

Neuroinformatics Quiz 1, Monsoon 2025

45 minutes

Q1: Arjun is planning an experiment to study attention by asking participants to detect a faint target in a rapid stream of visual stimuli. He wants to analyze theta oscillations (4–7 Hz) in the 500 ms after each target. His institute has asked him to recommend an EEG system.

As an expert advisor, specify:

1. The number of EEG channels (32, 64, or 128).
2. The sampling rate (128 Hz, 512 Hz, or 1000 Hz).
3. At least two specific recommendations for the experimental recording environment.

Justify all your choices in terms of spatial and temporal resolution, cost-effectiveness, and the frequency band of interest. (5 marks)

Q2: Arjun wants to compare EEG activity between two conditions: (1) when targets are predictable in the stream and (2) when targets appear randomly.

How would you design this study and begin the analysis? Specifically discuss (1 mark each = 4 marks):

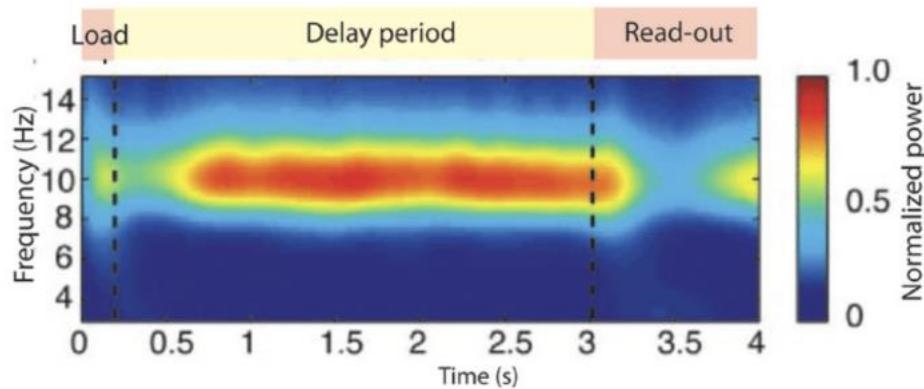
1. How many trials per condition should be planned?
2. The number of subjects required.
3. How you would segment (epoch) the data with respect to baseline and task periods, including the role of filter buffers.
4. The types of visualizations you would create at early, middle, and late stages of preprocessing and analysis.

Q3: List three major sources of artifacts in EEG recordings that might occur in this study. For each, describe one method to minimize or remove it, and mention a caveat or assumption of that method. (3 marks)

Q4: A lab releases an EEG dataset with epoched trials of 1 second baseline and 2 seconds task activity. You decide to analyze alpha activity (8–12 Hz) but later realize you also want to explore the delta band (2–4 Hz). You filter the already-epoched data and compare baseline vs. task delta power. You find what looks like a robust increase in delta power during the task, which fits your hypothesis.

A senior colleague warns you that the finding might be an artifact. Explain why they might be correct, and describe one or two strategies you could use to fix or validate the analysis. (4 marks)

Q5: Examine the following time-frequency plot obtained from a working memory experiment (averaged across all trials and electrodes) and answer the questions that follow:



- a. Write down your initial observations by paying attention to the axes, colors, and legends. (1 mark)
- b. What can you conclude from the above observations? Popular theories of working memory (WM) argue that WM is engaged continuously during the delay period of a relevant task. Do your observations support the theory? Justify. If you feel your observations are inconclusive, elaborate on the additional analyses required. (3 marks)