# EEG Signal Analysis Lab Assignment

## Alpha Rhythm in Eyes-Open vs. Eyes-Closed Conditions

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### **Overview**

In this lab, you'll analyze the differences in EEG activity between eyes-open and eyes-closed conditions, focusing on the alpha rhythm (8-13 Hz). You'll use prepared code to visualize and analyze data from the "Resting state EEG with closed eyes and open eyes in females from 60 to 80 years old" dataset.

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### **Objectives**

* Observe the alpha blocking phenomenon
* Identify individual differences in EEG patterns
* Document observations systematically
* Draw conclusions based on visual analysis

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### **Materials**

* Jupyter notebook with pre-written analysis code (found on course’s github page)
* EEG dataset (accessible on the course server)
* This lab worksheet

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### **Instructions**

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#### Part 1: Running the Analysis

1. Open the provided Jupyter notebook.
2. You'll be testing different subjects by changing the subject ID
3. Update the subject number in the code cell:

* subject = "XX" # Replace with your assigned subject number

1. Run all cells in the notebook.
2. Save any generated figures of interest for your report.

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#### Part 2: Visual Analysis

Carefully examine the figures produced by the code, focusing on:

1. **Power Spectral Density (PSD) Plots**
   * Look for differences between eyes-open and eyes-closed conditions
   * Identify the alpha peak (typically 8-13 Hz)
   * Note any other frequency bands that show changes
2. **Topographic Maps**
   * Observe the spatial distribution of alpha power
   * Compare the patterns between conditions
   * Look for regions with the strongest differences
3. **Time-Frequency Plots**
   * Check the stability of the alpha rhythm over time
   * Note any transient changes or patterns

#### Part 3: Documentation

Complete the attached Subject Analysis Checklist for your assigned subject.

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### **Subject Analysis Checklist**

**Subject ID**: 46

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#### 1. Alpha Rhythm Characteristics

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Feature*** | ***Strong*** | ***Moderate*** | ***Weak*** | ***Not present*** |
| ***Alpha blocking effect*** |  |  |  | X |
| ***Alpha peak clarity*** | X |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| ***Alpha band width*** | ***Narrow (< 2Hz)*** | ***Medium (2-4Hz)*** | ***Wide (>4Hz)*** |
| ***Check one:*** | X |  |  |

#### 2. Spatial Distribution

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Alpha topography*** | ***Occipital dominant*** | ***Parietal dominant*** | ***Widespread*** | ***Other pattern*** |
| ***Eyes closed*** | X |  |  |  |
| ***Eyes open*** |  |  | X (it’s widespread/frontal) |  |

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#### 3. Frequency Band Changes (Eyes Open vs. Closed)

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency band** | **Increased in eyes open** | **Decreased in eyes open** | **No change** |
| **Delta (0.5-4 Hz)** |  | X |  |
| **Theta (4-8 Hz)** |  |  | X |
| **Alpha (8-13 Hz)** |  | X |  |
| **Beta (13-30 Hz)** |  | X (slightly) |  |

#### 4. Notable Observations

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Yes** | **No** | **Details (if Yes)** |
| **Multiple alpha peaks** |  | X |  |
| **Unusual topography** |  | X |  |
| **Strong beta activity** | X |  | Parietal and frontal lobe both have a visible peak in beta band |
| **Asymmetry between hemispheres** | X |  | Left hemisphere has a little weaker response |
| **Visible noise or artifacts** |  | X |  |

#### 5. Quantitative Measurements

* Approximate alpha peak frequency: **9.8** Hz
* Ratio of alpha power (Closed/Open): ~**2:1**
* Channels with strongest alpha: **Fz, Cz, F3, P4, C4**

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#### 6. Subject Characterization

Compare the current subject to what you would expect for a typical subject:

* [ ] Typical alpha blocking pattern
* [ ] Stronger than expected alpha blocking
* [X] Weaker than expected alpha blocking
* [ ] Unusual spatial pattern
* [ ] Unusual frequency pattern

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#### Part 4: Reflection Questions

Answer the following questions in 3-5 sentences each:

1. How would you describe the alpha blocking effect in your assigned subject?

Very weak, I couldn’t detect it.

1. What individual characteristics did you notice that might be unique to your subject?

Very strong beta activity in eyes closed.

1. Based on your observations, what function do you think the alpha rhythm serves in the brain?

I would suspect that alpha rhythm performs the role of relaxation.

1. If you were to design a follow-up experiment to further investigate your subject's EEG patterns, what would you focus on?

I would focus on parietal and frontal lobe to discover the source of the strong beta response in eyes closed.

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### **Deliverables**

Submit the following by [due date]:

1. Completed Subject Analysis Checklist
2. Answers to the reflection questions
3. 2-3 key figures from your analysis that best illustrate your findings

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### **Next Steps**

In next session, we'll compile observations across all subjects to identify patterns and individual differences in the dataset. Be prepared to share your findings with the class.