Introduction to EEG and ERP Analysis
Spring 2026

Instructor: Chang-Mao Chao Course ID:

psycmc@ccu.edu.tw Office hours: anytime by appointment

Date/time: Thursday 19:10 – 22:00/ 19:15 – 22:00

Location: ??

Website: All course material will be available on ecourse2

This course provides a comprehensive introduction to the theory and practice of electroencephalography (EEG) and event-related potential (ERP) analysis, with a focus on applications in cognitive neuroscience and psychology. Students will learn the entire analytic workflow—from understanding the physiological basis of EEG signals to performing preprocessing, artifact rejection, averaging, and statistical analysis of ERP components. The course emphasizes both conceptual understanding and hands-on experience, using open-source tools such as MNE-Python and EEGLAB to analyze real or publicly available EEG datasets.

In addition to technical training, students will engage with classic and contemporary literature to understand how EEG/ERP methods are used to study perception, attention, memory, and cognitive control. Weekly readings and discussions will highlight the link between experimental design, data preprocessing choices, and interpretation of neural signals.

By the end of the course, students will be able to:

- Explain the neural and cognitive foundations of EEG/ERP signals.
- Design simple EEG/ERP experiments with proper timing and control.
- Perform basic preprocessing, including filtering, epoching, baseline correction, and artifact rejection.
- Identify and quantify major ERP components (e.g., P1/N1, N2, P3).
- Critically evaluate ERP studies and interpret findings within cognitive frameworks.

Course Objectives

By the end of the semester, students will be able to:

1. Understand the neural and physiological basis of EEG signals.
2. Review classic and contemporary ERP literature across perception, attention, and memory.
3. Perform preprocessing steps (filtering, referencing, ICA, artifact rejection).
4. Extract and analyze ERP components (N1, P2, N2, P3, ERN, LPP).
5. Apply statistical and visualization techniques for ERP data.

6. Interpret ERP results in relation to cognitive theories and brain mechanisms.

Weekly Schedule

Week	Topic	Content / Activities	Readings / Assignments
1	Introduction to EEG and ERP	History of EEG; electrophysiological basics; cognitive neuroscience applications	Luck (2014) *An Introduction to the ERP Technique*, Ch. 1–2
2	Brain Rhythms and ERP Components	Alpha, beta, theta oscillations; definition of ERP; time- vs. frequency-domain	Kappenman & Luck (2012), Ch. 3
3	EEG Hardware and Experimental Design	Electrodes, amplifiers, sampling rate; 10-20 system; designing ERP tasks	Review: Handy (2005), *Event-Related Potentials: A Methods Handbook*
4	Data Acquisition and Recording	Signal quality, impedance, grounding, participant preparation	Demonstration: mock EEG recording session
5	Preprocessing I: Filtering and Referencing	Band-pass filters, re-referencing strategies, bad channel detection	Lab 1: basic preprocessing in MNE-Python
6	Preprocessing II: Artifact Detection and ICA	Eye blink, muscle, and movement artifacts; ICA and manual rejection	Makeig et al. (1996) ICA paper
7	Epoching and Baseline Correction	Defining event markers; segmentation; baseline normalization	Lab 2: create epochs and baselines
8	ERP Averaging and Visualization	Averaging across trials; plotting ERP waveforms and scalp topographies	Lab 3: compute ERPs for a visual oddball task
9	Midterm Discussion & Literature Review Workshop	Student-led reviews of classic ERP papers (e.g., P300, ERN)	Prepare 5-min article summary presentation
10	ERP Components in Perception and Attention	N1/P1, N2pc, P3b; spatial attention and visual processing	Eimer (1996); Polich (2007)
11	ERP Components in Cognitive Control	N2, ERN, Pe; response inhibition and error processing	Falkenstein et al. (2000); Gehring & Willoughby (2002)
12	ERP Components in Memory and Emotion	LPP, old/new effect, and emotional modulation	Rugg & Curran (2007); Hajcak et al. (2010)

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13	Statistical Analysis of ERPs	Within-subject ANOVA, cluster-based permutation, multiple comparisons	Maris & Oostenveld (2007)
14	Source Localization and Time–Frequency Extensions	Dipole modeling, source estimation, ERSP/ITC	Delorme & Makeig (2004)
15	Integration and Interpretation	Connecting ERPs to behavior and cognitive models; replication study	Lab 4: final ERP analysis report
16	Final Presentations	Student project presentations and group discussion	Submit final project report

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Assessments

- **Weekly quizzes & discussions** – 15%
- **Laboratory assignments** – 35%
- **Literature review presentation** – 15%
- **Final ERP analysis project** – 35%

Software & Tools

- **EEG/ERP Software:** MNE-Python (preferred), EEGLAB (Matlab optional)
- **Statistical Tools:** Python (NumPy, SciPy, matplotlib), or R
- **Data Sources:** Open datasets (ERP CORE, PhysioNet EEG Motor Movement, or lab-recorded data)