

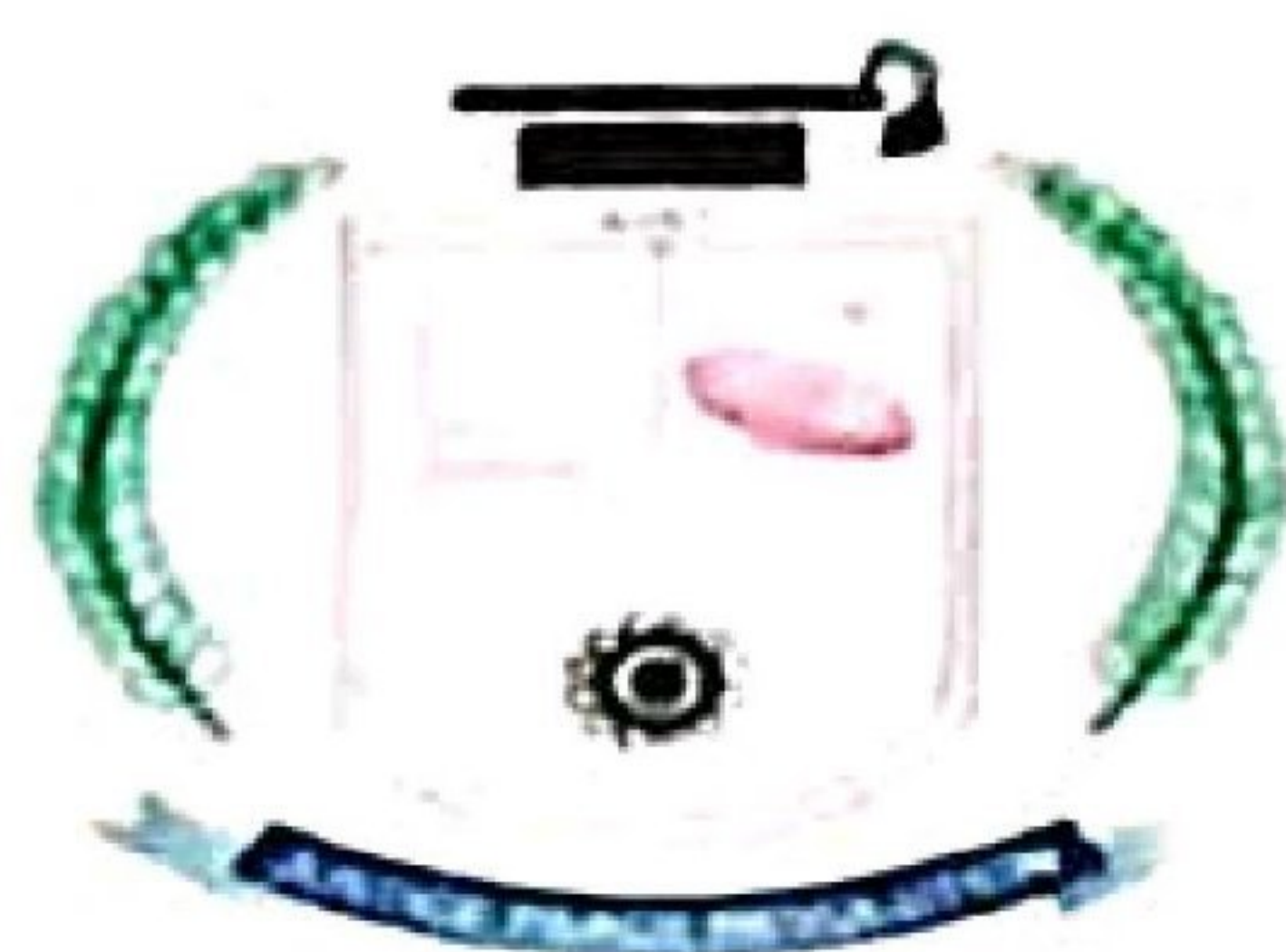
EEG ANALYSIS DURING PROBLEM SOLVING ACCORDING TO BLOOMS TAXONOMY LEVEL

Submitted in partial fulfilment of the requirements for the award of
Bachelor of technology in Biomedical Engineering

by

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
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DEPARTMENT OF BIOMEDICAL ENGINEERING BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of B.Periyanayagam Rozario (39240028) K.Tamilmaran (39240039). Who carried out the project entitled "EEG Analysis during Problem Solving according To Blooms Taxonomy Level" under my supervision from October 2022 to April 2023.


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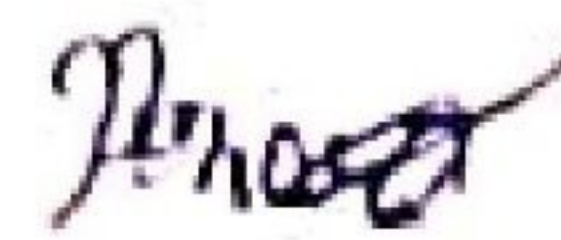
Submitted for Viva voce Examination held on 18.04.2023


Internal examiner

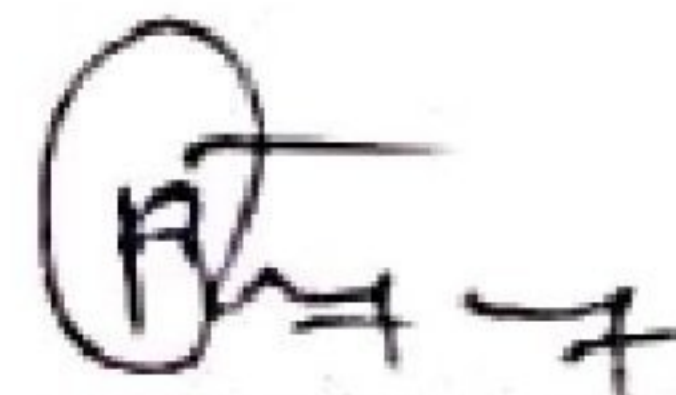

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DECLARATION

We, PERIYANAYAGAM ROZARIO B AND TAMILMARAN K hereby declare that the Project Report entitled EEG Analysis During Problem Solving According To Blooms Taxonomy Level done by us under the guidance of Dr. T SUDHAKAR, Head of the Department, Dept. of Biomedical Engineering at Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biomedical engineering.



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ABSTRACT

The primary goal of this research is to examine EEG during problem solving. The difficulties will be presented at various levels of the bloom taxonomy. When participants complete activities with varying degrees of mathematical and scientific difficulty that are offered at all six levels of Bloom's taxonomy, the EEG signals are monitored. We'll research the frontal, parietal, and occipital lobes' alpha and theta waves. To learn more about how the brain behaves while thinking and solving problems, statistical, spectral, and temporal frequency analysis of EEG data will be examined.

KEYWORDS : Bloom'sTaxonomy , Lobes , Statistical , Spectral

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LIST OF ABBREVIATION

ABBREVIATION	EXPANSION
API	Application Programming Interface
AI	Artificial Intelligence
CI	Confidence Interval
MLC	Myosin Light Chain
ICF	Intracellular Fluid
ML	Molecular Layer
CD	Cluster of Differentiation
PT	Peak Twitch
CMP	Comprehensive Metabolic Panel
LSS	Lab Safety Supply
TNP	Test Not Performed
SVM	Security Value Map
AC	Alba Conde

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CHAPTER -1

INTRODUCTION

The recording of electrical activity along the scalp caused by the firing of neurons in the brain is known as electroencephalography (EEG).

EEG is the term used to describe the recording of the brain's spontaneous electrical activity from many electrodes implanted on the scalp during a brief period of time, often 20 to 40 minutes. Since epileptic activity can clearly manifest as anomalies on a routine EEG scan, epilepsy is the principal condition for which EEG is used in neurology as a diagnostic tool. EEG is also used clinically to diagnose coma, encephalopathies, and brain death. When it comes to the diagnosis of tumors, strokes, and other localized brain illnesses, EEG used to be the gold standard, however with the development of anatomical imaging techniques like MRI and CT. Evoked potentials (EP), which average the EEG activity time-locked to the presentation of a stimulus of some kind (visual, somatosensory, or aural), is one of the EEG technique's derivatives. Event-related potentials are time-locked averaged EEG responses that are utilised in cognitive science, cognitive psychology, and psychophysiological studies to better understand how the brain processes more complex information. Attention is a fundamental cognitive function that governs all other cognitive processes, including perception, memory, and learning. Cognitive processes result from both overt (externally apparent) and covert attention (internally detectable). Attention can be inadvertently directed by outside events (i.e., top-down) or consciously directed by internal expectations requiring cognitive control (i.e., bottom-up). (Merve Keskin, et al .,2020)

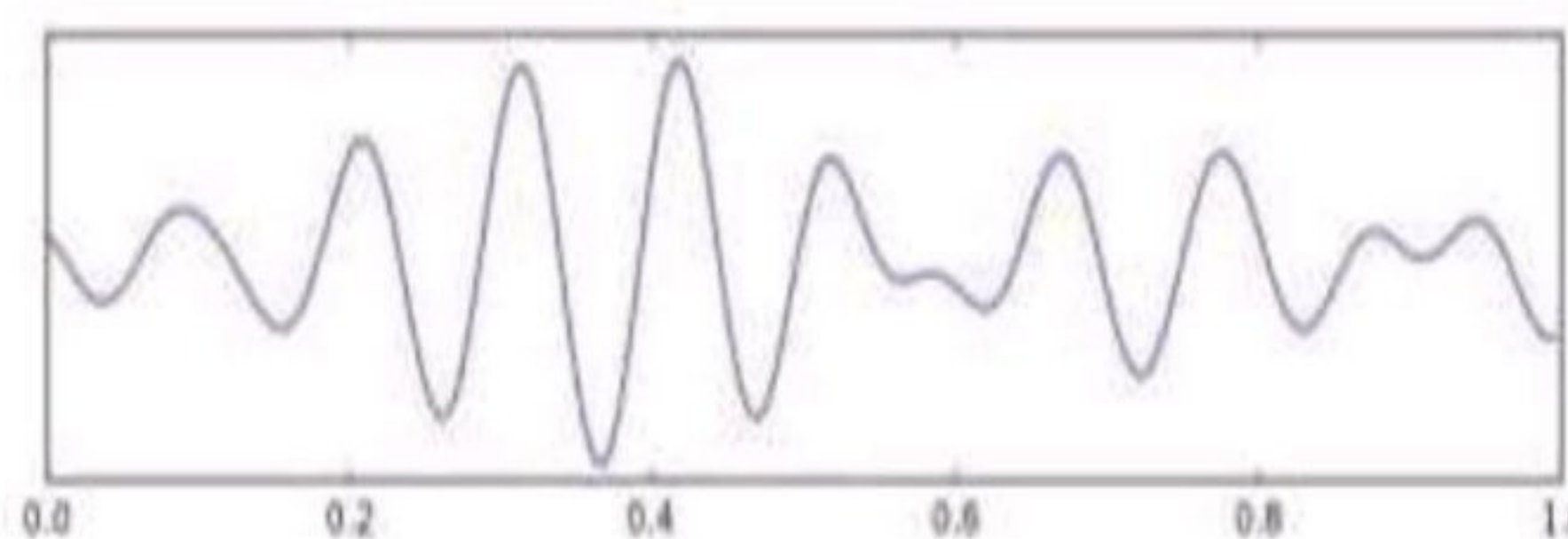


Figure 1.1 Alpha waves

The alpha frequency band spans from 8 to 12 Hz. The first rhythmic EEG activity

that Hans Berger observed was called a "alpha wave." On both sides of the skull, there is activity in the 8–12 Hz range, with the dominant side showing a larger amplitude. By relaxing and closing your eyes, it can be released. With eye opening or mental effort, it was noticed to lessen. The term "posterior basic rhythm," "posterior dominant rhythm," or "posterior alpha rhythm" are now used to describe this activity. Actually slower than 8 Hz in young children, the posterior basic rhythm is technically in the theta band. There are two other typical alpha rhythms in addition to the posterior basic beat. or instance, an EEG is said to be in "alpha coma" if diffuse alpha occurs in it while the subject is unconscious and unresponsive to outside stimuli. Chess has been helpful in the research of fundamental cognitive functions like memory, decision-making, and problem-solving . Additionally, because to the cognitive processes involved in this game, practising chess may enhance one's capacity for logic or the ability to solve mathematical problems . Chess has seen a change in the methodological models of practise during the previous few decades as a result of technological advancement.(Juan Pedro Funetes et al .,2019).

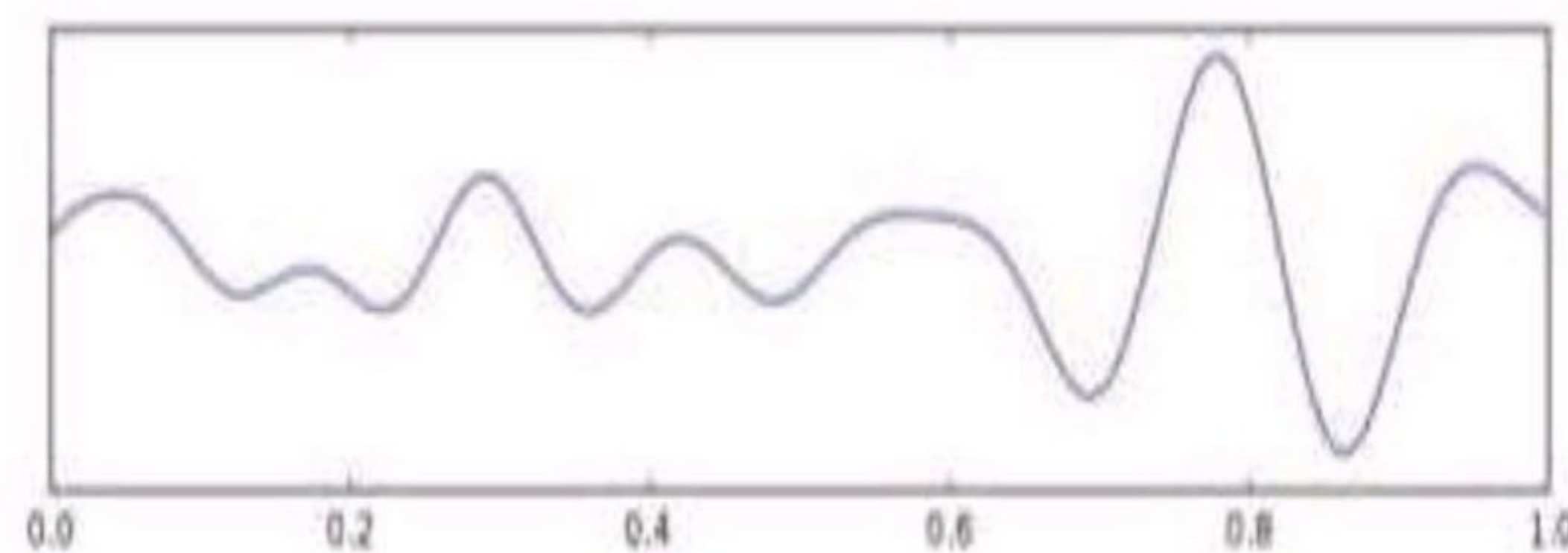


Figure 1.2 Theta waves

Theta refers to the frequency range between 4 and 7 Hz. Young children typically exhibit theta. Older children and adults may experience it as drowsiness or arousal, and it can even be observed during meditation. Age-excess theta indicates aberrant activity. In focal subcortical lesions, it can be seen as a focal disruption; in diffuse disorders, metabolic encephalopathy, deep midline problems, and in some cases of hydrocephalus, it can be seen as a generalised distribution. On the other hand, reports of peaceful, meditative, and creative moods have been linked to this spectrum. To ensure the safety of driving duties, drivers must maintain their focus in the traffic environment. Studies have shown that low load situations like

monotony can cause symptoms of fatigue and poor driving performance even when drivers are not sleep deprived or fatigued before driving duties.(Yule Zhang , et al .,2021)

1.1 EEG DATA ACQUISITION

- Through scalp-mounted electrodes, an EEG measures the electrical activity of your brain. In particular, epilepsy and other seizure disorders may be identified using the EEG data, which represent anomalies in brain activity.
- A corporation named BIOPAC manufactures data collection equipment that may be used to assess physiological data such as heart rate, electrocardiograms, grip strength, and other physiological phenomena.
- To assess and examine data on weariness, the EEG model is applied. Drivers need to concentrate their focus on the traffic condition in order to guarantee the safety of their driving activities.
- Despite the fact that drivers are neither sleep deprived nor in boring or low load settings, research have demonstrated that these variables lead to symptoms of tiredness and reduced driving abilities. or fatigued, driving-related duties are a cause of weariness. It is referred to as passive weariness.
- Causes of passive exhaustion through nerve habituation, such as by continuously driving on routes that are regularly utilized [2], as contrasted to the driver's active weariness brought on by an irregular circadian cycle and lack of sleep . Fell and Black performed research on accidents connected to driver sleepiness in Sydney, which encompassed all fatigue-related events.
- It was also observed that 45% of collision drivers As a consequence, the present study's purpose is to analyze the HRV and EEG power spectrum in chess players who compete against a computer and on a board. Additionally, we also want to look at the influence of exposure to chess. HRV and EEG power spectrums are measured . The most common mental health condition and a major contributor to disability globally is depression. More than 300 million individuals worldwide suffer from depression, and incident instances have increased by 50% between 1990 and 2017 .(Xue Lei,et al .,2022).

CHAPTER-2

LITERATURE SURVEY

Yule Zhang and Shoulin Zhu2021 Study on the Effect of Driving Time on Fatigue of Grassland Road Based on EEG and This research uses the semi-desert grassland landscape of Xilinhote city as the experimental setting and uses the provincial highway S101 (K278-K424) as an example to create an actual driving test in order to explore the change law of the tiredness degree of grassland expressway drivers over time. Using the experimental portion of Inner Mongolia Autonomous Region's Urumqi, utilising the Biopac MP150 multichannel physiological device, as well as its knowledge-assist software and mathematical algorithms The correlation between EEG and time was investigated using statistical techniques. Test findings for +e indicate that the main fatigue factors F1 and the secondary element of tiredness F2 may summarise the 96.42% of EEG data that makes up the tiredness law. 130 minutes into the The peak tiredness durations when driving on the prairie highway were 105 minutes and 125 minutes, respectively. Driving drowsiness five to sixty minutes of fatigue-free time, seventy to eighty minutes of fatigue transition, and ninety to one hundred thirty minutes of exhaustion. As time passes, fatigue develops. The sine function and the Gaussian function are followed by the +e law.

Juan Pedro Fuentes-García, Telmo Pereira2019 Heart and Brain Responses to Real Versus Simulated Chess Games in Trained Chess Players a Quantitative EEG and HRV Study,. The purpose of the current research was to look at how chess players' hearts and brains respond while playing against computers compared against other people in real life. We also want to find out whether being used to simulated practise affects the electroencephalographic (EEG) power spectrum and heart rate variability (HRV). 27 chess players participated in our cross-sectional research, which we created. They were given two different 3-minute plus 2-second chess games—one against a computer (a simulated situation), the other in a real-world setting—at random. In addition, participants were split into two groups based on how comfortable they were with playing chess on a computer. EEG and HRV were continually recorded as they played. Chess players did not show any differences in their HRV or EEG theta power spectrum

while playing in a real or virtual environment ($p\text{-value} > 0.05$). Significant variations in HRV and EEG were found between groups of individuals who had had familiar and unfamiliar virtual chess practise ($p\text{-value} 0.05$). In unfamiliarized participants during the simulated situation, the HRV was greater and the EEG theta power spectrum was much lower, which might mean that they were less attentive there than in a real-world setting. To attain the optimum results, the training procedure should take familiarisation with virtual surroundings into consideration.

Merve Keskin , Kristien Ooms2020 Exploring the Cognitive Load of Expert and Novice Map Users Using EEG and Eye Tracking this study's primary goal is to examine, using eye tracking and electroencephalograms, how experienced and inexperienced map users think when retrieving information about maps that is of different complexity (i.e., easy, moderate, and hard) (EEG). To investigate the impact of task complexity on map users' behaviour via assessments of cognitive load, we propose a spatial memory experiment with a high number of stimuli. In addition to reaction time and success rate, we also used eye tracking metrics for fixation and saccades (such as average fixation duration, fixations per second, saccade amplitude, and saccade velocity), as well as EEG power spectrum (such as event-related changes in alpha and theta frequency bands) to determine the cognitive load. Saccade measures contradicted fixation metrics, which showed no statistically significant difference between experts and beginners. On the other hand, the EEG power spectral density analysis suggested that at all levels of task difficulty for both experts and novices, there was an increase in theta (i.e., event-related synchronisation) and a decrease in alpha (except for moderate tasks) (i.e., event-related desynchronization), which is an indicator of cognitive load. Although there was no discernible difference between the two groups, when participants were categorised as moderately good and good learners, we discovered a substantial difference in their total scores. A thorough understanding of the variations in the individuals' cognitive processes during this spatial memory task was given by triangulating the EEG findings with the eye tracking data that had been obtained and the qualitative analysis of focus maps.

Jingzhou Guo¹, Xiaoyue Wu²⁰²² Research on the Method of Depression Detection by Single-Channel Electroencephalography Sensor Depression is a widespread mental health disorder that impacts our quality of life and capacity to function across the globe. Although previous research has utilised EEG signals to improve the accuracy of identifying depression, the rates of underdiagnosis remain significant, and innovative ways to diagnose depression are necessary. In this work, we developed a model to identify state depression using single-channel, dry-electrode EEG sensor technology, which captures the strength of depressed sensations and cognitions at a certain moment. In three independent investigations, we compared the outcomes of our model to other regularly used techniques for depression diagnosis, such as the PHQ-9, Hamilton Depression Rating Scale (HAM-D), and House-Tree-Person (HTP) drawing test. In research 1, we compared our model's outcomes to the PHQ-9 in a sample of 158 senior high pupils. The findings indicated that the two approaches had a consistency rate of 61.4%. The outcomes of our model were compared to HAM-D in research 2 among 71 people. The consistency rate of state-depression diagnosis by the two techniques was 63.38% when a HAM-D score greater than 7 was deemed depression, and it climbed to 83.10% when individuals had at least one depressive symptom (including depressed mood, guilt, suicide, lack of interest, retardation). In research 3, 68 persons took part, and the findings indicated that the consistency rate of our model and HTP drawing test was 91.2%. The findings demonstrated that our model is an excellent method for detecting state depression. Our research shows that by applying our approach, patients suffering from state depression may be detected in a timely way and given interventions or therapies, which may aid in the early diagnosis of depression.

Chanavit Athavipach , Setha Pan-ngum²⁰¹⁹, A Wearable In-Ear EEG Device for Emotion Monitoring. The capacity to remotely and constantly monitor patients' status is critical for future healthcare applications, which are progressively shifting toward out-of-hospital or home-based care models. Among the conditions that physicians or caregivers may be interested in is emotional state. This article describes an early effort to create a wearable device that is a low-cost, single channel, dry contact, in-ear EEG ideal for non-intrusive monitoring. All parts of the designs, engineering, and experiments with emotion categorization using

machine learning are discussed. Based on the valence and arousal emotion models, the gadget can categorise fundamental emotions with 71.07% (valence), 72.89% (arousal), and 53.72% accuracy (all four emotions). At the T7 and T8 scalp locations, the results are equivalent to those obtained with more traditional EEG headsets. These findings, together with its earphone-like wearability, point to its possible use in future healthcare applications, particularly home-based or tele-monitoring systems, as envisioned.

H. J. Engelbregt, K. Brinkman²⁰²², The effects of autonomous sensory meridian response (ASMR) on mood, attention, heart rate, skin conductance and EEG in healthy young adults ASMR (autonomous sensory meridian response) is a warm tingling sensation that is often accompanied by emotions of peace and relaxation. The current research looked at how an ASMR film affected mood, attentiveness, heart rate (HR), electrodermal activity (EDA), electroencephalography (EEG), and how it interacted with personality characteristics in 38 young individuals (33 females and 5 males). According to the ASMR-checklist replies of getting tingles while viewing the ASMR video, 15 of the 38 participants were classified as ASMR-experiencers. The Profile of Mood States, the Flanker task, and HEXACO were used to assess mood, attention, and personality traits. During the ASMR and control videos, EEG, HR, and EDA were recorded. Individuals experiencing tingles had less depression after seeing the ASMR film than those who did not experience tingles. Furthermore, regardless of whether or not the subjects experienced tingles, a reduction in HR was seen when viewing the ASMR film. During viewing the ASMR video, ASMR-experiencers with low Conscientiousness EDA tended to rise and HR tended to drop (compared to the group not feeling tingles). Watching the ASMR video was related with reduced alpha power among ASMR-sensitive people, as well as decreased theta and increased beta power in the whole sample of participants, according to EEG data. The observed ASMR-induced drop in alpha and theta power, rise in beta power, and (only in low conscientious people) EDA may imply that, in addition to relaxing, ASMR is associated with arousal and focused attention.

Emognition dataset: emotion recognition with self-reports, facial expressions, and physiology using wearables The Emognition dataset is devoted to evaluating algorithms for emotion recognition (ER) from physiological responses and facial

expressions. We obtained data from 43 individuals who watched short film video generating nine distinct emotions: laughter, amazement, enthusiasm, liking, surprise, wrath, disgust, fear, and sorrow. Three wearables were employed to collect physiological data: EEG, BVP (2x), HR, EDA, SKT, ACC (3x), and GYRO (2x); in tandem with the upper-body footage. After each film clip, participants completed two kinds of self-reports relating to nine distinct emotions and (2) three affective dimensions: valence, arousal, and motivation. The acquired data supports different ER techniques, e.g., multimodal ER, EEG- vs. cardiovascular-based ER, discrete to dimensional representation transitions. The technical validation demonstrated that viewing film clips produced the targeted emotions. It also supported signals' high quality.

A Portable Wireless Device for Cyclic Alternating Pattern Estimation from an EEG Monopolar Derivation. The cyclic alternating pattern, which is thought to be a sign of unstable sleep and is formed of two alternative electroencephalogram patterns, may be used to evaluate the quality of sleep. Experts often evaluate this pattern by visually analysing each electroencephalogram signal epoch lasting one second; this process is repetitious, time-consuming, and error-prone. In order to solve these problems, a home monitoring system was created that analyses the data from a single electroencephalogram derivation in order to automatically score the cyclic alternating pattern. Three classifiers were created and evaluated to see which was best for categorising the cyclic alternating pattern phase. These classifiers included two recurrent networks (long short-term memory and gated recurrent unit) and one one-dimension convolutional neural network. It was confirmed that the long short-term memory-based network had the greatest results, with average values of 76%, 75%, 77%, and 0.752 for accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve, respectively. The performance metrics for the finite state machine used to calculate the cycles of the cyclic alternating pattern were 76%, 71%, 84%, and 0.778, respectively. The results show that the device designed for clinical analysis is usable since they fall inside the upper limit of the experts' projected agreement range and are much higher than the inter-scorer agreement of several experts.

Sympathetic activity contributes to the fMRI signal The interpretation of functional magnetic resonance imaging (fMRI) investigations of brain activity is typically

complicated by the existence of brain-wide signal fluctuations that may result from a variety of neuronal and non-neuronal sources. Recent work implies a contribution from the sympathetic vascular innervation, which may impact the fMRI signal via its hypothesised and poorly understood involvement in cerebral blood flow (CBF) modulation. By analysing fMRI and (electro-) physiological signals concurrently acquired during sleep, we found that widespread fMRI signal changes often co-occur with electroencephalography (EEG) K-complexes, signatures of sub-cortical arousal, and episodic drops in finger skin vascular tone; phenomena that have been associated with intermittent sympathetic activity. These results support the hypothesis that the extrinsic sympathetic innervation of the cerebral vasculature contributes to CBF control and the fMRI signal. Accounting for this method might assist differentiate systemic from local signal contributions and enhance interpretation of fMRI investigations.

Watching Nature Videos Promotes Physiological Restoration: Evidence From the Modulation of Alpha Waves in Electroencephalography Pulmonary hypertension (PH) is a progressive fatal disease thus, non-invasive prognostic tools are needed to follow these patients. The aim of our study was to evaluate fractional exhaled nitric oxide (FeNO) and exhaled breath temperature (EBT) values in patients with PH from different causes and to correlate them with respiratory functional data. Methods. Twenty-four PH patients underwent spirometry, carbon monoxide diffusion (DLCO) test, transthoracic echocardiography, right-heart catheterization, and FeNO and EBT measurements.

CHAPTER-3

AIM AND SCOPE

3.1 AIM

- To acquire EEG signals while solving 6 levels of Blooms taxonomy using BioPAC.
- To do statistical, spectral, and time frequency analysis of EEG during problem solving.
- To classify the signals using AI to characteristics the brain behavior for reasoning and problem solving.

3.2 SCOPE

- BIOPAC provides a wide range of tools for recording, displaying, and analyzing surface EEG (sEEG) and implanted EEG signals from human and animal subjects.
- BIOPAC offers a number of hardware solutions that allow you to record from a single channel of EEG and up to 32 channels of wireless and logged data.
- EEG analysis during problem-solving is a rapidly growing field that seeks to understand the relationship between brain activity and cognitive processes involved in solving problems.
- Bloom's Taxonomy, a well-established framework for categorizing cognitive skills, provides a useful tool for characterizing the complexity of problem-solving tasks.
- By examining the EEG signals generated by the brain during problem-solving tasks of different levels of complexity, researchers can investigate the neural mechanisms that support the cognitive processes at each level of Bloom's Taxonomy.
- The different levels of Bloom's Taxonomy, from Remembering to Creating, represent a hierarchical organization of cognitive skills, with each level building

upon the previous one.

- At the Remembering level, problem-solving tasks involve the recall of previously learned information or facts.
- At this level, the brain activity is predominantly in the theta frequency range, and the EEG signals are localized to the medial temporal lobe, where long-term memories are stored.
- As the problem-solving tasks become more complex and move up the hierarchy of Bloom's Taxonomy, the brain activity changes.
- At the Understanding level, the EEG signals shift to the alpha frequency range and become more widely distributed across the cortex.
- This suggests that the brain is engaged in processing and integrating information to achieve a deeper level of understanding of the problem.
- At the Applying level, the brain activity shifts again to the beta frequency range and becomes localized to the prefrontal cortex.
- This suggests that the brain is actively applying previously learned knowledge to solve new problems.
- At the Analyzing level, the EEG signals shift to the gamma frequency range, indicating that the brain is engaged in high-level cognitive processing, such as pattern recognition and abstraction.
- At the Evaluating level, the brain activity shifts again to the delta frequency range, and the EEG signals become localized to the anterior cingulate cortex, which is involved in decision-making and error detection.
- This suggests that at this level, the brain is actively evaluating the solutions to the problem and making judgments about their effectiveness.
- Finally, at the Creating level, the brain activity shifts to the highest frequency range, the high gamma frequency range, indicating that the brain is engaged in creative thinking and problem-solving.
- EEG signals at this level are localized to the parietal cortex, which is involved in spatial reasoning and mental imagery.
- By analyzing the EEG signals generated during problem-solving tasks at each level of Bloom's Taxonomy, researchers can gain insights into the neural

mechanisms that support cognitive processes involved in problem-solving.

- This knowledge can be used to develop more effective educational interventions and improve our understanding of how the brain processes information during problem-solving tasks.

CHAPTER - 4

MATERIALS AND METHODS

4.1 SOFTWARE USED

4.1.1 *BIOPAC*

The BIOPAC Student Lab (BSL) Basic system is an integrated solution that allows students to record data from their own bodies, animals, or tissue preparations. It includes a complete solution with hardware, software, and curriculum for higher education life science applications, including ECG, EEG, EMG, and EOG. The BSL System uses dynamic lessons with students as subjects to increase interest and retention, and allows students to compare data from different experimental conditions with others in their group and with all students in the lab. The system can be upgraded to create Advanced or Ultimate systems, and can also be ordered a la carte. Biopac Student Lab software guides students through the lessons by using full color onscreen instructions, a detailed lab manual, and embedded procedure videos and data samples. Results and measurements can be compiled into the data reports contained in the rich-text journals and saved or emailed to instructors. BSL 4 is available in English with support for MP36, MP35 and MP45 hardware for Windows or Mac, and BSL 3.7 is required for MP30 or translations. Free Student Download enables students to prepare for class, analyze, share, and submit data. The Biopac Student Lab system consists of a data acquisition unit, software, and a teacher's guide. The data acquisition unit converts incoming signals into digital signals that can be processed by a computer, while the software displays the numbers as waveforms on the monitor. How to successfully care for the elderly becomes a significant difficulty as countries throughout the world struggle with the issue of an ageing population. This is particularly true for those who live alone who are less privileged.(Chanavit Athavipach, et al .,.2019).

The data acquisition unit connects to a PC running Windows or Mac OS X operating systems via USB. Students can record data from their heart signals, brain waves, muscle activity, eye movement, and more. The system helps to explain the concept of electricity flowing throughout a living body and allows students to understand physiology. The sensory and emotional phenomenon known as autonomous

sensory meridian response (ASMR) is characterised by the impression of a static-like, 'tingling' sensation that is often referred to as paresthesia.(H. J. Engelbregt,et al.,.2022).

4.1.2 BSL BIOPAC STUDENT LAB SOFTWARE

The Biopac Student Lab System is unique and powerful, and this Tutorial provides detailed instructions on how to use it for data recording and analysis. Important research and application prospects are made possible by the capacity to identify human emotions based on physiology and facial expressions, particularly in the fields of healthcare and human-computer interaction (Patients with affective disorders¹ and kids with autism spectrum disorder² can benefit from ongoing affect assessment. (Stanisław Saganowski, et al.,.2022) Biopac Student Lab System enables life science data acquisition and analysis. ECG, EEG, EMG, and EOG are important topics for basic physiology lab experiments. The Biopac Student Lab Basic System uses dynamic lessons with students as subjects to increase interest and retention. Students can record data from their own bodies and compare it to others in their group and with all students in the lab. The circadian rhythm includes the complicated, dynamic process of sleep, which is unique to each person. Stages of sleep are frequently tied to the operations of the autonomous nervous system. (Fábio Mendonça ,et al .,.2019).

4.2 HARDWARE USED

4.2.1 Surface electrode

Surface electrodes are types of electrodes applied to the skin of the subject. Major applications include electrocardiography (ECG), electromyography (EMG), or electroencephalography (EEG), which are techniques for recording and evaluating the electrical activities of the heart, skeletal muscles and neurons of the brain, respectively, from the surface of the skin.

- Other types of electrodes are used to measure the conductance of body

parts.

- Examples are measurements of skin conductance or transthoracic impedance.
- One of the most important goals for desirable surface electrodes is to obtain a lower contact impedance, which is crucial to attain high signal-to-noise ratio.
- The gel electrodes are the most widely used type of electrodes.
- They are part of routine, clinical EEG recordings and have been the gold standard in EEG research for a long time.
- Therefore, the gel between the skin and electrode allows for good-quality recording of biopotentials.
- Alternative gel electrode shapes Gel electrodes can also have other shapes besides disc-shaped electrodes.
- Moreover, alternative EEG solutions like cEEGrids also use gel to improve the skin-electrode connection/contact.
- Advantages of gel electrodes Allow for high-density EEG recordings. Very high signal quality.
- Less susceptible to mains interference and movement artifacts than dry and water electrodes.
- Stable recordings for a long time.
- Alternative measurement solution options (i.e. cEEGrids and ring electrodes) and can be integrated with other research equipment (i.e. fNIRS and TMS)
- Disadvantages of gel electrodes Skin needs to be prepared by lightly scratching the skin to reduce impedance.
- Inconvenient for researchers: Preparation time can be long, the head cap requires cleaning, and drying of the cap takes time.
- Inconvenient for participants: Hair needs to be cleaned and scratching the skin can feel uncomfortable.
- Requires a skilled technician.



Figure 4.1 Surface electrodes

4.3 METHODOLOGY

The Bloom's Taxonomy attempts to classify the many stages of learning, from remembering information to developing original ideas based on previously acquired material. Bloom's Taxonomy claims that learning is a sequential process. Before using a concept in the actual world, we must first understand it. Before we can understand a notion, we need to remember the key components of it. It was first described as a framework; nevertheless, it is now usually shown as a pyramid. Knowledge is the first level of learning and the base of the pyramid. It is preceded by comprehension, application, analysis, synthesis, and evaluation. The pyramid can only be climbed one step at a time since each level relies on the one below it. The fundamental taxonomy was first outlined in *Taxonomy of Educational Objectives*, a 1956 publication by American educational psychologist Benjamin Bloom and his associates Max Englehart, Edward Furst, Walter Hill, and David Krathwohl. In their book, learning goals are separated into one of the categories mentioned above (from Knowledge to Evaluation). Their goal was to provide instructors with a common vocabulary so they could more clearly address curriculum and assessment difficulties. The authors claim that professors have been describing what they anticipated from

their pupils using "nebulous language." As an example, some instructors want their students to "truly comprehend," while others want them to digest information, and yet other educators want them to understand the essence or core. It was primarily designed with college professors in mind at first, but it later took on with other educators, such as K–12 teachers and corporate trainers. Since its first publication, the book has been translated into more than twenty other languages and is currently utilized all over the globe for instructional design. Its modernized form is presently used more commonly, nevertheless. The purpose of the current systematic study was to examine how EEG measurements are used in neuromarketing. In particular, we concentrated on identifying the ERP and TF effects that were most consistently associated with consumer preference and purchase intention, the best computational approaches to predict consumer behavior, and the biometric measures that work best when combined with EEG measures to increase predictive accuracy.(Adam Byrne,et al .,.2022)

4.4 BLOCK DIAGARAM

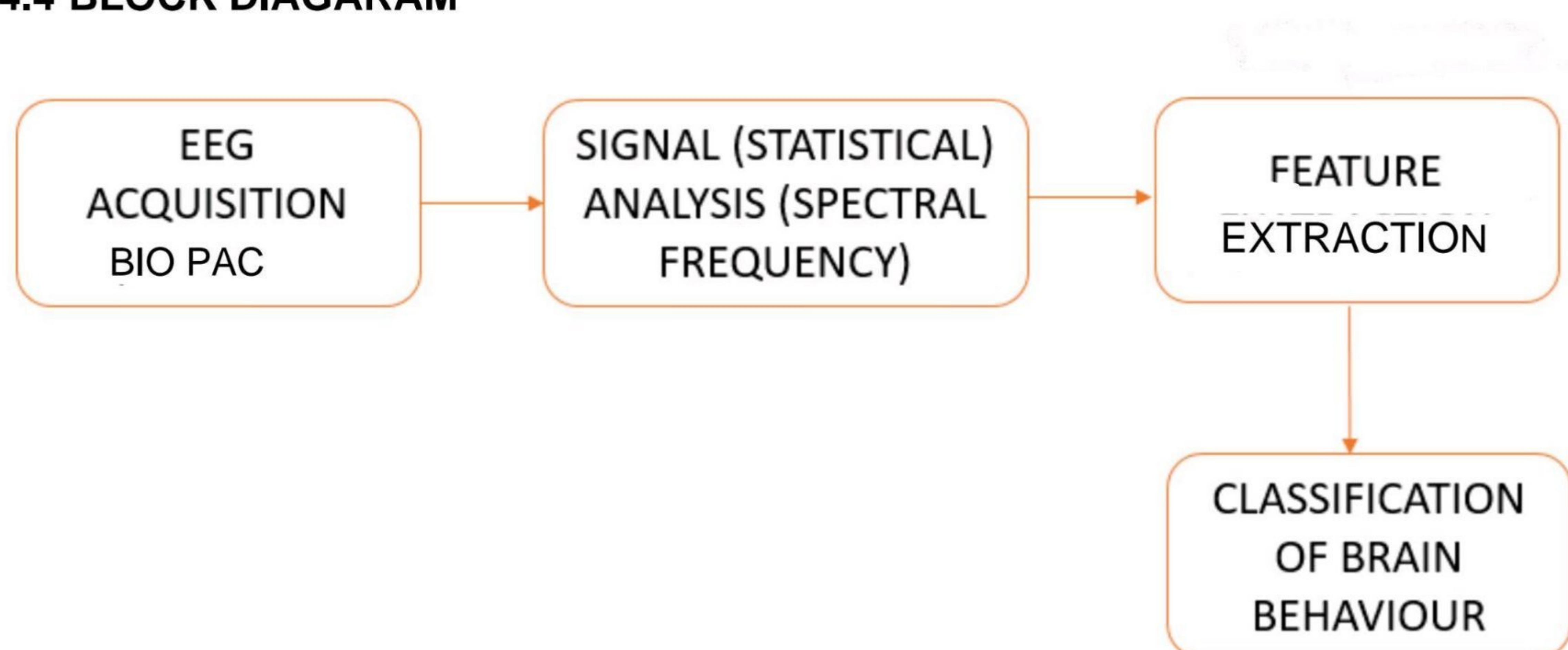


Figure 4.2 Block diagram

From the Block diagram, Figure 4.2 we can see that the EEG signals are feeded to the spectral frequency analysis. From there the relevant features will be extracted and then the classification takes place to analyze the brain behavior. This whole process is done using the Bloom Toxonomy level technique, in which a set of three hierarchical models used for classification of educational learning objectives into

levels of complexity and specificity. By using this method the data can be collected in a more clear manner and is also easier to read the data.

In the US, stroke is one of the main causes of long-term impairment. Functional ability and treatment response among stroke survivors vary substantially because stroke is heterogeneous. Clinicians now have trouble creating individualised treatment strategies that maximise patient outcomes due to inadequate prognostic skills. (Amanda A Vatinno, et al., 2022). Affective computing has an association with emotion recognition. The study of how computers perceive and recognise emotions is known as affective computing. The primary role of emotions in human daily life is the control of attention and decision-making (Dolan, 2002; Lerner et al., 2015). A person who is emotionally unbalanced could be less capable of carrying out routine chores. Emotions obviously play a significant influence in one's life. (Pallavi Pandey, et al., 2020).

There are three types of samples being used: low, moderate and advanced. Peoples of different age groups are tested. In Figure 4.1 we can see that the module is being tested to the different age group peoples. The electrodes are being connected to their head to read their brain signals.

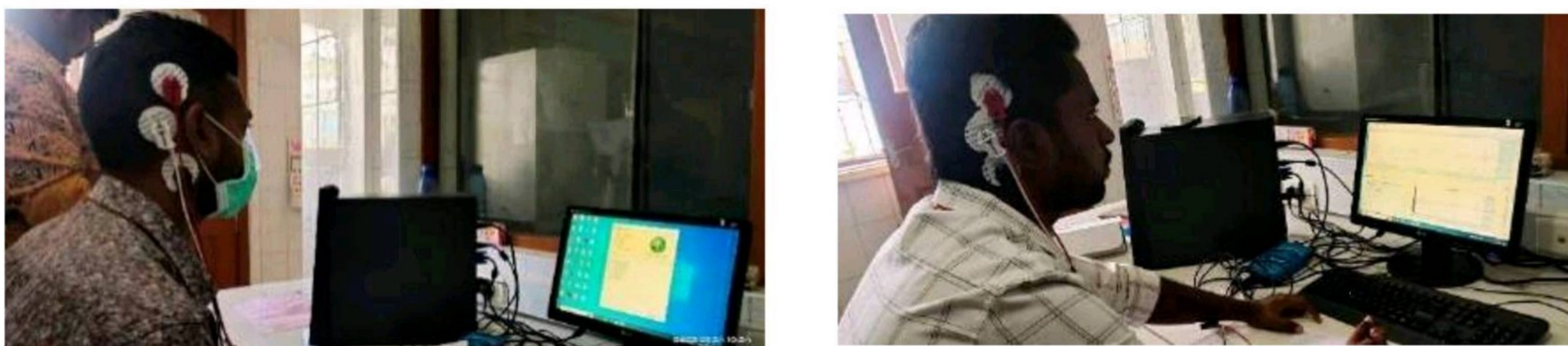


Figure 4.3. Analysis of the EEG signal for the various subjects

CHAPTER 5

RESULTS AND DISCUSSION

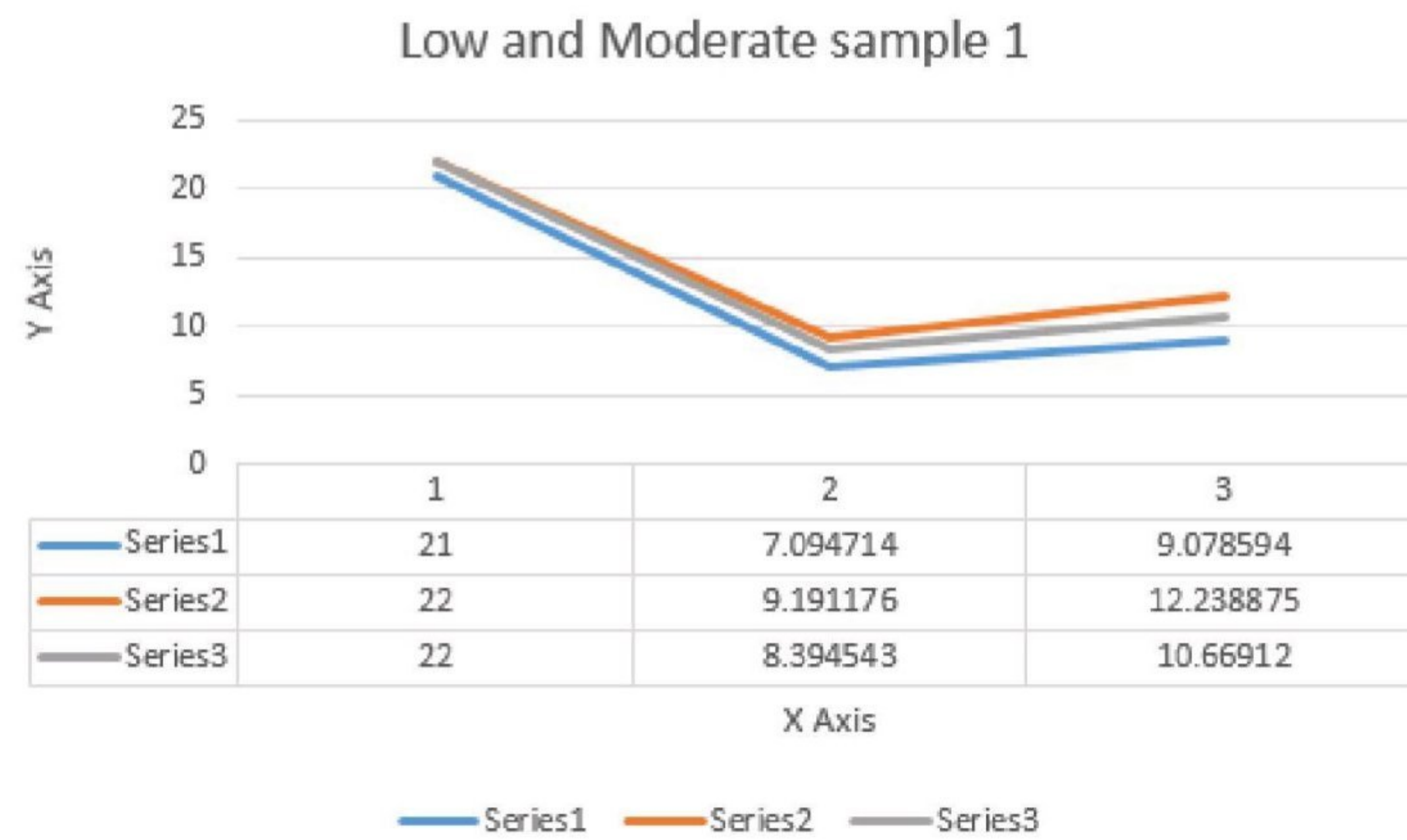


Figure 5.1 Comparison between low and moderate sample 1

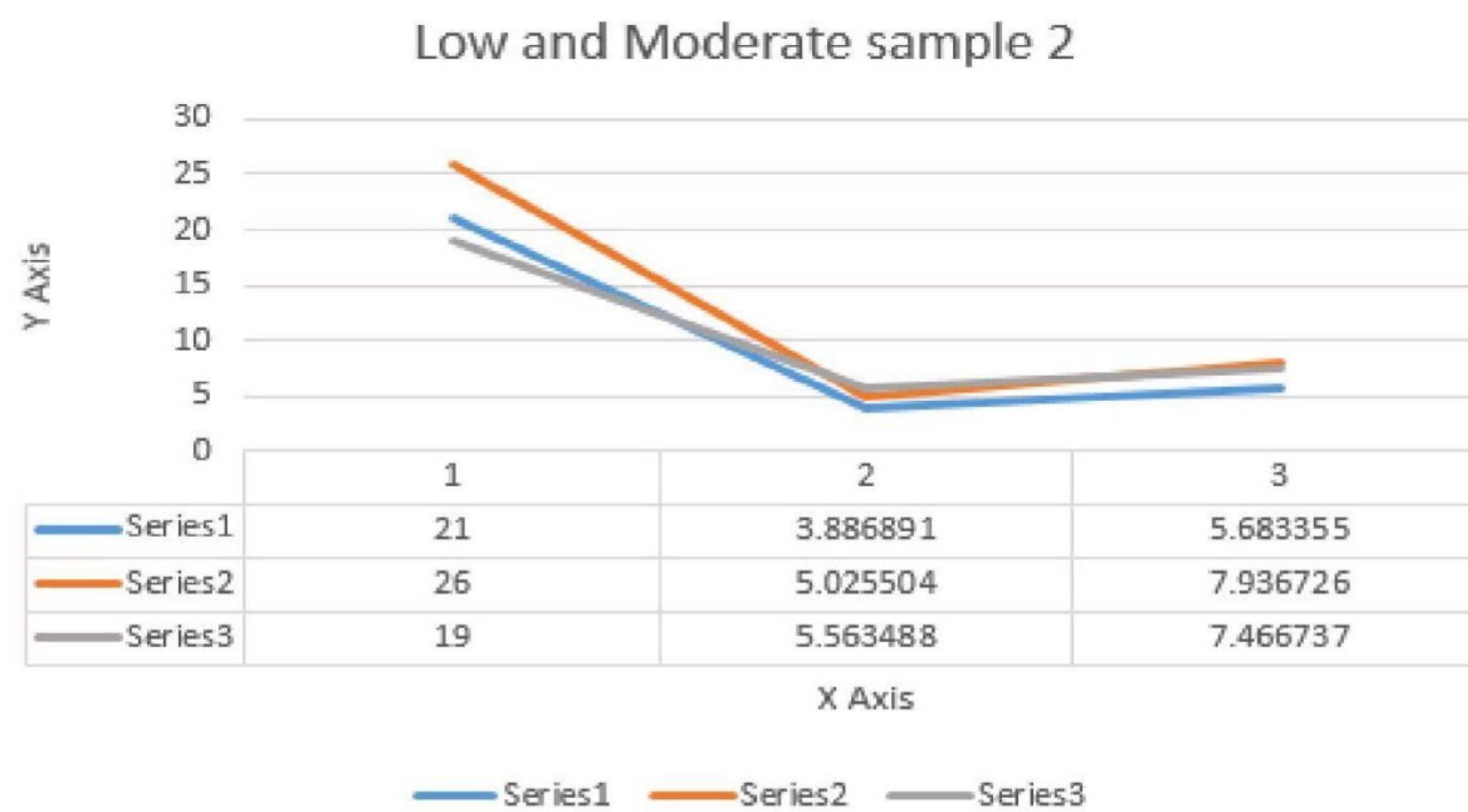


Figure 5.2 Comparison between low and moderate sample 2

In figure 5.1 and 5.2, we can see that low and moderate samples are being taken, where the x axis represents the signal frequency and the y axis denotes the age of the person. Here, in sample 1, the for 21 years person, the low frequency is 7.09 and the moderate frequency is 9.07, whereas for 22 years person, the low frequency is 9.19 and the moderate frequency is 12.23. For 22 years person, the low frequency is 8.39 and the moderate frequency is 10.66. In sample 5.2, for 21 years person, the low frequency is 3.88 and the moderate frequency is 5.68 whereas for 26 years person, the low frequency is 5.05 and the moderate frequency is 7.93.23. For 19 years person, the low frequency is 5.56 and the moderate frequency is 7.46.

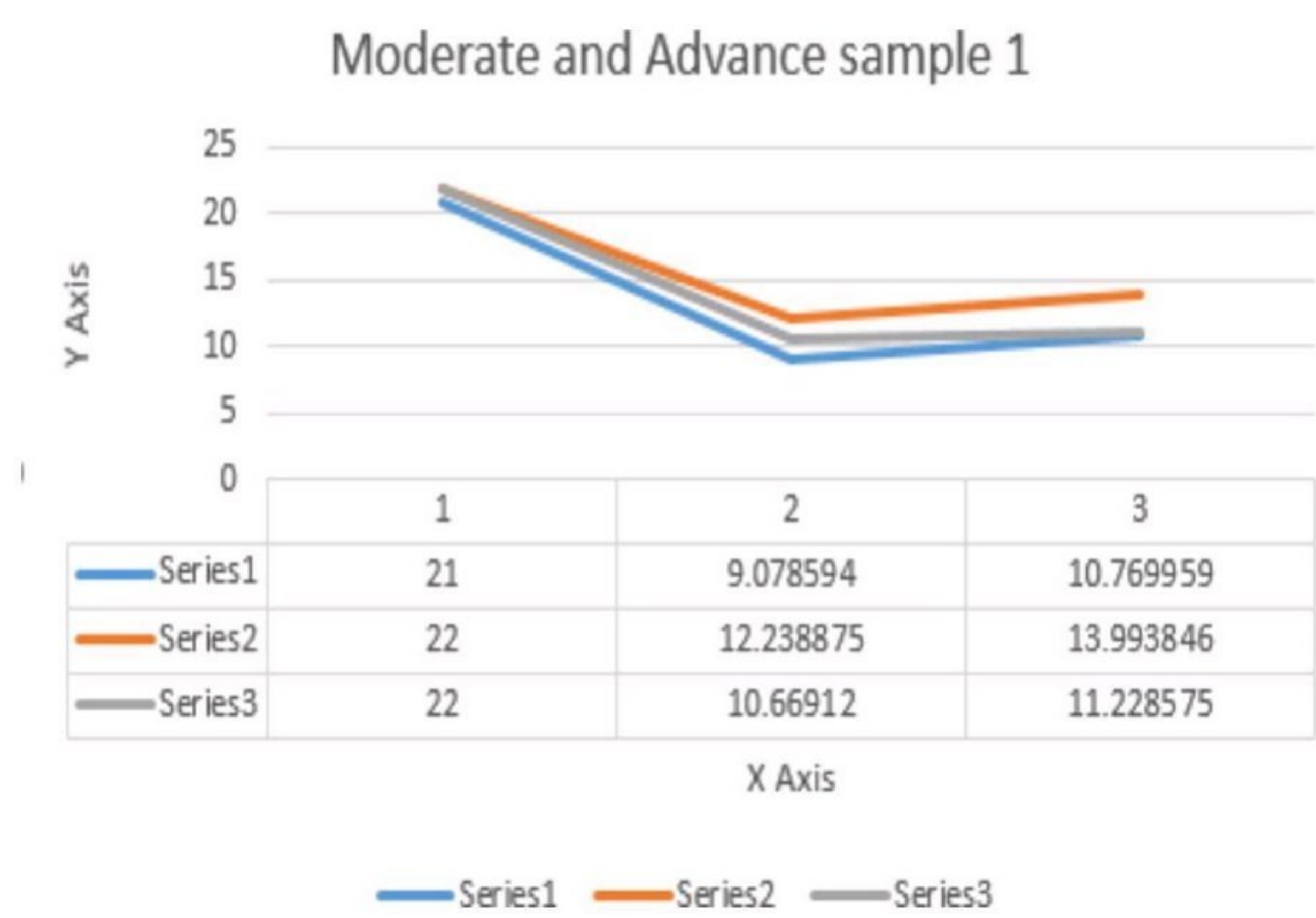


Figure 1.3 Comparison Between moderate and advanced sample 1

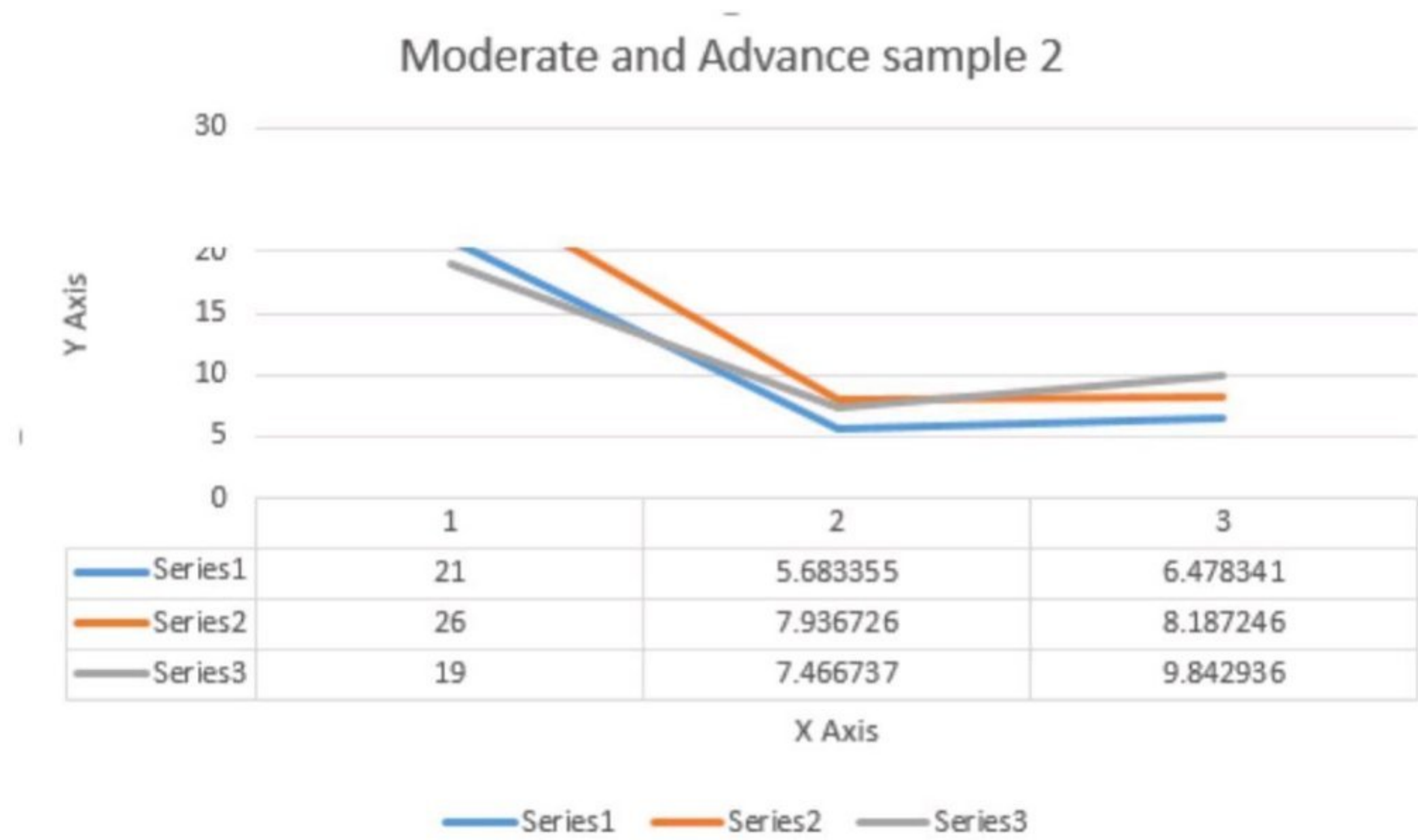


Figure 2.4 Comparison Between moderate and advanced sample 2

In figure 5.3 and 5.4 we can see that moderate and advanced samples are being taken, where the x axis represents the signal frequency and the y axis denotes the age of the person. Here, in sample 1, the for 21 years person, the moderate frequency is 9.07 and the advanced frequency is 10.76, whereas for 22 years person, the moderate frequency is 12.38 and the advanced frequency is 13.99. For 22 years person, the moderate frequency is 10.66 and the advanced frequency is 11.22. In sample 2, we can see that for 21 years person, the moderate frequency is 5.68 and the advanced frequency is 6.47, whereas for 26 years person, the moderate frequency is 7.93 and the advanced frequency is 8.18. For 19 years person, the moderate frequency is 7.46 and the advanced frequency is 8.84.

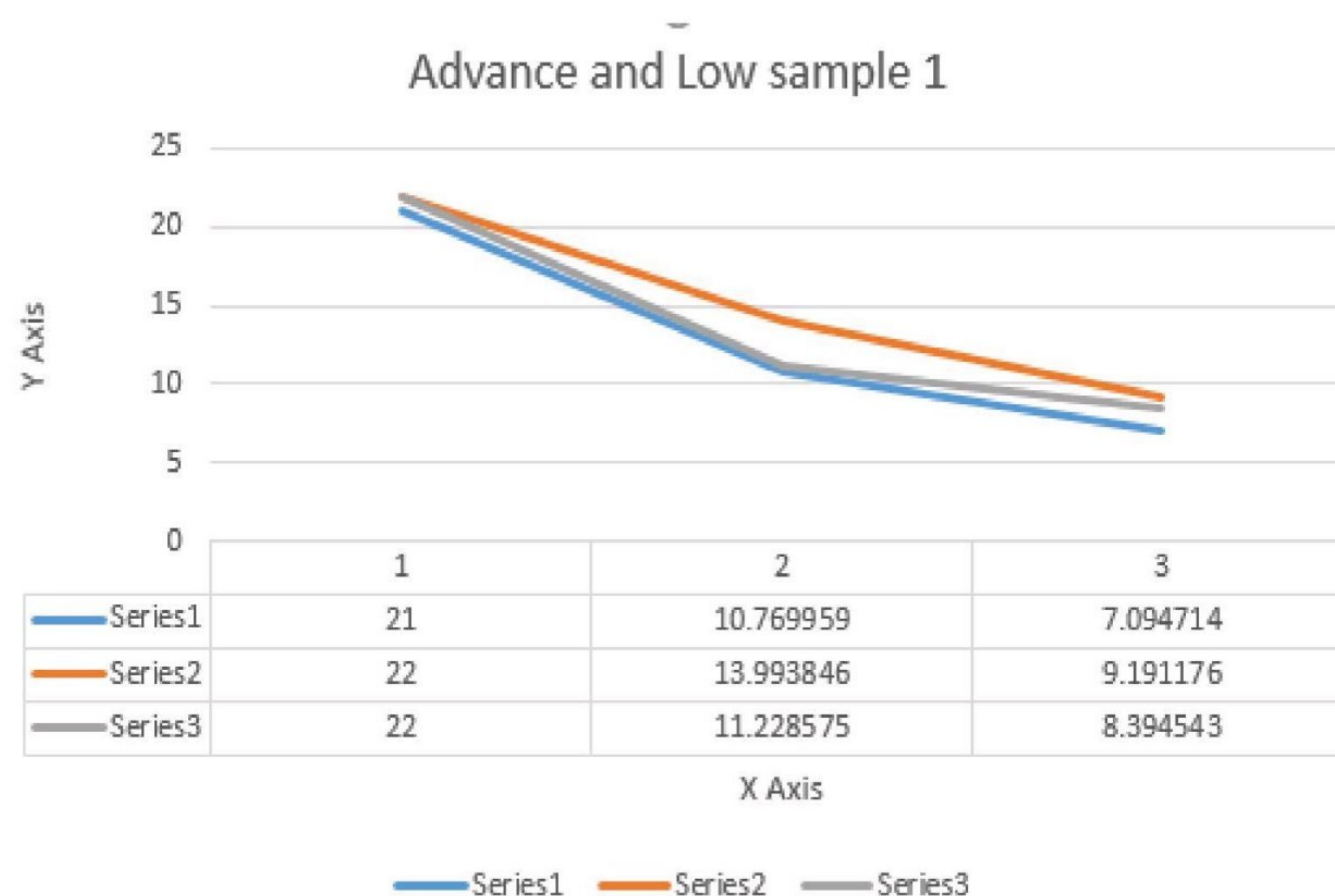


Figure 5.5 Comparison between advanced and low sample 1

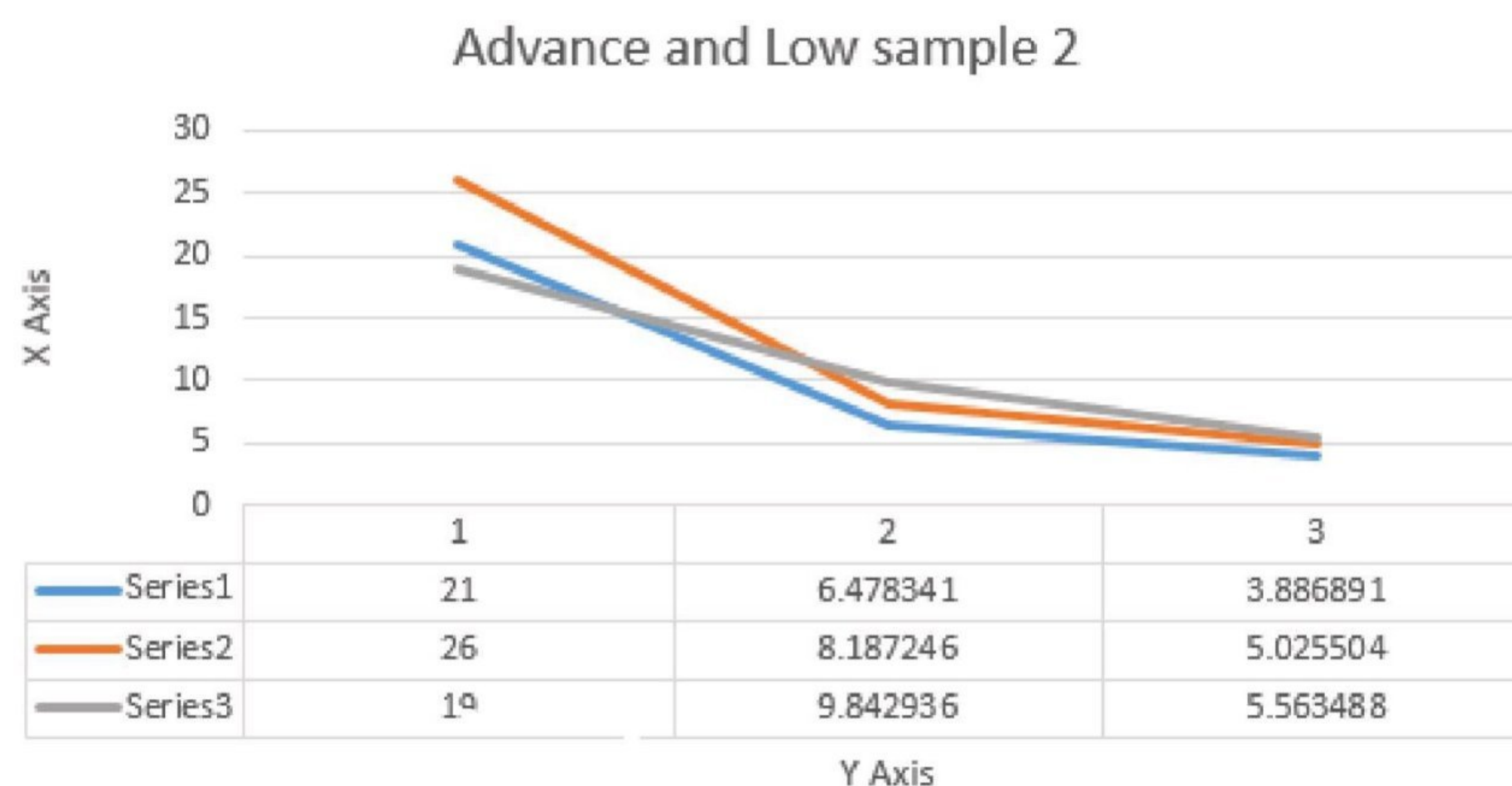


Figure 5.6 Comparison between advanced and low sample 2

In figure 5.5 and 5.6, we can see that low and advanced samples are being taken, where the x axis represents the signal frequency and the y axis denotes the age of the person. Here, in sample 1, the for 21 years person, the advanced frequency is 10.76 and the low frequency is 7.09, whereas for 22 years person, the advanced frequency is 13.99 and the low frequency is 9.19. For 22 years person, the advanced frequency is 11.22 and the low frequency is 8.39. In sample 2, for 21 years person, the advanced frequency is 6.47 and the low frequency is 3.88, whereas for 26 years person, the 9.84 and the low frequency is 5.56. Consumer neuroscience, also known as neuromarketing, is a new area of study that has emerged in recent years as a result of the idea of using neuroscience approaches in marketing. It has also given rise to numerous specialised consulting firms.(Andrea Bazzani,et al .,2020).

The World Health Organization (WHO) has reported that more than 322 million individuals worldwide are estimated to suffer from depression, making this mental illness the primary factor in the development of disabilities.(Atefeh Safayari a,et al .,2021).

CHAPTER 6

SUMMARY AND CONCLUSION

This work is an attempt to derive a relationship between different frequency levels of the brain and the underlying cognitive skills of individuals through EEG analysis. The aim of using this technique is that any given task can be broken down to such elementary tasks. For experimentation, set of electrodes are used based on three cognitive categories from Bloom's Taxonomy. The results indicate that they can be used in different clusters indicating the possibility of further refinement in mapping to Bloom's Taxonomy. The distances between each value indicates that different aged individuals have different thinking process which is characteristics of that subject. If the Blooms taxonomy defined standard objective hierarchy, which can be modeled with the help of EEG signals the people can make their own strategies or build required skill sets. Here in this project we have taken sample of different age group peoples and followed the low , moderate and advanced tests , recorded the results and interpreted the same. The test are being conducted using the BioPac instrument. Hence we can conclude that the Bloom's Taxonomy based reading of EEG signals is very much successful in reading the brain signals efficiently.

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DEPARTMENT OF BIOMEDICAL ENGINEERING BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of B.Periyanayagam Rozario (39240028) K.Tamilmaran (39240039). Who carried out the project entitled "EEG Analysis during Problem Solving according To Blooms Taxonomy Level" under my supervision from October 2022 to April 2023.



Internal Guide

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Submitted for Viva voce Examination held on 18.04.2023



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