Neurofeedback and Beethoven music for relieve of stress

Vee Felly *, Norsiah Fauzan

Department of Cognitive Science, Faculty of Cognitive Science and human Development, Universiti Malaysia Sarawak (UNIMAS), Sarawak, Malaysia

A R T I C L E   I N F O

A B S T R A C T

Stress is defined as a mild mental disorder and can be relieved using psychological treatment or neurorehabilitation such as neurofeedback training. In this research neurofeedback training (NFT) was applied using sound therapy such as music to reduce stress and increase calmness of final year university students. Data was collected using a quantitative electroencephalogram (QEEG) with Neurofeedback (NFT) and Beethoven music as the therapy medium. The data were analyzed using Microsoft Excel. Five respondents were involved in this research and they were chosen based on their scores from the stress inventory. The subjects were required to completan inventory to identify their stress levels and were selected based on total points accumulated. The subjects went through pre-test, NFT training session and posttest to look at the changes in brain organization. Delta and Beta training protocol were conducted; the results showed that the most dominant brainwaves to improve calmness (Alpha) were Delta protocol to stabilize the excessive waves.

1. Introduction

Neurofeedback training (NFT) is a form of behavioral training that aimed at developing skills for self - regulation of brain activity. NFT emerged with neuroscience fields involving clinical clinical application based on the general principles of biofeedback. Neurofeedback training had been applied in the treatment of depression and autism. Lubar & Shouse (1976) reported that neurofeeedback (NF) activities were applied in the field of child and adolescent psychiatry since the past 30 years ago. Apart from that, NFT had been applied in individuals with depression (Rosenfeld, 1997). Most of the treatment was successful in experiment and the success rate was from 60 - 90 % (Wright & Gunkelman, 1998). Some of the patient might show reduction in symptoms in the earlier session for 5 - 10 sessions. In this research, the purpose of the study is to to analyse the effects of sound therapy on the final year students in order to increase the calmness and reduce the stress among the final year students. Most students were likely to choose music to reduce stress. Stress is a psychological feeling with emotion of nervousness, apprehension and helpless. Stress actually passes through three stages from the time it exists until it reaches the most maximum level (Melgosa, 2000). The three stages were alarm stage, resistance stage and exhaustion. The alarm stage was a warning by detecting the present of stress agent. Once the cause of the stress was detected, resistance stages occurs when human body system reacts to threaten or challenging the current situation. If an individual can deal or manage the stress, then it would stop slowly. Otherwise, if it is not handled, it will continue until the exhaustion stages. The exhaustion stages are the maximum level of stress which might affect an individual by feeling fatigue, anxiety and depress.

2. Background of the study

In this research, auditory stimulus for the NFT training was Beethoven's music. Beethoven's were composed by Ludwig Van Beethoven from Germany. Beethoven music can be used as relaxation and meditation since the music rhythm were soft and sometimes comes with natural sound. According to Hanser (1985), classical music were used as a tool for relaxation purpose and stress reduction resulting in self - reported, behavioral, and physiological changes related with stress reduction.

Listening to classical influenced the changes of physiology. When a person faced a hard time in their life such as cancer patient, listening to classical music can allow a person to be where they were in coping with the illness. The physiological changes occurred is associated with listening to classical music and related with stress reduction. According

* Corresponding Author.
Address: Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak,94300 Kota Samarahan, Sarawak, Malaysia

to Mc-kinney et al. (1995) there was a significant decreased in β - endorphins which followed with a session of progressive relaxation, classical music and guided imagery condition combination Based on the previous studies, done by Scheufele (1999), on the effect of progressive relaxation and classical music on measurement of attention, relaxation, and stress responses, it was indicated that the effect of progressive relaxation can decreased the heart rates but then classical music was more effectively to decreased heart rates. Progressive relaxation t (16) = 6.651, p < 0.001, music, (t14) = 8.377, p < 0.001, attention (t16) = 5.476, p < 0.001 and silence (t14) = 5.556, p < 0.001. So, based on the means, the highest mean was music. Listening to classical music can decreased the heart rate goes back to the normal and at the same beneficial to psychology impact.

Khalfa, Bella, Roy, Peretz and Lupien (2003), studied on effects of relaxing music on salivary cortisol level after psychological stressor. As the result, Khalfa and her colleague indicated that relaxing music was more effective than silence in decreasing the cortisol level after the stress induction. Based on the baseline phase, silence mean, t (8) = 3.3, p < 0.01, while music mean t (7) = 8.2, p < 0.001. After the stressor and the first part of the stress recovery period which were conducted for 70 protocol, the salivary cortisol continued to increase in the silence group t(8) = 2.3, p < 05 and As the discussion, relaxing music such as classical music really impact in a positive effect especially in term of psychology.

3. Method

3.1. Research design

This is a training study using pre-test and post-test single cohort design to look at the efficacy of Neurofeedback training and Beethoven's music as sound therapy for the final year students. The selected participants would be 5 students chosen based on the stress inventory. All participants were female final year students chosen based on their stress inventory. The individuals were evaluated based on the value of 32 items of life event and resulted to stress level (Holmes and Rahe, 1967). These ranges indicate three level of stress which is: Mild stress: < 150: Moderate Stress: 150 to 300 and Severe Stress: >300.

The selected participants were assessed using QEEG in the pretest and post-test to find out the efficacy of the NFT and Beethoven's music. The brain waves were observed and analysed to find out the appropriate protocol for the training after the pre-test. This is followed by Neurofeedback training using Beethoven music as the therapy medium to reduce the stress. The second session of QEEG was taken once the therapy period is finished. This is to compare the previous brainwave with the current brainwave to see the changes after the treatment.

4. Results and discussion

Firstly the QEEG data for pre - test and post - test was taken from the EEG personal computer. Then, all of the data would be view by Microsoft Excel in order to make it more nicely and being arranged. The data for every participant would be analyzed based on the brain waves such, delta, theta, alpha, beta1 and beta2. Here, only one condition would be choosing which during eyes closed to saw the brain waves improvement at brain region. This condition does not acquire any physical movement which may influence the brain waves during the QEEG session. So the results of QEEG would be valid. Plus during eyes closed condition, the participant was in a relax condition.

4.1. Pre QEEG

In order to get the average for every brain waves, the value of amplitude (uV^2) were divided with the brain waves frequency (Hz). These results were calculated again by getting average for each of the electrodes for single brain waves (Table 1).

Based on the assessment, the delta waves were mostly at the frontal hemisphere, right hemisphere (T4), on the left (T3) and at the occipital area. The color indicators were set to 50 uV^2. There were less activation of theta, beta1 and beta2 brain waves and it can be interpreted that there less firing of the neurons in the area. Based on these analyses the researcher determined the suitable protocol for Neurofeedback training.

4.2. Neurofeedback training (Nft) data analysis

NFT data were collected from the EEG personal computer by sorting the data accordingly to the date of training session. These data were analysed using Microsoft Excel and calculated for the average. The calculation of average was based on the training session. Firstly, data from each participant would be calculated the average of the frequencies for every protocols. As in Delta protocol, the reward frequency was delta, as low inhibit was beta and high inhibit was high beta. This protocol was suggested for the first three sessions. Then, for the 4th session until the 9th session was using beta protocol. Beta protocol does consist of theta as the low inhibit, beta was the reward frequency and high beta as the high inhibit frequency. All of the participant complete their 9 session of the training due to the time constraints. Their most ideal number of training session are 20 - 22 session depending on their psychological improvement (Hammond, 2005).

The data were sorted out by grouping them according to the frequencies and sessions. The purpose of the research was to interpret the results based on the sessions, for both protocols, the data were calculated based on the sessions average (Look at Table 2 and 3).

Based on the graphs above, the high and lower inhibit increased more than the reward frequencies. As for delta training, the reward frequency increased from the first until the third session. As observed, the

increasing of delta waves was because the participant was in a deep sleep and closed eyes. Delta waves are brain waves activated during the sleep states especially when the person is in a very deep sleep.

Table 1: Pre-QEEG (average)

	DELTA EC	THETA EC	ALPHA EC	BETA1 EC	BETA2 EC
Fp1-Av	5.280	0.634	1.015	0.082	4.453
Fp2-Av	5.305	0.642	0.9471	0.075	5.061
F7-Av	5.080	0.608	1.011	0.0957	4.201
F3-Av	1.68	0.462	1.011	0.0862	3.602
Fz-Av	1.58	0.637	1.138	0.0792	3.647
F4-Av	2.00	0.481	0.867	0.0754	4.863
F8-Av	5.62	0.595	0.848	0.086	5.424
T3-Av	5.61	0.459	1.129	0.145	1.228
C3-Av	1.03	0.300	0.655	0.0540	5.555
Cz-Av	1.264	0.528	1.403	3.697	4.987
C4-Av	0.877	0.3412	0.626	4.002	7.57
T4-Av	2.125	0.329	0.4204	2.197	5.11
T5-Av	3.750	1.230	4.304	2.583	5.66
P3-Av	1.635	0.500	1.095	2.941	7.309
Pz-Av	1.54	0.510	1.882	2.0364	7.309
P4-Av	2.738	0.554	2.368	1.4403	4.586
T6-Av	4.042	0.8581	2.398	2.1162	5.985
O1-Av	3.418	1.368	2.856	1.7282	4.953
O2-Av	4.69	1.521	5.536	0.3373	5.400

Table 2: Average for delta protocol

	beta	delta	hi beta
1st	37.198	64.127	42.60
2nd	77.342	74.452	129.61
3rd	194.74	165.81	268.29

Table 3: Average for beta protocol

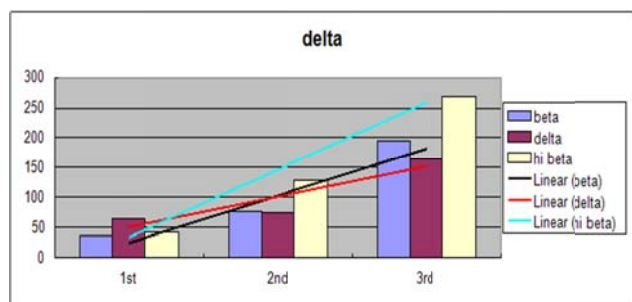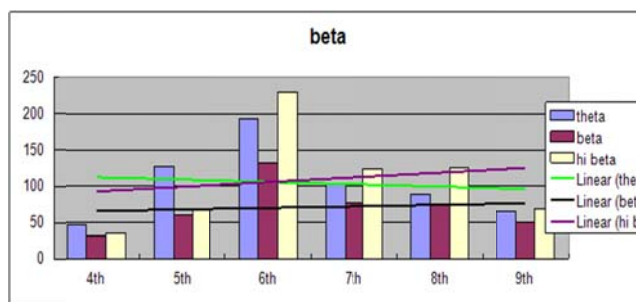|	theta	beta	hi beta
4th	46.131	30.72	34.58
5th	125.59	60.06	68.18
6th	192.84	131.59	229.48
7th	102.29	75.90	123.02
8th	87.88	74.00	125.011
9th	64.35	48.48	67.25

Fig. 1: Delta protocol

Fig. 2: Beta protocol

Two participants iterated that they liked the training and the Beethoven music. Some participant were having difficulties to sleep at night and mid-day. Three of the participant increased their delta waves for the first three week increase in scores for every period.

One of the subjects completed the delta training for two sessions because her delta was too high. It was suggested that she pursue beta training at the third session. At some period the participants scored very low and her waves were not consistence. During the training, observation showed that she was thinking putting her hand under her chin sitting in a straight position. After the training session, the participant was being interviewed and she confessed that she was not accepted for internship in her favourite company. She kept on thinking and was not able to focus during the training; the right brain frontal wave very active. Even though inhibits increased more than the reward frequency delta waves still increased. In this research, inhibits frequency was known as the stress level. In this training, delta waves showed an improvement meaning that this training achieved the objective.

As for beta protocol, the reward frequency increased slowly and theta wave was descending from the 6th session until the 9th session which means that the stress level decreased. There is an improvement of beta waves because it is getting increased. As observed during the training session, the beta waves looks even better when the participant closed their eyes but in conscious condition.

During the training session, the participant to listen to the music alone without any disturbance using the new ear phone; as being observed, when the participants listened to the music alone the beta waves increased. So do the scoring marks for each period. The scoring marks for every period can be referred in the appendix.

During delta protocol, left hemisphere (T3) and right hemisphere (T4) were trained. The delta waves were activated. The same goes to beta, at the left front hemisphere, Fp1 on the left forehead and C3 to increase the wave. The left hemisphere approximately shows the positive effect on affect and memories whereas right hemisphere is equivalent to the negative emotions (Henriques & Davidson, 1991). When a person involved with stress, their right hemisphere is more activated than the left hemisphere.

4.3. Post QEEG

The data from the post QEEG from differents bands and sub bands were averaged. The value of amplitude (uV^2) has to be divided with the brain waves frequency (Hz). These results can be referred in Table 4 below.

Table 4: Post QEEG

	DELTA	THETA	ALPHA	BETA1	BETA2
Fp1-Av	3.487	0.3833	0.867	0.1782	0.1545
Fp2-Av	7.345	0.4800	0.962	0.1035	0.0983
F7-Av	5.527	0.5273	0.696	0.1147	0.0616
F3-Av	1.4123	0.429	1.013	0.1114	0.0610
Fz-Av	2.439	0.406	1.064	0.061	0.0359
F4-Av	2.636	0.315	0.8086	0.073	0.0433
F8-Av	9.651	0.627	0.7914	0.0988	0.0796
T3-Av	2.3606	0.3773	0.4831	0.1509	0.0957
C3-Av	1.4453	0.366	0.9030	0.0540	0.0460
Cz-Av	1.3587	0.408	1.3184	0.0569	0.0418
C4-Av	1.830	0.2400	0.569	0.0580	0.0434
T4-Av	2.552	0.5060	0.641	0.151	0.1394
T5-Av	1.955	0.632	2.057	0.165	0.0677
P3-Av	3.983	0.450	1.368	0.101	0.0709
Pz-Av	3.089	0.510	1.4657	0.113	0.0664
P4-Av	1.951	0.364	2.2303	0.121	0.0642
T6-Av	2.960	0.825	11.028	0.1464	0.1025
O1-Av	6.977	1.0747	2.928	0.1526	0.0847
O2-Av	2.023	0.622	3.316	0.1638	0.0738

4.4. Comparison between pre and post QEEG

At the beginning of the research it was stated that the main aim was to achieve alpha state (relaxation wave). In this research, delta wave seems to dominate. As mentioned earlier, delta waves is a state where the person was really in a very deep sleep without any stressing factor that might disturb their sleeping.
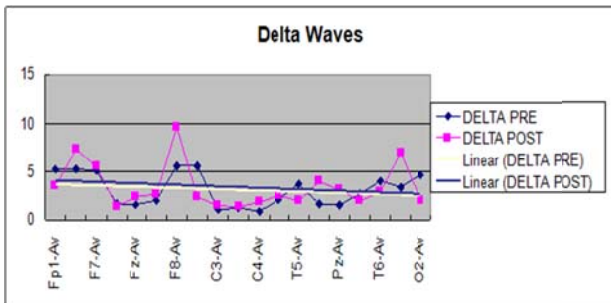

Fig. 3: Delta waves

Fig. 4: Alpha waves graph

As shown in the above graph, there were changes on delta waves, based on the pre and post. The trend line for pre QEEG increased at the beginning but sloping at the end. Since this graph was an average of single electrodes, these results tend to show that there were points on the brain with less activation.
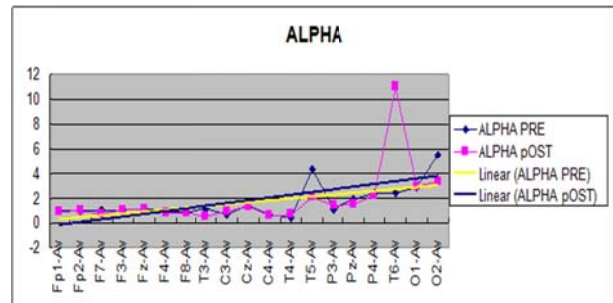
It's active at Fp1 on the left forehead then sloping down to the rest of the points. Alpha waves showed a slight improvement especially at T6 region as seen in the graph. T6 is a hub of processing area, the increase of alpha wave at this point shows a relaxation improvement at the emotional region that

triggered sadness, anger, and fear. There is slight improvement at the frontal area related to the temporal region reflecting the state of calmness after several times of training. Both waves improved after several training. Plus the training protocol that dominant to increase the waves was delta protocol. Stress is categorized as mild mental disorder and can be relieved using NFT and the sound of Beethoven music as demonstrated in this research. The progress for every session would be followed up so that the waves can be controlled. Based on the pre-test and post-test QEEG results, the were differences in the brain organization with the increase in Delta and Alpha waves.

5. Conclusion

The mostly dominant waves in this context research were Delta and Alpha waves. Brain topography had shown that the most activated brain waves at brain region were Alpha and Delta. The objectives of the training were achieved since alpha waves increased after several NFT sessions. This research had been conducted in order to follow up the participants' psychological progress. People knows that music are good for relieving stress but then not all people were aware of this information. While listening to the music the brain waves were monitored. So, the inhibit frequency can be controlled and the same time increased the reward frequency. The participants were final year student and they were burdened with lots of final year subjects and project which lead to stress and negative behaviour. Students need to find alternative to relieve their stress. The result of this research may help the students to choose the correct music with the right pitches and rhythms apart from their preferred music. Rhythm and pitch bring its own meaning to human life especially emotion. In this research, T3 and T4 were trained for both hemisphere stabilization and while C3 and Fp1 were trained to increase the activation since the left hemisphere was the positive region. Delta and Beta protocol were used as the training frequency since both hemispheres need to be stabilizing especially the left hemisphere. Both protocol leads to increased alpha waves. More training sessions should be conducted to gain more significant results from the training.

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