Crux 2023-20 24

Literature Review

02/17/24

Introduction

This Literature Review is focused on identifying what EEG channels to use for our project. The focus in on measuring concentration through measuring beta power and averages.

Source 1 - Analysis of EEG Signals for the Estimation of Concentration Level of Humans

- Introduction
  - Characteristics extracted from raw EEG using FFT, mean, standard deviation, median and mean root square. Concentration level determined by comparing extracted features.
  - Prefrontal lobe responsible for attention and concentration, judgement and motor skills.
  - Dominant high frequencies indicate ppl are alert.
  - Intensities(Hz) split into bands
  - Beta Waves - 14-30 Hz, awake, alert and perceptive state
- Methods
  - EEG 10-20 amplification method
  - 3 electrodes (not given??)
  - notch filter
  - participants aged 20-23
  - task of reading a book, puzzle, counting in reverse for 10 minutes
- Feature Extraction
  - FFT, average, SD, determination of variance
  - raw signal => frequency domain using FFT
  - signal classified among the 5 brain waves
  - Max mean, RMS, SD, and Var observed in first 2 mnutes, and min in last 2 minutes
- Results and Discussion
  - FFT is effective for feature extraction

Overall this paper was okay, i dont think its a very reliable source, but it at least offered some simple methods for feature extraction.

Source 2 - Measurement of Concentration Duration on Reading Activity: EEG Analysis with OpenBCI Ganglion Board

- Abstract
  - Someone who is concentrating will be at a frequency of 15-18Hz
  - Reading requires concentration
  - concentration power while reading is indicated through the duration of concentration
  - 15 minute recordings usign OpenBCI
  - sampling rate of 200Hz, max impedance of 15 ohms
  - Processed with EEGLab and EDGF Browser
  - 3 classes for results: low, non, and high concentration
- Introduction
  - concentration is at a frequency of 15-18Hz which is in the beta range
  - concentration power can be described based on the duration of concentration
- Methods
  - two main theories are used: neurolinguistic theory and brain wave theory
- Findings
  - EEG with the brain wave range at 13-40Hz (Beta Rhythm) is characterized as the optimal concentration condition, especially at 15-18 Hz.
  - If it is above 22 Hz even up to 40 Hz (Gamma Rhythms), EEG data is characterized as high concentration (focus), but can have anxiety / anxiety impact.
  - Meanwhile, if under 13 Hz it shows diminished concentration and towards a relaxed state and toward a reduction of awareness conditions
  - average concentration in 15 was 11 minutes 3 seconds: optimal con. 3m19s, low con. 6m9s

This paper is much clearer, still not a great academic source, but at least offers more on how to classify concentration.

Influence of Binaural Beats on EEG Signal

- Abstract
  - requency of f = 10 Hz. The left ear was exposed to a signal with a frequency of 100 Hz, and the right ear — to a signal with a frequency of 110 Hz, the acoustic pressure level SPL = 73 dB
  - ecrease of average amplitudes of spectral density function of EEG strength signal for alpha and beta frequency ranges
  - amplitude of spectral density function of the strength has increased in theta frequency range
- Introduction
  - Binaural beats are a result of superposition of neuron discharge coming from the left and right ear on a suitable level of the hearing route
  - Two signals are connected in the brain, the result being a sensation of hearing a third signal — with a frequency of a signal provided to the left and the right earcalled binaural beats

  - reticular system decides about lucidity, concentration and consciousness, changes the brain wave activity so that it is adjusted to the stimulation of the beat signals
  - maintain homeostasis
  - subjects listened through stereo headphones to pure tones designed to produce delta and theta binaural beats
  - analysis of the EEG data involved computing the changes in the percentages of total EEG amplitudes, comparing the conditions of waking rest, binaural-beat stimulus periods,and a second period of rest
  - ubjects generated significantly less alpha and beta, and more delta and theta freq. brainwaves
  - binaural beats may be associated with reduced EEG arousal
  - other research observed reductions in the percentages of occipital alpha (bipolar O1-O2) were significant
  - reductions in the percentages of central delta(bipolar C3-C4) were similarly significant

- Methods
  - binaural beats with an acoustic pressure level of SPL = 73 dB,
  - frequencies: the right ear — 110 Hz,left ear - 100 Hz
  - total duration of the experiment was 35 min, 20 with stimulus
  - played on stereo headphones
  - EEG cap was fitted in accordance with a standard 10/20 system
  - electrodes are placed along sagittal line of the head **(5 on the left side: Fp1, F3, C3, P3, O1 and 5 on the right side: Fp2, F4, C4, P4, O2 and a reference electrode on the OP, Pz)**
  - The initial 5 min was without the binaural beats exposition, 20 min with the signal exposition and 10 min without the exposition.

- Results
  - analysis of a spectral density function of EEG strength signal
  - occurred a component in EEG signal morphology, with a frequency of the presented binaural beats
  - assumed an EEG signal frequency division used in the electro encephalography: beta — from 12.0 to 29.9 Hz, alpha — from 8.0 to 11.9 Hz, theta — from 4.0 to 7.9 Hz, delta — from 0.5 to 3.9 Hz

- Conclusion
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This paper was much nicer, methods were much clearer and thought out. This study was focused on the effect overall on EEG rather than on just concentration, however, they did go over the effect on beta waves, which is of interest. Since binaural beats seem to decrease beta power, we may see less strong indicators of concentration in out study.