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POSTERS

Poster numbers / topic :

1-17 : Cognition
18-29 : Clinic
30 -50 : Methods
51-57 : Tools

	Monday 5th	Tuesday 6th	Wednesday 7th	Thursday 8th
17h45 - 18h15	A	B	C	D
18h15 - 18h45	B	C	D	A
18h45 - 19h15	C	D	A	B
19h15 - 19h45	D	A	B	C

1 - (A) Hyperscanning: A Valid Method to Study Neural Inter-brain Underpinnings of Social Interaction

Artur Czeszumski(1), Sara Eustergerling(2), Anne Lang(3), David Menrath(4), Michael Gerstenberger(5), Susanne Schuberth(6), Felix Schreiber(7), Zadkiel Zuluaga Rendon(8) and Peter König(9)
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Social interactions are a crucial part of human life. Understanding the neural underpinnings of social interactions is a challenging task that the hyperscanning method has been trying to tackle over the last two decades. Here, we review the existing literature and evaluate the current state of the hyperscanning method. We review the type of methods (fMRI, M/EEG, and fNIRS) that are used to measure brain activity from more than one participant simultaneously and weigh their pros and cons for hyperscanning. Further, we discuss different types of analyses that are used to estimate brain networks and synchronization. Lastly, we present results of hyperscanning studies in the context of different cognitive functions and their relations to social interactions. All in all, we aim to comprehensively present methods, analyses, and results from the last 20 years of hyperscanning research.

2 - (A) Neurophysiological dynamics underlying age-related modulations of stimulus-response binding processes: A cross-sectional developmental EEG study

Roxane Dilcher, Christian Beste, Adam Takacs, Annet Bluschke, Eszter Tóth-Fáber, Maximilian Kleimaker, Alexander Münchau, Shu-Chen Li
Deutschland

Humans differ in their capacity for integrating perceived events and related actions. The "Theory of event coding" (TEC) conceptualizes how stimuli and actions are cognitively bound into a common functional representation (or "code"), the "event file". To date, however, the neural processes underlying the development of event file coding mechanisms across age are largely unclear. We examined age-related neural changes of event file coding from late childhood to early adulthood, using EEG signal decompositions methods. We included a group of healthy participants (n = 91) between 10 and 30 years, who performed an established event file paradigm with different numbers of overlapping features and response types. The study revealed age-dependent event file coding processes both at the behavioural and the neurophysiological level. The behavioural results revealed that processes of event file binding become more efficient from late childhood to early adulthood in a linear fashion. These effects are reflected by two neurophysiological subprocesses associated with the superior parietal cortex (BA7) as revealed in analyses using EEG signal decomposition. The first process entails mapping and association processes between stimulus and response; whereas, the second comprises inhibitory control subprocesses subserving the selection of the relevant motor programme amongst competing response options.

3 - (A) Maturational changes in EEG-derived spectral bursts through adolescence during working memory maintenance

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Adolescence is characterized by neurodevelopmental specialization that impacts cognition and decision-making. Simultaneously, changes in the inhibitory (Gamma-Aminobutyric Acid, GABA) and excitatory (glutamate) signaling mechanisms in prefrontal cortex suggest changes in excitatory/inhibitory (E/I) balance which may contribute to developmental changes in cortical signal processing and, consequently, cognitive behaviors. The interplay of GABA and glutamate signaling plays a role in the generation of high frequency oscillations measured through electroencephalogram (EEG). Using EEG, we investigated age-related changes in the gamma (30-70 Hz), beta (15-30 Hz), theta (4-7 Hz) and alpha (8-12 Hz) frequency bands during the delay period of a memory-guided saccade (MGS) task in 148 10-30-year olds. A linear mixed-effects model and a support vector regression (SVR) were utilized to determine associations between EEG activity (power, event duration, number of events, and trial-by-trial variability), behavior, and age. We found significant age-related decreases for spectral events in the gamma and beta bands and increases in the alpha band. The SVR-machine learning approach found that the delay period measures were more highly predictive of age than the fixation measures. Trial-to-trial variability in EEG activity decreased with age, consistent with decreases in performance variability. Gamma and beta band activity showed significant associations with MGS performance, with increases in these measures corresponding to increases in performance. Together, these data suggest that spectral events in high frequency bands, such as gamma and beta, may be indicative of developmental maturation of cognitive control underlined by maturational changes in GABA/glutamate function. Next steps will investigate associations between EEG findings and MRS evidence of age related changes in GABA and glutamate.

4 - (A) Actions attenuate sensory responses and disrupt memory encoding for concurrent, but unpredictable sounds.

Nadia Paraskevoudi (1, 2), Iria SanMiguel (1, 2, 3)
Spain (1, 2, 3)

Motor activity has been shown to modulate sensory processing, as evident by the attenuated physiological responses for self- compared to externally-generated stimuli. Although these effects have been traditionally attributed to motor-related prediction, they are observed in non-predictive contexts as well, i.e., with mere coincidence between the sound and the motor act. Meanwhile, the effects of self-generation on memory remain largely unknown. While some studies report better memory recall for self-generated stimuli (i.e., production effect), further evidence points to memory enhancements for unpredicted items. According to the latter account, stimuli eliciting larger prediction errors at

encoding result in better recall at retrieval. Yet, to-date, no attempts have been made to assess whether and how motor actions affect the memory encoding of concurrent sounds. In this study, we employed a memory task, where participants performed a series of button presses at encoding that could either elicit a sound (motor-auditory; MA) or not (motor-only control; M), while more sounds were passively presented (auditory-only; A). At the subsequent retrieval phase, they were passively presented with two test sounds and they had to respond which one was presented at encoding. Behaviourally, we found memory enhancements for sounds that were encoded as auditory-only (A), which was reflected in larger ERP amplitudes for these sounds at encoding compared to those coinciding with a motor act (MA). Yet, the way the sound was encoded did not affect the ERPs at retrieval. Collectively, our findings show that the sensory attenuation for self-generated, albeit non-predictable, stimuli disrupts memory encoding and suggest that memory performance may be driven by the prediction error elicited at encoding, with items yielding larger prediction errors resulting in more efficient retrieval.

5 - (B) Decoding Typing from Electro-Encephalography Reveals how the Human Brain Simultaneously Represents Successive Keystrokes

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"The dynamic properties of language production processes have been difficult to study because the muscular artefacts generated during speech production disrupt neuronal recordings. To bypass this difficulty, we investigate language production through typing. Like speech gestures, keystrokes are produced as sequences of precise movements stemming from high level linguistic representations. Critically, however, typing movements are performed away from the brain and hence do not perturb the recording of brain activity. To investigate how linguistic representations are translated into successive keystrokes, we aimed to decode individual keystrokes from electrophysiological (EEG) recordings acquired during a picture typing task. We re-analysed the data of a previous study (Pinet et al., 2016) in which 31 participants performed a picture naming task through typing. We implemented multivariate pattern analyses to decode the hand laterality and the finger corresponding to each keystroke as a function of time. Our results show that laterality can be significantly decoded up to 500ms before each keystroke onset, irrespective of the position of the keystroke in the word. Finger decoding, based on a standard finger-key correspondence, yielded qualitatively similar but much lower decoding performances. Most notably, the decodable time courses of individual keystrokes systematically overlapped with one another. Finally, we implemented temporal generalization analyses by training a decoder at each time sample to test how well they decode other time samples. The results show that each keystroke is characterized by a diagonal pattern, implying that the neural representation of each keystroke is dynamic. We discuss how these novel EEG findings reveal the simultaneous representation of successive keystrokes in large-scale neuronal activity. More generally, we show that the representation of language production can be decoded as multiple and rapidly evolving neural codes."

6 - (C) Pip-and-flip? Uncertainty factors the modulation of visuospatial attention on hearing

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"Environments propagate audiovisual (AV) signals that we need to attend to oftentimes. While visual and auditory contributions may jointly serve as a basis for selection, it is unclear what hierarchical effects arise when initial selection criteria are unimodal, or involve uncertainty.
The effects of visuospatial selection on auditory processing were investigated with electroencephalography (EEG). Using temporal response function models (TRF) of the auditory EEG timeseries, we addressed the neural encoding of tone pips probabilistically associated to spatially-attended visual changes ('flips'). AV precision (temporal uncertainty) was manipulated while participants sustained goal-driven, visuospatial selective attention. The roles of unimodal (visuospatial and auditory) uncertainties were further investigated.
TRF estimates showed bimodal AV precision determines cross-modal modulations but also does visuospatial uncertainty unimodally, by enabling the visual priming of tones when relevant for auditory segregation. Unimodal auditory uncertainty, in addition, determined susceptibility of early tone encoding to change by incoming visual update processing.
Uncertainty estimation is a key factor considered in computational models of attention where precision weighting acts as primary mechanism for selection. The findings suggest a hierarchical account of the role of uni- and cross-modal sources of uncertainty on the neural encoding of sound dynamics in a multimodal attention task."

7 - (C) Neural generators of the frequency-following response elicited to stimuli of low and high frequency: a magnetoencephalographic (MEG) study

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The auditory frequency-following response (FFR) to periodic complex sounds has gained recent interest in auditory cognitive neuroscience as it captures with great fidelity the tracking accuracy of the periodic sound features in the ascending auditory system. Seminal

electroencephalographic (EEG) studies suggested the FFR as a correlate of subcortical sound encoding, yet recent EEG and MEG studies aiming to locate its sources challenged this assumption, demonstrating that FFR receives a major contribution from the auditory cortex. Based on frequency-specific phase-locking capabilities along the auditory hierarchy, we hypothesized that FFRs to higher frequencies would receive less cortical contribution than those to lower frequencies, hence supporting subcortical involvement in the encoding of these high-frequency sounds. Here, we used a simultaneous magnetoencephalographic (MEG) and electroencephalographic approach to trace the neural sources of the FFR elicited in healthy adults (N=19) to low (89 Hz) and high (333 Hz) frequency sounds. Data were recorded with a 306-channel whole–head Elekta Neuromag® TRIUX system consisting of 204 planar gradiometers and 102 magnetometers, and a compatible 64-channel EASYCAP GmbH EEG cap. FFRs elicited to high and low frequency sounds were clearly observable on MEG and comparable to those obtained in simultaneous EEG recordings. Distributed source modeling analyses, using weighted minimum norm estimate source distribution algorithm with unconstrained source orientations, revealed midbrain, thalamic, and cortical contributions to FFR, arranged in frequency-specific configurations. These findings support the multiple generator hypothesis of the FFR and are relevant for our understanding of the neural encoding of sounds along the auditory hierarchy, suggesting a hierarchical organization of periodicity encoding.

8 - (C) The neural correlates of embodied L2 learning. Does embodied L2 verb learning affect representation and retention?

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Within the framework of embodied semantics, the overlap between sensorimotor and language processes has important implications for second language (L2) acquisition. Indeed, both neural and behavioral evidence show that motor-language coupling enhances language learning. The present study uses virtual reality (VR), to investigate how performing naturalistic actions during the learning of L2 action verbs may enhance mapping between word form and meaning. We will examine whether this "embodied learning" creates linguistic representations that produce greater motor resonance, due possibly to stronger and more specific motor traces, compared to a control condition. Moreover, we will investigate whether embodied learning leads to better retention. Training will occur over two days using auditory verbs and a VR oculus headset plus hand controller. Native French speakers will learn the same set of L2 verbs in Serbian, in either the "embodied learning" or the control condition. The "embodied learning" group will learn the action verbs using different specific movements for each verb to manipulate virtual objects; the control group will simply point to the virtual objects. Both pre and post training, EEG will be recorded while participants passively listen to the new verbs. Time-frequency analyses will be carried out to measure mu and beta suppression, associated with motor activation. EEG and behavioral accuracy will also be used to assess learning in an audio-visual match-mismatch task. We expect that the "embodied learning" group will show greater motor activation during verb processing post-training, and that this will correlate with improved learning as indexed by a greater N400 effect and improved behavioral results compared to the control condition. This pattern of results would suggest that embodied learning adds a motor trace to lexical items, which would support theories of embodied semantics.

9 - (C) Do sleep slow waves modulate information processing along the visual pathway?

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"Cortical slow waves (SW) generated during deep sleep reflect alternating phases of heightened or depressed cortical excitability which affect the magnitude of the brain's response to sensory information ("sensory gating"), at least in the acoustic and somatosensory domain. This study investigates if SW-phase also modulates the response to visual stimuli, and if this happens early (in the retina) or late (in the cortex) along the visual pathway. Whether humans have cortico-retinal feedback connections is controversial; retinal response modulation would provide evidence supporting their existence.

Sixteen healthy volunteers were stimulated with alternating monocular light flashes (ISI 1-2 s) overnight while sleeping. Following one habituation night, cortical and retinal responses were measured on the second night using EEG and electroretinography (ERG).

All volunteers were able to sleep and only mildly to moderately disturbed by the flash stimulation, although sleep onset was generally delayed and more frequently interrupted. Preliminary analyses confirm the presence of visual evoked responses and SW-activity in the EEG. Flash-evoked ERG b-waves were demonstrated throughout the night in all participants; oscillatory potentials (100-160 Hz) were observed in a subset. Ongoing analyses of the relationship of these responses to SW-phase will inform our understanding of sensory gating in the visual system during sleep."

10 - (C) Changes in brain oscillations during recognition real-world autobiographical episodic memory

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Brain oscillations play an important role in encoding and retrieval of episodic memories(Düzel, Penny, & Burgess, 2010; Nyhus & Curran, 2010). These oscillations associated with recollection of laboratory based episodic memories have been examined using miniature events such as words or pictures. These studies have highlighted

the role of synchronisation in gamma (25-100 Hz) and theta (4-7.5 Hz) bands (Gruber, Tsivilis, Giabbiconi, & Müller, 2008) as well as desynchronization in alpha (10-13 Hz) and beta (13-18 Hz) bands (Hanslmayr, Staudigl, & Fellner, 2012) during recognition of episodic memories. However, the recollection of real-world autobiographical episodic memories has not been explored. Therefore, we used wearable cameras to explore the role of brain oscillations in response to the recognition of autobiographical episodic memories. Fifteen participants (Age; M=29, SD=10) were taken on a museum tour while they wore the camera. One week later they performed a recognition memory task while their EEG was being recorded. We used cluster-based permutation tests to examine the changes in all frequency bands in association with recognition of real-world autobiographical episodic memories. Our results show an early desynchronization over the frontal electrodes, a later desynchronization over parietal electrode in the gamma frequency band, and no significant clusters in other frequency bands. Our findings suggest that the recognition of real-world autobiographical episodic memories might be relying on different neurophysiological mechanisms than the recognition of laboratory-based episodic memories.

11 - (C) Illusionary Sense of Agency in Auditory Processing: EEG Correlates of Predictions, Errors and Illusions

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The Sense of Agency, the experience of being the agent of an action and its sensory consequences, is a complex, constructive phenomenon that can be subject to illusions, as previous studies have shown, and as can become apparent through the study of psychiatric conditions. One of the illusory phenomena related to agency is linked to the order of actions and their effects. An illusory Sense of Agency may emerge when the sensory effects of an action precede their related motor action, i.e. when the natural order of causal events is violated. This study explores how we can induce this illusory Sense of Agency by manipulating the timing of actions and their effects, as well as by violating previously learned associations. Participants performed a behavioural task in which they had to learn button-sound-associations and make explicit judgements as to whether or not they had created the sounds they heard. This was accompanied by an EEG recording, which we analysed in order to better understand the neural correlates of expectation violation, the Sense of Agency, sensory attenuation, and how they relate to explicit post-hoc agency judgements. More specifically, participants pressed buttons, which created sounds, and in some trials, we manipulated the order of these events, so that the sound would occur slightly before the button press. We furthermore included "incongruent" trials, in which the sound produced did not match the learned sound-button association. Congruent sounds that were preceded by a button press were generally judged as self-generated, while the opposite was true for incongruent sounds occurring before the button press. Illusory agency judgements occurred for a significant number of trials where sounds preceded button presses by up to 60ms. The N2 event-related component was found to vary as a function of timing, with "early" sounds triggering a large N2, while late sounds occurring after the button press did not trigger any N2 at all.

12 - (C) Evidence for simultaneous lexical and sublexical access in production and perception & roles of item variation

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In word production and perception there are two general classes of theories: separation models and integration models. Separation models argue that the different linguistic stages of word production and perception occur sequentially, with upstream processes occurring before downstream processes. In contrast, integration models argue that all linguistic stages in word production and perception occur simultaneously. To test this, we carried out an EEG study (19 analysed participants) where all participants took part in a production and perception task using the same stimuli. The stimuli contained two manipulations, word frequency and phoneme frequency, which target different processing stages, lexical and sub-lexical stages, respectively. Separation models predict that these two frequency effects should arise in different time windows in production and perception, whereas integration models predict that both frequency effects are found in the same time windows. We used linear mixed effects models to analyse the EEG signal in three different time windows throughout the trial. We found effects of both frequency manipulations in the same time windows, suggesting that processing at different linguistic stages occurred simultaneously, thus supporting predictions by integration models. Interestingly however, we noticed a large amount of variance attributable to items used in the experiment, and when comparing our results with a previously typical analysis strategy (linear regression), our results were much more conservative. A more in-depth visualisation of our items suggests that the strength and direction of the frequency effects varies between high versus low frequency items, across time windows, and this variation is taken into account in the mixed models analysis, but not in linear regression. This suggests that not accounting for item variability in this (and likely in similar studies) can have a strong, and possibly detrimental, effect on data interpretation.

13 - (C) The cerebellar clock - predicting and timing sensory touch

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"Humans are adept at predicting what will happen next and when precisely it will occur. An activity as everyday as walking at a steady pace through a busy city while talking to a friend can only happen as smoothly as it does because the human brain has predicted most of the sensory feedback it will receive. It is only when the

sensory feedback does not match what was expected, say, a sudden slippery spot on the pavement, that one becomes aware of the sensory feedback. The cerebellum is known to be involved in these predictions, but not much is known about the precise timing of them due to the scarcity of time-sensitive cerebellar neuroimaging studies, such as ones conducted with magnetoencephalography.
We here investigated the timing of sensory expectations as they are expressed in the cerebellum using magnetoencephalography. We did this by comparing the cerebellum's response to somatosensory omissions from regular trains of stimulation to its response to omissions from irregular trains of stimulation. This revealed that omissions following regular trains of stimulation showed higher cerebellar power in the beta band than those following irregular trains of stimulation, precisely when the omitted stimulus should have appeared. We also found evidence of cerebellar theta band activity encoding the rhythm of new sequences of stimulation
Our results furthermore strongly suggest that the putamen and the thalamus mirror the cerebellum in showing higher beta band power when omissions followed regular trains of stimulation compared to when they followed irregular trains of stimulation.
We interpret this as the cerebellum functioning as a clock that precisely encodes and predicts upcoming stimulation, perhaps in tandem with the putamen and thalamus. Relative to less predictable stimuli, perfectly predictable stimuli induce greater cerebellar power. This implies that the cerebellum entrains to rhythmic stimuli for the purpose of catching any deviations from that rhythm."

14 - (C) Somatosensory evoked potentials along the neuraxis

Birgit Nierula (1), Tilman Stephani (2), Merve Kaptan (3), André Mouraux (4), Burkhard Maess (5), Gabriel Curio (6), Vadim V. Nikulin (7) & Falk Eippert (8)
Max Planck Research Group Pain Perception, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany (1,3,8); Research Group Neural Interactions and Dynamics, Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany (2,7); Institute of Neuroscience, Université Catholique de Louvain, Brussels, Belgium (4); Methods and Development Group Brain Networks, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany (5); Department of Neurology, Charité University Medicine, Berlin, Germany (6); Institute for Cognitive Neuroscience, National Research University Higher School of Economics, Russian Federation (7) "Neuroscientific research on human somatosensation has largely focused on cortical processes, although an extensive amount of processing already occurs before somatosensory input reaches the cortex, including in the dorsal horn of the spinal cord (Abraira et al., 2017; Paixao et al., 2019). Here, we non-invasively investigate somatosensory processing in the spinal cord using somatosensory evoked potentials (SEPs; Cruccu et al., 2008). We aimed to replicate and extend earlier spinal SEP studies by making use of an adequately powered sample-size, a higher electrode density, and state-of-the-art acquisition and analysis methods.
In study 1, we elicited SEPs in 36 participants (18 females) by mixed-nerve stimulation and recorded from the peripheral nerves, the spinal cord, and the brain in order to provide a comprehensive picture of somatosensory processing. In study 2, we aimed in 24 participants (12 females) to i) replicate these findings, ii) extend them by stimulating purely sensory nerve fibers, and iii) investigate integrative processes at the level of the spinal cord. All stimuli were non-painful electrical pulses applied to the left wrist (median n.) and the left ankle (tibial n.) for mixed nerve stimulation or, for sensory nerve stimulation, to two fingers (or toes) separately or simultaneously. We recorded from 64 cortical, 40 spinal and 2 peripheral skin electrodes.
In study 1 we demonstrate that SEP waveforms are reproducible within and between participants on all levels of the neuraxis. In study 2, we replicate the results of study 1 and extend them to stimulation of purely sensory afferents. We compared the SEP amplitudes between double-finger stimulation and the sum of two single-finger stimulations and find that SEP to double-digit stimulation was reduced on a cortical and spinal level, suggesting integrative processes there. Ultimately, we aim to use the approach we developed here to investigate spinal responses to natural nociceptive stimulation."

15 - (C) Evoked responses to flicker relative to intrinsic frequency vary across alpha generators

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Rhythmic flickering stimulation in the alpha range produces steady-state visually evoked potentials (SSVEPs) in electroencephalogram (EEG) recordings. Based on scalp-level (i.e. electrode-level) analyses, two dichotomous models of the underpinning mechanisms leading to SSVEP generation have been proposed: either entrainment or superposition, i.e., phase-alignment or independence of endogenous brain oscillations to/from flicker-induced oscillations, respectively. However, scalp-level analyses represent an averaged view of underlying 'source-level' activity, at which variability in SSVEPs may lie, possibly suggesting the co-existence of multiple mechanisms. To probe this idea, we investigated the variability of SSVEPs derived from the sources underpinning scalp EEG responses during presentation of a flickering radial checkerboard. Flicker was presented between 6-12 Hz, and at individual alpha frequency (IAF: the dominant frequency of endogenous alpha oscillatory activity). We tested whether sources of endogenous alpha activity could be dissociated

according to evoked responses to different flicker frequencies relative to IAF. Occipitoparietal sources were identified by temporal independent component analysis, maximal resting-state alpha power at IAF, and source localisation. The pattern of SSVEPs to rhythmic flicker relative to IAF was estimated by correlation coefficients, describing the correlation between the peak-to-peak amplitude of the SSVEP and the absolute distance of the flicker frequency from IAF across flicker conditions. Remarkably, we observed extreme variability in correlation coefficients across sources, ranging from -0.84 to 0.93. This result provides evidence for variation in evoked responses to flicker relative to IAF across identified sources of endogenous alpha oscillatory activity, suggesting that alpha generators deal differently with visual flicker relative to IAF and offers first insight into the possibility of multiple SSVEP mechanisms.

16 - (D) Frequency tagging and functional connectivity analyses reveal parallel speech segmentation and word-picture association in 8-year-old children

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When learning a new language, one must not only segment words from continuous speech but also associate them onto meanings. Previous electrophysiological studies suggest that low-frequency oscillations are particularly sensitive to different levels of hierarchical complexity found in the input making them a plausible neural substrate for parsing of speech. Here, we investigated the functional role of these brain oscillations during parallel speech segmentation and meaning acquisition in a large group of 9-year-old children. We recorded EEG while children performed an audio-visual statistical learning task in which they were exposed to i) a speech stream with consistent word-picture associations (learning condition) and ii) a random stream with inconsistent word-picture associations (random condition) before being tested on their ability to recall words and word-picture associations. We capitalized on the brain property to entrain at the same rate as a rhythmic stimulus to explore modulations of neural synchronization and long-distance connectivity at two target frequencies corresponding to the word- and syllabic-rate using Frequency Tagging and functional connectivity analyses (weighted Phase-Lag Index). Results showed enhanced power at both word- and syllabic-rate, as well as an increase in connectivity between fronto-occipital regions in the learning, compared to the random condition. Overall, these findings suggest that top-down modulations of low-frequency oscillations and long-distance connectivity play an important role in successful multimodal learning in children.

17 - (D) FREE YOUR SUBJECTS - A FAST AUDITORY ODDBALL PARADIGM

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The auditory oddball task is widely used in neuroscience, psychology, and psychiatric field for its reliability and accuracy for cognitive activities. However, participants often feel exhausted and experience mind-wandering during the long-time recording. Voice is a special auditory material to the human brain. Based on the steady-state auditory evoked potential theory, presenting stimuli in a certain frequency can elicit relatively high amplitudes compared to the neighboring frequency. In this experiment, vocal stimuli were presented in the fixed frequency. The results showed that when the vocal stimuli were presented in a fixed frequency, a corresponding peak was significantly elicited compared to the random frequency. Besides, when adding 100ms silence after vocal stimuli higher amplitudes with higher SNR were elicited. Compared to other oddball studies, we have a rather short recording time(7mins/10mins). As the results showed, there is a convincing peak on the voice-selective frequency, supporting that this is an efficient new paradigm.

18 - (A) Evolutionary Unsupervised Fuzzy ART Algorithm for Seizure Free Epileptic Data Classification

Geetika Srivastava

Dr. Ram Manohar Lohia Avadh University, Ayodhya

This paper employs power spectral density (PSD) with Fuzzy ART neural network to detect the epilepsy. The approach utilizes self-organized, unsupervised Adaptive Resonance Theory (ART) neural network with fuzzy decision rule applied on neural network outputs to improve algorithm selectivity for a variety of real events not necessarily anticipated during training. Tuning of input signal pre-processing steps and enhanced unsupervised learning are implemented, and their influence on the algorithm classification capability is investigated. Simulation results show improved algorithm recognition capabilities when compared to a previous version of ART algorithm for each of the implemented scenarios. In this research article PSD (Power Spectral Density) with evolutionary unsupervised Fuzzy ART algorithm approach applied on EEG signals for diagnosis of Epilepsy. The results are 91% accurate and it can be used to easily classifying epileptic data.

19 - (A) Central serotonergic activity is affected by fasting and selective uptake of nutrition

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"Serotonin is an important neuromodulator involved in many physiological processes including mood and satiety. In the brain, serotonin is manufactured from tryptophan, an essential amino acid, as serotonin itself cannot cross the blood-brain barrier. Previous research has shown that blood-tryptophan levels increase upon ingestion of carbohydrates, and decrease upon protein consumption. How this translates into serotonin availability is as yet under-researched.

In the present study we examined the effect of fasting versus consuming pure carbohydrates or protein on the central serotonergic activity using a repeated measures cross-over design in a sample of thirty-seven healthy males. The loudness dependence of auditory evoked potentials (LDAEP) is an indicator of synaptically released serotonin and serves as a non-invasive method to study central serotonergic activity. Blood glucose levels and mood changes were also monitored before and after the nutritional intervention.

The intervention had a significant and nutrition-specific effect on LDAEP and blood-glucose levels. A significant difference emerged between the fasting condition and satiety, with LDAEP being lower during satiety, irrespective of the type of food. Thus, serotonergic activity increased after food consumption, which was further related to mood improvement. Moreover, the LDAEP differed between the two measurements only for the carbohydrate testing day, suggesting that serotonergic activity can be selectively modulated by the type of nutrition consumed. Our data further indicate a high intra-individual stability of LDAEP, as the electrophysiological signals were very similar in the fasting condition across the two testing days.

Together, these findings demonstrate that the LDAEP can serve as a robust biological marker for central serotonergic activity, while at the same time being sensitive to nutritional changes."

20 - (A) RELATIONSHIPS BETWEEN AMPLITUDE OF RESTING STATE ALPHA ELECTROENCEPHALOGRAPHIC RHYTHMS AND EDUCATION ATTAINMENT IN COGNITIVELY UNIMPAIRED SENIORS AND PATIENTS WITH ALZHEIMER'S DISEASE AND AMNESIC MILD COGNITIVE IMPAIRMENT

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"In normal old (Nold) and Alzheimer's disease (AD) persons, a high cognitive reserve makes them more resistant and resilient to brain neuropathology and neurodegeneration. Here we tested whether these effects may affect neurophysiological oscillatory mechanisms generating dominant resting state electroencephalographic (rsEEG) alpha rhythms in Nold and patients with mild cognitive impairment (MCI) due to AD (ADMCI).

Data in 40 Nold and 70 ADMCI participants, stratified in higher (Edu+) and lower (Edu-) educational attainment subgroups, were available in an Italian-Turkish archive. The subgroups were matched for age, gender, and education. RsEEG cortical sources were estimated by eLORETA freeware.

As compared to the Nold-Edu- subgroup, the Nold-Edu+ subgroup showed greater alpha source activations topographically widespread. On the contrary, in relation to the ADMCI-Edu- subgroup, the ADMCI-Edu+ subgroup displayed lower alpha source activations topographically widespread. Furthermore, the two ADMCI subgroups had matched cerebrospinal AD diagnostic biomarkers, brain gray-white matter measures, and neuropsychological scores.

The current findings suggest that a high cognitive reserve may be related to changes in rsEEG alpha rhythms in Nold and ADMCI persons. These changes may underlie neuroprotective effects in Nold seniors and subtend functional compensatory mechanisms unrelated to brain structure alterations in ADMCI patients."

21 - (A) CHRONIC BACE-1 INHIBITOR ADMINISTRATION IN TASTPM MICE (APP KM670/671NL and PSEN1 M146V): AN EEG STUDY

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Background. Previous evidence of the PharmaCog project (https://www.imi.europa.eu/projects-results/project-factsheets/pharma-cog) showed that ongoing electroencephalographic (EEG) rhythms at delta (1-6 Hz) and theta (6-10 Hz) frequencies differed between freely behaving C57 wild-type (WT) and transgenic TASTPM mice (double mutation in APP KM670/671NL and PSEN1 M146V) developing brain amyloidosis and cognitive deficits over time like Alzheimer's disease .Objective. Here, we tested whether those EEG rhythms may reflect the effects of a chronic administration (4 weeks) of an anti-amyloid β-site APP-cleaving enzyme 1 inhibitor (BACE-1; ER-901356; EISAI Co, Ltd, Tokyo, Japan) in TASTPM as compared to WT mice. Methods. Ongoing EEG rhythms were recorded from a bipolar frontoparietal and 2 monopolar frontomedial (prelimbic) and hippocampal channels in 11 WT Vehicle, 10 WT BACE-1, 10 TASTPM Vehicle, and 11 TASTPM BACE-1 mice (males; aged 8/9 months old at the beginning of treatment). Normalized EEG power (density) was compared between the first day (Day 0) and after 4 weeks (Week 4) of the BACE-1 inhibitor or vehicle administration in the 4 mouse groups. Frequency and magnitude of individual EEG delta and theta frequency peaks (IDF and ITF) were considered during animal conditions of behaviorally passive and active wakefulness. Results. Compared with the WT group, the TASTPM group generally showed a significantly lower reactivity in ITF power during the active over the passive condition ($p<0.05$). Notably, no effect of the BACE-1 inhibitor over vehicle administration was observed. Conclusions. EEG biomarkers reflected differences between WT and TASTPM mice but not of a 4-week treatment of that drug.

22 - (B) RESTING-STATE ELECTROENCEPHALOGRAPHIC DELTA RHYTHMS MAY REFLECT GLOBAL CORTICAL AROUSAL IN HEALTHY OLD SENIORS AND PATIENTS WITH ALZHEIMER'S DISEASE DEMENTIA

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"Extending Başar's theory of event-related EEG oscillations, here we hyp*othesize that even in quiet wakefulness, transient increases in delta rhythms may enhance global cortical arousal as revealed by the desynchronization of alpha rhythms in normal (Nold) seniors with some derangement in Alzheimer's disease dementia (ADD).

Clinical and EEG datasets in 100 ADD and 100 Nold individuals matched as demography, education, and gender were taken from an international archive. Standard delta (< 4 Hz) and alpha1 (8-10.5 Hz) bands were used for the main analysis, while alpha2 (10.5-13 Hz), theta (4-8 Hz), beta1 (13-20 Hz), beta2 (20-35 Hz), and gamma (35-40 Hz) served as controls. In the interpretation, the higher the alpha1 power (density), the lower that arousal. As expected, when compared to the Nold group, the ADD group showed higher global (scalp) power density at the delta-theta band and lower global power density at the alpha-beta bands. As novel findings, we observed that: (1) in the Nold group, the global delta and alpha1-2 power were negatively and linearly correlated; (2) in the ADD group, this correlation was just marginal; and (3) in both Nold and AD groups, the EEG epochs with the highest delta power (median value for stratification) were associated with the lowest global alpha1 power. This effect was related to eLORETA freeware solutions showing maximum alpha1 source activations in posterior cortical regions.

These results suggest that even in quiet wakefulness, delta and alpha rhythms are related to each other, and ADD partially affects this cross-band neurophysiological mechanism."

23 - (B) Different abnormalities of cortical neural synchronization are related to visual hallucinations in patients with Parkinson's and Lewy Body Diseases

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"Parkinson's disease (PD) is the second-most common neurodegenerative disorder that affects 2–3% of the population ≥ 65 years of age and may belong to cognitive deficits and dementia in 50% of cases. Disease with Lewy Bodies (DLB) is emerging as another important cause of dementia in pathological aging. PD and DLB are both due to intra-neuronal Lewy bodies and are characterized not only by motor dysfunctions but also cognitive and/or psychiatric symptoms. An open issue is the extent to which these diseases are distinct entities. In this respect, here we compared cortical sources of resting state eyes-closed electroencephalographic (rsEEG) rhythms in PD and DLB patients having visual hallucinations.

Clinical and rsEEG rhythms in demographic matched PD (N = 93), DLB (N = 46), Alzheimer's disease dementia (AD, N= 70) and healthy elderly (Nold, N = 60) subjects were available from an international archive. Pathological groups were matched as cognitive status. Individual alpha frequency peak was used to determine the delta, theta, alpha1, alpha2, and alpha3 frequency band ranges. Fixed beta1, beta2, and gamma bands were considered. The eLORETA freeware estimated rsEEG cortical sources.

As a confirmation of previous studies, compared to the Nold subjects, the AD, LBD, and PD patients showed higher widespread delta source activities and lower posterior alpha source activities. Specifically, posterior alpha source activities were more abnormal in the AD than the LBD and PD groups, while widespread delta source activities were more abnormal in the PD and DLB than the AD group. As novel results, in relation to the LBD and PD patients without visual hallucinations and the control groups (Nold, AD), those with visual hallucinations were characterized by higher parietal delta source activities and parieto-occipital alpha sources activities."

24 - (B) ABNORMAL CORTICAL SOURCES OF RESTING STATE DELTA RHYTHMS ARE RELATED TO EPILEPTIFORM ACTIVITY IN PATIENTS WITH AMNESIC MILD COGNITIVE IMPAIRMENT NOT DUE TO ALZHEIMER'S DISEASE

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"In the present exploratory and retrospective study, we hypothesized that cortical sources of resting state eyes-closed electroencephalographic (rsEEG) rhythms might be more abnormal in patients with epileptiform EEG activity (spike-sharp wave discharges, giant spikes) and amnesic mild cognitive impairment not due to Alzheimer's disease (noADMCI-EEA) than matched noADMCI patients without EEA (noADMCI-noEEA).

Clinical, neuroimaging, neuropsychological, and rsEEG data in 32 noADMCI and 30 normal elderly (Nold) subjects were available in a national archive. Age, gender, and education were carefully matched among them. No subject had received a clinical diagnosis of epilepsy. Individual alpha frequency peak (IAF) was used to determine the delta, theta, and alpha frequency bands of rsEEG rhythms. Fixed beta and gamma bands were also considered. Regional rsEEG cortical sources were estimated by eLORETA freeware. Area under receiver operating characteristic (AUROC) curves indexed the accuracy of eLORETA solutions in the classification between noADMCI-EEA and noADMCI-noEEA individuals.

As novel findings, EEA was observed in 41% of noADMCI patients. Furthermore, these noADMCI-EEA patients showed higher temporal delta source activities as compared to noADMCI-no EEA patients and Nold subjects. Those activities discriminated individuals of the two NoADMCI groups with an accuracy of about 70%.

The significant percentage of noADMCI-EEA patients showing EEA and marked abnormalities in temporal rsEEG rhythms at delta frequencies suggest a substantial role of underlying neural hypersynchronization

mechanisms in their brain dysfunctions."

25 - (B) INTERNATIONAL FEDERATION OF CLINICAL NEUROPHYSIOLOGY (IFCN) GUIDELINES FOR TOPOGRAPHIC AND FREQUENCY ANALYSIS OF RESTING STATE ELECTROENCEPHALOGRAPHIC RHYTHMS

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Resting state EEG (rsEEG) rhythms reflect neurophysiological mechanisms and operational functions related to the fluctuation of brain arousal and quiet vigilance in humans and are largely investigated in clinical practice and research in Clinical Neurophysiology. In 1999, the International Federation of Clinical Neurophysiology (IFCN) published the Guidelines (PMID: 10590973). In 2017, the IFCN Executive Committee committed to a Working Group of 15 field experts the update of the part of those Guidelines concerning frequency and topographic analyses. This contribution will report the outcome of the mentioned Working Group. The paper by the Work Group was published this year (PMID: 31501011). Recommendations about relevant procedures of recording, storage, visualization, and quantitative frequency and topographic analyses of rsEEG data in Clinical Neurophysiology of vigilance were expressed based on theoretical ground and relevant core literature findings. Those recommendations reflected the consensus in the Working Group. Recommendations regarded main controversies in the field such as (1) the optimal experimental conditions ensuring that recordings of rsEEG rhythms fit requirements of a neurophysiological experiment on vigilance; (2) the minimum requirements of scalp electrode montage, reference electrode, and settings for subsequent frequency and topographical analyses; (3) choice of frequency bands; (4) linear/nonlinear synchronization and interdependence of rsEEG rhythms at scalp electrodes and sources; and (5) statistical modeling and neurophysiological inferences in clinical practice and research. Linear frequency and topographical source analyses of rsEEG rhythms (e.g., 10-20 electrode montage at minimum and extracephalic reference) are mature for both clinical practice and research applications. Nonlinear frequency and connectivity analyses of those rhythms require more research before their current use in clinical practice.

26 - (B) CORTICAL SOURCES OF RESTING STATE DELTA EEG RHYTHMS ARE ABNORMAL IN PATIENTS WITH AMNESIC MILD COGNITIVE IMPAIRMENT DUE TO ALZHEIMER'S DISEASE WITH EPILEPTIFORM-LIKE SIGNATURES

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"BACKGROUND: Cortical sources of resting state eyes-closed electroencephalographic (rsEEG) rhythms are abnormal in patients with amnesic mild cognitive impairment due to Alzheimer's disease (ADMCI). In the present exploratory and retrospective study, we tested whether those abnormalities may be stronger in ADMCI with (ADMCI-EEA) than without (ADMCI-noEEA) epileptiform-like EEG signatures.
METHODS: Clinical, neurophysiological, and rsEEG data in 56 ADMCI patients and 35 normal elderly (Nold) subjects were available in a national archive. The eLORETA freeware estimated rsEEG cortical sources. Area under receiver operating characteristic (AUROC) curves indexed the accuracy of eLORETA solutions in the classification between ADMCI-EEA and ADMCI-noEEA individuals.
RESULTS: As compared to AD7MCI-noEEA patients, ADMCI-EEA (N=25%) patients showed worse executive functions (Trail making Test B-A) and more abnormalities in widespread delta (about 2-4 Hz) and temporal theta (about 4-6 Hz) source activities. Furthermore, those sources were able to classify with moderate/good accuracies (AUROC =0.75-0.85) the ADMCI-EEA vs. ADMCI-noEEA individuals.
CONCLUSIONS: These results suggest higher abnormalities in low-frequency (i.e. delta and theta) rsEEG cortical activities in ADMCI-EEA than ADMCI-noEEA patients at both group and individual levels."

27 - (B) Transcutaneous vagus nerve stimulation in humans induces pupil dilation and attenuates alpha oscillations

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Vagus nerve stimulation (VNS) is widely used to treat drug-resistant epilepsy and depression. While the precise mechanisms mediating its long-term therapeutic effects

are not fully resolved, they likely involve locus coeruleus (LC) stimulation via the nucleus of the solitary tract (NTS), which receives afferent vagal inputs. In rats, VNS elevates LC firing and forebrain noradrenaline levels, whereas LC lesions suppress VNS therapeutic efficacy. Non-invasive transcutaneous VNS (tVNS) employs electrical stimulation that targets the auricular branch of the vagus nerve at the cymba conchae of the ear. However, the extent that tVNS mimics VNS remains unclear. Here, we investigated the short-term effects of tVNS in healthy human male volunteers (n=24), using high-density EEG and pupillometry during visual fixation at rest. We compared short (3.4s) trials of tVNS to sham electrical stimulation at the earlobe (far from the vagus nerve branch) to control for somatosensory stimulation. Although tVNS and sham stimulation did not differ in subjective intensity ratings, tVNS led to robust pupil dilation (peaking 4-5s after trial onset) that was significantly higher than following sham stimulation. We further quantified, using parallel factor analysis, how tVNS modulates idle occipital alpha (8-13Hz) activity identified in each participant. We found greater attenuation of alpha oscillations by tVNS than by sham stimulation. This demonstrates that tVNS reliably induces pupillary and EEG markers of arousal beyond the effects of somatosensory stimulation, thus supporting the hypothesis that tVNS elevates noradrenaline and other arousal-promoting neuromodulatory signaling, and mimics invasive VNS.

28 - (C) THE ROLE OF THE SUBTHALAMIC NUCLEUS IN IMPLICIT AND EXPLICIT EMOTIONAL PROCESSING: INSIGHTS FROM INTRACRANIAL RECORDINGS IN PARKINSON DISEASE

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"BACKGROUND
The specific role of the subthalamic nucleus (STN) remains controversial even though clinical and empirical work have established its implication in overall emotional processing. Here, we aimed to investigate changes in the frequency and pattern of activityin the STN during implicit and explicit processing of emotional information in Parkinson's disease (PD) patients.
METHODS: We examined the bipolar STN local field potentials and the induced time-frequency activity in five PD patients elicited while categorizing affective images with covert/implicit vs overt/explicit conditions and distinguishing "stimulus valence" (pleasant/unpleasant images), and "stimulus target" (human/non-human).
RESULTS: Stimulus valence induced a significant response slowing for unpleasant pictures relative to pleasant pictures, particularly in the covert condition. Furthermore, significantly shorter reaction times were also observed for human compared with non-human stimuli, specifically when the stimuli were implicitly presented during covert conditions. Time-frequency results showed the expected alpha (8-12 Hz) event-related desynchronization (ERD) both for pleasant and unpleasant stimuli. In addition, an ERD in the low-frequency range (4-12 Hz) was also identified mediating covert and overt emotion processing. Importantly, whereas the general identification of human and non-human stimuli seemed to be modulated in the alpha and low-gamma (36-45 Hz) ranges, under covert processing, however, this effect was specifically modulated in the low-gamma range.
CONCLUSIONS: Our findings suggest that processing an ongoing stream of emotional information may engage the STN-basal ganglia network, particularly for implicit emotional items, favouring thus the emotional and attentional stimuli processing based on their human characteristics necessary for goal-directed control of behaviour."

29 - (C) Somatosensory evoked potentials reveal reduced embodiment of emotions in Autism Spectrum Disorder

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In the past two decades, research has shown the contribution of the somatosensory system to emotion recognition, supporting the embodied emotion hypothesis. Atypical processing of emotional expressions in Autism Spectrum Disorder (ASD) has been mainly investigated at a visual level, here we aim to test if ASD individuals show atypical responses in the somatosensory system during emotion recognition, compared to Typically Developed (TD) individuals. We presented neutral, fearful and happy faces and asked our two groups of participants to observe the emotional expression (emotion task) or the gender (control task) while recording their brain activity with a 64-channels EEG. To ensure participants were paying attention to the task, in 20% of trials we presented a question on the emotion or gender of the face stimulus. We measured Visual Evoked Potentials (VEPs) over the occipital lobe and Somatosensory Evoked Potentials (SEPs) over sensorimotor areas. Task-irrelevant SEPs were evoked in 50% of trials by applying a tactile stimulation on participants' index finger after 105 ms of visual onset. To isolate somatosensory activity from visual carryover effects, we subtracted the neural responses recorded in the visual condition from activity in the visuo-tactile condition (Sel et al., 2014). Interestingly, we found significant task and group and task, group and region interactions in the P100 SEPs component. Follow-up analysis revealed reduced amplitude of P100 in ASD compared to TD only in emotion task. Moreover, we observed increased responses in frontal sensorimotor regions in emotion task compared to gender task in TD but not ASD. Simple linear regressions revealed that autistic traits, measured by Autism Quotient and Social Responsiveness Scale, significantly predicted the amplitude of P100 only in emotion task. Our study

provides novel evidence of atypical recruitment of the somatosensory system during recognition of emotional expressions in individuals with ASD.

30 - (A) Bayesian inference of population prevalence

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Within neuroscience, psychology and neuroimaging, the most frequently used statistical approach is null-hypothesis significance testing (NHST) of the population mean. An alternative approach is to perform NHST within individual participants and then infer, from the proportion of participants showing an effect, the prevalence of that effect in the population. We propose a novel Bayesian method to estimate such population prevalence that offers several advantages over population mean NHST. This method provides a population-level inference that is currently missing from study designs with small participant numbers, such as in traditional psychophysics and in precision imaging. It delivers a quantitative estimate with associated uncertainty instead of reducing an experiment to a binary inference on a population mean. Bayesian prevalence is widely applicable to a broad range of studies in neuroscience, psychology and neuroimaging. Its emphasis on detecting effects within individual participants could also help address replicability issues in these fields.

31 - (A) Timeflux, an open-source framework for the acquisition and real-time processing of biosignals

Pierre Clisson, Raphaëlle Bertrand-Lalo
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The field of Brain-Computer Interfaces is currently experiencing a momentum, attracting both researchers and hackers. At the same time, a growing number of people rely on the thriving Python datascience and machine learning ecosystem. Yet, until recently, there was no fully open source Python framework for building BCIs. Timeflux (https://timeflux.io) aims to fill this gap. It allows multimodal acquisition, real-time processing of biosignals, and includes a variety of data structures, network protocols, and machine learning tools. It also provides a JavaScript API for sub-millisecond stimulus presentation in web browsers.

32 - (A) Validation of Volume Conduction Models with Stereotactic EEG Data

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Volume conduction models of the human head are used in various neuroscience domains, such as for source localization in EEG and MEG, and for modeling effects of transcranial stimulation. Many studies have used numerical simulations to quantify the accuracy of the head model, the sensor model, and the source model. However, it is hard to empirically validate and to compare model simulation results to actual measurements. The recording of stereotactic EEG during electric stimulation mapping provides an opportunity for such a validation. In our study we used the potential distribution of cortical stimulation artifacts to evaluate the accuracy of finite element method (FEM) volume conduction models. We compared the measured potentials with the simulated potential in three volume conduction models, with increasing level of detail, using measurements in three epilepsy patients. We quantified the overall correspondence between measured and modeled potentials. Our results show that, overall, there is little advantage in increasing the level of detail of the FEM head model. The mismatch between measured and modeled potentials reaches up to 40 microvolts (i.e., 10% relative error) in 80% of the cases, and only changes marginally with an increasing level of detail in the FEM model. The mismatch is highest for a small distance between recording and stimulating electrodes, and decreases for increasing distances. Our study suggests that the efforts to make more and more detailed FEM models do not pay off as expected and might have to be reoriented and channeled towards other directions, such as, for example, higher resolution imaging methods and better estimates of tissue conductivities. We share the dataset to allow researchers to further investigate the mismatch between measurements and FEM models and to contribute to improving volume conduction models.

33 - (A) Phase Amplitude Coupling: Methodological Pitfalls and How to Avoid Them

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Previous work has demonstrated that the phase of low frequency neural oscillations can be coupled with the amplitude of high frequency oscillations (phase amplitude coupling; PAC), to support certain neurocognitive processes. However, numerous incidences of reported PAC may in fact be false positives, caused by suboptimal analysis practices and/or the presence of artifacts within the data (Aru et al., 2015; Hyafil, 2015). This talk will outline the crucial steps involved in quantifying PAC in neural time-series data, alongside the algorithms commonly used by the field. This will be followed by a detailed discussion on the methodological pitfalls surrounding PAC analysis, including: filtering and edge artefacts; non-sinusoidal oscillations; the construction of appropriate surrogate data; and statistical analysis. Practical solutions to these pitfalls will be outlined. Finally, openly available MATLAB scripts and intracranial EEG data will be used to show how PAC can be quantified in real neurophysiological data, in order to answer a particular hypothesis of interest.

34 - (A) Multisensory correlation computations in the human brain uncovered by a time-resolved encoding model

Jacques Pesnot Lerousseau (1), Cesare Parise (2), Marc O. Ernst (3), Virginie van Wassenhove (4)
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The neural mechanisms that help the brain arbitrate between integrating and segregating multisensory information is currently poorly understood. Recent behavioral and neurophysiological studies suggest that computing the temporal correlation of multisensory signals may provide an essential cue for integration vs. segregation. The specific computations to solve these operations have been recently implemented in a model, the Multisensory Correlation Detector (MCD). While MCD has a good explanatory power for behavior, whether it is also a good candidate for the neural implementation of multisensory integration mechanisms remains to be tested. In this magnetoencephalography (MEG) study, we parametrically tested the prediction of the MCD model for the human brain. We had observers judging whether pseudorandom sequences of auditory and visual impulses appeared to originate from the same sources and which modality seemed to be presented first. We developed a novel approach using encoding models of electrophysiological activity based on the predictions of the MCD: we used multivariate Temporal Response Functions to model both stimuli and the predicted time-resolved outputs of the MCD and measured their goodness of fit with neural activity. We found that activity in the temporo-parietal junction can be predicted by the MCD model, which computes the temporal correlation of audiovisual signals. Intriguingly, temporal correlation computations are present independently of the task whereas temporal lag computations are present only in a temporal order judgment task.

35 - (A) From BIDS-formated EEG data to group results: a fully reproducible workflow with EEGLAB and LIMO EEG

Cyril Pernet (1), Ramon Martinez-Cancino (2), Dung Truong (2), Scott Makeig (2) & Arnaud Delorme (2)
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Reproducibility is a cornerstone of scientific communication without which one cannot build upon each other's work. Because modern human brain imaging relies on many integrated steps with a variety of possible algorithms, it has however become impossible to report every detail of a data processing workflow. In response to this analytical complexity, community recommendations are to share data analysis pipelines (scripts that implement workflows). Here we show that this can easily be done using EEGLAB and tools built around it. BIDS tools allow importing all the necessary information and create a study from EEG-Brain Imaging Data Structure compliant data. From there preprocessing can be carried out in only a few steps using EEGLAB and statistical analyses performed using the LIMO EEG plug-in. Using Wakeman and Henson (2015) face dataset, we illustrate how to prepare data and build different statistical models, a standard factorial design (faces * repetition) and a more modern trial based regression approach for the stimulus repetition effect, all in a few reproducible command lines.

36 - (A) Considerations for Detecting & Measuring Neural Oscillations

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"Throughout approximately 100 years of research, and in particular across the last 50 years or so of applying computational approaches, research has investigated neural oscillations and how they relate to cognition. This work is premised on a set of analysis tools and approaches for identifying and measuring oscillatory activity. The interpretation of the results provided by these tools is constrained by the assumptions embedded in the tools themselves, which are often hidden from the users, and may at times be at odds with the realities of the data. Over time, our understanding of these signals, and how that relates to the methods we typically use to investigate them, has also evolved. In this project, we develop a best-practices checklist of methodological considerations one should keep in mind in order to appropriately measure oscillations. This list comprises:
1) verifying the presence of oscillations; 2) verifying oscillation band definitions; 3) addressing the presence of concurrent aperiodic activity; 4) variable rhythmicity and temporal fluctuations of oscillatory bursts; 5) the implications of oscillatory waveform shape; 6) the requirement of spatially separating rhythms 7) considering the signal-to-noise ratio for arriving at good estimates For each topic, we consider and explore how each can lead to methodological and interpretive errors. We examine this for common analyses such as filtering, power and phase estimates, and also how these issues propagate to multivariate measures such cross-frequency coupling metrics and connectivity measures."

37 - (B) Convolutional Neural Network for Octave Illusion Classification Using Magnetoencephalography Data

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The octave illusion occurs when two tones with one-octave difference are alternately played to both ears repeatedly. The aim of this study is to classify participants into illusion (ILL) and non-illusion (non-ILL) groups by applying a convolutional neural network (CNN). Brain activity data were recorded by magnetoencephalography (MEG), and the activation

levels between the two groups were analyzed. The study proposes a method for developing several layers of learning units for comparing activities in the same brain regions for the ILL and non-ILL groups. The proposed neural network shows 100% accuracy, sensitivity, and specificity performance results, with training and validation losses around 0.02% on the octave illusion dataset. This study is the first to apply deep neural networks for the classification of MEG data to ILL and non-ILL groups. The developed CNN showed stable results in the classification of octave illusion and non-illusion data with 100% accuracy and low training and validation losses, which indicate that no overfitting occurred. Moreover, the developed architecture has also shown good results in the classification other auditory illusion data such as binaural hearing, and in future it can become an universal tool for classification auditory illusions using MEG data.

38 - (B) Forward Looking Operations Workflow (FLOW) for Collaborative Reproducible MEEG Data Management and Analysis

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"Advances in EEG/MEG (MEEG) data analysis have included scientist-designed analysis software in increasingly powerful interpreted languages including Python (MNE) and MATLAB (Fieldtrip, EEGLab, SPM, Brainstorm). At the same time, software industry advances have integrated powerful data mining and machine learning capabilities that are optimized by Big Data in large database repositories with access through cloud computing and web services user interfaces. Our goal is to integrate these paradigms so that a laboratory utilizing FLOW can optimize their research with the speed of advanced cloud computation and large data repositories.

We designed the BEL Cloud Platform to integrate a lab database and web browser visualization within an efficient workflow (FLOW) management that can build on current MEEG tools (MNE and others). We draw upon modern industry technologies to optimize MEEG signal analysis and interpretation. An MEEG database organizes multiple common file formats (EDF, FIF, MFF) with the Brain Imaging Database Structure (BIDS) standard, and with key information for each file (subject and experiment description, event tracks, indexing) managed in the database. With this organized access to the database, validated and replicable analysis workflows can be integrated with Docker Containers.

For standardized analysis paths, the workflows can be "forward looking" in that they are precomputed for evaluation by both machine algorithms and human inspection. For example, in our initial implementation, an EEG Event Related Potential (ERP) analysis path is developed in MNE Python and implemented with parameter passing in a Docker Container. The output is stored in filtered, averaged, intermediate files managed by the FLOW database, and then processed with statistical extraction and analysis in an R script running in its own Docker Container. "

39 - (B) EEG and fMRI connectomes are reliably related: a simultaneous EEG-fMRI study from 1.5T to 7T

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"Both electroencephalography (EEG) and functional Magnetic Resonance Imaging (fMRI) are non-invasive methods that show complementary aspects of human brain activity. Despite their differences in probing brain activity, both electrophysiology and BOLD signal can map the underlying functional connectivity structure at the whole brain scale at different timescales. Previous work demonstrated a moderate but significant correlation between resting-state functional connectivity of both modalities, however there is a wide range of technical setups to measure simultaneous EEG-fMRI and the reliability of those measures between different setups remains unknown. This is true notably with respect to different magnetic field strengths and different spatial sampling of EEG (electrode coverage).

Here, we investigated the reliability of the bimodal EEG-fMRI functional connectome in the most comprehensive resting-state simultaneous EEG-fMRI dataset compiled to date including a total of 72 subjects from four different imaging centers. Data was acquired from 1.5T, 3T and 7T scanners with simultaneously recorded EEG using 64 or 256 electrodes. We demonstrate that the whole-brain monomodal connectivity reliably correlates across different datasets and that the crossmodal correlation between EEG and fMRI connectivity of r≈0.3 can be reliably extracted in low and high-field scanners. The crossmodal correlation was strongest in the EEG-β frequency band but exists across all frequency bands. Both homotopic and within intrinsic connectivity network (ICN) connections contributed the most to the crossmodal relationship.

This study confirms, that simultaneous EEG-fMRI offers a consistent estimate of multimodal functional

connectomes in healthy subjects being organized into reliable ICNs across different timescales. This opens new avenues for estimating the dynamics of brain function and provides a better understanding of interactions between EEG and fMRI measures."

40 - (B) Multiple Sparse Priors applied to epileptic spike source localization

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"Introduction: About 30% of epileptic patients are non-responsive to drug treatment and neurosurgical resection of the epileptogenic tissue becomes the primary therapeutic option. The goal in pre-surgical planning is to determine the location of the so-called epileptogenic zone. This location can be estimated by means of electroencephalography (EEG) source localization algorithms or "inverse solvers". Accurate source localization of epilepsy spikes is dependent on accurate electrical head models and appropriate inverse solvers. In this work, we compare the performance of the multiple sparse priors (MSP) inverse method with the standardized low-resolution brain electromagnetic tomography (sLORETA) method in a set of fifteen epilepsy patients.

Methods: For each subject, we built high-resolution and individual electrical head models. The inverse solvers require the computation of the distribution of the electromagnetic field within the head. We solved this using our hexahedral finite element method (HexaFEM) engine. For each patient, spikes were grouped according to spatial similarity prior to spike averaging. The averaged spikes were source localized using our own implementations of the MSP and sLORETA methods. The criteria for accuracy was given by the spatial mask of the volume resected in the surgery, considering that all subjects of this set remained seizure free.

Results: The MSP method performed similarly to the sLORETA method and slightly better in terms of success rate. The MSP was more focal than sLORETA with the advantage of not requiring an arbitrary selection of a hyperparameter or thresholding of reconstructed current density values to determine focus.

Conclusions: Results suggest that both methods are complementary and could be used together. In practice, the MSP method will be easier to use and interpret compared to sLORETA."

41 - (B) Detection of mesial networks with magnetoencephalography during cognition

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The non-invasive recording of deep structures such as the hippocampus is one of the greatest ambitions in neuroscience. Although it has been demonstrated that their neural activity can reach the surface of the head, its contribution to magnetoencephalography (MEG) recordings may be eclipsed by the activity of large neocortical networks. With independent component analysis (ICA) on MEG, we can disentangle activities that arise from the medial temporal lobe. In a memory task involving recognition of old and new images, we identified a robust putative mesial component with ICA, present in all patients. In combination with simultaneous intracranial recordings, we validated the origin of the component, and identified the deep source in the medial temporal lobe, composed by the activity generated by the hippocampus, the rhinal cortex and the temporal pole. This finding confirms previous studies with epileptic activity and opens new possibilities for the study of deep structures in cognition and disease.

42 - (B) An unexpected parameter issue when estimating source-space connectivity using MNE

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"Functional brain connectivity aims at quantifying and explaining the statistical dependencies that can occur between different brain regions. Thanks to their temporal resolution, magneto- and electro-encephalography (M/EEG) are providing a crucial contribution to the investigation of brain connectivity by non-invasively recording time-courses of measurements of the electromagnetic field induced by neural currents. Connectivity estimation is usually achieved in a two-step process: first the neural time-courses are estimated, then functional connectivity is computed between the estimated time-courses. When using Minimum Norm Estimate (MNE) (Hämäläinen and Ilmoniemi, 1994) to estimate the neural time-courses, a regularization parameter has to be set to tune the trade-off between fitting the data and mitigating the impact of measurement noise; but of course, the choice of the regularization parameter impacts the whole two-step process.

In this poster I will show that, under the assumption of white-noise Gaussian signals and using the cross-power spectrum to quantify connectivity, the parameter that provides the best reconstruction of the time-courses is suboptimal for the subsequent connectivity estimation. Indeed, analytical results show that a smaller parameter should be set for the latter intent (Vallarino et al., 2020). I will also show that this somehow unexpected behaviour of the regularization parameter holds also when the

unrealistic assumption of white-noise Gaussian signals is relaxed and more realistic models are considered. In addition, empirical results suggest that, in these circumstances, the parameter that provides the best connectivity estimation is influenced by the spectral properties of the signals. Specifically, the optimal parameter for connectivity estimation gets smaller as the spectral complexity of the signals grows."

43 - (C) Detection Power of Functional Connectivity Measures: A Simulation Study

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Magnetoencephalography (MEG) is a non-invasive technique that allows for the study of functional connectivity between brain regions with high temporal resolution. However, mapping the sensor data to source-space limits its spatial resolution and introduces `signal leakage'. This manifests as large numbers of false interactions in functional connectivity. These are caused by active, non-interacting sources, and their contributions to connectivity are real-valued. Several functional connectivity measures have been proposed to mitigate this problem by taking into account only imaginary-valued interactions. This means that in practice they can only detect interactions with sufficiently large delays. In order to investigate connectivity detection in the presence of signal leakage, we perform a simulation study on five measures: Imaginary Coherency, Lagged Coherence, Phase-Locking Value, Phase Lag Index, and weighted Phase Lag Index. We use a statistical testing procedure to assess the power of functional connectivity measures as test-statistics. We assume that the generative model follows a Gaussian distribution. Two homologous sources are active, with locations known and fixed. The model's coherence has two parameters, γ and ϕ, which correspond to the amplitude and delay of the connection $\gamma e^{i\phi}$. Since signal leakage originates from active, non-interacting sources, this case is set as the null hypothesis. The alternative hypotheses correspond to the sources interacting with various values of the connection parameters. The statistical power is computed for each measure as a function of the model parameters, and it indicates the probability that the measures detect true connectivity when the sources are interacting. Further, this study provides guidance on which measure to choose in practice.

44 - (C) Linear distributed inverse solutions for interictal EEG source localisation

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"Linear distributed inverse solutions are widely used for EEG source localisation of interictal epileptic discharges. Until now, it is unclear which among them yields the most accurate results.
Based on 204 EEG channels, averaged interictal discharges, and the LSMAC forward model, we assessed the accuracy of the minimum norm, weighted minimum norm, LORETA, LAURA, sLORETA and eLORETA algorithms. Spatial accuracy was tested clinically by concordance with the resected brain area in 30 patients with successful epilepsy surgery, and in computer simulations applying different levels of noise to the signal in both sensor space and source space.
In the clinical data, both LORETA and LAURA yielded an accuracy of 67% while all other inverse solutions performed significantly worse (33-37%; corrected $p<0.01$). In the simulation studies, LORETA and LAURA had substantially smaller localisation errors than the other inverse solutions when noise levels exceeded 10%.
Thus, in comparison with the other linear distributed inverse solutions tested here, LORETA and LAURA should be preferred for interictal EEG source localisation due to their higher robustness towards noise. "

45 - (D) Effect of default experimental constraints (fixation and still images) on ratings, gaze behavior, and EEG signal quality in a visual aesthetic rating task

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"Free gaze and stimulus variability are typically avoided in EEG experiments due to the generation of artifacts or fear of introducing systematic biases. Yet, for a growing number of research questions untightening these rigorous restrictions would be beneficial. Among those is the investigation of aesthetic experiences, which typically involve open-ended exploration of highly variable stimuli.
To our knowledge, no systematic comparison of conservative vs. more liberal experimental settings exists. Here we aimed to assess EEG signal quality during an aesthetic rating task of both static images and dynamic (video) stimuli. Participants either fixated on a dot or were allowed to gaze freely. Visual content consisted of either dance performances or nature scenes. In every trial participants rated aesthetic preference and state boredom. An auditory stream of 40Hz amplitude modulated pink noise was played during each trial. We recorded EEG and eyetracking from 43 participants. Signal-to-noise-ratio (SNR) of the auditory steady-state response was extracted as proxy for overall EEG signal quality. The study including hypotheses and a priori power analysis was preregistered.
Our data suggest that both behavioral ratings were influenced by experimental condition (lower boredom ratings in free-viewing task, higher aesthetic ratings for video stimuli; both effects stronger in dance). Gaze behavior was significantly affected not only by viewing task, but also by stimulus dynamics (fewer micro-saccades and large saccades for videos), and content (fewer large saccades for dance), with several significant interactions.
EEG SNR, to our surprise, was not significantly linked to any of the investigated conditions - despite only minimal preprocessing and no trial rejection. Average SNR varied by participant, but there was no main effect of task

conditions, and no correlation of SNR with individual ratings or gaze behavior. "

46 - (D) Data-driven approach for the delineation of the irritative zone in epilepsy

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"Objectives: The reliable identification of the IZ(IZ) is a prerequisite for the correct clinical evaluation of medically refractory patients affected by epilepsy. Given the complexity of MEG data, visual analysis is highly time consuming and might leave clinically relevant information undetected.
Methods: We recorded and analyzed the interictal activity from eight patients affected by multifocal epilepsy (Vectorview Neuromag). We implemented an innovative pipeline for the detection of interictal spikes and the delineation of the IZ. First, we detected candidate timestamps from "peaky" ICA components [1], then extracted spatio-temporal patterns applying convolutional sparse coding (alphaCSC [2]). We used our library of patterns to create IZ maps computed at the amplitude peak (PEAK), and at the 50% of the peak ascending slope (SLOPE). We validated our approach by spatially comparing these maps of the IZ with the sources of visually marked spikes (VIS) and with the surgically resected area (RA).
Results: We successfully identified spatiotemporal patterns mimicking the underlying interictal activity in all patients. Across patients, the accuracy in the delineation of RA was 95% in both SLOPE and VIS, while it was 92% for PEAK. The distance of the IZ from resection margin was lower for the SLOPE, followed by VIS and PEAK. More importantly, when considering the extension of the delineated IZ and its average distance from the resection margin, we observed more precise and clinically relevant pattern in PEAK than in SLOPE for 6 out of 8 patients. In 5 of these 6, SLOPE was also better than VIS.
Conclusions: We validated here the performance of an innovative data-driven approach for the automated detection of interictal spikes, and semiautomatic delineation of IZ. This computational framework provides the basis for reliable, reproducible, bias-free analysis MEG recordings in epilepsy.

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[2] ArXiv:1805.09654 2018"

47 - (D) Separability of finger somatotopic activity in sensorimotor cortex using high-density ECoG

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"Brain-Computer Interfaces (BCIs) controlled by electrocorticography (ECoG) are used to restore and replace communication in severely paralyzed people. To date, motor-based BCIs have mainly focused on the sensorimotor cortex, resulting in a stable albeit slow control by the patients. The performance could be improved by considering more discrete classes of movement to steer the BCI. A promising candidate could be to decode individual finger movements and hand gestures. This requires a deeper understanding of the spatial resolution of the ECoG grid because it depends on activity in smaller regions of the cortex.
Here, we investigated whether simulated somatotopic activity of individual fingers in M1 and S1 can be separated from each other when recording with a high-density ECoG grid. We performed our simulations with FEMfuns, a volume conduction modeling software toolbox based on the finite element method. A realistic head model and ECoG grid was used to construct lead field matrices (LFMs) for somatotopic source patterns representing the fingers in M1 and S1 based on recent fMRI data. Singular value decomposition is used to describe how separable the LFMs of fingers are.
We find high separability values of the somatotopic activity of individual fingers in sensorimotor cortex if the ECoG grid has sufficient coverage of the active region. Furthermore, due to low signal magnitude of deep sources, minimal separability is found between deep and superficial sources.
In conclusion, we show that sources representing finger activity close to the electrodes and with sufficient grid coverage are separable when using a high-density grid. This approach can be used to estimate the spatial resolution of the recording equipment."

48 - (D) Analyzing the frequency spectrum of neurophysiological responses to complex linguistic stimuli: a methodological investigation

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For decades researchers have been using the frequency tagging technique to capture steady-state evoked potentials during repetitive, rhythmic presentation of visual and somatosensory stimuli. Recently, this method has been further deployed to capture processing of top-down mechanisms driven by experience or higher-level integrative processing mechanisms. One example of this is the MEG/EEG research on sentence processing. Several recent studies reported that peaks of neurophysiological power arise at frequencies of sentence constituents when people process isochronously organized sentences. This was claimed to reflect that humans perform online processing of syntactic hierarchies, with the neural mechanism being the neural entrainment of slow neural oscillations to syntactic structure of the stimuli. Here we conducted a methodological investigation of the frequency tagging approach in sentence processing to assess both its

potential and limitations. We report two data simulations and outline several methodological considerations, concluding that analyzing the spectrum of neurophysiological responses to complex stimuli such as sentences requires careful choice of experimental stimuli and consideration of arrhythmic fluctuations in the signal. Among other factors, word-level information, such as word frequency and linear chunking driven by transitional probabilities, can modulate spectral power peaks at low frequencies. Taking into account these concerns, we discuss advisable methodological practices for experiment creation and data analysis that should be considered by future frequency tagging studies of sentence processing and other higher-level constructs (incl. music and complex visual processing).

49 - (D) Spatio-temporal signal separation approaches for artefact suppression and source leakage correction

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"Source leakage or volume conduction is a ubiquitous problem in MEG which can influence both source estimation and the estimation of connectivity within brain networks. Traditional approaches to mitigate the effects of source leakage rely on post-hoc leakage correction after source signal estimation – usually through orthogonalization or regression based approaches which are applied on sources within a particular network of consideration. Whilst such approaches are useful, they do not take into account the effect of source leakage from other brain areas that are not within the network of consideration. Furthermore, source leakage can lead to spatiotemporal correlations which significantly impair the performance of source reconstruction algorithms, leading to poor estimations of sources on which leakage correction algorithms are subsequently applied. Here we propose a data driven pre-processing approach for leakage correction which addresses the spatial (source space separation) and temporal (canonical correlations) interactions of distributed sources. This approach can be employed before source estimation. We show preliminary simulations of our approach and its application on reconstructing evoked responses during Deep Brain Stimulation experiments."

50 - (D) Spatio-temporal analysis of error-related brain activity

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Electroencephalography (EEG)-based brain-computer interface (BCI) systems read and infer brain activity directly from the brain and generate user intended commands such as moving a cursor on a screen, moving a wheelchair, etc. However, existing BCI systems do not perform perfectly and when the BCI makes a mistake – i.e., its output differs from what was intended by its user – error-related brain activity is generated. The brain response to error is known to be classifiable (Chavarriaga et al., Front. Neurosci., 2014) and can be used in an active BCI setting as a secondary source of information to improve reliability (Mousavi et al., JNE, 2020) or as the main source of information in a passive BCI (Zander et al., PNAS, 2016). To this end, improving the performance of existing classifiers on error-related brain activity can have a vast impact on improving the reliability of various BCI systems. With this goal, we proposed CREST: a novel algorithm combining Euclidean and Riemanian geometry-based features for the detection of spatial and temporal aspects of the error-related brain activity (Mousavi and de Sa, BCI Journal, 2019). We showed the superiority of our proposed algorithm in comparison to existing methods on two different BCI datasets. The algorithms behind this work could be applied to recognize other types of EEG signals and lead to more reliable and consistent processing of EEG data that can be used in a variety of active and passive BCI applications for patients as well as the healthy population or for general EEG analysis in cognitive neuroscience research.

51 - (B) Sharing An Open Stimulation System for Autitory EEG experiments using Python, RasberryPi and HifiBerry

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"Background: In neurosciences experiments, the variability of stimulation solutions both for software and hardware adds unnecessary technical constraints in behavioral and EEG studies. Easy to use, low cost and shareable systems to run experiments could improve collaborations and comparison of data between different sites and contexts, for example between labs and clinics.
New method: This poster describes how a Raspberry pi coupled with python programming and pimped by HifyBerry could be used for high timing accuracy and sound quality constraints needed in auditory cognition experiments, furthermore allowing simple use and diffusion.
Results: Our system shows high performances and results coupled to excellent feedback from users. It is cheap, easy to share, construct and improve-upon. Working with such low cost, powerful and collaborative hardware and software tools allows the creation of adapted and shareable systems that can be standardized across different collaborative sites, while being extremely simple and robust in use."

52 - (B) BIDS-Pipeline: a Framework for performing muli-subject analysis in electrophysiology within the Brain Imaging Data Structure

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Neuroscience community has faced the challenge of reusing scripts to analyse data coming from different projects or different centers, however analysing large cohorts of data is very important to increase statistical power. Brain Imaging Data Structure (BIDS) has been developed, in part, to overcome this problem. Our goal was to develop tools for transferring and organising data from different centers in the BIDS format, and to launch automated analyses on several subjects with common criteria. To work on multicenter projects, we developed a framework to collect, organise, manage and automatically analyse multimodal datasets. To collect data, we designed an uploader programme to transfer the files and prepare them for import into BIDS. Then, the data are automatically converted and organised in BIDS structure through a software suite called BIDS Manager. For the analysis, Matlab scripts, Python scripts, AnyWave plugin, BIDS App and executable software can be launched on subjects through BIDS Pipeline. BIDS Pipeline can be considered as a bridge between BIDS dataset and software. Thanks to the interface, users can filter the subject in the dataset by ID or by criteria, and input common analysis parameters. BIDS Pipeline controls whether the selected values can be applied to the selected subset, provided the inputs and the outputs, and run the process on all selected subjects. The way to store the results is based on BIDS derivatives specifications. BIDS Pipeline also provides a batch system to launch several processes one after the other. The last BIDS Pipeline's function is to create a table gathering the different metrics by channels resulting from the analysis across subjects, for later statistical analysis. Bids Manager/Pipeline allows organizing and analysing data from large cohorts, either in basic neuroscience or in clinical research. This framework can take advantage of tools developed by the neuroscience community, centralizing and facilitating their use.

53 - (C) PyMultiFracs: a Python wavelet leader multifractal toolbox for assessing scale-free activity in brain signals

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"Numerous signals collected on biological and physical systems have been shown to display 1/f power-spectra, suggesting the presence of scale-free temporal dynamics. Multifractal analysis, based on the theoretically grounded wavelet-leaders, provides a formal tool to assess scale-free dynamics (long-range correlations, self-similarity and multifractality) in time series. We have implemented this practically robust and efficient multifractal formalism in an open-source Python toolbox called PyMultiFracs, which provides state-of-the-art tools for the characterization of scale-free temporal dynamics and the estimation of the associated scaling exponents.
In this poster, we illustrate the use of the PyMultiFracs Toolbox on MEG recordings at the scalp level (sensors), although it can be easily applied to source estimates and/or EEG signals. In this poster, we will explain how to select key parameters (e.g. the mother-wavelet, the range of scales in which the estimation is performed, the order of the fractional integration, the norm defining the leaders, etc.). For a given MEG time series recorded on a specific sensor (magnetometer or gradiometer), we extract the scaling exponents to construct its multifractal spectrum. This spectrum summarizes how scale-free brain activity in the infraslow regime (below 1 Hz) varies in time globally and locally for a given sensor. By repeating the analysis for each sensor, we can simply draw topographic maps of scale-free exponents. Using the features developed in the PyMultiFracs toolbox, we can (i) illustrate how scale-free dynamics in resting-state differs from empty room noise, by comparing machine (squid) noise to resting-state recordings and (ii) provide the best practice for artifact removal (e.g. eye blinks, heart beat, etc.) potentially affecting the estimation of scale-free parameters."

54 - (D) ERPscope: a new R package to easily visualize ERP data

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One crucial step of scientific research is visualizing the data, which can be especially challenging with multidimensional EEG data. Several toolboxes exist to preprocess EEG data involving different platforms but their plotting capacities are often limited, not always easy to use, or difficult to customize. As many researchers already export their data to the R environment in order to run statistical analyses, it would be best to also take full advantage of R's plotting capabilities. Here we present ERPscope, a freely available R package that makes it easy to visualize and analyze ERP data. This user-friendly package allows for creating ERP graphs and voltage maps with flexible and intuitive customization options. It offers a set of functions to plot ERP waves (plot_erp) and difference waves (plot_difference) for multiple individual electrodes or regions of interest. Both functions can add labels at specific time points (e.g., "target word" or "verb"), plot confidence intervals around the average waveform, indicate the baseline interval used in preprocessing, and apply alternative (simulated) baseline corrections to the data. Graph background, line colors, line types and thickness are easily adjustable for each ERP wave. It is also possible to display the results of a running t-test between two conditions at each electrode along with the ERP difference wave and to plot voltage maps for customized time windows. The function plot_cor_with_erp_effect computes and plots the correlation between an ERP effect in a given time window and an external variable for various scalp regions. Finally, using generate_ERP_stats_table, one can run the same statistical model across different time windows and get an easy-to-read table that highlights significant factors (optionally color-coded according to

polarity). ERPscope is compatible with most existing data analysis pipelines. For further details and illustrations, please visit github.com/aherbay/erpscope.

55 - (D) BIDS Derivatives – Standardizing processing results of neuroimaging data

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The Brain Imaging Data Structure is a community-led standard for organizing, describing and sharing brain imaging data. It currently supports data coming from MRI, MEG, EEG, iEEG and behavioral data generated by a broad range of neuroscientific experiments. BIDS has facilitated the generation of multiple applications and tools that may run with minimal intervention on BIDS datasets (i.e., BIDS-Apps) and fostered data sharing within labs and in large scale databases (e.g., OpenNeuro). In this poster, we will present the very recently released BIDS Common Derivatives, a set of principles for organizing and describing outputs of computations performed on brain imaging data, enabling researchers and tools to understand and reuse those outputs in subsequent processing. Additionally, we will introduce the ongoing efforts on the Common Electrophysiological Derivatives which will further contribute to good scientific practices in EEG and MEG research.

56 - (D) The MNE Study Template: A standardized automated M/EEG processing pipeline.

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"Cognitive neuroscience research faces a reproducibility crisis, to which open science approaches provide potential solutions. In the endeavour to ensure repeatability of results, we face a number of different challenges: data management, publication of datasets while safeguarding participants' privacy, or sharing of analysis software are just a few examples that can cause but a long-lasting headache.

Fortunately, the neuroimaging community started an international effort to standardize the sharing of magnetic resonance imaging (MRI) data. Today, this Brain Imaging Data Structure (BIDS) also covers magnetoencephalography (MEG, added in 2018) and electroencephalography (EEG, 2019) data as well. This means we can now – for the first time ever – not only share our data in a standardized format, but also develop and share entire data processing and analysis pipelines. The combined sharing of data and analysis tools guarantees an unprecedented degree of reproducibility of research results.

The MNE-BIDS package allows for a seamless operation on M/EEG BIDS data using MNE-Python, the de-facto standard software for M/EEG data processing in Python. Users can conveniently read, write, and alter BIDS datasets, as well as anonymize and convert existing (non-BIDS) data to BIDS.

Building on top of BIDS-formatted data is the free and open-source MNE Study Template. This project aims to create a standardized pipeline that can process an entire dataset, including but not limited to: preprocessing, epoching, automated artifact rejection, ERP/ERF analysis, time-frequency analysis, contrasting conditions, and even inverse modeling and group analyses. It creates an extensive report, summarizing all vital steps and results of the conducted analyses. Users only need to adjust a simple configuration file to start using the Study Template; the inner workings of the pipeline follow established best practices and, therefore, ensure a high degree of consistency among the research community."

57 - (D) Can Lab Streaming Layer (LSL) be used to combine Virtual Reality Experiments programmed with Unity and Electrophysiology Recordings (EEG)?

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"A common problem of simultaneous data acquisition or analysis from different sampling sources is the time synchronization between them. LSL is a software that automatically solves this issue by unifying the collection of time-series measurements in research experiments handing both networking and time-synchronization of the data (https://github.com/labstreaminglayer/). Moreover, LSL is a cross platform and open source application with great community support. Due to the increasing demand of EEG research using virtual (realistic) environments it seems necessity of to check LSL's reliability combining them. Additionally, it is important to identify the time distance between the virtual reality (VR) framework, and the VR glasses during the presentation of visual and auditory stimuli.

We therefore tested visual and audio latencies in a virtual environment. As a visual stimulus, a black screen

changing to white for one frame every 500 ms was used. Additionally an auditory stimulus, a short click sound lasting for one frame, was played at the same time as the visual stimulus changed color. Using the game engine Unity® (www.unity.com) we tested LSL using both, a 2-D and a 3-D scene in which a black and white plane inside a more heavy load environment was used as a visual stimulus.

The frame rate influenced the outcome of the recoding with 90 frames-per-second (FPS) ensuring a constant frame rate but leading to more frame drops compared to a frame rate of 50 FPS. Using 90 FPS, the latency for visual stimuli was relatively constant (mean: ~75ms (2D) or ~83ms (2D and 3D), std: 0.4 - 0.7 ms). The latency of audio stimuli was more variable. Overall, using LSL for combing VR recordings and EEG data looked reliable for visual stimuli, however, not for audio stimuli. For the latter even the best latencies we managed to record had a higher difference between the shortest and longest latency than would be acceptable for EEG measurements."