut de Neurosciences des Systèmes, Marseille, France ② Institute of Language, Communication, and the Brain, Aix-Marseille Univ, Marseille, France ③ MRC Cognition and Brain Sciences Unit, University of Cambridge, UK ④ APHM, Timone Hospital, Epileptology and Cerebral Rhythmology Department, Marseille, France*

Theta and gamma oscillatory dynamics emerge in the auditory cortex during speech perception, with the phase of the former coupled to the amplitude of the latter. However, it is unclear whether this coupling is exogenous, echoing the properties of the

stimulus, or an endogenous property linked to high-level speech processing. Moreover, the mechanisms underlying the coupling between theta and gamma activity remain unknown. Here, we acquired intracerebral electrophysiological recordings from the auditory cortex of epilepsy patients while they were passively listening to natural speech. By combining independent component and Granger Causality analyses, we measured the interaction between the speech signal and different cortical auditory sources characterized by their modal frequencies. Our results show that: (i) The envelope of the speech signal linearly drives different theta (2-6 Hz), low-gamma (30-50 Hz) and high-gamma (100-150 Hz) sources in the auditory cortex, approximating the syllabic rate, phonetic features and the speaker's fundamental frequency; (ii) the coupling between theta and gamma rhythms is already present in the stimulus, and consistent across 17 languages; (iii) in the auditory cortex, the amplitude of gamma activity modulates the phase of the theta rhythm, likely aligning it with the acoustic input. Our findings are consistent with the multiplexed view of sensory processing in the auditory cortex, with different processes for theta and gamma oscillations, but challenge the vision of phase-amplitude coupling as an endogenous neural mechanism for speech comprehension.

Online

#9 - SPONTANEOUS MODULATION OF ALPHA POWER DURING A PSEUDO-NEUROFEEDBACK SESSION

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Electroencephalographic neurofeedback (EEG-NF) typically targets spectral changes within specific frequency bands, often attributed to an active self-regulation mechanism. However, recent findings suggest that these changes may partly result from uncontrolled factors, intrinsic to EEG-NF protocols such as spontaneous increases in alpha power over time and processing of visual information that elicits an increase in theta power. In this study, we aim to replicate these findings using a pseudo-EEG-NF task, in which participants received real-time alpha power feedback without being aware of it, as they were not given explicit instructions to modulate their brain activity. Over multiple trials, healthy young adults observed a grey circle that either remained constant (control condition) or continuously changed in size based on their alpha power at Pz. We investigated whether standard EEG frequency bands: (i) change spontaneously over time, and (ii) are influenced by the perception of a continuously modified visual stimulus used as feedback. The results showed that without explicit neurofeedback instructions, the alpha power spontaneously increased over time in EEG-NF settings. In contrast, the increase in theta power supposed to be associated with visual information processing was not replicated, suggesting that the real-time alpha-based modification of the visual stimulus differs from a random continuous visual modification. These findings highlight the importance of considering non-specific sources of effect when designing EEG-NF protocols.

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#10 - MEG OSCILLATORY MECHANISMS OF ANTICIPATORY MOTOR INHIBITION IN BIMANUAL LOAD LIFTING

• **V. Manyukhina ①, F. Di Rienzo (1,2), F. Barlaam ①, S. Daligault ③, C. Delpuech (1,3), M. Bonnefond ①, C. Schmitz ① |** *① Lyon Neuroscience Research Center (CRNL), Computation, Cognition and Neurophysiology Team (Cophy), INSERM UMRS 1028, CNRS UMR 5292, Université de Lyon, Université Claude Bernard Lyon 1, Lyon, France; ② Laboratoire Interuniversitaire de Biologie de la Motricité, Université de Lyon, Université Claude Bernard Lyon 1, Lyon, France; ③ Département Magnétoencéphalographie, CERMEP Imagerie du Vivant, Bron, France*

In motor networks, inhibition can be triggered by bursts of beta activity (13–30 Hz). Additionally, evidence suggests that sensorimotor alpha oscillations (8–12 Hz) may also play a role in inhibiting habitual motor actions. In this study, we aimed to determine whether alpha or beta activity underlie efficient anticipatory inhibition as reflected by a decrease in electromyography (EMG) activity. To test this, we recorded magnetoencephalography (MEG) in 16 adult participants during a Bimanual Load Lifting Task (BLLT), in which participants were instructed to lift aload voluntarily. We found that the most effective postural stabilization was associated with EMG inhibition occurring about 30 ms before the actual unloading. We observed a significant correlation between EMG inhibition and high gamma power (90–130 Hz), which reflects global excitability, in pre-SMA (not in M1), i.e. the lower the gamma activity the stronger the inhibition. This pre-SMA activity began earlier and overlapped with the inhibition period (from 60 to 18 ms before unloading). In the same pre-SMA region, more efficient inhibition was associated with higher beta power (~24–25 Hz) range, but not higher alpha, which overlapped with the gamma effect in time. This 24–25 Hz beta power negatively correlated with high gamma power. We conducted a mediation analysis to test whether inhibitory beta signal might drive inhibition in the Biceps Brachii by reducing pre-SMA excitability (gamma power, mediator). The model revealed a significant, though partial, mediation effect. Additionally, contrasting trials with bursts of high beta activity with trials of low beta power around the time of inhibition revealed a decrease in EMG activity (i.e. inhibition) around the 30 ms before the unloading.

Online

#11 - ELECTROPHYSIOLOGY OF LEARNING IN A SERIAL FEAR CONDITIONING PARADIGM

• **Pavlov, YG ① |** *① University of Tuebingen, Tuebingen, Germany*

In a serial compound conditioning paradigm, a sequence of several conditioned stimuli (CS) is predictive of an unconditioned stimulus (US) (e.g., CSA⟶CSB⟶US). Animal research has shown that when the US is aversive, CSA elicits the strongest conditioned response, while CSB appears redundant. These effects of primacy and proximity are rarely investigated in humans, and neurophysiological data underlying learning under such conditions are lacking. To study the effects of temporal proximity of imminent threat and safety, we analyzed brain event-related potential responses in an aversive serial compound conditioning experimental paradigm. In two EEG experiments (discovery sample: N = 22; replication sample: N = 38), participants were presented with sequences

of four vowels [CSA→CSB→CSC→CSD]. The first vowel in the sequence differed between CSA+ and CSA- (e.g., [ah] or [uh]), while the remaining three (CSB, CSC, CSD) were identical (e.g., [oh]). CSD+ was followed by a painful electrical shock (US), while CSD- was not. No ERP component distinguished between CS- and CS+ for the first three stimuli in the sequence (i.e., CSA, CSB, CSC). The last CS (CSD+) elicited a strong fronto-central stimulus-preceding negativity (SPN) developing 400 ms before shock administration. Our data indicate that the main neural mechanism for responding to predictable threat is related to the flight response, as manifested in the SPN immediately preceding US.

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#12 - EXPLORING BEHAVIORAL AND ERP INDICATORS OF PHONOLOGICAL AWARENESS IN SHALLOW ORTHOGRAPHY

• **Stekić, K. ①, Šoškić, A. ②, Ranđić, Lj. ③, Lazarević, E. ④, Tenjović, L. ①, Jovanović, V. ① & Ković, V. ① |** *① Laboratory for Neurocognition and Applied Cognition, Faculty of Philosophy, University of Belgrade, Serbia, ② Faculty of Education, University of Belgrade, Serbia, ③ Algo Centar, Belgrade, Serbia, ④ Institute for Educational Research, Belgrade, Serbia*

This study focuses on exploring phonological awareness by behaviorally examining phonemic analysis and synthesis in pre-reading children, as well as exploring long-term ERP indicators upon an early reading intervention in a shallow orthography (Serbian) to determine the dynamics of its development. Behavior results show significant age differences in phonemic awareness among pre-reading children (N=250, aged 3.5-6.5 years, 48% girls). Success rates varied significantly between age groups, with the most substantial differences observed between the oldest (5.5-6.5) and youngest (3.5-4.5) groups. The developmental shift in phonemic awareness is task dependent, varying between 53 and 78 months of age. Age-specific variations were also observed, suggesting that phonemic awareness is a continuous, rather than a discrete ability.

ERP indicators of phonological awareness (MMN and N1) were examined in children that underwent an early reading intervention 5 years earlier, in their preschool years (N=13, aged 9.5-10.6 years, 38% girls) and compared to a control group (N=9, aged 9.6-10.6 years, 30% girls). In this context, MMN represents phonological sensitivity while N1 is considered a measure of print sensitivity. ERPs were recorded using a mobile 24-channel semi-dry mBrainTrain Mobi system. For MMN measurements, an auditory oddball experiment was designed in Presentation software to play /ba/ and /da/ sounds in a 90-10 ratio. Participants watched a silent cartoon while listening to the stimuli. For the N1 experiment, a modality judgement task was used with real words and false fonts which were presented visually, auditory, or both at the same time. The N1 and late MMN effects were analysed in the 100-300ms and 300-500ms time windows, respectively. Preliminary results of the longitudinal neurocognitive effects of an early reading intervention in shallow orthography are presented and discussed.

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#13 - FUNCTIONAL STATE OF THE PREFRONTAL CORTEX SHAPES THE RESPONSE TO PAINFUL LASER STIMULATION

• **Sulcova, D (1,2), Baumgärtner, U ①** | ① *Institute of Cognitive and Affective Neuroscience (ICAN), Medical School Hamburg (MSH), Hamburg, Germany;* ② *Institute of Neuroscience (IoNS), UCLouvain, Brussels, Belgium*

Pain evoked by the activation of the nociceptive system can be regulated via descending pain modulatory pathways. Since the prefrontal cortex (PFC) plays a key role in this process, its momentary state likely influences the response to painful stimuli. The level of cortical activation and functional integration is governed by the excitation (E) and inhibition (I) ratio. In humans, the E/I ratio can be estimated from the power spectrum density (PSD) of an electroencephalogram (EEG), particularly from the slope of its aperiodic component defined by the power-law exponent x. This study aimed to determine whether the E/I in the PFC, approximated by x, could predict cortical activity (laser-evoked potentials, LEP) and pain intensity in response to laser stimuli.

30 healthy young volunteers received 60 painful laser stimuli to the hand dorsum (15 on dominant hand), pain intensity ratings were taken after each stimulus using a visual analogue scale. EEG was recorded with a 63 active electrode system. At single-trial level, x was extracted from the pre-stimulus EEG, and the amplitude and latencies of three LEP components were estimated using multiple linear regression. Data were analysed in sensor space, focusing on 7 frontocentral electrodes mainly reflecting PFC activity (target). The signal from 7 posterior electrodes was included as control. The results were corroborated by source-space analysis.

Preliminary findings indicate that a steeper slope of the aperiodic PSD component over the PFC is selectively associated with higher pain intensity. As a larger x suggests a shift of E/I towards inhibition, these findings imply that decreased PFC excitability leads to increased pain, possibly due to reduced descending pain inhibition. Additionally, steeper slopes were associated with slower LEPs, regardless of topographic area. This supports the notion that steeper slopes correspond to lower E/I and indicates that LEPs reflect neural activity across distributed brain areas.

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#14 - COULD SPONTANEOUS BRAIN RHYTHMS HELP TO UNDERSTAND SPEECH?

• **Rosanne Timmerman[1], Tanja Atanasova[1], Joachim Gross[2], Anne Keitel[1]** | ① *University of Dundee, Scotland;* ② *University of Muenster, Germany*

Imagine being at a concert while having a conversation with a friend; some people would be able to maintain a conversation without too much effort, while others would struggle to understand what is being said. In challenging situations like these, people differ greatly in their ability to understand speech.

Previous literature has shown that spontaneous brain rhythms are involved in a range of speech related processes. We aim to find out what spontaneous brain rhythms are involved during speech comprehension. We hypothesize that understanding speech in noise is associated with the individual power of theta (4-8Hz) in the primary auditory cortex

during rest, whereas rapid speech comprehension is associated with the individual peak frequency of theta.
In the current population study, we are aiming to recruit 500 participants from different backgrounds, aged between 16 and 75. So far, 236 participants have taken part and data collection is still ongoing.
Using EEG, we recorded people's brain activity in rest for 10 minutes. This was followed by three speech comprehension tasks where participants listened to rapid, interrupted and noisy sentences. Participants were required to repeat what they understood from each sentence.
This study is built on a MEG pilot study (N=22), where Keitel & Gross (2016) found that the power of theta oscillations in the auditory cortex during rest is associated with better speech in noise comprehension. In the current EEG study, we aim to explore the relationship between individual brain rhythms (their power or peak frequency) and the three speech comprehension conditions.
Knowing which spontaneous brain rhythms are involved in understanding speech, we could potentially manipulate these brain rhythms in individuals that are struggling with speech comprehension. A next step would be to try and influence the brain rhythms involved, using repetitive transcranial magnetic stimulation (rTMS).

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#15 - STATISTICAL LEARNING IS NOT SUPPORTED BY REPRESENTATIONAL CHANGE OF BRAIN PATTERN ACTIVITY BUT PREDICTIVE ACTIVITY

• **Tirou, C ①, Vékony, T (1, 2), Rey, A (4, 5), Tossatto, L (4, 5), Brovelli, A ⑥, Németh, D (1, 2, 3†), Quentin, R (1†)** | ① *Lyon Neuroscience Research Center (CRNL), INSERM U1028, CNRS UMR5292, Université Claude Bernard Lyon 1, Lyon, France;* ② *Department of Education and Psychology, Faculty of Social Sciences, University of Atlántico Medio, Las Palmas de Gran Canaria, Spain;* ③ *BML-NAP Research Group, ELTE Eötvös Loránd University & HUN-REN Research Centre for Natural Sciences, Budapest, Hungary;* ④ *CNRS, LPC, Aix Marseille Univ, Marseille, France;* ⑤ *ILCB, Aix Marseille Univ, Aix-en-Provence, France;* ⑥ *Aix Marseille Univ, CNRS, INT, Institut de Neurosciences de la Timone, Marseille, France*

Extracting regularities from the environment is a fundamental process. This ability, known as statistical learning, is important in many daily life skills, from driving a car to conversing. Yet the neural underpinnings of such learning have not been clearly exposed yet. One candidate for explaining this learning is representational change, in which brain patterns of activity of associated stimuli converge towards each other during learning. Previous studies using fMRI identified representational changes, but they could not pinpoint the fine temporal dynamics of such changes. In this study, participants (n=11) learned a sequence containing both regularities and noise while their neural activity was measured with magneto-encephalography (MEG). Using multivariate pattern analyses (MVPA), our results revealed that elements that are temporally paired (i.e., statistically related in the 2nd order) do not exhibit increasingly similar neural activity patterns. Another potential explanation of statistical learning is predictive coding, where neural computations are facilitated by expectations of upcoming stimuli, achieved through top-down modulation or pre-activation of neural circuits. Our results suggest a pre-activation of the upcoming stimulus in paired elements at the brain level. Our next step involves source reconstruction to identify the specific brain regions involved in this predictive coding process.

Online

#16 - MEG-BASED TONOTOPIC MAPPING OF THE HUMAN AUDITORY CORTEX

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Tonotopic organization refers to the systematic arrangement of neurons in auditory brain regions based on their frequency selectivity, a characteristic observed from the cochlea to the auditory cortex. Functional magnetic resonance imaging (fMRI) has consistently demonstrated tonotopic maps in the human auditory cortex, particularly around Heschl's gyrus (HG), with characteristic high-low-high frequency gradient reversals. However, further investigation is required to clarify the precise orientation and lateralization of these maps. While fMRI offers excellent spatial resolution, certain aspects of rapid auditory processing require higher temporal precision. Magnetoencephalography (MEG) provides this temporal advantage but has poorer spatial resolution. This trade-off necessitates optimized stimulus designs to resolve tonotopically specialized populations of neurons.

Falet et al. (2021) recently demonstrated tonotopic mapping in the human auditory cortex with MEG, using high-density pure tone bursts. The current project seeks to replicate their findings, and compare the tonotopic mapping with the results from a frequency sweep paradigm, which demonstrated slightly higher sensitivity to frequency tuning compared to narrowband sequences in previous fMRI studies. Here, we present preliminary results comparing tonotopic maps generated by both paradigms (one exemplary participant). The overall aim is to refine MEG-based tonotopic mapping techniques and assess their broader applicability in auditory neuroscience.

Online

#17 - PHASE-DEPENDENT REPRESENTATIONAL SEPARATION AND BINDING OF WORKING MEMORY CONTENT

• **Yao, J (1, 2), ten Oever, S ③, Westner, BU (4, 5), Bruera, A ①, Knösche, TR ②, Hartwigsen, G ① |** ① *Research Group Cognition and Plasticity, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany;* ② *Methods & Development Group Brain Networks, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany;* ③ *Department of Cognitive Neuroscience; Faculty of Psychology; Maastricht University, The Netherlands;* ④ *Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, The Netherlands;* ⑤ *Department of Cognitive Neuroscience, Donders Institute for Brain, Cognition and Behaviour, Radboud University Medical Center, Nijmegen, The Netherlands;*

Successful maintenance of multiple items in working memory has been linked to oscillatory mechanisms in low-frequency ranges. Previous research indicates that sensory working memory content can be encoded at specific phases of these oscillatory signals. However, generalizing this finding to higher cognitive functions remains challenging. This study investigates whether higher-level cognitive content, such as the semantic representation of words, can be encoded in a phase-dependent manner durng working memory maintenance. We also examine whether the binding of multiple semantic

representations influences the phase coding of individual items. We conduct an EEG study during a verbal working memory retention task where participants memorized semantically bindable or unbindable adjective-noun pairs. To enhance the read-out of neural activity specific to each working memory representation, a high-intensity auditory impulse stimulus is randomly presented during the maintenance period. We train a decoder to differentiate activity patterns between adjectives and nouns with the source-level neural activity from the encoding time window and test its performance on the impulse-response time window at the trial level. We hypothesize that for unbindable pairs, the semantic representation of each word would be maintained phase-separately in low-frequency signals during working memory, while the decoder should be able to distinguish between the two word categories if the impulse hits at the content-carrying phase and "boosts" either representation. While multiple words are composed, we expect the formation of compressed representation, suggesting that word composition and/or WM-storage involves a change of representational format that prevents the individual words from being linearly read out. As a result, the individual word representations lose phase-dependent decodability.

Online

#18 - OSCILLATORY DETERMINANTS OF GRAPHOMOTOR PERFORMANCE IN MONO- AND BISCRIPTUALS

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Handwriting is a complex motor skill that requires years of practice before full proficiency is reached. Current knowledge about the neural and cognitive correlates of handwriting is largely based on evidence collected from Latin script writers. However, a large number of literate adults master two writing systems: a phenomenon termed biscriptuality. We have recently evidenced that Latin-Arabic biscriptuals displayed a better graphomotor coordination performance than Latin monoscriptuals. Here, we aim to investigate the neurocognitive foundations of this biscriptual advantage. Participants completed a loop-tracing task on a digitizing tablet while kinematic data and EEG signals were synchronized. Behavioral analysis confirmed the biscriptual advantage, with higher tracing frequency and decreased loop variability in biscriptuals. We analyzed theta (4-7Hz), beta (13-30 Hz) and delta (0.5-4 Hz) oscillatory dynamics of the EEG signal to test whether this advantage is consequent to better sensorimotor control, or to more optimal executive control. Midfrontal theta dynamics are thought to mediate domain-general cognitive control functions, whereas delta and beta dynamics are associated with sensorimotor processes. Preliminary Power Spectrum Density (PSD) analysis using non-parametric tests showed that monoscriptuals displayed higher theta power in prefrontal regions around the tracing movement onset. We also observed significant differences between groups in beta oscillations dynamics in the parieto-occipital region throughout the entire duration of the movements. Overall, the integration of behavioral and EEG results provides valuable insights into the neural underpinnings of graphomotor control and its

variations according to expertise. It highlights the major role of executive processes in the emergence of the biscriptual advantage, and opens new perspectives on the contribution of parieto-occipital beta oscillations to the online control of handwriting.

Online + On site

#19 - NOVEL TOOLS FOR THE ANATOMICAL REGISTRATION OF INTRACRANIAL ELECTRODES

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Motivation

Intracranial electrodes are usually located using artifacts from post-implantation CT scans. However, current automatic algorithms struggle to accurately localize low signal-to-noise ratio artifacts and handle high-density electrode arrays. Furthermore, the implantation of grids and strips can cause brain deformations, which leads to registration errors when merging post-implantation CT images with pre-implantation MRI scans. While brain-shift compensation techniques aim to project electrode coordinates onto the cortex, they often fail to provide smooth solutions or do not adequately account for brain deformations.

New methods

First, we present GridFit, a model-based fitting technique designed to accurately identify and localize simultaneously all the CT artifacts associated with electrodes within grids, strips, or depth arrays. Next, we introduce CEPA, a brain-shift compensation algorithm that effectively integrates orthogonal-based projections, spring-mesh models, and spatial regularization constraints to correct brain shifts.

Results

GridFit demonstrated remarkable performance in localizing CT artifacts, achieving <1 mm errors in ~6,000 simulated challenging scenarios, including noise, overlaps, and high-density implants. Validation using challenging data from 20 patients showed 99% accuracy in electrode localization. I.e., GridFit succeeded in difficult scenarios that challenged available methods.

We tested CEPA brain-shift compensation with data from 15 patients. Projections accounted for simple mechanical deformation principles with <0.4 mm errors, smaller than those reported for well-established alternatives. Additionally, modeling resting-state high-frequency activity further supported CEPA.

Conclusion

GridFit and CEPA are practical tools for

registering intracranial electrode coordinates, achieving high accuracy even in challenging implantation scenarios. These methods are included in the iElectrodes open-source toolbox.

Online

#20 - A GENERAL (CLUSTER-) PERMUTATION TEST FOR MASS-UNIVARIATE LINEAR MIXED MODELS (LMMS)

• **Benedikt V. Ehinger (1,2), Phillip Alday ③, Jaromil Frossard ④, Olivier Renaud ④ |** ① *University of Stuttgart, Stuttgart Center for Simulation Science;* ② *University of Stuttgart, Institute for Visualization and Interactive Systems;* ③ *Beacon Biosignals Inc., Boston, MA, US;* ④ *Université de Genève, Faculté de Psychologie,*

Linear mixed models (LMMs) are versatile and increasingly popular in cognitive psychology to analyze behavioural datasets with both within-subject and within-item effects. Some brave researchers have already applied these hierarchical models to EEG data, typically on averaged space/time regions of interest. When trying to combine LMMs with the mass-univariate approach, that is, fitting one LMM per time-point and channel, some practical, and several conceptual issues arrise. The main issue we successfully adress in our work here is, that in order to use cluster-correction to adjust for the multiple-comparison problem, one typically needs a permutation test. The only prior proposed permutation test for fixed effects in LMMs is limited to the simplistic case of no within-subject and no within-item effects, making it applicable only to a very small subset of EEG studies. To compensate, we developed a new general permutation test for fixed effects in LMMs and concurrently adress the issue of slow fitting by using MixedModels.jl in JuliaLang, with a speed-up of up to factor 100 compared to the state-of-the-art R/C++ LME4 package. I will present simulation studies on the new LMM-permutation test and show early results in regards to using it for mass-univariate cluster-permutation tests, modelling both subject and item effects.

Online + On site

#21 - WITHIN AND BETWEEN SESSION RELIABILITY OF DECODING OF VISUAL REPRESENTATIONS OF COLOR AND CATEGORY

• **Chen T. Frenkel & Leon Y. Deouell |** ① *Human Cognitive Neuroscience Lab, the department of psychology & Edmond and Lily Safra institute of brain science, the Hebrew University, Jerusalem, Israel*

The human visual system represents stimuli in a rich and detailed manner. Traditional methods of studying visual representations, such as event-related potentials (ERP) or mass-univariate fMRI, are not always sensitive to study visual representations of different stimuli at the single subject level. Time-resolved multivariate pattern classification analysis (MVPA), or Decoding, is able to efficiently extract the visual representations of stimuli from the EEG topography without a priori assumptions about the location of the effect in time and space at the single subject level. The rich information this method provides has increased its popularity dramatically in recent years, leading to many methodological studies comparing different algorithms and processing protocols. Less is

known about the reliability of these methods within participants. Critically, we know that different subjects show variable quality of decoding performance, but it is unclear if the accuracy of decoding is maintained within subjects across different tasks and attentional conditions, different hierarchical levels (e.g. whether accuracy in category decoding will predict similar levels of color decoding). In the current study subjects performed three visual tasks, over two separate sessions (1-7 days apart). We examined the correlation of a representational MVPA model accuracy: within the cross-validation set, between sessions, between features (color and category) and to different measurements of behavioral performance. We also examined how models generalized to different tasks and different attention conditions. We found that the visual representations reflected by decoding accuracy are robust within subjects. The correlation between decoding accuracies of different features and in different sessions were fairly high, as well as the generalizability of the model to different tasks, attentional conditions and sessions. However, behavior did not strongly correlate with decoding accuracy.

Online

#22 - ENHANCING MEMORY IN HUMANS VIA MEG-CLOSED-LOOP RHYTHMIC SENSORY STIMULATION (RSS) TUNED TO THE FREQUENCY OF HIPPOCAMPAL THETA OSCILLATIONS

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Hippocampal theta oscillations are essential for binding multisensory information into episodic memories. Recent studies suggest that 4-Hz audio-visual rhythmic sensory stimulation (RSS) can enhance episodic memory performance in humans. However, this "one-size-fits-all" approach neglects individual differences in brain rhythms, potentially accounting for variability in outcomes. To address this limitation, we developed a novel pipeline to estimate the individual hippocampal theta frequency during memory tasks and dynamically align stimulation parameters accordingly.

The pipeline consists of several key components: First, we extract hippocampal signals during MEG measurements using an LCMV beamformer. Next, theta activity is enhanced from the broadband signal using Generalized Eigen Decomposition (GED). Finally, the Cyclic Homogeneous Oscillation (CHO) detection method is applied to identify oscillation presence and determine its centre frequency.

We validated the combined use of GED and CHO on rodent LFP data, successfully replicating the well-established correlation between running speed and hippocampal theta frequency.

Subsequently, we tested the full pipeline on an offline MEG dataset involving 4-Hz RSS during an associative memory task. Our objective was to determine if the pipeline could accurately identify the entrainment effect induced by stimulation. Results showed that

the hippocampal frequency during stimulation was significantly closer to 4 Hz compared to pre- and post-stimulus time windows.

We are now validating the pipeline using a concurrent MEG-iEEG dataset from epilepsy patients to compare identified frequencies in MEG data with ground-truth frequencies from hippocampal signals recorded via iEEG, providing insights into the accuracy and reliability of our approach.

Online

#23 - THE ART OF BRAINWAVES: A SURVEY ON EVENT-RELATED POTENTIAL VISUALIZATION PRACTICES

• **Mikheev V ①, Skukies R (1, 2), Ehinger BV (1, 2)** | ① *Institute for Visualization and Interactive Systems, University of Stuttgart;* ② *Stuttgart Center for Simulation Science, University of Stuttgart*

Electroencephalography (EEG) and event-related potentials (ERPs) have been analyzed for more than 70 years. Yet, we know little about how practitioners visualize the results of their analyses. Here, we designed an online survey (n=213) targeting M/EEG practitioners from novice to expert level. Our primary goal is to better understand the visualization tools currently in use, the challenges researchers face, and their experiences and opinions on how best to display their brain data. Finally, we explored whether researchers are aware of more general visualization issues related to visualization of uncertainty and color maps. In this paper, we provide an overview of the most popular ERP visualization tools. Additionally, we found that the community does not have a unique nomenclature to refer to some plot types, and we propose a set of recommendations to name the most popular ERP plot types. Finally, we provide an analysis of practitioner feature preferences for software developers and conclude with further recommendations for ERP practitioners.

Online + On site

#24 - BREAK UNFOLD: CAVEATS AND BEST-PRACTICES OF OVERLAP CORRECTED REGRESSION ERP ANALYSIS

• **Skukies, R. (1, 2), Ehinger, B. (1, 2)** | ① *University of Stuttgart, Stuttgart, Germany* ② *SimTech, Stuttgart, Germany*

With the increasing use of toolboxes like Unfold and LIMO, the regression ERP framework is gaining more attention in cognitive research. With this promising method, researchers are able to gather deeper insights into brain activity by moving away from traditional, controlled lab settings and towards more complex, naturalistic experimental environments. However, much like classical ERP studies, using the regression ERP framework requires careful consideration of its suitability for a given experiment. Especially when the linear model is extended to correct for overlap between adjacent events via deconvolution, key challenges arise: the feasibility of including numerous covariates, the impact of non-random event sequences, or the (often) unclear applicability of deconvolution models. In fact, “How much jitter between events is needed for deconvolution?” is the most asked question we get from collaborators, as in extreme cases

where no jitter between event onsets is present, time-locked activity can be attributed to any event equally well, and the method fails. This is an issue as neither the ""allowed"" parameter space is known, nor a practical measure exists to evaluate this appropriateness.
In this project, we will focus on identifying the conditions under which deconvolution models are applicable to EEG data. Through extensive simulations using the UnfoldSim.jl toolbox, we aim to investigate potential challenges in modelling overlap in EEG analysis. Specifically, we will examine factors such as the impact of jitter, sequence randomness, number of covariates and the number of trials through systematically varying simulation parameters. By analysing these simulations and comparing the estimated results to their ground truth, we hope to gain insights into the impact these factor have. Additionally, we will assess whether and when the condition number of the design matrix can serve as an a priori indicator of the model's estimability.

Online + Onsite

#25 - YOU ARE ABOUT TO MOVE! DECODING MOTOR PREPARATION FROM MEG SIGNALS

• **Thiboud, R ①, Rassoulou, F ①, Schwartz, D ②, Vernet, M ① |** *(① Impact team CRNL (Inserm, CNRS, UCBL), Lyon, France; ② Cophy team CRNL (Inserm, CNRS, UCBL), Lyon, France*

Previous research on motor brain-computer interfaces (BCIs) has demonstrated the feasibility of decoding different movements. However, less attention has been given to decoding motor preparation (i.e., action vs. no action) to predict when a movement is about to occur. In this study, we wanted to assess how effectively motor preparation can be decoded.
Participants (n=18) are presented with a simple self-paced motor task where they can either press a button to change an image shown on screen or let the computer change the image. During the task we recorded brain activity using magnetoencephalography. The electrophysiological data were then filtered (0.1-30 Hz) and epoched around the changing of the image. For data visualization we add a preprocessing step to remove artifacts and bad epochs. On these cleaned data we were able to observe, before the initiation of the movements, motor preparation markers already described in the literature such as a Readiness Potential-like activity or the Event-Related Desynchronization.
We then tested several machine/deep learning models (logistic regression, SVM, random forest, XGBoost) and feature extraction methods (CSP, PCA) on the filtered and epoched data to determine the best approach for decoding motor preparation. Classifiers were applied in both the temporal and time-frequency domains, with our novel HYDRE classifier (Hybrid Domain Recurrent Ensemble) emerging as the best-performing method. This model integrated features extracted using PCA from time and time frequency domains, achieving an average decoding accuracy above chance levels up to 900ms before the action, with a maximum ROC score of 74±9%.
In future, this classifier will be integrated in a BCI able to trigger the consequence of an action shortly before the performance of the action itself. We will evaluate how much the sense of agency, which is the feeling of control we have over our actions and their consequences, will adapt to this novel situation.

Online + Onsite

#26 - BRAIN-FINGERPRINT CORRELATES OF THE EEG RESPONSE TO TRANSCRANIAL MAGNETIC STIMULATION

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Brain Fingerprinting (BF) is a neuroimaging analysis method that quantifies how a subject's features are reproducible over time and identifiable across subjects. A key metric from this approach is iDiff, which measures the idiosyncrasy of specific brain features. Subject-level idiosyncrasy may depend on structural and functional differences within the sample, but also on brain states induced by experimental protocols targeting specific cognitive domains, leading to Augmented Fingerprints (AFs). AFs have been shown to better predict behavioral outcomes related to the targeted cognitive domain compared to resting-state BFs. Nevertheless, AFs may also be obtained to capture the idiosyncrasies of generalizable, trait-like properties of discrete brain regions. We aimed to obtain such trait-like, local fingerprints by perturbing the left primary motor cortex of 12 healthy subjects with Transcranial Magnetic Stimulation (TMS) pulses while recording concurrent 64-channel electroencephalography (EEG). Each subject received 840 pulses divided into seven stimulation blocks serving as test-retest sessions. Compared to pre-TMS periods, EEG idiosyncrasy increased in post-TMS windows in both Time-Frequency Power and Inter-Trial Phase-Clustering (ITPC) time series. Additionally, fingerprint augmentation was stronger in the mu band for TF-Power and in the beta band for ITPC, and was more pronounced over channels below the TMS coil. These findings highlight the potential of TMS in obtaining AFs and their relation to differential neural mechanisms when derived from power or phase data. In turn, such AFs could be used to predict treatment response or aid in biomarker identification.

Online

#27 - TACTILE ENTRAINMENT REVEALS A DETAILED CATEGORIZATION OF DIGIT REPRESENTATION AND LATERALIZATION

• **Castellani, N (1,2), Federici, A ①, Fantoni, M ①, Ricciardi, E ①, Garbarini, F ② and Bottari, D ① |** *① Momilab, IMT school for advanced studies, Lucca, Italy ② ManibusLab, University of Turin, Turin, Italy*

Tactile interactions involve continuous processing of non-stationary inputs that change in location, duration, and intensity. Here, we aimed to demonstrate the possibility of objectively measuring how the somatosensory system synchronizes to continuous and unpredictable tactile stimulation. We computed a Temporal Response Function (TRF) at the individual level and investigated whether this measure of stimulus-brain synchronization could dissociate digit representation and digit lateralization, a pivotal feature of the somatosensory cortex.
Twenty-seven young adults (F=15) were passively stimulated with a random series of

continuous and gentle brushes on single fingers of each hand, which were covered from view. An encoding model measured the degree of synchronization between brain activity and these continuous series of tactile inputs.

A clear TRF emerged for each fingers even when accounting for auditory and visual confounds. Results highlighted a central and contralateral positive response (50-170ms) a central bilateral negativity (200-300ms) (pclusts<0.05). Our results highlighted that TRF topographies clearly dissociated neural synchronization for stimulations to left and right-hand thumbs and pinkies between 50 and 380 ms (pclusts<0.05). Strikingly, topographies of the tactile TRF were also sensitive to finger stimulations within each hand between 50 and 250 ms (pclusts<0.05).

Our results demonstrated for the first time the possibility of using EEG to measure the neural synchronization or neural tracking of an ecological, unpredictable, and continuous stimulation in the somatosensory domain. Crucially, this method distinguishes digit lateralization and representation, linking the activity of the somatosensory system with individualized, idiosyncratic stimulations of a specific finger.

Online

TOOLS

#28 - A HIGH-SPEED OLED MONITOR FOR TEMPORALLY PRECISE STIMULATION IN VISION, EYE-TRACKING, & EEG RESEARCH

• **Dimigen, O. ① & Stein, A. ① |** ① *Experimental Psychology, University of Groningen*

The recent introduction of organic light-emitting diode (OLED) monitors with refresh rates of 240 Hz or more opens new possibilities for their use as precise stimulation devices in time-critical visual experiments, including those with EEG. These affordable high-speed monitors, targeted at video gamers, promise several advantages over the cathode ray tube (CRT) and liquid crystal display (LCD) monitors commonly used in these fields. Unlike LCDs, OLED displays have self-emitting pixels that can show true black, resulting in superior contrast ratios, a broad color gamut, and good viewing angles. More importantly, the latest gaming OLEDs promise excellent timing properties with minimal input lags and rapid transition times. However, OLED technology also has potential drawbacks, notably Auto-Brightness Limiting (ABL) behavior, where the local luminance of a stimulus can change with the number of currently illuminated pixels. This study characterized a 240 Hz OLED monitor, the ASUS PG27AQDM, in terms of its timing properties, spatial uniformity, viewing angles, warm-up times, and ABL behavior. We also compared its responses to those of CRTs and LCDs. Results confirm the monitor's excellent temporal properties with CRT-like transition times (around 0.3 ms), wide viewing angles, and decent spatial uniformity. Additionally, we found that ABL could be prevented with appropriate settings. We illustrate the monitor's benefits in two time-critical EEG paradigms: Rapid "invisible" flicker stimulation and the gaze-contingent presentation of stimuli during eye movements. Our findings suggest that the newest gaming OLEDs are cost-effective stimulation devices for time-critical visual experiments that have several key advantages over both CRTs and LCDs.

Online + Onsite

#29 - MEEGSIM: A PYTHON PACKAGE FOR SIMULATING SPONTANEOUS M/EEG WITH GROUND TRUTH CONNECTIVITY PATTERNS

• **Kapralov, N (1, 2), Studenova, A (1, 3), Jamshidi Idaji, M (4, 5), Villringer, A ①, Nikulin, V ① |** *① Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany ② International Max Planck Research School NeuroCom, Leipzig, Germany ③ Max Planck School of Cognition, Leipzig, Germany ④ BIFOLD - Berlin Institute for the Foundations of Learning and Data, Berlin, Germany ⑤ Machine Learning Group, Technical University of Berlin, Berlin, Germany*

Simulated M/EEG data with known ground truth source activity allow researchers to benchmark different analysis methods and better understand the results obtained with real data. The existing toolboxes such as MNE-Python provide important forward modeling functionality for such simulations, but the waveforms of source activity have to be generated by the user from scratch. At the same time, the set of parameters that are relevant for simulations is often quite small. For example, for M/EEG connectivity, parameters of interest may include the frequency range and the signal-to-noise ratio (SNR) of oscillations as well as the phase lag and the strength of coupling. In that regard, it could be very convenient to manipulate these parameters directly without a necessity to separately construct the corresponding waveforms every time. To address this, we extracted a set of building blocks from the previous simulation studies by our group (Jamshidi Idaji et al., 2020, 2022) and combined them in an open-source Python package MEEGsim. We provide template waveforms of aperiodic (1/f) and periodic (narrowband oscillation) activity with options to adjust sensor-space SNR and set custom patterns of phase-phase coupling. By doing so, we hope to help the users focus on what they want to simulate instead of thinking about how to implement the simulation. While the main focus of the toolbox is currently on simulating connectivity, we plan to incorporate event-related dynamics (ERP, ERD/ERS) in the future.

Online + Onsite

#30 - EEG WHILE CYCLING WITH OR WITHOUT VR: AN EXPERIMENTAL SET-UP TO ASSESS OSCILLATORY ACTIVITY

• **Kexel, A.M. ①, Widemann Y ①, Tiihonen M ①, Schnitzler A ①, Dalal S ②, Butz M ① |** *①Institute of Clinical Neuroscience and Medical Psychology, Medical Faculty, Heinrich Heine University Düsseldorf, Düsseldorf, Germany; ② Center of Functionally Integrative Neuroscience, Department of Clinical Medicine, Aarhus University, Aarhus, Denmark;*

Many patients in late stages of Parkinson's Disease (PD) experience Freezing of Gait (FoG), which manifests as a sudden inability to initiate walking. In contrast, the ability to bicycle remains seemingly unreserved in the very same patients. Earlier EEG work of our group demonstrated that FoG is related to an abnormal synchrony of oscillatory activity in the beta-frequency range (Storzer et al., 2017). Yet, the exact pathophysiological mechanisms of FoG remain vague, partly due to the challenges of designing studies that balance experimental control with realistic, ecologically valid conditions.

One way to surpass these challenges is using Virtual Reality (VR). We created a VR paradigm, based on an earlier experimental set-up (Gratkowski et al. 2017), with various triggers

inducing FoG. After establishing this set-up with piloting and behavioural analysis, 40 healthy participants were recruited and separated in two groups, a VR-group and a control group. The VR-group navigated a VR-course on a stationary bike consisting of turns, traffic lights, and constrictions as FoG triggers. The control-group was given auditory triggers while bicycling. EEG and electromyogramm measurements were recorded throughout the entire experiment. Data was analysed using the Fieldtrip toolbox (Oostenveld et al. 2011).
This experimental set-up enabled us to analyse the effect of VR on cortical activity and evaluate the feasibility of measuring cortical activity while cycling in VR.The initital piloting of our set-up revealed that cyber sickness due to VR stimulation is a significant limitation to study EEG activity during VR stimulation. Nevertheless, our study has proven the feasability of recording cortical activity while cycling in a VR-scenario and that a modulation of oscillatory activity similar to non-VR recordings can be observed. This knowledge can be used for further analyses of movement and movement disorders such as PD or as a base for VR-neurorehabilitation in the future.

Online + Onsite

DATA SET

#31 - A CO-REGISTERED EEG AND EYE-TRACKING UNRESTRICTED VIEWING DATA SET ON NATURAL IMAGES

• **Schepers, J ①, Marathe, M ①, Barman, M ①, Ehinger, BV (1, 2)** | ① *Institute for Visualisation and Interactive Systems, University of Stuttgart, Stuttgart, Germany;* ② *Stuttgart Center for Simulation Science, University of Stuttgart, Suttgart, Germany*

Eye movements play a crucial role in human visual perception, as humans move their eyes approximately two or three times per second to explore their environment. However, many traditional EEG experiments instruct participants to avoid eye movements because they introduce physiological artefacts and lead to analysis issues due to the temporal overlap of the different signals. However, advances in EEG analysis tool development make it feasible to analyse such data sets, offering the possibility to study, for instance, the consequences and precursors of eye movements, the processing of natural images, or the analytical tools themselves. Nevertheless, recording co-registered EEG and eye-tracking data is challenging due to the necessity of simultaneous recording and subsequent synchronization of the two data streams. Consequently, there are only very few openly available data sets that combine EEG and eye-tracking, especially with an unrestricted viewing task. To fill this gap, we plan to record a co-registered EEG and eye-tracking data set for studying eye movement effects during unrestricted viewing, for example, the influence of specific eye movement properties, e.g. saccade amplitude or angle on fixation-related potentials. For the stimulus material, we selected a subset of the "Shared 1000 images" from the Natural Scenes Dataset (NSD, Allen et al., 2022) which originate from the MS-COCO data set (Lin et al., 2015). For these images, corresponding fMRI data is available (via NSD) along with image categories and segmentation masks (via MS-COCO). We plan to collect data from 40 adults with normal or corrected-to-normal vision, allowing unrestricted viewing on 400 images shown for 5s each. During the experiment, we will record co-registered 128-channel EEG data and eye-tracking data (Eyelink1000+). To promote Open Science and ensure the data is accessible to other researchers, the data set will be provided in BIDS format, containing both raw and preprocessed data.

Online + Onsite

DEVELOPMENTAL

#32 - INFANT SPEECH PROCESSING AND ACCENT FAMILIARITY: PRELIMINARY RESULTS FROM A NEURAL TRACKING STUDY

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Young children, particularly those at familial risk for dyslexia, struggle with accented speech, highlighting the challenge that speech variability poses to early language processing. Infants' neural activity can phase synchronize with the amplitude envelope of speech through neural tracking. Research shows infants can track speech like adults, which may relate to future linguistic outcomes. While infants track infant-directed speech (IDS) more than adult-directed speech (ADS), no studies have examined if differences in neural processing for easy versus difficult speech predict future language outcomes.

Monolingual 7-8 month old infants (current n=20, goal n=40) from the Greater Toronto Area, Canada, heard sentences spoken in familiar and unfamiliar accents (Canadian-accent and Mandarin-accented English, respectively). Neural activity was continuously recorded (32-channel BrainVision system). In MatLab, amplitude envelopes were extracted from sentence stimuli and EEG was preprocessed offline with EEGLab and Fieldtrip. Phase coherence between the envelopes and EEG was assessed for frequencies up to 40 Hz, separately for each accent condition. The hypotheses and methods have been preregistered (embargoed in Open Science Framework).

Preliminary results show stronger entrainment to familiar accents at lower (4-8 Hz) and higher (8+ Hz) frequencies. Lower frequencies, linked to syllabic processing, may suggest attention to prosodic and syllabic structures of familiar accents, while higher frequencies, associated with rime and onset, suggest a focus on phonemic details and segmental features. These findings highlight distinct processing strategies and suggest the auditory system's adaptability to varied linguistic inputs. We hypothesize that successful tracking of different accent types in infancy will predict subsequent language outcomes at 1 and 2 years old.

Online

SLEEP

#33 - IOTA: 25-35 HZ EEG OSCILLATIONS CHARACTERIZE WAKE & REM SLEEP IN CHILDREN & YOUNG ADULTS

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Background: High-frequency EEG activity is normally classified as either beta (13-30 Hz) or gamma (>30 Hz) and is associated with cognitive functions and sensory-motor processing. Here, I identify a new oscillation which I propose to call "iota" that sits between these bands, from 25 to 35 Hz, and characterizes both wake and REM sleep in a subset of young individuals.

Methods: High-density resting wake EEG data was analysed from the Healthy Brain Network (HBN) clinical paediatric dataset. This included 2701 patients with various psychiatric diagnoses, between the ages of 5 and 21.

High-density sleep EEG data from 19 healthy young adults (18-26 years old, 10 female) was further analysed.
Results: In the paediatric wake dataset, 26.3% of individuals had an iota peak between 25 and 35 Hz, with a bandwidth less than 4 Hz. For children under 15, 27.5% had iota, and for adolescents/adults the proportion dropped to 18% (z-statistic = 3.491; p-value<.001). In the healthy adult sleep dataset, iota was identified in 9 individuals (7 female) and was almost exclusively in REM sleep. As determined by visual inspection, iota occurred in localized bursts during both wake and REM sleep. These were independent of both alpha oscillations and eye movements.
Conclusions: Iota oscillations are some of the smallest oscillations still detectable on the surface EEG. They are more common in children than adults, suggesting they relate to brain development. They occur consistently during wake and REM sleep but not NREM sleep, which could suggest a link to conscious experience.

Online + Onsite

#34 - THE IMPACT OF FACE MASKS ON THE NEURAL TRACKING OF SPEECH IN NOISE: DISSOCIATING AUDITORY AND VISUAL OBSTACLES

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Face-to-face communication is multimodal, face masks represent an efficient natural model for investigating AV speech processing, generating acoustic and visual communication obstacles. We investigated the specific effects of face masks on naturalistic speech processing. While the EEG was recorded, participants (29 adults, mean age: 27.7y) were exposed to three conditions of continuous AV speech in noise (No-mask - NM, full AV input; Virtual-Mask - VM, occluded mouth and intact audio; Real-Mask - RM, occluded mouth and degraded audio) and answered questions on listening difficulty, content retrieval, and self-confidence. Neural tracking of the sound envelope and lip movements was measured using backward modeling, by reconstructing stimulus properties from neural activity. Our findings revealed that face masks heightened perceived difficulty and increased phonetic errors in content retrieval. Also, comparing NM vs. VM conditions showed that mouth occlusion impaired speech tracking at the earliest processing stages, while VM vs. RM comparisons indicated that degraded acoustic information affected neural tracking at later stages. Evaluating NM vs. RM allowed us to assess the combined negative impact of audiovisual filtering from face masks. Lastly, we examined associations between neural and behavioral measures by correlating the drop in reconstruction performance with the perceived difficulty difference between NM and RM conditions. The results showed that perceived difficulty mirrored the neural cost of listening to speech in the RM condition. The missing visual cue prevented lips tracking and affected envelope tracking, reducing the ability to predict and integrate AV speech. The auditory filter impacted the envelope tracking at later stages, likely associated with auditory selective attention. Behavioral and neural measures were linked, showing an impact of masks on the metacognitive levels subtending speech processing.

Online