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Analyzing Brain Activities in Response To Music and Video Stimulants

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Abstract: Studying the effects of different stimulants on the brain is an ongoing research aiming to discover the activities and reactions of the brain. In this sake, we propose a study to show the impact of external stimuli on the human brain. The implementation includes 50 subjects exposed to four various stimuli while recording EEG. First, a control experiment is done where EEG is recorded in the absence of any stimulation. Then, EEG is recorded while the subjects are watching two consecutive sections from nature and violence videos, listening to sections of classical music and then heavy music.

The recorded signals are analysed through EEGLAB. The power spectral densities are computed and an analysed. The results showed a decrease in alpha absolute power was observed in 68.1% subjects when watching the nature movie, and in 72.34% subjects when watching the violence video. An increase in alpha and beta absolute power was detected in 70.45% of subjects when listening to the heavy music. Relative power spectral density showed a significant increase of delta rhythm upon watching the video of natural scenes, and a significant increase of alpha rhythm when listening to classical music. ANOVA test is also used to verify if any effect of the stimuli can be observed on each frequency bands. The results showed that the delta rhythm's highest values were obtained in reaction to the natural scenes video and that there is a significant relationship between alpha rhythms and the stimulus due to Classical music.

Keywords: *Data Analysis, Machine learning, ANOVA, EEG: Electroencephalography, δ: Delta wave, θ: Theta wave, α: Alpha wave, β: beta wave, γ: Gamma wave*

1. INTRODUCTION

For several medical purposes, there is a crucial need to study the effects of external stimulants, mainly auditory and visual, on the brain of human beings. These studies will help in detecting changes in the brain activity due to these stimulants. This in turn will lead to more and more discoveries of the behavior and functioning of the brain as well as different disorders of the brain.

Being the most interesting and complicated organ in the human body, discovering brain behavior and activity represents a major concern for the worldwide medical society. Therefore, studying brain activity is a necessary need for which many research activities are being performed in perspective of finding methods for measuring and representing brain activities.

An effective widely used method for studying the electrical activity of the brain is the "Electroencephalography" (EEG). EEG measures and displays the electrical activity of the brain. It has the ability to detect wide variety of mental activities and brain disorders and diseases including autism, epilepsy, and dementia [1]. EEG is a non-invasive, painless, and safe technique.

Many research works were carried out attempting to understand different brain disorders by using the EEG. Moreover, several studies have been designed and implemented to test the effect of various external stimulations on the brain via EEG.

One of the most commonly used stimuli in previous research studies is music. Music is a universal mode of auditory communication. In the beginnings of modern science, music has been studied as sounds and vibrations. The scientific research seeking an understanding of the cognitive aspects of music has grown almost recently. Music engages much of the brain processes; it evokes emotions whether positive or negative, connects to memory, and may trigger physical activities like dancing.

In this paper, we tend to examine the effect of music (auditory) as well as audio-visual (video) stimuli on the brain using EEG. A new approach using music stimulation is proposed. The main objective of this paper is to detect any type of change in the brain activity due to these stimulants.

On another hand, till now, there is still poor scientific understating of the biological role of music and its connection to certain brain disorders. New insights concerning the connection between music and brain disorders have been provided by clinical neuroscience [2]. However, in this paper we go deeper to prove on a scientific level the biological role of music in modulating brain processes. Moreover, the paper proposes a new approach in selecting the music and video stimuli. The music and video criteria are chosen to be as much opposite as possible in order to be able to detect variety of changes within the brain. Thus, music was taken from two distinct genres, and the videos were taken from two diverging styles.

2. LITERATURE REVIEW

Studying the brain's function and process has been aa long research journey. In particular, experimenting the response of the brain to certain external stimuli, via EEG or other acquisition technologies, is an essential part of this research. In this section, we present the most relevant articles researching the effect of music on the brain, the special effect of Mozart's music, and the effect of visual and combined audio-visual stimuli.

2.1 Music Effect on EEG

Using the EEG technology, Geethanjali et al. (2012) studied the impact of three different types of music, Carnatic, Hard Rock and Jazz, on the brain function with and without performing mental task activity. The study finds that during mental task performance, listening to Carnatic music showed high a significant increase in beta activity compared to listening to Jazz and Hard Rock. However, when listening to Jazz music without any mental task, the power spectrum of theta was significantly high compared to Carnatic and Hard Rock [4].

Anilesh et al. (2013) examined the impact of music on the central nervous system by comparing the EEG of various subjects while listening to instrumental music to their EEG recorded in normal conditions. Both the results of quantification of EEG signals and the obtained topological maps has led to similar conclusion, that music affected mainly the frontal lobe of the brain. The central lobe showed some changes but not as significant as the frontal one [5].

In the same context, Hurless et al. (2013) studied the effect of music genre and tempo on brain waves, specifically alpha and beta. EEG was recorded for 10 non-musician participants while listening to songs belonging to two music genres: rock and jazz, in which the tempo of each song was varied artificially three times: slow (100 beats per minute BPM), normal (120 BPM), and fast tempo (140 BPM). Music preference was also taken into consideration. Hurless et al. demonstrated that alpha waves amplitude increased upon listening to preferred music, yet no impact was seen on alpha when the tempo varied. On the other hand, as tempo increased beta waves amplitude showed a huge increment, whereas no change was observed on beta when changing genres [6].

2.2 Mozart's Effect

Mozart's music has gained a lot of attention since the first article published in Nature in 1993 studying the effect of listening to Mozart on human's spatial reasoning. In their experiment done to study and compare the effect of classical and heavy metal music on the brain and cardiovascular system, Kalinowska et al. (2013) recorded EEG signals for 33 participants before, during, and after listening to Mozart's sonata K.448 (classical) and Iron Maiden (heavy metal). They've seen that no noteworthy contrasts of power spectra between measurements of before, during, and after listening to both types of music. Only the amplitude of alpha rhythm showed a significant decrease after listening to the Mozart's music [7].

Yang et al. (2014) tried to prove Mozart effect scientifically by designing an experiment where the EEG is measured before, during, and after listening to Mozart's K.448 for 29 college students. The study indicates a decrease in alpha, theta, and beta power spectra in healthy adults due to listening to Mozart [8].

In 2015, Verrusio et al. (2015) studied Mozart's effect on the brain activity of healthy young adults, healthy elderly, and elderly with Mild Cognitive Impairment (MCI) through quantitative EEG. After listening to Mozart K448, an increase in alpha band and median frequency index of background alpha rhythm activity was observed, whereas no such change was detected after listening to Beethoven's "Fur Elise". The study argues that Mozart's music is capable of activating neuronal cortical circuits related to attentive and cognitive functions in young subjects, as well as in the healthy elderly [9].

2.3 Visual and Audio-Visual Stimulants Effect on EEG

In 2012, Ahirwal and Londhe (2012) implemented a study to test the effect of visual attention on the brain's electrical activity through power spectrum analysis of EEG signals. The power spectrum of the signals while focusing attention on a visual stimulus was 10-12 dB, with frequency range of 18-22 Hz, which lies in the beta frequency band. The study concludes that in the beta frequency band corresponds to cognitive brain process or visual attention [10]. Along with investigations of the brain's reaction in response to auditory or visual stimulations separately, the effect of simultaneous combination of these two types of stimulations has been also studied by few researchers and for various objectives.

Christos et al. (2010) examined the impact of audio-visual stimulation on alpha brain oscillations using EEG technology. Subjects were exposed to binaural auditory beats with different frequencies combined with flickering lights of 4 different colors (RGBY), and their effect on upper and lower alpha bands has been analyzed. The study showed that this combination can significantly synchronize alpha 1 and alpha 2 bands [11].

In a very different setup experiment, Lee et al. (2016) studied the EEG signals of subjects watching disgust-eliciting videos of disgusting creatures and body mutilation but with varying the auditory music. The videos were played two times; first with their original soundtrack, and then with relaxing music or exciting music and the original soundtrack muted. Extracting the relative power spectra from the EEG data showed that alpha, theta, and delta frequency bands were lower with disgust-eliciting videos with external music stimuli than with the original soundtrack. This study argues that participants experienced less disgust when watching disgust eliciting videos while listening to music rather than the original soundtrack [12].

After summarizing some of the previous researches done studying the effect of different stimulations on the human brain using EEG technology, the methods we have adopted in our research project for EEG signal treatment and time frequency analysis, are presented next.

3. STUDY DESIGN AND METHODOLOGY

3.1 Database

EEG signals are recorded for 56 healthy students using KT88 EEG Machine. The recording is done while applying different auditory and visual stimulations. The 21 males and 35 females' participants are aged between 18 years and 26 years (mean age 20.82 years). Subjects suffering from any neurological disorders or complications, or taking central nervous system depressants are excluded from undergoing the experiment. After obtaining the EEG recordings of all participants, 50 recordings among them are considered for further analysis. The recordings of 6 subjects (2 males and 4 females) are discarded due to errors and huge artifacts. The percentages of males and females remaining in the study, and whether they're right or left handed are given as follows; 38.0% males, 62.0% females, 86.0% right-handed, 14.0% left-handed.

3.2 Pre-experimental Conditions

Subjects are asked to wash their hair the day before, and not to expose it to any kind of oils, gels, and chemical reagents. Subjects are forbidden to drink any source of caffeine (tea, or coffee) and alcohol 12 hours before the experiment. Subjects are also asked to get enough sleep on the day before.

Prior to starting the experiment, the participant is asked to read and sign a consent in order to make sure that he accepts the whole experimental process and he is voluntarily participating. To preserve his confidentiality, a number is assigned for each participant, instead of name, that is used on the EEG recording and all research documents.

3.3 Positioning

The experiment is done in a dark room. The participant is asked to sit down on an armchair and to extend his feet on a facing chair, so that he sits while his body is lying and relaxed. This helps us avoid any unnecessary movement.

3.4 Electrodes Attachment

After ensuring the right positioning, 19 reusable cup gold-plated electrodes) are attached to the subject's scalp using a gel named "Ten20". Electrodes are positioned according to the standard methodology named "The International 10-20 System" that is recommended by the International Federation of Societies of Electroencephalography and Clinical Neurophysiology [1]. According to the 10-20 International System, the electrodes cover all cortical lobes including Frontal (Fp1, F3, F7, Fp2, F4, F8), Temporal (T3, T5, T4, and T6), Parietal (P3 and P4), Central (C3 and C4), and Occipital (O1 and O2). Two electrodes are attached to left and right earlobes, named A1 and A2 respectively. An additional electrode is added on the forehead of the subject to filter the signal. After placing electrodes, the participant wears the earphones that are connected to a portable hp-PC where music and videos are played. In and two students appear in the dark room, well positioned, and with the electrodes attached to their scalp.

3.5 Montage

The referential/monopolar montage is used, in which the 16 channels represent potential difference between one active and one inactive reference electrode. The inactive electrodes are the one's attached to earlobes A1 and A2. The left hemisphere active electrodes are defined by their odd index (Fp1, F3, F7, T3, T5, O1, P3 and C3) and their reference electrode is A1. The right hemisphere active electrodes are defined by their even index (Fp2, F4, F4, T4, T6, O2, P4, and C4) and their reference electrode is A2. In, the board of KT88 EEG machine appears, where the names of electrodes and their position are drawn on its surface.

3.6 Experiment Procedure

For each subject, five separate EEG signals are recorded; each for 2 minutes. The total time is 10 minutes for each subject.

The 1st EEG recording is done while the subject is closing his eyes and not exposed to any auditory or visual stimulation. After that, stimulations are applied according to the following steps:

Videos part: The 2nd and 3rd EEG recordings are done while the participant watches two consecutive 2-minutes videos on a PC screen in front of him. The first video is of scenes of nature accompanied with Piano Instrumental music (Spring Flowers Inspiration, YouTube). The second video is of violence scenes mainly killing and gun shooting (from "Headshot" movie, 2016). Thirty seconds break was taken between them.

Music part: The 4th and 5th EEG signals are recorded simultaneously while the participant listens to two consecutive 2-minutes music sections with a 30 seconds break between them. First, a section of Dubstep, Electronic Dance Music ("Bangarang" by Skrillex) and then a section of Classical Music (Mozart's Sonata Nb. 16). The participant is asked to close his eyes during listening to avoid eye blinking artifacts. A resting time, two minutes, is taken between videos and music part, where the participant is allowed to distract himself by any other activity.

Table 3-1 represents the stimuli applied while recording EEGs and summarizes different stimuli applied during the 5-EEG recordings and the URL of the music and videos used.

4. SIGNAL PROCESSING PHASE

Multiplying the number of subjects with the number of recorded signals for each subject, i.e. 50*5, gives us a total of 250 datasets. These EEG datasets are saved on the EEG software.

4.1 Pre-processing

Pre-processing of each signal was done before exporting them from the software. The signals are filtered with a band-pass filter, which is included within the software, of frequency range 1-40 Hz. This allows the exclusion of the noise of very low and very high frequencies. After filtering, the signals are exported in BDF format, and then introduced, one by one, into EEGLAB for the sake of analysis and interpretation.

4.2 Artifact Rejection

Artifacts in EEG, due to eye movements, blinks, muscle activity, etc. can greatly mislead EEG results and thus must be rejected. Standardly, visual inspection is used which allows users, mainly professional experts, to differentiate between artifact and non-artifact components. However, some artifacts features can be ambiguous to notice leading to difference in making decisions between users. Moreover, visual inspection requires a lot of experience and consumes time.

To avoid its complications, researchers have developed several algorithms capable of detecting artefactual ICs automatically, such as IC-Label. In these procedures, objective statistical measures from ICs are computed and used therefore to decide automatically whether this component is artefactual or not [13]. "IC Label" is a novel EEGlab-plugin which allows Automatic Artifact Rejection: It classifies ICs into brain and non-brain components determining specifically the contents of each component.

Using EEGLAB, Independent Component Analysis (ICA) decomposition is applied on each EEG dataset, giving rise to independent components of the same number of channels. IC-Label is then applied on these datasets to detect which ICs are mainly composed of artifacts.

IC-Label classifies artefactual components into 6 categories: Eye, Muscle, Heart, Line Noise, Channel Noise, and Other. And the components containing neural information from the brain are called Brain components. After visual inspection of the classification given by IC-Label, the index of each artefactual component is inserted manually in order to be rejected, i.e. excluded from the dataset. The number of rejected components may differ from one dataset to another depending on how much artifacts appear in each one.

4.3 Power Spectral Density

After removing the components of non-neural origin, Fast Fourier transform is applied to the dataset. Then the power spectral density PSD of each waveform, delta, theta, alpha and 40 beta, is calculated for each component using Welch method. That is, for each component in a dataset four numbers, PSDs, are obtained.

Since we have 250 datasets, and each dataset has up to 16 components (depending on how much components are removed after artifact rejection), and in order to avoid the complications of high number of obtained PSD values, the average of PSD of each dataset is calculated. In other words, for each dataset the mean PSD of delta, theta, alpha, and beta is computed, i.e. 4 PSD values are obtained for each dataset.

Then, and as stated in [12], the relative power spectrum was computed. Then ANOVA test was applied to obtain if there a relationship between the stimuli and the brain rhythms. SPSS was used in order to perform the required ANOVA test.

5. RESULTS

In this section the results of our experiment will be presented and discussed.

A brief glance on the effect of filtering and artifact rejection is illustrated first.

5.1 Filtering EEG Signals

The EEG signals are first filtered in order to remove all very low and very high frequencies.

5.2 ICA and IC-Labelling

Rejecting artifacts by running the ICA decomposition, and then applying IC-Label has cleaned the EEG signals from data of non-neural origin. The EEG signal is first transported to EEGLAB where ICS is applied first and independent components appear instead of channels. Then, running the IC-Label in the EEGLAB allows the classification of the artefactual components. In this dataset, 3 components are contaminated: IC2 (eye component), IC8 (eye component), and IC16 (other). Via EEGLAB, the contaminated components are removed, and therefore 13 ICs are only kept.

After being sure that each EEG dataset is clean of artifacts, absolute PSD of delta, theta, alpha, and beta rhythms is calculated for each component in the dataset.

5.3 Results from the Power Spectral Density Calculation

Recall that the power spectral density, or power spectrum, of a signal illustrates the power existing in a signal as function of frequency. The average PSD over the whole dataset is computed. The following are the results of absolute PSD variation for each stimulation ANOVA test is then performed for relative PSD values.

5.3.1 Absolute PSD variation after each stimulation using SPSS techniques

Consider first this notation: A denotes 1st recording (no stimulus), B denotes the 2nd (nature video), C denotes the 3rd (violence video), D denotes the 4th (heavy music), and E denotes the 5th (classical music). For each subject, the value of PSD, for all bands, was observed and compared between (A and B), (A and C), (A and D), and (A and E), not to detect the difference between values but to observe whether it increased or decreased. After that, the number of subjects in which PSD increased or decreased is determined. Finally, the percentage of subjects is computed.

Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 present the percentage of subjects in which an increase or a decrease was observed in their delta, theta, alpha, and beta PSD values between experiment “A” (no stimulus) and the other cases of different stimuli (B, C, D, E).

Table 5-1: The stimuli applied while recording EEGs

EEG Recording	Type of Stimulus	Name of Stimulus	URL
1st		*No Stimulus*	
2nd	Nature Video	Spring Flowers Inspiration	https://www.youtube.com/watch?v=FTBnAdrqZU4
3rd	Violence Video	Action scene from “Headshot” movie, 2016	https://www.youtube.com/watch?v=GlbojT7u7HA
4th	Dubstep Electronic Music	“Bangarang” by Skrillex	https://soundcloud.com/skrillex/skrillex-bangarang-feat-sirah
5th	Classical Music	“Sonata Nb. 16” by Mozart	https://soundcloud.com/moozar/mozart-the-piano-sonata-no-16

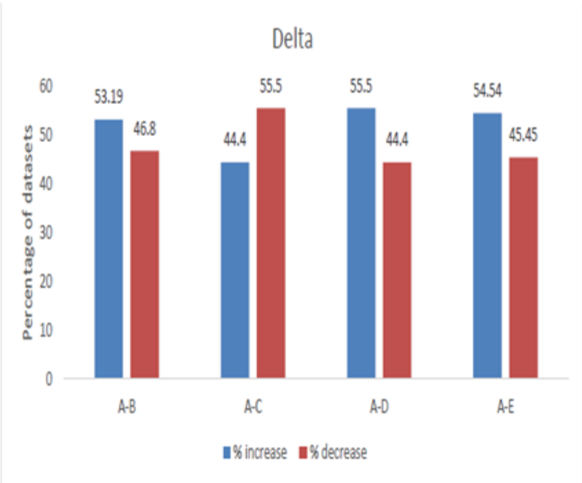

Figure 5-1: Variation of Delta PSD in all datasets

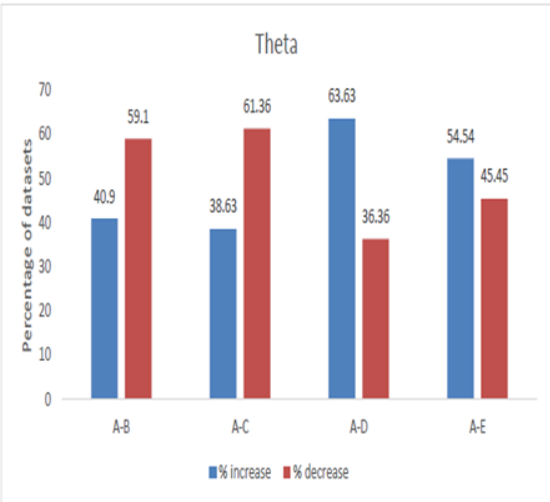

Figure 5-2: Variation of Theta PSD in all datasets

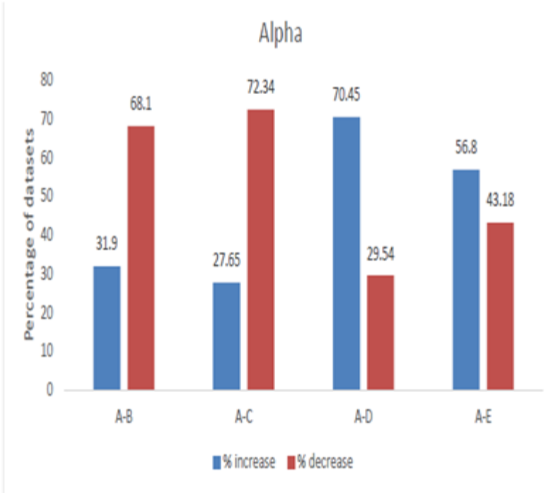

Figure 5-3: Variation of Alpha PSD in all datasets

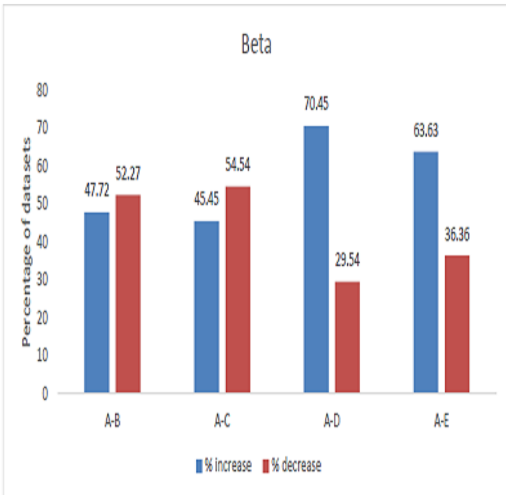

Figure 5-4: Variation of Beta PSD in all datasets

The results presented in Figure 5-1 and Figure 5-2 showed no significant difference between the percentages of datasets in which an increase or decrease was obtained in their PSD value of both Delta and Theta. Whereas in the case of Alpha and Beta, in some cases the percentage of people with an increase (or decrease) in PSD value due the application of stimuli is higher than that where a decrease (or increase) is obtained.

For alpha frequency band (Figure 5-3) in the case of A-B, the percentage of subjects with decreasing PSD is high **(68.1%)** compared to that of increasing PSD **(31.9%)**. Also, in the case of A-C, the percentage of subjects with decreasing PSD is high **(72.34%)** compared to that of increasing PSD **(27.65%)**. Moreover, in the case of A-D the percentage of subjects with increasing PSD is high **(70.45%)** compared to that of increasing PSD **(29.54%)**.

For beta frequency band (Figure 5-4), in the case of A-D the percentage of subjects with increasing PSD is high **(70.45%)** compared to that of increasing PSD **(29.54%)**.

5.4 ANOVA Test of Relative PSD

ANOVA test is used in order to obtain if any effect of the stimuli can be observed on each frequency bands. Table 5-2, Table 5-3, Table 5-4, and Table 5-5 show the results of the ANOVA test of relative PSDs of each of the brain rhythm: delta, theta, alpha, and beta. The same notation of the previous section is followed here for A, B, C, D, and E.

Table 5-2: ANNOVA test between Delta rhythm and the stimuli

Wave	Stimulus	Mean	Std. Deviation	Minimum	Maximum	p-value	Result
Delta (1-4 Hz)	A	0.678	0.144	0.250	0.886	0.049	Significant
	B	**0.709**	0.156	0.250	0.935		
	C	0.699	0.140	0.250	0.939		
	D	0.654	0.163	0.250	0.937		
	E	0.626	0.169	0.185	0.941		
	Total	0.673	0.157	0.185	0.941		

Table 5-3: ANNOVA test between Theta rhythm and the stimuli

Wave	Stimulus	Mean	Std. Deviation	Minimum	Maximum	p-value	Results
Theta (4-8 Hz)	A	0.166	0.054	0.046	0.289	0.864	Not Significant
	B	0.176	0.092	0.033	0.568		
	C	0.177	0.063	0.038	0.353		
	D	0.175	0.060	0.024	0.335		
	E	0.181	0.056	0.036	0.299		
	Total	0.175	0.066	0.024	0.568		

Table 5-4: ANNOVA test between Alpha rhythm and the stimuli

Wave	Stimulus	Mean	Std. Deviation	Minimum	Maximum	p-value	Results
Alpha (8-13 Hz)	A	0.129	0.089	0.046	0.509	0.000	Significant
	B	0.085	0.057	0.024	0.250		
	C	0.092	0.063	0.017	0.278		
	D	0.142	0.115	0.031	0.563		
	E	**0.162**	0.122	0.018	0.522		
	Total	0.122	0.097	0.017	0.563		

Table 5-5: ANNOVA test between Beta rhythm and the stimuli

Wave	Stimulus	Mean	Std. Deviation	Minimum	Maximum	p-value	Results
Beta (13-30 Hz)	A	0.028	0.047	0.006	0.250	0.987	Not Significant
	B	0.030	0.048	0.007	0.250		
	C	0.032	0.048	0.006	0.250		
	D	0.029	0.047	0.006	0.250		
	E	0.032	0.052	0.004	0.308		
	Total	0.030	0.048	0.004	0.308		

In order to obtain a significant relationship between the variables, p-value must be less than 5% (0.05). For Delta rhythm, Table 5-2 shows that p-value equals 0.049 which is less than 0.05 (5%) indicating that there is a significant relationship between them. The mean of stimulus B is the highest (**Mean = 0.709**) amongst all other stimuli.

Moreover, for Alpha rhythm, Table 5-4 shows that p-value is 0.00 which is also less than 0.05 (5%). There is also a significant relationship between alpha rhythm and the stimuli, and the highest mean is for stimulus E (**Mean = 0.162**).

On the other hand, for Theta brain rhythm, Table 5-3 shows a p-value of **0.864**, which not less than 5% (0.05). Consequently, the results are not significant, and none of these variations can be generalized. The same goes for Beta, where the p-value in is **0.987** (greater than 0.05) as shown in Table 5-5.

6. DISCUSSION AND LIMITATION

6.1 Discussion

Referring to Figure 5-4, the increase of PSD of beta rhythms in the case D, i.e. while listening to heavy music (Electronic Dubstep music, “Bangarang” by Skrillex), can be explained by the fact that beta is known as expression of alertness. The high percentage of subjects who showed an increase in PSD of beta when listening to the electronic dubstep music is logical. Heavy music may have induced alertness and attentiveness of the subject.

For alpha frequency band (Figure 5-3), the percentage of subjects with decreasing PSD is high compared to that of increasing PSD in both cases of A-B and A-C. Alpha appears in the state of relaxed awareness with no attention or concentration, and appears more during eye closure. That is why a decrease in alpha is observed when comparing A-B and A-C, since in both cases of B and C, the subject opens his eyes to watch the videos (nature and violence) and therefore his attention increased compared to the case A where he is closing his eyes with no stimulus around.

In the case of A-D, the percentage of subjects with increasing alpha PSD is higher than that of decreasing PSD. This indicates that an increase of alpha PSD occurs at the case of Electronic Dubstep music. In fact, this results are counter common sense, since the heavy electronic music because it induces some alertness. In [6], Hurless et al. demonstrated that alpha waves amplitude increased upon listening to preferred music. This may suggest that alpha power spectrum increases also upon listening to a preferred type of music, and the electronic music may be a preferred genre for the subjects whose alpha showed an increase.

Referring to ANOVA test performed between relative PSDs of brain rhythms and the various stimuli, the results of Table 5-2 has shown that the highest mean was of stimulus B, the video of natural scenes accompanied with Piano Instrumental music. This implies that delta rhythm's highest values were in the reaction to the natural scenes video. This result is logical, since delta appears in the sleeping on drowsiness state. This may indicate that watching this video has relaxed the subjects and made them a bit sleepy due to its relaxing scenes of nature and flowers and the calm music accompanied with it.

Additionally, the results of alpha rhythm, displayed in Table 5-4, has shown a significant relationship between alpha rhythm and the stimulus E, the Classical music (Mozart's Sonata Nb. 16). This result is also logical since alpha represents the state of relaxed awareness. This means that the classical music may have increased the relative power spectral density of alpha rhythm due to its relaxing effect.

6.2 LIMITATIONS

In this study, certain limitations have stood in the face of obtaining more specific results. Technically, the subject was not completely lying on his back, and although the positioning was good to reduce movement, it was not sufficient to prevent it. Thus, artifacts appeared frequently in the data.

Although the stimulations were as divergent as possible to elicit a change in the brain, but in fact the time of the stimulation, 2 minutes for each, was relatively short. Two minutes were not enough to trigger a detectable change in brain rhythms power spectra. Also, the time separating the exposure to each stimulus was not sufficient (30 s between the 2 videos, 2 minutes between video and music part, 30 s between the 2 music stimuli). In fact, extending the time of the experiment was difficult, since the volunteers were students who cannot tolerate length experiments.

7. CONCLUSION

The brain is the most complex and undiscovered organ in the human body. Therefore, studying the effects of various stimulants on the brain can help grasp some of knowledge about it. This work has studied the impact of listening to heavy and classical music on the brain activity using EEG technology. A control experiment was done by recording EEG with no stimulus. The absolute and relative power spectral density of the four brain waves was studied.

ANOVA test was done between relative power spectral density and the various stimuli. High delta power implies that watching this video has made the participants sleepy or triggered their feelings of drowsiness, and this agrees with the usual appearance of delta in the states of sleep or drowsiness.

ANOVA test also showed a significant increase of alpha relative power when listening to classical music ("Sonata Nb. 16" by Mozart). Since alpha appears frequently in the state of relaxed awareness and in less frequency during alertness or tense, high alpha power indicates that the classical music has relaxed the participants and decreased their tense.

Moreover, observing the variations of absolute power spectral density of the four brain rhythms in the EEG signals showed a high percentage of subjects whose alpha decreased from the case of no stimulus to both cases of watching nature and violence videos.

Additionally, a high percentage of subjects whose alpha and beta increased when listening to heavy music (Electronic Dubstep music, "Bangarang" by Skrillex) is detected.

The study aims to collect the different values of ANOVA signals after a various stimulus, in order to predict the patient situation in a normal case, that will help the medical teams to get direct notification about the real diagnostics or unexpected measures.

Several limitations have been detected in our study and may have affected our results, including the short time of applying the stimulations, the large number of artifacts in the EEG signals

8. FUTURE WORK

Further work can be done using EEG machine in order to know the impact of stimulations of the brain activity. Future work can have a more specific design for the experiment. It can consider studying only music with adding more than two genres. Preference may be taken into consideration too. It can also include healthy subjects in addition to subjects suffering from certain brain disorders, in order to study the effect of music on both healthy and non-healthy subjects. Additionally, using feature extraction tools like Wavelet Transform and Approximate Entropy is essential in a further research about EEG, due to their high accuracy in analyzing time varying signals

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