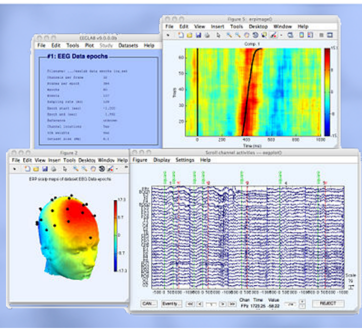
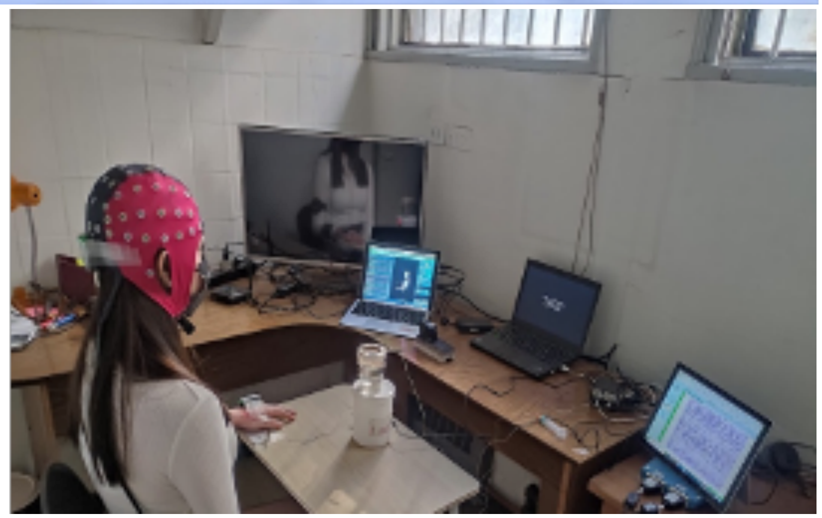


The EEGLAB News

Issue #19, January 2025



(Left) The exoskeleton was built by Dr. Pablo Burgos's team at George Fox University in Oregon for stroke rehabilitation. (Right) EEG assessments were applied before and after the rehabilitation process.

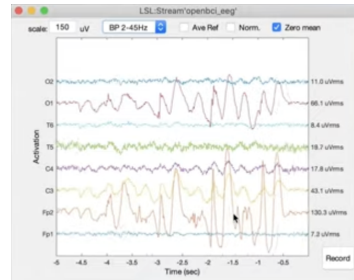
What’s New

EEGLAB 2025.0 has been released. The EEGLAB update (version 2025.0.0) includes minor code adjustments across various functions, improving error handling, addressing edge cases, and enhancing functionality. These updates affect functions related to channel information and location checks, dataset integrity, event latency adjustments, and file I/O. Additionally, a UI bug in the input GUI (input UI) has been fixed, ensuring proper behavior for dependent functions like coregister.m and pop_editeventvals.m. EEGLAB studies now support the calculation of FOOOF measures (a tutorial is coming soon). Several plug-ins, including EEG-BIDS, ICLabel, clean_rawdata, and dipfit, have also been updated, with EEG-BIDS now included as a default plug-in in EEGLAB. For a full list of changes, refer to the EEGLAB release page.

Massive Healthy Brain Network EEG (HBN-EEG) data has been released. Available on NEMAR and OpenNeuro, HBN-EEG is a collection of high-density EEG (and soon eye-tracking) recordings from ~3000 subjects aged 5 to 21 years old. Please refer to the Open Science section for more information.

Plug-Ins

Here we highlight new EEGLAB plug-ins of possible wide interest to EEGLAB users. Please send descriptions of new plug-ins for consideration. These should have a brief lead introduction and further text and images to be published on a continuation page.



The EEGLAB LSL streaming and data recording plug-in has been updated to support Mac silicon, enhancing compatibility with current hardware. Improvements include more stable data streaming through subsampling, as well as new features for debugging LSL EEG streams. These features include the ability to deactivate specific channels and apply new filters, providing users with greater control and flexibility during EEG data acquisition and analysis. New options have been added including the capability to hide channels by clicking on their traces.

The EEG-BIDS plug-in is now part of the default EEGLAB release. In version 10.1, it was updated to fix the export wizard and to re-export processed BIDS datasets as derivative datasets. The first EEG derivative dataset has been released. Note that this plug-in is also available as a standalone program when you download the compiled version of EEGLAB.

Open Science

Here we highlight news of open EEG and related data, tools, and other resources.

The Swartz Center for Computation Neuroscience at the University of California San Diego has received a gift from ***Meta Reality Labs*** to support open science efforts, including extending EEGLAB tools to enable importing more biosignal modalities such as electromyography (EMG) signals. The tools will interface with the EMG-BIDS datasets (specifications are currently under development) and will enable researchers to import multi-subject, multi-task, and multi-session datasets into an EEGLAB STUDY structure.

The stim-BIDS extension proposal [BEP044] is seeking community reviews. This extension will facilitate sharing and reuse of stimulus files and their associated annotations. The draft specifications are compiled for public review, and we invite researchers to provide their feedback on the pull request or the original issue for this BEP.

The Child Mind Institute's Healthy Brain Network (HBN) project has released "analysis-ready" EEG data (HBN-EEG) collected from over 3,000 participants aged 5–21, formatted as Brain Imaging Data Structure (BIDS) datasets. The data also include, for the first time, four mental health measures for all participants. The high-density (128-channel) EEG recordings include annotated behavioral and task-condition events using Hierarchical Event Descriptors (HED) to ensure easy and consistent analysis. The dataset features six tasks (three passive and three active) and provides participant information such as age, gender, and four psychopathology dimensions (internalizing, externalizing, attention, and p-factor). The HBN-EEG data, available on NEMAR and OpenNeuro with ongoing updates, is designed to support a wide range of neuroimaging and behavioral research. Please refer to the preprint or this blog post for more information.

Profiles

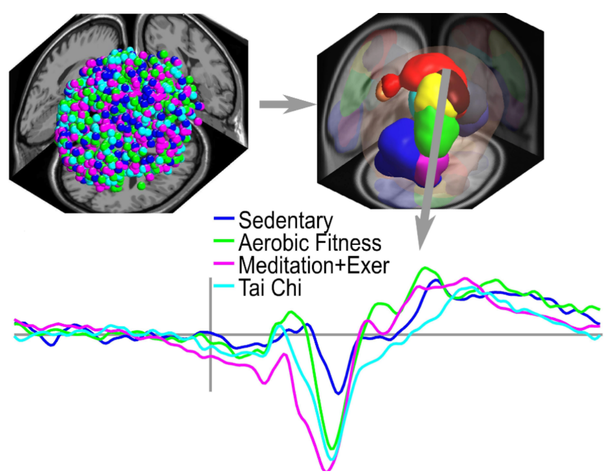
This section contains personal profiles of EEGLAB developers and/or users, with a description of how they use EEGLAB in their research.

Dr. Pablo Burgos, Associate Professor at George Fox University in Newberg, Oregon, and at Universidad de Chile in Santiago

Born and raised in Santiago, Chile, Dr. Pablo Burgos pursued a degree in Physical Therapy before earning a Ph.D. in Biomedical Sciences at the Faculty of Medicine, Universidad de Chile. During his doctoral studies, he worked in the Neuro-systems Lab under the guidance of Dr. Pedro Maldonado. He also completed a research internship at the Swartz Center for Computational Neuroscience (SCCN) at UC San Diego with Dr. Scott Makeig. Dr. Burgos is currently an Associate Professor at George Fox University in Newberg, Oregon, and at Universidad de Chile in Santiago. He also serves as a Senior Research Associate at Oregon Health and Science University in Portland, Oregon.

Dr. Burgos's research focuses on human neuroscience, with a particular emphasis on sensorimotor integration during motor learning. Utilizing EEG, eye tracking, and biomechanical measures, he studies hand coordination in interactive tasks, such as video games. His postdoctoral work at the University of Oregon in the Motor Control Lab with Dr. Marjorie Woollacott expanded his research to investigate the relationship between cognition and motion through dual-task paradigms, balance, and exercise. Inspired by the longstanding debate over the modularity of brain functions, Dr. Burgos seeks to understand the modular aspects of the sensorimotor system to develop advanced techniques for neurorehabilitation.

His interest in neuroscience was sparked during his early career as a physical therapist working with patients suffering with neurological conditions such as stroke, traumatic brain injury, and Parkinson's disease. Realizing the need for a deeper understanding of the neurological mechanisms underlying his patients' conditions, Dr. Burgos decided to delve into neuroscience research. Initially focusing on the basic aspects of motor learning, he shifted his focus to translational neurorehabilitation, particularly in motor recovery for stroke and Parkinson's disease patients.



This figure illustrates the processing and clustering of EEG source dipoles into brain domains based on location and ERP activity. See [1].

Dr. Burgos first learned about the Swartz Center for Computational Neuroscience (SCCN) and Dr. Scott Makeig's work while analyzing his Ph.D. thesis data using EEGLAB, an EEG analysis software. Through a connection with a colleague, Dr. Gabriela Cruz, he arranged an internship at SCCN, where he benefited from the lab's resources and expertise. He first encountered EEGLAB during his Ph.D. studies, as it was frequently used in Dr. Maldonado's lab for data analysis. He continues to rely on EEGLAB to analyze EEG data, maintaining his MATLAB skills specifically for this purpose due to the lack of comparable tools in Python.

In his research, Dr. Burgos frequently uses EEGLAB plug-ins such as AMICA, DIPFIT, IC-Label, and SIFT. He appreciates the platform's versatility, particularly its combination of graphical user interface (GUI) and scripting capabilities, as well as its data organization and processing features through the STUDY function. However, he notes that distinguishing brain signals from artifacts, especially during dynamic tasks like gait or balance, remains a significant challenge. He also emphasizes the need for more automated tools to replace manual data processing, ensuring replicable analyses. Despite these challenges, Dr. Burgos finds great satisfaction in cortical localization of information using tools like DIPFIT and DSI, as well as analyzing connectivity in stroke patients using the SIFT plug-in.

Dr. Burgos hopes to further his understanding of neurorehabilitation over the next seven years, focusing on whether interventions promote proper recovery or compensatory mechanisms. By investigating the relationship between training-specific impairments and functional recovery, he aims to refine strategies that enhance neuroplasticity and cortical interactions, particularly in stroke patients. He actively collaborates with researchers worldwide and attributes much of his success to these partnerships. As a former president of the Chilean Association of Movement Sciences and current president of the Latin-American Association of Neurorehabilitation, Dr. Burgos fosters collaboration through scientific societies and meetings.

In addition to his scientific work, Dr. Burgos is remembered by colleagues at SCCN for his musical talents, often playing classical guitar during his internship at UC San Diego. A recording from this time, featuring Dr. Burgos and his colleague Grace Leslie, remains a fond memory. His recent publications include studies on long-term physical and mental training effects and sensorimotor learning, demonstrating his continued contributions to neuroscience and neurorehabilitation research.

Some of Pablo Burgos' publications

[1] Behavioral and ERP Correlates of Long-Term Physical and Mental Training on a Demanding Switch Task. Burgos PI, Cruz G, Hawkes T, Rojas-Sepúlveda I, Woollacott M.Front Psychol. 2021 Feb 23;12:569025. doi: 10.3389/fpsyg.2021.569025. eCollection 2021.PMID: 33708155

[2] Event-related (de)synchronization and potential in whole vs. part sensorimotor learning. Mariman JJ, Bruna-Melo T, Gutierrez-Rodriguez R, Maldonado PE, Burgos PI.Front Syst Neurosci. 2023 Mar 21;17:1045940. doi: 10.3389/fnsys.2023.1045940. eCollection 2023.PMID: 37025165

Upcoming Events

EEGLAB workshops. The next EEGLAB workshop will be in Aspet, France (June 30-July 4, 2025), and another workshop in San Diego (November 21-25, 2025) following the Society for Neuroscience meeting.

From the EEGLABLIST

This section contains messages from the EEGLABLIST that may be of general interest. Messages are edited for clarity.

Filtering and ICA

Ayaka Hachisukavia wrote: I'm wondering what your thoughts are on "aggressively filtering" only the EOG channels for ICA? I read this recommendation in the EEGLAB wiki (see this section) and, to save myself a step, I implemented a 1 Hz high-pass filter for EOG channels only. The EEG channels are still filtered at 0.05 Hz, my original parameter.

It seems to work really well for detecting eye movement artifacts, and my data visually looks better than before after ICA, but I wasn't sure if this was a reasonable approach.

Makoto Miyakoshi: I recommend that you show three results:

1. No EOG-IC removal
2. Standard EOG-IC removal
3. Customized EOG-IC removal

Include these in your paper, either in the main text or the Supplement. Based on the comparison, try to convince your reviewers and readers, including experts, that your approach is the most sensible.

For advanced users, the spectral ICA approach could make a lot of sense. However, the current status of their out-of-the-box application and its performance compared with what's available today is unknown. Regarding ICA, based on my experience, results above 13 Hz start to show correlations among ICs, worsening progressively as frequency bins increase. However, as long as you focus on ERP components at 13 Hz and below, the standard use of ICA, including your suggested version, is fine.

Arnaud Delorme: The approach to high-pass filtering EOG primarily makes sense on paper because these are the channels most contaminated by eye-related low-frequency oscillations. As Makoto mentions, this is more of an experimental question than a theoretical one. Even if you high-pass filter EOG channels aggressively at 2 Hz, for example, other channels should still be filtered at least at 0.5 Hz, as explained here.

ASR artifact rejection, data discontinuities, and phase distortion

Masa wrote: I usually use ASR for preprocessing in resting-state EEG analysis. This function removes segments of data that contain excessive noise. It works quite well; however, after the rejection, it directly concatenates the periods before and after the removed segments, resulting in abrupt changes in the waveform. I am concerned that these abrupt changes may introduce additional noise, such as ripples, in subsequent steps of the analysis, such as time-frequency or connectivity analysis. Is this approach acceptable for further analysis? Or do you know of any good solutions to avoid this problem?

Arnaud Delorme: If you are using the clean_rawdata plug-in on EEGLAB, it will remove segments and add discontinuity events between segments (i.e., 'boundary' events). When you perform spectral decompositions in EEGLAB, the spectral decomposition will not cross these boundaries and will process each chunk individually (this is true for both the dataset and the study level).

John: *Using regular ASR that corrects data (not the default that Arnaud mentioned above that removes data segments),* you can taper the ends of the segments to avoid abrupt changes, similar to tapering the ends of a time series before doing FFT. Google "taper ends of time series" or "taper concatenated time series." This will avoid throwing abrupt changes in the time series, which will affect frequency analyses. Ultimately, concatenated data will disrupt any analysis where the phase of a regular frequency pattern is interrupted by the concatenation.

Makoto: John is absolutely right. The original ASR, which is the core part of clean_rawdata, DOES address this issue by using the exact solution John has suggested. If I remember correctly, clean_rawdata (written by Christian Kothe) uses linear blending. Users can even specify the slope coefficients. Regarding concerns about ASR introducing artificial signals during interpolation: if you see my demonstration in this video, you will find that your concern is probably unwarranted.
For more details, check this commentary: Commentary on ASR. For example, here is a comparison of no cleaning, ASR, ASR+ICA_level1, and ASR+ICA_level2: Paper Link. My post-doc Heyonseok and I have submitted a paper entitled "Juggler's ASR," which is under review now. Without ASR, how do you process EEG data recorded during three-ball juggling?
Three-ball juggling EEG presentation (July 2023, Tel Aviv)

Masa: I appreciate all of your support and advice. The filter function in EEG sounds great, as it doesn't affect the boundary. So, I think most of my concerns for power analysis are resolved. However, as you mentioned, this method still distorts the phase data, and I believe it's impossible to correct after epoch rejection. I think using clean_rawdata with ASR, without the window rejection function, is really helpful as it keeps the data continuous.

Arnaud Delorme: Yes, when using ASR to correct the data (not the default), it maintains data continuity without discontinuity; however, phase distortion is possible (this is why it is not the default). One should be careful with this approach, as it was mostly designed for real-time processing during BCI or neurofeedback.

In Print

Subash, P., Gray, A., Boswell, M., Cohen, S. L., Garner, R., Salehi, S., Fisher, C., Hobel, S., Ghosh, S., Halchenko, Y., Dichter, B., Poldrack, R. A., Markiewicz, C., Hermes, D., Delorme, A., Makeig, S., Behan, B., Sparks, A., Arnott, S. R., Wang, Z., … Duncan, D. (2023). A comparison of neuroelectrophysiology databases. Scientific data, 10(1), 719.
https://doi.org/10.1038/s41597-023-02614-0

Roshanaei, M., Norouzi, H., Onton, J., Makeig, S., & Mohammadi, A. (2025). EEG-based functional and effective connectivity patterns during emotional episodes using graph theoretical analysis. Scientific reports, 15(1), 2174. https://doi.org/10.1038/s41598-025-86040-9

Online

This newsletter was edited by Arnaud Delorme