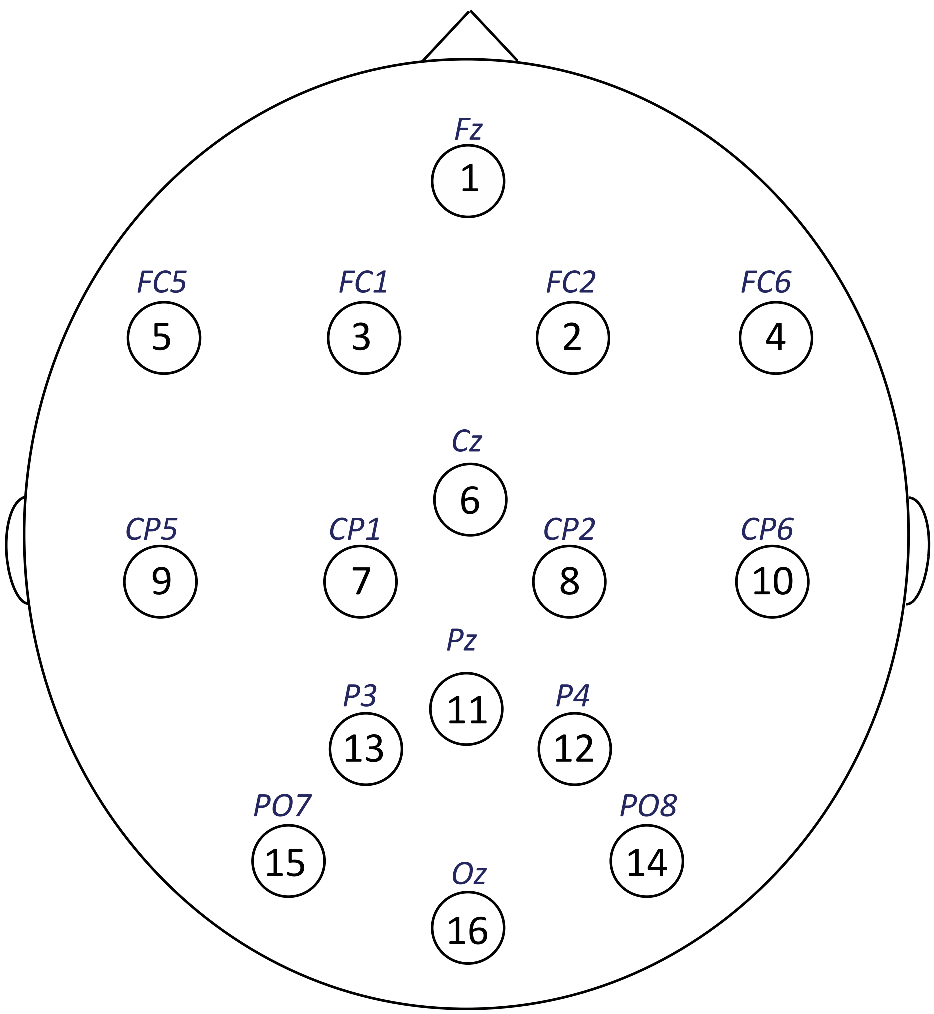
Lab Instruction 7
Attentional Modulation of ASSR

Brain Computer Interface Lab
ECBM 4090



Attentional Modulation of ASSR:

In the previous session, we measured the Auditory Steady State Response (ASSR), the neural measurement of a rapidly modulated sound (e.g. tone or noise). In this project, we will examine whether ASSR reflects only the sound that the person listens to, or also the subject's perception.

We will generate two different carrier and modulator frequencies, one in each ear. We will ask the subject to attend first to the left ear, and then to the right ear. The sound that the subject hears remains fixed; only the subject's attention changes. We will measure the ASSR under these conditions and examine the effect of attention on the amplitude of the ASSR response.

Setup:

1. Electrodes: **Fz, Cz, Pz, FC1, FC2, CP1, CP2**
2. Filter: Bandpass 0.5Hz to 60Hz. Notch at 60Hz.
3. The subject should keep their eyes open and fixated, but not on the monitor.

Experiment 1. Measuring the effect of attention on ASSR

1. Use the StereoASSR function provided on Courseworks
    a. This function generates a stereo sound (two channels: one for the left ear and one for the right ear).
        i. The left channel plays a tone at 730Hz, modulated at 40Hz.
        ii. The right channel plays a tone at 1130Hz modulated at 35Hz.
    b. The code also generates small frequency wiggles in the carrier frequency. The subject can be instructed to attend by counting the number of wiggles in one ear or the other.
    c. First listen to the sound and make the subject familiar with the task.

2. Create a Simulink s-function that plays a continuous sound.
    a. The sound should begin 10 seconds after the beginning of the experiment to allow for the EEG signal to settle.
    b. Your program should also output a flag at the onset of the sound which can later be used for segmentation of the EEG signal. Save this signal to file.
    c. After the sound has been played, your s-function should set the output back to 0.
    d. **Important**: Make sure the sound is played only once in the s-function.
    e. **Reminders**:
        i. To get the simulation time use Ct = get (block , 'CurrentTime');
        ii. To stop playing a sound, use "clear sound".

3. Play the ASSR sound four times in four different experiments.
    a. **Make sure to save to different files.**
        i. **This data is needed for the homework**
    b. The four conditions are:
        i. **attend to left** (count the number of wiggles in the left ear)
        ii. **attend to right** (count the number of wiggles in the right ear)
        iii. **attend to both** (count the number of wiggles in both ears)
        iv. **unattended** (give the subject a secondary task, e.g. watch a silent movie).
    c. Collect at least 300s of data as the subject listens to the sounds.

Experiment 2. Online implementation

1. Design a Simulink model to find the spectral energy present in the EEG response to the modulated tone at 40Hz in real time. Hints:
    a. Generate a bandpass filter around 40 Hz in Simulink.
    b. Estimate the envelope using "Abs" and "Bandpass" blocks.
    c. For a review of how to detect envelope, refer to lab instruction 3.
2. Modify your s-function to play a 40Hz modulated tone 30 seconds after the beginning of the experiment.

Report: What do you observe? Report the average EEG spectral energy at 40 Hz from 100 - 300 seconds after the onset of the experiment. (2 pts)

3. Do the same experiment with a tone modulated at 35 Hz. Remember that you should find EEG spectral energy at 35 Hz.

Report: What is the difference between the average value of the EEG spectral energy at 35Hz versus 40Hz? Why do you find different frequencies of the spectral energy for each experimental condition? Which condition produces greater magnitude? Does this finding match your observation from the previous experiment? (4 pts)

Experiment 3. Online implementation of attentional effects

1. Use 2 bandpass filter blocks to separate the modulator frequencies and estimate the envelope.
2. Plot the ratio of left to right spectral energy and save it to a .mat file.
3. In your s-function, design a trigger that marks every 60 seconds.
4. Run the experiment for 300 seconds, switching your attention every 60 seconds when your lab partner sees the trigger on the scope.
    a. Take a screenshot during each attentional condition
5. Find a threshold to predict attention.

a. First find the average ratios (saved in .mat file) for each attentional case.
b. Do not include the first 60 seconds in your analysis.
c. Take the mean value of the averaged ratios. This is the threshold.
d. Modify your model to compare the ratio with the appropriate threshold.

Report: Explain the calculation of your threshold. Can you use it to show which ear the subject is attending to in real-time? Include plots of the ratio between left and right and screenshots of the signal when the subject is attending to different ears. (4 pts)

Homework: Use Experiment 1 data only

Plot the time waveform of the sounds used in your experiments (only the first 100ms of the signal, separately for the left ear and the right ear) and their time-frequency decomposition called a spectrogram (use specgram function in MATLAB). (1 pt)

Load the EEG signal in Matlab. Use the trigger signal from the s-function to separate the EEG response to sound. (1 pt)

Take the Fourier transform of each channel, and then average the magnitude of FFT over all channels. (1 pt)

Question: if the length of the FFT is L, and given the sampling frequency of your EEG signal (256Hz), what samples in FFT correspond to the modulator frequencies of the left ear and the right ear? (i.e. 40Hz & 35Hz)? (1 pt)

Create a table or bar graph showing the average magnitude of the ASSR signal over all channels for the two modulator frequencies and for each of the four listening conditions. How do you interpret the data? (6 pts)