Electroencephalography

- Intracranial High-Frequency Oscillations and Epileptogenic Zone: Incorporating Neuroanatomic Variation
- Surgical cure of intractable epilepsy caused by retained intracranial foreign body under cortical electroencephalography monitoring: case report and literature review
- Distinct oscillatory mechanisms in low and high alpha-band activities for screening and potential treatment of Schizophrenia
- Near-Infrared Spectroscopy to Assess Covert Volitional Brain Activity in Intensive Care
- Asymmetry of generalized discharges in idiopathic generalized epilepsy in adults
- Theta bursts in patients with sleep-related hypermotor epilepsy: potential marker of impaired inhibitory control and its mitigation through musical stimulation
- Neurophysiology Signal Codecs for the DICOM® Standard: Preliminary Results
- Hybrid brain-computer interface using error-related potential and reinforcement learning

This technique measures the electrical activity of the brain by placing electrodes on the scalp. EEG is particularly useful for studying overall brain activity patterns and is often employed in sleep studies, epilepsy diagnosis, and cognitive neuroscience.

In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a short period, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations that can be observed in EEG signals.

see Continuous EEG monitoring.

see Intracranial electroencephalography.

Nascimento et al. published a list of “must-know” routine EEG (rEEG) findings for trainees based on expert opinion. They studied the accuracy and inter-rater agreement (IRA) of these “must-know” rEEG findings among international experts.

A previously validated online rEEG examination was disseminated to EEG experts. It consisted of a survey and 30 multiple-choice questions predicated on the previously published “must-know” rEEG findings divided into four domains: normal, abnormal, normal variants, and artifacts. Questions contained de-identified 10-to-20-second epochs of EEG that were considered unequivocal examples by five EEG experts.

The examination was completed by 258 international EEG experts. Overall mean accuracy and IRA (AC1) were 81% and substantial (0.632), respectively. Domain-specific mean accuracies and IRA were: 76%, moderate (0.558) (normal); 78%, moderate (0.575) (abnormal); 85%, substantial (0.678) (normal variants); 85%, substantial (0.740) (artifacts). Academic experts had a higher accuracy than private practice experts (82% vs. 77%; p=0.035). Country-specific overall mean accuracies and IRA were: 92%, almost perfect (0.836) (U.S.); 86%, substantial (0.762) (Brazil); 79%, substantial (0.646) (Italy); 72%, moderate (0.496) (India). In conclusion, collective expert accuracy and IRA of “must-know” rEEG findings are suboptimal and heterogeneous.

They recommend development and implementation of pragmatic, accessible, country-specific ways to

measure and improve expert accuracy and IRA [1].

Mullen et al., [2] designed a dry, wearable, and wireless EEG acquisition system with dynamic, real-time signal processing and data analysis software. In their article, they review the design of the device, providing a detailed description of the mathematical methods of artifact reduction and their methods for reconstructing EEG data to analyze underlying neuronal electric activity. They tested their analytic methods in simulated 64-channel EEG data and in recordings from their wearable EEG device. Their analysis of cognitive states demonstrates that wearable EEG may be a potential tool for human cortical recording with broad applications.The mobile EEG system supports 64 channels of high-density recordings. The headset contains an internal Faraday cage to filter external interference and a wireless transducer to transfer data. The cage conforms to the shape of the patient's head and provides tension to maintain sensors on the scalp. The contact sensors used have durable, high recording quality. One type of sensor has conductive "feet" that better contact the scalp through hair. The other sensor is a wet/dry hybrid, using an ion-permeable membrane to contain the conductive gel. Although these dry and hybrid electrodes may be less accurate at higher frequencies, they generally produce recordings similar in quality to those of standard wet electrodes. This EEG system is complemented by a software analysis pipeline that removes artifacts, performs source localization and functional connectivity analyses, determines cognitive and behavioral states, and generates images of the data in real-time. The software removes high-amplitude artifacts from online data using artifact subspace reconstruction. Next, EEG data can be used to localize activity sources, to define regions of interest, and then to analyze features of neural activity such as spectral power and functional connectivity within and between regions of interest. The connectivity analysis is then used to classify activity into cognitive and behavioral states using a novel method, ProxConn. ProxConn allows learning of flexible, predictive models of cognitive and behavioral states with just a few experimental trials, making EEG data processed in this manner accessible for brain-computer interface use. Finally, this system can generate 2-dimensional plots of EEG data and project spatiotemporal features of neural activity features on a 3-dimensional model brain.This EEG data acquisition and analysis system was successfully validated in a study of 8 subjects performing the Eriksen flanker task. The task requires subjects to identify when visual stimuli surrounding or flanking the target stimulus are congruent, incongruent, or neutral with respect to the target stimulus; thus, the subjects must suppress certain responses on the basis of the flanking context. Performance of this task has been shown to activate the anterior cingulate cortex (ACC) and to lead to characteristic patterns of event-related potential (ERP) detected over the caudal ACC when target and flanking stimuli are incongruent. Data collected and analyzed through the hardware and analysis system replicated the ERP pattern localized to the same region corresponding to the ACC for incongruent target and flanking stimuli. The area under a receiver-operating characteristic curve was used to classify performance and was calculated for the data analyzed using the current gold standard for ERP classification analysis, dual-spectral regularized logistic regression (DSLR), and ProxConn. The 2 methods yielded similar performance in subjects, although the ProxConn method produced lower between-subject variance, a larger percentage of subjects performed above chance level than with DSLR method, and the group mean for performance was higher with DSLR.Mullen et al have designed a wearable EEG system that can be used to ascertain cognitive states in human subjects. The group used the BCILAB + SIFT system, from the EEGLAB toolbox in MATLAB data, for real-time analysis, which is not yet available in alternative methods of connectivity analysis. They were able to ascertain cognitive states from mobile EEG data in subjects, suggesting that their methods could be used in alternative settings to ascertain cognitive states in ambulatory situations [3].

Recommended Books

Niedermeyer's Electroencephalography: Basic Principles, Clinical Applications, and Related Fields

1)
Nascimento FA, Katyal R, Olandoski M, Gao H, Yap S, Matthews R, Rampp S, Tatum W, Strowd R, Beniczky S. Expert accuracy and inter-rater agreement of “must-know” EEG findings for adult and child neurology residents. Epileptic Disord. 2023 Nov 30. doi: 10.1002/epd2.20186. Epub ahead of print. PMID: 38031822.
2)
Mullen TR, Kothe CA, Chi YM, et al. Real-time neuroimaging and cognitive monitoring using wearable dry EEG. IEEE Trans Biomed Eng. 2015;62(11):2553–2567.
3)
Boone C, Wojtasiewicz T, Anderson WS. Characterization of a Wearable Dry Electroencephalography System. Neurosurgery. 2016 Oct;79(4):N10-1. doi: 10.1227/01.neu.0000499703.35843.82. PubMed PMID: 27635965.