Deep Dive into Event Related Potentials Technique

Ms. Pragati Gupta

Course Content:

We see in the electroencephalogram a concomitant phenomenon of the continuous nerve processes which take place in the brain, exactly as the electrocardiogram represents a concomitant phenomenon of the contractions of the individual segments of the heart -

-Hans Berger

Our brain is one of the universe's most complex, dynamic, and fascinating elements. It enables us to recall past events, process all current sensory feedback, and project all of our emotions, memories, and predictions into the future. Our brain is in constant action, generating electrical activity which is very subtle and can be captured through Electroencephalography (EEG). An exceptional tool for investigating the neurocognitive mechanisms that underpin human behavior such as covert attention, perception, emotions, working memory etc.

Through this course we will learn about the basics of EEG and ERP Signals, Closer look of ERP and its components, Experimental design and its significance in EEG/ ERP Analysis, ERP Components, Artifacts, Pre-Processing Steps and Pipelines, Quantifying ERP Amplitude and Latencies etc. Various Case studies will be discussed pertaining to the EEG and ERPs with recent advancement in the field (such as Brain Computer Interface etc.). The idea is to help one develop a holistic perspective of the EEG/ERP in terms of it's generation, signals, artifacts, designing of experiments, it's relation to different cognitive factors before performing the analysis, to actually know of what we are dealing with when we later perform the analysis/ signal processing.

Short Quiz after every module will be taken, for enhanced understanding of the topic. In the end you will be able to know the tool of EEG in more details of what all it does and how it works, its strengths and weakness. You will be able to design the experiment, more clarity while reading research papers in EEG and ERP domain, Preliminary Analysis, and gaining insight into the

underlying reasons for performing the pre-processing, and Basic Analysis.

Prospective overview of the sessions (likely to change)

1.) Basics of EEG signal and EEG recordings

*Overview of the theory behind neural signals (History)

*Generation and Propagation of ERP and EEG

* Different EEG Recording Systems with its specifics (Amplifier, Electrodes etc.)

* 10/20 Electrode System, Reference, Montages, Impedance, etc.

* Brain Rhythms and Cognition (Based on Clinical and Research Studies)

2.) Basics of ERP Components

* ERP Components (MMN, P300, N400, N170, VPP, CNV, Sensory ERP Components, etc.)

* Difference Wave, Forward-Inverse Problem

* Challenges in ERP Source Localization

* Peaks and Components

3.) EEG-ERP Prepossessing with Various Preprocessing Pipelines

* Basic Principles and Challenges

* Filtering, Baseline Correction, Interpolation, Artifact Rejection and Correction, Re-referencing,

ICA etc.

* Pipelines: MAKATO, HAPPE, BEAP and etc.

4.) Experimental Design

* Principles of Experimental design for ERP in Clinical and Research Settings

* Significance of Measurement Window

* Common Design Problems and Solutions

* Case Studies on research articles with good and bad design

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📍 Vanke Tianyu, International Building, Central City, Longgang District, Shenzhen ,Building C1 ,4003 Unit   📞 +8613380781282

6.) **Basic Analysis**

* Quantifying ERP Amplitudes and Latencies

* Introduction to the Analysis tool boxes (EEGLAB, ERPLAB)

* FFT, Time Frequency Analysis

7.) **Common Mistakes (in lack of parameters)**

* Overlapping

* Filtering

* Epoching

* Baseline Correction

* Measurement Window

8.) **Conclusion**

* Case Studies and Experiments with EEG -ERP Analysis

* Application, Strength and Weakness of EEG/ERP.

* Recent Development in the field (Biomarkers in Various Neurocognitive Disorders, Brain Computer Interface etc.)