The Fourth
Neuroadaptive Technology Conference

NEUROADAPTIVE TECHNOLOGY

NAT´25

CONFERENCE PROGRAMME

April 7 – 10, 2025, Berlin, Germany

The Fourth
Neuroadaptive Technology Conference

Conference Programme

The Fourth
Neuroadaptive Technology Conference
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Conference Programme

	Welcome	The Science of Neuroadaptive AI	Innovations, Regulation, & Opportunities	Global Strategy, New Markets & Advancing Research
	Mo, 07.04.	Tue, 08.04.	Wed, 09.04.	Thu, 10.04.
08:30		**Opening & Welcome**	**Check-in**	**Check-in & Coffee**
09:00		**Keynote: Prof. Dr. Grosse-Wentrup** Brain-Artificial Intelligence Interfaces	**Keynote: Prof. Dr. Zander** What Is Neuroadaptive AI and Why Will It Change Much More Than You Think?	
09:30				**NAT@BTU: Prof. Dr. Hübner**
10:00		**Panel Discussion:** Future Trajectories of Neuroadaptive AI	**Fireside Chats: How to Accelerate Radical Innovation?** Featuring Aria, Cyberagency, and SPRIN-D	**Keynote: Prof. Dr. Hummert** From resilience to vigilance. Is it smart to hand over responsibility to machines?
10:30				
11:00		**Presentations** Track A **Presentations** Track B		**Vision Talks** Young Investigators and Start-ups
11:30				
12:00			**Live-Podcast with Dr. Joscha Bach** The Future of AI	**Keynote: MdB Thomas Jarzombek** AI in Germany and Europe
12:30		**Lunch**		
13:00			**Lunch**	**Lunch**
13:30				
14:00		**Keynote: Prof. Dr. Zuidema** Blackbox meets blackbox: predicting brain activation from language models, and understanding what that means		
14:30			**Use Cases:** Presented by Capgemini	**German AI Association & brAIn network**
15:00		**Presentations** Track A **Presentations** Track B	**Impulse Talk: Foresight Institute**	**Interview: Ansgar Baums** AI, Europe, and the Tech Cold War
15:30			**Impulse Talk *Shift Grants* and Breakout Sessions** Facilitated by Nodes	
16:00				
16:30			**Talk: Prof. Dr. Noldus** Navigating the EU AI Act: Implications for Neuroadaptive Research and Development	**Poster Presentations** Showcasing the Latest Scientific Advances in Neuroadaptive AI
17:00		**Guided Sessions:** Carl-Zeiss Foundation		
17:30		**Presentations** Track A **Presentations** Track B	**Closing**	**Wrap-up & Closing** Prof. Dr. Zander
18:00				
18:30		**Closing**		
19:00				
evening	**20:00-23:00 Reception & Drinks**		**19:30 - 22:00 Conference Dinner**	

NAT’25

Monday, the 7th of April

20:00 – 23:00 Reception & Drinks

Tuesday, the 8th of April

08:00 – 08:30 Registration
08:30 – 09:00 Welcome
09:00 – 10:00 **Keynote**: Prof. Dr. Moritz Grosse-Wentrup: Brain-Artificial Intelligence Interfaces
10:00 – 10:15 Coffee Break
10:15 – 10:45 **Panel Discussion**: Future Trajectories of Neuroadaptive AI
10:45 – 11:00 Coffee Break
11:00 – 12:30 **Session 1A**: From Speech to Gesture: Decoding Communication
11:00 – 12:30 **Session 1B**: Cognitive Monitoring for the Workplace
12:30 – 14:00 Lunch
14:00 – 15:00 **Keynote**: Prof. Dr. Willem Zuidema: Blackbox meets blackbox: predicting brain activation from language models, and understanding what that means.
15:00 – 15:15 Coffee Break
15:15 – 16:45 **Session 2A**: Restoring Motion: BCI for Rehabilitation & Prosthetics
15:15 – 16:45 **Session 2B**: New Ways for BCI: Generalization and Novel Markers
16:45 – 17:00 Coffee break
17:00 – 17:45 **Guided Session**: Carl-Zeiss Foundation
17:45 – 18:45 **Session 3A**: Beyond the Lab: Wearables & Real-World Usability
17:45 – 18:45 **Session 3B**: Neuroadaptive Virtual Environments
18:45 – 19:00 Closing

Wednesday, the 9th of April

08:00 – 09:00 Registration
09:00 – 10:00 **Keynote**: Prof. Dr. Thorsten O. Zander: What Is Neuroadaptive AI and Why Will It Change Much More Than You Think?
10:00 – 10:15 Coffee Break
10:15 – 11:45 **Fireside Chats**: How to Accelerate Radical Innovation?
11:45 – 12:00 Coffee Break
12:00 – 13:00 **Live-Podcast**: Dr. Joscha Bach: The Future of AI
13:00 – 14:30 Lunch
14:30 – 15:15 **Use Cases**: Capgemini
15:15 – 15:30 Coffee Break
15:30 – 15:45 **Impulse Talk**: Foresight Institute
15:45 – 16:30 **Impulse Talk**: *Shift grants* & Breakout sessions by Nodes
16:30 – 16:45 Coffee Break
16:45 – 17:45 **Talk**: Prof. Dr. Lucas Noldus: Navigating the EU AI Act: Implications for Neuroadaptive Research and Development
17:45 – 18:00 Closing

19:30 – 22:00 Conference Dinner

Thursday, the 10th of April

08:30 – 09:30 Registration & Coffee
09:30 – 10:00 **NAT@BTU**: Prof. Dr. Michael Hübner
10:00 – 11:00 **Keynote**: Prof. Dr. Christian Hummert: From resilience to vigilance. Is it smart to hand over responsibility to machines?
11:00 – 11:15 Coffee Break
11:15 – 12:00 **Vision Talks**: Young Investigators and Start-Ups
12:00 – 13:00 **Keynote**: MdB Thomas Jarzombek: AI in Germany and Europe
13:00 – 14:30 Lunch
14:30 – 15:15 **German AI Association & brAIn network**
15:15 – 16:00 **Interview**: Ansgar Baums: AI, Europe, and the Tech Cold War
16:00 – 16:15 Coffee Break
16:15 – 17:45 **Poster Presentations**
17:45 – 18:15 Wrap-Up & Closing

Keynote Lectures

Prof. Dr.-Ing. Moritz Grosse-Wentrup

Brain-Artificial Intelligence Interfaces

Tuesday, April 8th
09:00 – 10:00

The introduction of machine learning methods into the field of brain-computer interfacing (BCIs), which began almost two decades ago, has enabled unprecedented performance gains. Today, machine learning algorithms have become an indispensable component of BCIs. However, the field of machine learning has undergone a radical transformation in the past decade, giving rise to artificial intelligence (AI) systems that surpass human performance in many real-world tasks. In this talk, I argue that it is time for the BCI community to embrace these developments and build Brain-AI Interfaces (BAIs), i.e., systems that leverage the power of modern AI technologies to enable natural human-computer interaction. In particular, I suggest that to realize BAIs, we need to move beyond using AIs merely to decode neuronal signals and instead integrate AI agents into the neuroadaptive feedback loop. I will showcase a prototype of a conversational BAI and outline future directions and challenges in realizing the full potential of BAIs.

Prof. Dr.-Ing. Moritz Grosse-Wentrup leads the Neuroinformatics Research Group at the University of Vienna, focusing on the convergence of machine learning, neurotechnology, and biosignal processing. He earned his Dipl.-Ing. in Electrical and Information Engineering (2004) and his Dr.-Ing. (2008) from the Technical University of Munich.
His career includes postdoctoral research at the Max Planck Institute for Biological Cybernetics (2008–2013), leading a research group at the Max Planck Institute for Intelligent Systems (2013–2017), and serving as a Professor of Data Science at the Ludwig-Maximilians-Universität München (2017–2019).

Prof. Dr. Willem Zuidema

Blackbox meets blackbox: predicting brain activation from language models, and understanding what that means.

Tuesday, April 8th
14:00 – 15:00

Language models have surprised the world with their linguistic abilities. Intriguingly, the internal states of language models (while processing an input sentence) align quite well with the brain activity that can be measured in humans (while processing the same sentence). In this talk, I discuss how this alignment can be measured, how robust these findings are, and, most importantly, how we can figure out what drives the alignment between models and the brain. I will go over a number of methodological pitfalls that can lead to spurious correlations between high-dimension vector spaces, and argue for a research program that tries to open the blackbox of language models to achieve not only accurate predictions of brain activity and possible ways to "read minds", but also to advance the cognitive neuroscience of language.

Prof. Dr. Willem Zuidema is associate professor of Natural Language Processing, Explainable AI and Cognitive Modelling at the University of Amsterdam. Also, he is fellow of the Brussels Institute for Advances Study (BRIAS), Spring Semester 2025. He leads a group that has done pioneering and impactful research into the interpretability of deep learning models, including text-based language models and neural speech models. His work has been published in a diversity of venues across cognitive science and AI, including NeurIPS, ICLR, EACL, EMNLP, ACL, Journal of AI Research, Psychonomic Bulletin & Review, Journal of Phonetics, PNAS and Nature.

Prof. Dr. Thorsten O. Zander

What Is Neuroadaptive AI and Why Will It Change Much More Than You Think?

Wednesday, April 9th
09:00 – 10:00

Neuroadaptivity refers to the capability of a technological system to continuously and implicitly adapt its behavior based on the real-time interpretation of a user's neurophysiological state. This process relies on passive Brain-Computer Interfaces (pBCIs) to monitor and interpret cognitive, affective, and motivational processes, enabling systems to respond in a context-sensitive manner to the user's moment-to-moment mental state — such as, but not limited to their workload, attention, engagement, or intention — without requiring any explicit input. In the context of Human-Computer Interaction (HCI), neuroadaptive systems use this information to dynamically optimize usability, performance, safety, and experience. They transform machines from passive tools into responsive partners that are capable of tuning their behavior in real-time based on the user's internal state — thus enabling a new paradigm of implicit, state-aware interaction.

Extending this principle beyond short-term interaction, Neuroadaptivity also encompasses the development of long-term user models that capture how a person subjectively perceives, interprets, and evaluates the world. These models go beyond simple state classification to represent the user's evolving patterns of emotional responses, values, cognitive strategies, and other meaning-making processes. When such user models are used to inform an AI system, they give rise to Neuroadaptive AI — an artificial intelligence agent that does not merely predict or imitate behavior but aligns itself with the user's inner world. This alignment allows the AI to act in a way that is not only functionally effective but also experientially coherent, reflecting the user's unique perspective and subjective reality.

By grounding artificial cognition in the user's own neurocognitive and affective dynamics, Neuroadaptive AI offers a fundamentally new approach to the alignment problem — creating systems that are truly human-compatible. Instead of approximating human goals abstractly, these systems learn to understand and respect the person they interact with, building a foundation for co-adaptive, trustworthy, and ethically grounded machine intelligence.

Prof. Dr. Thorsten O. Zander is a leading pioneer in the field of Neuroadaptive Technology and the founder of Passive Brain-Computer Interfaces (pBCIs). As the head of the Neuroadaptive Human-Computer Interaction Lab at Brandenburg University of Technology and Scientific Director of Zander Labs, and director of the Society for Neuroadaptive Technology, he has shaped the field through foundational contributions to brain-computer interfacing, cognition-aware systems, and human-compatible AI. His research bridges neuroscience, artificial intelligence, and real-world application, with a focus on systems that interpret the user's mental and emotional state to enable adaptive, intuitive interaction. Thorsten co-leads the large-scale NAFAS project, supported by a €30M grant, and co-founded the brAIn network.

Dr. Dr. h.c. Joscha Bach

Live-Podcast: The Future of AI

Wednesday, April 9th
12:00 – 13:00

Dr. Bach will discuss how his research connects to core concepts in Neuroadaptive Technology, including the alignment between human cognitive processes and adaptive AI systems. He will explore themes such as human-AI symbiosis, cognitive modeling, and the evolution of intelligent systems that respond dynamically to human needs. He will challenge conventional thinking on how machines and humans can collaborate more effectively, offering new perspectives on the future of adaptive technology and human-machine interaction.

Dr. Joscha Bach is a leading expert in cognitive science and artificial intelligence, known for his work on cognitive architectures, artificial general intelligence (AGI), and the philosophy of mind.
He has held key positions at prominent institutions such as the MIT Media Lab and the Harvard Program for Evolutionary Dynamics. His research focuses on understanding how intelligence emerges from both human cognition and machine learning models, exploring topics like consciousness, perception, and mental representation.
Dr. Bach's work seeks to bridge the gap between cognitive science and AI, providing new frameworks for the development of adaptive and human-compatible AI systems. His thought-provoking ideas have made him a highly sought-after speaker at conferences worldwide, where he shares his vision of AI's role in society and its ethical implications.

Prof. Dr. Christian Hummert

From resilience to vigilance. Is it smart to hand over responsibility to machines?

Thursday, April 9th
10:00 – 11:00

TBA

Prof. Dr. Christian Hummert is the Research Director at the Agency for Innovation in Cybersecurity (Cyberagentur) in Halle, Germany. Previously, he served as the Head of the "Digital Forensics" division at the Central Office for Information Technology in the Security Sector (ZITiS) and was a Professor of IT Security/Digital Forensics at Mittweida University of Applied Sciences, where he now holds an honorary professorship. He also teaches as a lecturer at Ludwig Maximilian University (LMU) in Munich. Dr. Hummert has over ten years of experience in the field of digital forensics and spent six years working as a practitioner at the State Criminal Police Office of Thuringia. He has led several large research and development projects and has taught extensively in the field of cybersecurity.

MdB Thomas Jarzombek

AI in Germany and Europe

Thursday, April 9th
12:00 – 13:00

TBA

Thomas Jarzombek is a German CDU politician, member of the German parliament, and an advocate for science and innovation policy. As the former Coordinator for Aerospace and Commissioner for the Digital Economy and Start-ups, and now as the CDU/CSU parliamentary group's spokesperson for education and research, his political work centers on strengthening research integrity, modernizing science policy, and promoting innovation ecosystems in Germany.

Picture: © Tobias Koch

Talk Sessions Overview

Tuesday, April 8th

11:00 – 12:30 **Session 1A: From Speech to Gesture: Decoding Communication**

Gabriel Ivucic EEG-Based Decoding of the Attended Speaker During a Simulated Conversation in a Multi-Talker Environment

Switching attention between different sound sources is a fundamental aspect of selective listening in real-world conversations, yet its neural dynamics remain understudied. We investigated EEG-based decoding of exogenous attention switching in a multi-talker environment, where twenty participants switched attention between two target speakers who were taking turns, while two background speakers were ignored. We reconstructed speech envelopes from EEG responses, revealing significantly higher decoding accuracy for the attended speaker compared to distractors. Spectral analysis revealed ipsilateral parietal alpha power decrease after switches, returning to baseline within 5 seconds. Our findings demonstrate the feasibility of tracking dynamic auditory attention in conversations and advancing neural decoding models for auditory attention applications.

Philipp Wicke Exploring LLM's Interpretation of Gestures Within Textual Contexts for Neuroadaptive Technologies

This paper investigates the capability of Large Language Models (LLMs) to interpret gestures described in textual prompts, exploring their potential application in neuroadaptive technologies. By examining how LLMs comprehend non-verbal cues embedded in text, we conducted a pilot study assessing models' abilities to interpret gesture descriptions accurately. Initial results indicate that current LLMs face challenges in understanding and correctly interpreting gestures within textual contexts. This ongoing research aims to enhance human-computer interaction by integrating LLMs with neuroadaptive systems, and we seek feedback from the community to refine our approach.

Michal Žák Auditory Conversational BAI: A Feasibility Study

We introduce a novel auditory brain-computer interface (BCI) paradigm, Auditory Intention Decoding (AID), designed to enhance communication capabilities within the brain-AI interface (BAI) system EEGChat. AID enables users to select among multiple auditory options (intentions) by analyzing their brain responses, offering a pathway to construct a communication system that requires neither muscle movement nor syntactic formation. To evaluate the feasibility of this paradigm, we conducted a proof-of-concept study. The results demonstrated statistically significant decoding performance, validating the approach’s potential. Despite these promising findings, further optimization is required to enhance system performance and realize the paradigm's practical application.

11:00 – 12:30 Session 1B: Cognitive Monitoring for the Workplace

Taeho Kang

Experimental Task Design for Investigating Error-Related Negativity in Simulated Cable Assembly Tasks With Two Different Targets of Blame Attribution

In this study, we designed an experimental paradigm to elicit error-related potentials (ErrPs) under a simulated cable-assembly context memory task. We devised a grid in which simulated cable-ends must be correctly placed by participants. Error feedback would be triggered under two different conditions: when the participant incorrectly placed a cable, or when the system falsely called out an error despite the participant performing correctly. Our initial implementation is computer screen based, in order to first observe differences in ErrP from different blame attribution entity (self vs. system). We plan to subsequently implement a physical version of the task.

Michael Middleton

Refining LLM-Driven Neuroadaptive Guidance for Aviation

This work reviews AdaptiveCoPilot, a neuroadaptive cockpit guidance system that tailors visual, auditory, and textual cues based on pilots' cognitive workload during preflight operations. The system leverages functional Near-Infrared Spectroscopy (fNIRS) to monitor memory, attention, and perception states, dynamically adjusting feedback to optimize pilot performance. A formative study identified adaptive rules for guidance, which were tested using a large language model (LLM) in a VR-simulated cockpit with pilots of varying experience levels. Results showed some improved cognitive load management, though further refinement is needed. This work further introduces a follow-up study that will examine two adaptation frameworks, rule-based and free-reign. These frameworks aim to enhance the system's accuracy and reasoning in managing cognitive load, ultimately furthering the understanding of a LLM's role in neuroadaptive guidance.

Matthew Russell

LLM-Tools' Effects on Users During Complex Decision-Making With fNIRS

We explore the effects of Large Language Models (LLMs) on human users with fNIRS during a complex decision-making task while using Microsoft Copilot 365. Statistical analysis of fNIRS responses indicated a decrease in workload for novice AI users who engaged with the task after initially learning it. No differences in workload were shown for frequent AI users. These results indicate that LLM tools like Copilot may help reduce cognitive load for novice users once they overcome the initial task learning curve, while having minimal impact on experienced users who have developed processes for interaction with AI-based tools.

15:15 – 16:45 **Session 2A: Restoring Motion: BCI for Rehabilitation & Prosthetics**

Morteza Khosrotabar

Personalizing Assistive Wearable Devices Through Passive BCI: A Proof-of-Concept Study

Lower-limb exoskeleton performance depends on personalization, yet current methods face challenges in capturing user-specific needs. This proof-of-concept study explores EEG-based passive BCIs for user-centric exoskeleton optimization. Fourteen participants donned a one-degree-of-freedom knee exoskeleton with adjustable pneumatic stiffness, while EEG, EMG, and knee kinematics were recorded during a sinusoidal knee-tracking task. Subjective difficulty ratings increased with rising pneumatic pressures, and cortical activity changes aligned with these reports, particularly in alpha and beta bands. Classifiers trained on these neural patterns achieved 72% accuracy in identifying exoskeleton settings. These findings underscore the viability of neuroadaptive exoskeleton control guided by passive EEG signals.

Anna Makarova

Incorporating a Bionic Hand Into the Body Schema: An sEEG Study

The usability of neural prostheses of the limbs crucially depend on how well they incorporate into the body-schema owing to brain plasticity. Here we developed an experimental paradigm where such incorporation was facilitated by the participants both observing the movements of a bionic hand and reproducing them mentally and/or physically. The testing was conducted in patients undergoing sEEG examination for medical reasons. A bionic hand was mounted in front of the patient; it performed nine gestures: finger flexions, pinches, and fist clenching. sEEG data were collected during these trials, preprocessed with time-frequency analysis and PCA-based dimensionality reduction methods. Several machine learning models were applied to classify gestures from sEEG, with NuSVC achieving the best accuracy (63%) for 9-class predictions. We suggest that this approach allows monitoring body-schema incorporation while improving ecological validity and participant engagement.

Lucija Mihić Zidar

REVIRE: BCI-Based Motor Rehabilitation in Virtual Reality – A Feasibility Study

REVIRE is a virtual reality (VR) platform for motor recovery after stroke that integrates EEG monitoring to track neurophysiological markers of motor learning. Designed for commercially available VR, the application can be used outside of clinical settings, including for home training. Testing with healthy participants showed improved task performance and modulation of sensorimotor EEG activity associated with motor learning. Together with minimal reports of VR-induced discomfort, these preliminary results demonstrate the suitability of the application for integration into a neuroadaptive BCI-based system and further validation in clinical studies.

15:15 – 16:45 **Session 2B: New Ways for BCI: Generalization and Novel Markers**

Virginia de Sa AI Foundation Models in BCI

We discuss an evolution of ML use in BCI from simple classifiers on low-dimensional inputs (hand-picked features) predicting low complexity outputs to current and future models that operate on high-dimensional barely processed brain signals and use powerful AI foundation models to enable decoding of high complexity signals.

Lena Andreessen Towards Real-World Applications of Passive Brain-Computer Interfaces: A Session- and Subject-Independent Error-Detection Classifier

This study investigates methods to enhance the applicability of passive brain-computer interfaces (pBCIs) in real-world contexts by minimizing dependency on subject-specific and session-specific training data. We developed a pre-calibrated classifier for error-detection that worked on any subject and all sessions as well as a classifier calibrated for that individuum in that session, specifically. We further reduced electrode numbers, maintaining accuracy and improving usability, presenting a calibration method that generally enables a plug-and-play approach for neuroadaptive technology (NAT) in human-computer interaction (HCI). Findings confirm the developed classifier's robust performance and real-time applicability, enabling real-world adoption of pBCIs.

Matthew Russell Very-Low Frequency Oscillations as a Correlate of Neural Activation

Machine learning methods are commonly used to infer differences between neural conditions in Functional Near-Infrared Spectroscopy (fNIRS) based Brain-Computer Interface (BCI) work, but practical and straightforward validation techniques can provide essential verification of these computational findings. We demonstrate that power in the Very-Low Frequency Oscillation (VLFO) band can approximate prefrontal cortex activation by application to the 68-participant Tufts Mental Workload dataset. Reinforcing previous fNIRS and fMRI literature, we show increased left prefrontal activation, in this case because of mental workload increase during the N-Back task, relates to a decrease in VLFO activation.

17:45 – 18:45 **Session 3A: Beyond the Lab: Wearables & Real-World Usability**

Laurens Krol	NAFAS' Unobtrusive Mobile EEG Electrodes: First Results

We show that known event-related brain responses can be recovered from a low number of novel, comfortable, flex-printed EEG electrodes placed on hairless areas of the skin.

Mansi Sharma	Moving Beyond the Lab: Enabling Natural Human-Robot Collaboration Using Multimodal Interaction

Brain signals offer significant potential for natural interaction by providing insights into the human mind, improving intent recognition and enabling intuitive collaboration. Current EEG setups fail to enable natural collaboration, as they are often overly controlled, requiring shielded environments, screen-based recordings, limited movement, and context-lacking, cue-based interactions that feel artificial. These controlled lab conditions make it difficult to transfer solutions to real-world applications. We address these limitations by introducing a multimodal interaction scenario for industrial assembly tasks, using EEG, hand gestures, and speech in a less controlled lab setup for natural, self-paced interaction with a robotic system.

17:45 – 18:45 **Session 3B: Neuroadaptive Virtual Environments**

Emile Savalle	Neuro Task-Manager: Enhancing Well-Being in the Workplace Using Passive BCI

This study explores the feasibility of using passive brain-computer interfaces (BCIs) to optimize task assignments in the workplace and address fatigue, stress, and alienation caused by task misalignment. We developed a virtual factory with three tasks designed to elicit unique executive functions (Shifting, Updating, and Inhibition). Using passive BCI, we calibrated two user models: either based on cognitive workload or behavioral performance, each adapting task selection to the participant. Results revealed that the performance-based model caused more fatigue while maintaining performance comparable to the workload-based model, highlighting the potential of passive BCIs to address some workplace-related issues.

Aleksandrs Koselevs	Neuroadaptive XR: Combining Neural Decoders With Reinforcement Learning Agents for Personalized Spatial Computing

Neuroadaptive extended reality (XR) systems can enhance immersion by dynamically adjusting multisensory feedback based on user preferences. We present an approach that combines neural decoders with reinforcement learning (RL) to personalize spatial computing environments. A user study was conducted where participants performed object interactions in virtual reality while neural and physiological data were collected via EEG. A reinforcement learning agent adapted haptic feedback based on either explicit user ratings or implicit neural decoder outputs. Results showed that the RL agent's performance was comparable regardless of feedback source, suggesting that neuroadaptive approaches can effectively guide XR personalization without requiring explicit user input. The electroencephalogram (EEG)-based neural decoder achieved a mean F1 score of 0.8, indicating reliable classification of user experience.

Poster Session Overview

Thursday, April 10th
16:15 – 17:45

#1 *Nils Harmening* — Improved M/EEG Source Localization by Data-Driven Head Model Individualization in Case of Unavailable MRI/CT

We propose a data-driven algorithm to approximate individual head anatomies to improve source localization accuracy over the widely used standard head models Colin27 and ICBM-152 when structural MRI/CT scans are not available. Based on a low-dimensional representation of a large head model database, we derive individual head shape parameters solely from additional knowledge of the subject's scalp (e.g., photogrammetry scans or exact electrode positions). Compared to every other approach, we demonstrate that our individualized head models provide better-approximated head anatomies and significantly improve EEG source localization accuracy.

#2 *Marc Welter* — Physiological Single-Trial Decoding of Art Interest

Both well-being and aesthetic experience are correlated with physiology. Thus, optimizing art presentation to evoke desirable mental states in virtual environments based on physiological states could have beneficial effects on user experience and well-being. However, single trial aesthetic experience decoding from physiological signals has not been well studied. We tested a Support Vector Machine classifier with cardiac and electrodermal features to decode art interest. Although, average performance was poor (54%), the model yielded high accuracy beyond chance level for a few participants. This shows that art interest can, at least for some individuals, be decoded from single trial physiological data.

#3 *Muhammad Salman Kabir* — Data Augmentation Improves Decoding of Handwriting With Optomyography

Optomyography (OMG) works well in wristbands that extract commands from muscle contractions. Here we improved this approach by coupling OMG with data augmentation methods. This approach was applied to decoding of handwriting. The OMG method proved to be successful for decoding when combined with an artificial neural network. Among the data augmentation methods, adding gaussian noise and frequency shift and performing Fourier transform (FT) surrogate improved the decoding whereas channel shuffling and time reversal did not.

#4 *Maria Fărăgău*

Cognitive Workload in Virtual Reality: Exploring Multimodal Classification and Postural Influences

Passive brain-computer interfaces (pBCI) use EEG for real-time mental state detection, enhancing Human-Computer Interaction (HCI). Virtual Reality (VR) offers a promising HCI platform but adds challenges due to head-mounted technology and body posture changes. Combining EEG with other signals may help maintain classifier robustness in noisy VR environments. Our study examined multimodal cognitive workload classification in VR, assessing body posture's impact. EEG and psychophysiological signals were recorded and classified independently before decision-level fusion. Results show fusion doesn't significantly improve accuracy, and EEG-only remains the most effective method for workload detection. Additionally, no significant difference was found between sitting and standing conditions in multimodal classification performance, reinforcing EEG's reliability for mental workload detection in VR applications.

#5 *Derya Ide*

Effects of Binaural Beats on Mental States: Applications in Neuroadaptive Technologies and BCIs

An individual's mental state significantly influences decision-making, behavior, perception, and error rates. Recent advancements in neuroadaptive technologies and Brain-Computer Interfaces (BCIs) have opened new avenues for modulating mental states. One innovative approach is binaural beat technology, an auditory illusion occurring when two slightly different frequencies are presented to each ear, resulting in the perception of a rhythmic beat. This beat can synchronize neuronal electrical activity, potentially modulating brain wave patterns. Prolonged exposure to binaural beats has demonstrated the ability to influence brain wave synchronization, suggesting its utility as a tool for mental state modulation.

#6 *Diana Gherman*

Could Implicit Feedback Enhance LLM Alignment? Moral and Error Processing via Passive BCI

Large-language models (LLMs) are revolutionizing digital interactions, yet aligning them with human values remains a challenge. While explicit human feedback has revolutionized chatbot training, passive brain-computer interfaces (pBCIs) offer a novel approach by capturing implicit cognitive and affective responses. This study investigates the feasibility of using pBCIs to decode users' mental states in response to text stimuli. Electroencephalography (EEG) data was collected to classify neural responses related to moral judgment and error-processing. Results indicate successful classification of moral salience and error detection, suggesting that neuroadaptive chatbots could enhance LLM alignment by incorporating implicit human feedback.

#7 *Lea Rabe*

Identifying Neural Indicators of Category Learning for Real-Time BCI: Preliminary Insights

Passive brain-computer interfaces (pBCI) are envisioned to be applied in real-life contexts such as education and training. Yet, studies have mostly investigated pBCIs in controlled laboratory settings. As the first of three studies aiming to develop a pBCI-based learning system, this work investigates EEG-based neural markers of category learning to guide classifier development. Participants will categorize three different stimulus sets: two abstract sets replicating prior category-learning studies, and one naturalistic set aimed at increasing ecological validity. By the time of the conference, a pilot study will yield preliminary insights into the feasibility and performance of this approach.

#8 *Sowad Rahman*

Neuro-Informed Adaptive Learning (NIAL) Algorithm: A Hybrid Deep Learning Approach for ECG Signal Classification

The detection of cardiac abnormalities using electrocardiogram (ECG) signals is crucial for early diagnosis and intervention in cardiovascular diseases. Traditional deep learning models often lack adaptability to varying signal patterns. This study introduces the Neuro-Informed Adaptive Learning (NIAL) algorithm, a hybrid approach integrating convolutional neural networks (CNNs) and transformer-based attention mechanisms to enhance ECG signal classification. The algorithm dynamically adjusts learning rates based on real-time validation performance, ensuring efficient convergence. Using the MIT-BIH Arrhythmia and PTB Diagnostic ECG datasets, our model achieves high classification accuracy, outperforming conventional approaches. These findings highlight the potential of NIAL in real-time cardiovascular monitoring applications.

#9 *Toby Newey*

Modelled Optimisation of Communication for Ecologically Relevant Dyadic Group Decision-Making

Group decision-making allows cognitive resources and information to be pooled, compensating for individual decision deficits which improves decision accuracy. However, unhelpful group dynamics and biases can sometimes emerge resulting in poor performance. Importantly, it is unclear how communication between members can be optimised for group decision performance. We addressed this by modelling data acquired from participants in an ecologically relevant perceptual decision-making task. These computational agents were coupled using three different inter-agent communication conditions, including two novel, and optimal pairing was investigated. Continuous, imbalanced communication between optimised pairs was found to have the best mean performance.

#10 *Jesus Ricardo Licona Munoz*

EEG-Based Emotion Classification Using Riemannian Geometry and Tangent Space

Emotion recognition from EEG signals is essential in affective computing and brain-computer interfaces. Traditional approaches rely on machine learning classifiers such as support vector machine (SVM). This study explores Riemannian geometry-based techniques applied to the DEAP dataset to classify valence and arousal using Tangent Space Gaussian Bayes (TSGB), Tangent Space Shrinkage LDA (TSsLDA), and Riemannian MDM with Geodesic Filtering. A 4th-order Butterworth filter (15-36 Hz) was applied, and stratified k-fold cross-validation (K=10) ensured balanced training. Results show TSGB (73.82%) excels in valence, while TSsLDA (67.42%) is best for arousal, confirming Riemannian methods' effectiveness for EEG-based emotion classification.

#11 *David Trocellier* BCI Classifiers Integrating Measures of Variability Factors: A Mini-Review

Brain-computer interfaces (BCIs) are sensitive to variability factors, such as changes in mental states, experimental setups, and individual neurophysiological differences, which degrade classification performance. This review examines machine learning approaches that integrate variability factors to enhance robustness and classification performance. We conducted a PRISMA review, finally identifying nine relevant papers and we proposed a taxonomy based on variability factors and their integration methods. While promising results, such as improved classification accuracy and feature separability, were observed, more research needs to be done to better understand the interaction between classifiers and variability factors and how it can enhance algorithmic robustness.

#12 *Alessia Bussard* MAP-DRIVE: Optimizing Driver Monitoring Systems Through Perception-Action Sequences and Neurophysiological Insights

When drivers disengage during high automation, situational awareness and readiness decline, increasing reaction times and safety risks. Our research seeks to develop adaptive systems that predict driver readiness by mapping perception-action sequences and neurophysiological responses in real-time. In a driving simulator, 80 participants navigate varying traffic, speed, and event conditions, revealing how cognitive demands influence visual and driving behaviors. Preliminary findings show route familiarity shifts oculomotor behavior and autonomous system engagement from explorative uncertainty to predictable navigation, while introduction of traffic and unexpected events re-engage exploratory activity and emotional engagement. These insights lay the groundwork for developing real-time neuroadaptive systems that model, predict and improve driver-car-environment interactions to enhance safety.

#13 *Caterina Cinel* Decoding Emotional Arousal: A Nonlinear Approach to Removing Luminosity Effects From Pupil Dilation

Pupil dilation is a well-known physiological indicator of emotional arousal and has potential as a real-time marker of high-intensity emotions or stress. However, its reliability is limited by the fact that pupil size is also influenced by ambient luminosity, making pupillometry less effective for emotion evaluation, particularly in environments with rapid lighting changes, such as during video viewing. Previous attempts to disentangle emotional responses from luminosity effects have faced significant challenges. Here, we present an innovative method to isolate emotional responses in pupil dilation by systematically removing the effect of luminosity. Our approach accounts for the known non-linear relationship between pupil size and luminosity and is then validated with 42 participants. Here, we describe our methodology and provide preliminary results.

#14 *Matthew Russell* Neural Correlates of Move Quality During Chess Games: A Low-Cost EEG Study

Consumer-grade electroencephalography (EEG) presents promising opportunities for applied Brain-Computer Interfaces (BCI). We examine the relationship between neural activity and chess move quality using the MUSE 2. Linear mixed-effects modeling identifies significant positive correlations between move quality and power in beta and gamma bands. With machine learning, we investigate the potential application of these findings towards real-time implicit BCI. Using two-class classification with leave-one-out cross-validation across participants, we achieve 54% accuracy. These findings indicate that, while consumer-grade EEG devices can detect meaningful cognitive variation during complex decision-making, the subtlety of these distinctions may be difficult to capture with machine learning.

#15 *Atique Ahmed* An ongoing study on Implicit Shape Morph Control

Recent advances in brain-computer interfaces (BCIs) have enabled the development of systems that adapt in real time to the user's cognitive states. Building on the concept of implicit cursor control, this study investigates the feasibility of a neuroadaptive system that regulates the width and height of a shape based on real-time analysis of brain activity, specifically targeting the medial prefrontal cortex (mPFC) responses to expectation violations. In a controlled experimental setting, 15 to 20 healthy volunteers will wear a 64-channel EEG headset while observing a dynamically changing diamond shape on a screen. The experiment consists of a calibration phase—where a linear discriminant analysis (LDA) classifier is trained using error-related brain potentials—and an application phase, during which the shape's parameters are modulated in response to the classifier's outputs. This approach aims to deepen our understanding of the neural correlates of shape perception and manipulation while paving the way for more intuitive human-computer interfaces in areas such as computer-aided design, gaming, and virtual reality.

#16 *Reetik Raj* Proof of concept for an Auditory Attention based BCI for VR games

Attention is a crucial cognitive process that allows individuals to selectively concentrate on relevant stimuli in their environment while filtering out distractions. Among its many forms, auditory attention is particularly essential for navigating acoustically complex environments—most famously demonstrated by the Cocktail Party Effect. This study presents a novel approach by being the first to conduct the Cocktail Party experiment using only natural sounds in a Virtual Reality (VR) environment, moving beyond traditional methods that use speakers and headphones. Unlike the conventional setups, VR offers immersive environments that more closely mimic real-world listening conditions, making the process of selective attention more natural and ecologically valid. The study will leverage EEG-based brain tracking alongside auditory stimulus reconstruction technique to map neural signals to the auditory envelope of attended sounds. This method will enable a decoder to identify the attended audio stimuli. The primary objective of this research is to support the development of a Brain-Computer Interface (BCI) capable of decoding auditory attention to naturalistic soundscapes from EEG signals in a VR setting. In doing so, this study seeks to lay the foundation for more immersive and inclusive neuroadaptive systems, marking a significant step forward in both applied auditory neuroscience and human-computer interaction.

#17 *Yanzhao Pan*

Mind-to-Action: Automatic Intent Decoding in VR Gaming — Paradigm Design

Integrating eye gaze with EEG-based brain-computer interface (BCI) provides a fully hands-free, immersive interaction in virtual reality (VR), especially in VR gaming. Prior research shows that EEG signals can differentiate intentional from spontaneous gaze fixations, yet these studies typically rely on induced P300 waves or expectation wave detection, which do not capture genuine interaction intent. This study presents a VR gaming paradigm that integrates eye gaze and EEG-based BCI to decode user interaction intent in real time. Participants, equipped with a 64-channel EEG cap and a Meta Quest Pro headset, engage in a game structured into explicit calibration, implicit calibration, and real-time gameplay phases. The system distinguishes intentional from spontaneous gaze fixations within a [0, 800ms] post item-reveal epoch. By investigating potential temporal and spectral features, the approach advances hands-free, intuitive interaction in VR gaming environments.