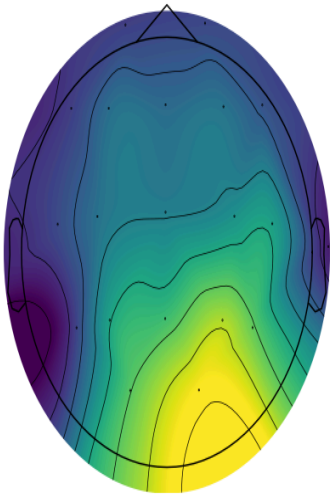
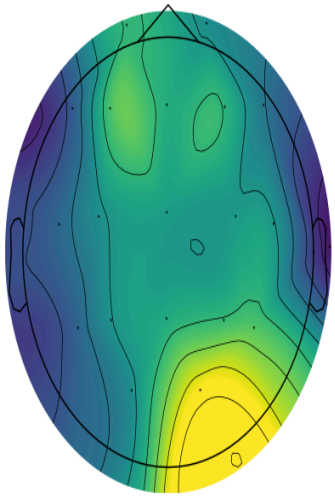
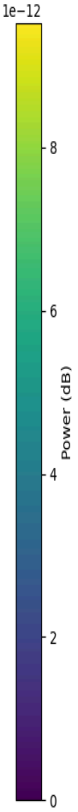
Question 4

Alpha Band (8-12 Hz) PSD Topomap - Subject 06 Baseline

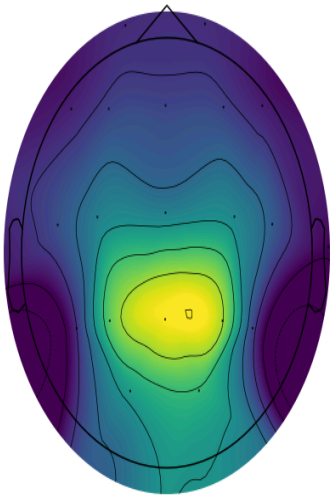


Alpha Band (8-12 Hz) PSD Topomap - Subject 06 Task

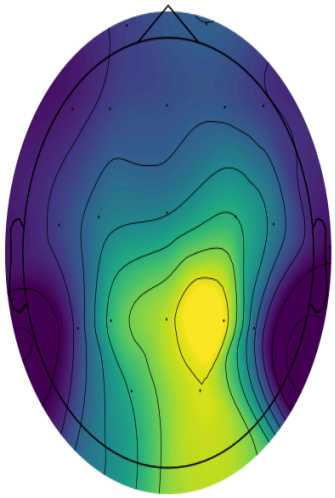




Alpha Band (8-12 Hz) PSD Topomap - Subject 07 Baseline



Alpha Band (8-12 Hz) PSD Topomap - Subject 07 Task



Discussion:

The topomaps show a noticeable reduction in alpha power (8-12 Hz) from the baseline to the task condition for both subjects, particularly in the rear regions of the scalp. During the baseline, both Subject 06 and Subject 07 exhibit strong alpha activity, especially in the rear areas, which is typical for relaxed or resting states. In the task condition, both subjects show a decrease in alpha power, indicating a shift to a more focused and engaged mental state. This reduction, known as alpha desynchronization, is more pronounced and widespread in Subject 06 compared to Subject 07, suggesting greater cognitive engagement for Subject 06. Overall, the reduction in alpha power from baseline to task reflects the brain's transition from relaxation to active task performance.

Code:

```
import mne
import os
import numpy as np
import matplotlib.pyplot as plt

# Load subject 06 edf files
subject_06_baseline = mne.io.read_raw_edf(os.path.join("data", "Subject06_1.edf"),
preload=True)
subject_06_task = mne.io.read_raw_edf(os.path.join("data", "Subject06_2.edf"),
preload=True)

# Load subject 07 edf files
subject_07_baseline = mne.io.read_raw_edf(os.path.join("data", "Subject07_1.edf"),
preload=True)
subject_07_task = mne.io.read_raw_edf(os.path.join("data", "Subject07_2.edf"),
preload=True)

# Clean up channels
raw_data = [subject_06_baseline, subject_06_task, subject_07_baseline,
subject_07_task]
for raw in raw_data:
    raw.rename_channels({
        'EEG Fp1': 'Fp1', 'EEG Fp2': 'Fp2', 'EEG F3': 'F3', 'EEG F4': 'F4',
        'EEG F7': 'F7', 'EEG F8': 'F8', 'EEG T3': 'T3', 'EEG T4': 'T4',
        'EEG C3': 'C3', 'EEG C4': 'C4', 'EEG T5': 'T5', 'EEG T6': 'T6',
        'EEG P3': 'P3', 'EEG P4': 'P4', 'EEG O1': 'O1', 'EEG O2': 'O2',
        'EEG Fz': 'Fz', 'EEG Cz': 'Cz', 'EEG Pz': 'Pz', 'EEG A2-A1': 'A2',
        'ECG ECG': 'ECG'
    })
    raw.set_channel_types({'ECG': 'ecg'})

    # Set the montage for the channel locations
    montage = mne.channels.make_standard_montage('standard_1020')
    raw.set_montage(montage)

# Define frequency range for alpha band
alpha_band = (8, 12)

# List of subjects and their corresponding data
subjects = [
    ('Subject 06 Baseline', subject_06_baseline),
```

```
    ('Subject 06 Task', subject_06_task),
    ('Subject 07 Baseline', subject_07_baseline),
    ('Subject 07 Task', subject_07_task)
]

fig, axes = plt.subplots(2, 2, figsize=(15, 12))  # 2x2 grid for 4 plots

# Loop through each subject and condition
for i, (title, raw) in enumerate(subjects):
    # Compute average PSD for each condition
    psd, freqs = raw.compute_psd(method='welch', fmin=alpha_band[0],
fmax=alpha_band[1], n_fft=2048).get_data(return_freqs=True)

    # Average the PSD across the frequency range for the alpha band
    alpha_psd = np.mean(psd[:, (freqs >= alpha_band[0]) & (freqs <= alpha_band[1])],
axis=1)

    # Determine subplot position
    row, col = divmod(i, 2)

    # Create topomap
    im, cn = mne.viz.plot_topomap(alpha_psd, raw.info, axes=axes[row, col], show=False,
contours=8, cmap='viridis')
    axes[row, col].set_title(f'Alpha Band (8-12 Hz) PSD Topomap - {title}',
fontsize=14)
    axes[row, col].grid(True)

# Add color bar
cbar_ax = fig.add_axes([0.92, 0.15, 0.02, 0.7])
fig.colorbar(im, cax=cbar_ax, orientation='vertical', label='Power (dB)')

plt.tight_layout(rect=[0, 0, 0.9, 1])
plt.show()
```