Resilience Building among University Students: A Heart Rate Variability Biofeedback Study

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Abstract. National Health and Morbidity Survey 2017 stated that 1 in 5 adolescents in Malaysia are having depression while 2 in 5 are anxious and 1 in 10 adolescents are in a stress state. This statistic is worrying as adolescents will be the future leaders of our country. Due to this increasing mental health problems, heart rate variability biofeedback technologies are used to increase resilience among university students. A person who is low in resilience is easily gets stress and a higher tendency to be depressed. Based on previous research, there were many kinds of research that have been done to quantify resilience through psychometric tools for example questionnaires and surveys. However, to the best of our knowledge, there has been little research before this in investigating how efficient heart rate variability biofeedback (HRVB) in improving resilience, especially among university students. The waveform of the HRV able to reflect either the person has low or high resilience. This study is a multidisciplinary field that includes electronics, psychology, and cognitive neuroscience. The aim is to determine the impact of HRV in resilience building among university students through biofeedback training. 120 students from Malaysia-Japan International Institute of Technology (MJIIT) are selected to participate in responding to the Brief Resilience Scale (BRS). BRS is used as psychometric tools to measure the level of resilience of the students. Based on the BRS score, the subjects were divided into 3 categories of resilience which are low resilience, normal resilience, and high resilience. The research used EmWave device and software of the HeartMath Institute to collect the variations of the heart rate data. Those who have low resilience took part in the biofeedback training for 5 sessions. The intervention used in the study is the slow breathing technique (6 breaths per min). Based on the HRV power spectrum, HRV data can be divided into 3 parts which are very low frequency (VLF), low frequency (LF) and high frequency (HF). The result obtained after completed all biofeedback training sessions shows that the use of heart rate variability biofeedback helped to increase the level of resilience of the students.

1. Introduction

Heart Rate Variability (HRV) is a non-invasive tool that records the heart changes and displays in waveform where we can study and analyse. Many studies stated that HRV can be used to evaluate the changes in autonomic nervous system (ANS). HRV measures beat to beat interval response in the heart rate and the main usage of the HRV biofeedback is to control the oscillation of the heart (Appelhans et al., 2006 ; Lehrer et al., 2003) There are three spectrums of HRV frequencies which are very low

frequency (VLF) which range less than 0.05 Hz, low frequency (LF) which the range is between 0.05 - 0.15 Hz and lastly is high frequency (HF) which is between 0.15 - 0.4 Hz (Sarwari et al., 2018). Many studies have stated that people with high HRV correlate with psychological flexibility, they able to adapt faster, and cope well with situation. Meanwhile, according to Lehrer (2007) and Lagos *et al*. (2008) people with low HRV associate with anxiety, depression and high stress which all of this not just give a negative impact on their mental wellness but also will affect their physical health.

Previous study showed that biofeedback training helps to improve health and emotions. Emotions self-regulation works closely with resilience. Emotions are the key maker of the physiological processes involved in energy regulation. While resilience also can be interpreted as the ability of someone to bounce back from problem or the ability to handle well the difficulty of having a problem. Thus, in order to maintain good health, resilience is important in handling one's emotions. As per data taken by the National Health and Morbidity Survey 2017, the result of the survey is worrisome where 1 out of 10 mental health of Malaysian are affected by stress. Based on previous studies, people with high resilience can interact with the environment and improve their wellbeing or protect them against the overwhelming influence of risk factors (Rollin et al., 2009)

HRV biofeedback training was developed in the early 19080s and was mainly used as intervention that targeted autonomic nervous system (ANS). HRV has been widely used in treating Asthma and Chronic Obstructive Pulmonary Disorder (COPD), fibromyalgia (FM), hypertension, chronic muscle pain, sports performance, depression and anxiety (Gevirtz 2013). However, previous research regarding the efficiency of heart rate variability biofeedback in improving resilience especially among university students is very hard to obtain. Therefore, this article is to study the impact of HRV in resilience building among university students. This study also includes the analysis of biofeedback training using HRV device in promoting emotional wellness to the students.

2. Methodology

2.1 Subject

Students are selected randomly to take part in responding to the Brief Resilience Scale (BRS). 120 students are included in this first stage. There are from postgraduate and undergraduate students who studied in MJIIT. Their age ranges from 19-40 years old.

2.2 Materials

There 2 main materials used in this study which are psychometric tools (questionnaire) and hardware and software to record and analyze data.

2.2.1 Questionnaire

Brief Resilience Scale (BRS) is used in this research to evaluate the level of resilience of each student. The scale assessed the ability of the student to bounce back or recover from stress. The scale contains 6 questions where subject needs to rate the question. Subject can choose either strongly disagree up to strongly agree. Based on the BRS score, the subject is divided into 3 categories of resilience which are low resilience, normal resilience, and high resilience. Table 1.1 is the BRS score guideline.

Table 1.1 BRS Score Guiding

BRS Score	Interpretation
1.00-2.99	Low Resilience
3.00-4.30	Normal Resilience
4.31-5.00	High Resilience

Based on the previous research, BRS shows a good internal correlation with the value of Cronbach's alpha range from 0.80-0.91. The BRS is reliable as much research has been using this scale (Smith et al., 2008).

2.2.2 Hardware and Software

The device used in this study is emWave HRV device and the emWave PC biofeedback (1.0) software. The emWave is a portable device that helps individuals to monitor HRV and apply biofeedback training. HeartMath Institute has developed a system of simple, user-friendly, mental and emotional self-regulated tools and techniques in which people of all ages and cultures around the world able to use it (Edwards 2016). Besides that statistical package social science (SPSS) is also used in this study to evaluate the efficiency of heart rate variability biofeedback.

Figure 2.1 EmWave Kit (Yousaf et al., 2016)

Figure 2.2 Ear sensor (Yousaf et al., 2016)

2.3 Experiment Procedure

This study focusing on building resilience for those who obtained low scores. Thus 10 subjects are selected to undergo biofeedback training for 5 sessions. Each session is around 20 minutes. A consent form is given for all the subjects. Based on Figure 2.2, ear sensor is clipped at the earlobe and the lapel needed to be clip to the subject's collar. The device must be calibrated for each time used to ensure the accuracy of the data taken. Statistical analysis such as ANOVA is used to analyse the HRV data. Figure 2.3 below shows the steps of the biofeedback training

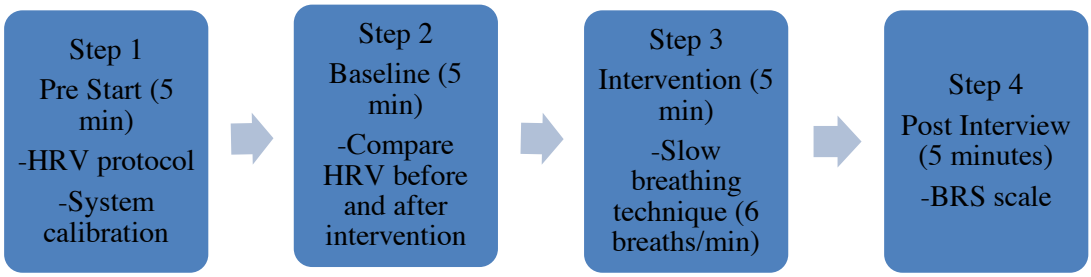

Figure 2.3 Summary of biofeedback training procedure

According to the HRV biofeedback protocol, the health condition of the subject is probed in each session. Only healthy subjects included in the study. Subject is briefed about the instruction. The first session is baseline recording which is to record the reading of the heart while they were in the current state. This process took 5 minutes and was recorded in the emWave desktop software. The basic purpose of baseline data collection is to determine the baseline value and to be compared with the value collected after the intervention has been given to the subject.

Subject is given resonant frequency breathing intervention which is 6 breaths per minute. 6 breaths per minute is a part of deep breathing which is broadly utilized as a strategy for decreasing pressure and act as a mood booster especially in Japan. This is also a fundamental technique in yoga and muscle relaxation (Perciavalle et al., 2017; Hayama et al., 2012; Wells et al., 2012). The method is proposed due to suitability to run the experiment within the period of time despite the number of the participant, each session will take approximately 15 minutes (Sutarto et al., 2010; Nubli et al., 2015). After completed all biofeedback training sessions, subject needed to answer the Brief Resilience Scale again to record the resilience level either improved or not after received the biofeedback training.

3. Experimental Result

Figure 3.1 and 3.2 below are the examples of heart rate variability of a subject. This shows the recording session for HRV during baseline and intervention. According to the result from the study using HRV, this shows a positive change in the level of heart coherence of the subject from the baseline to intervention for all 5 sessions. Coherence is a state where our nervous system, cardiovascular, hormonal and immune systems working proficiently and symphonically.

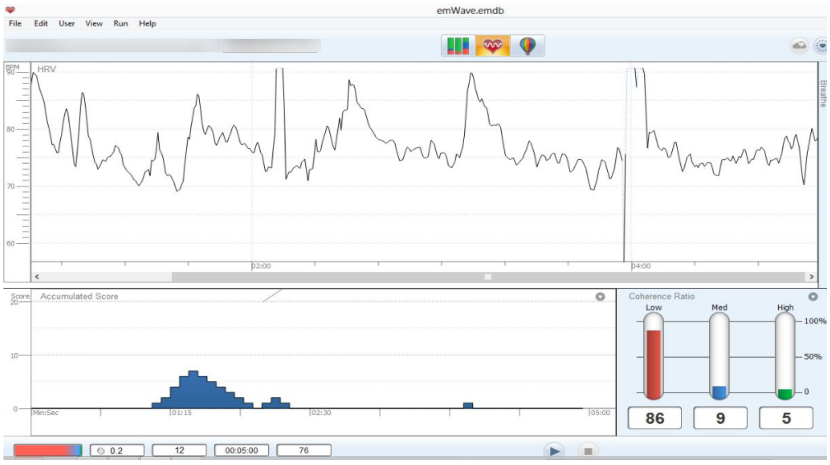

Fig. 3.1 Heart rate variability of one subject during baseline

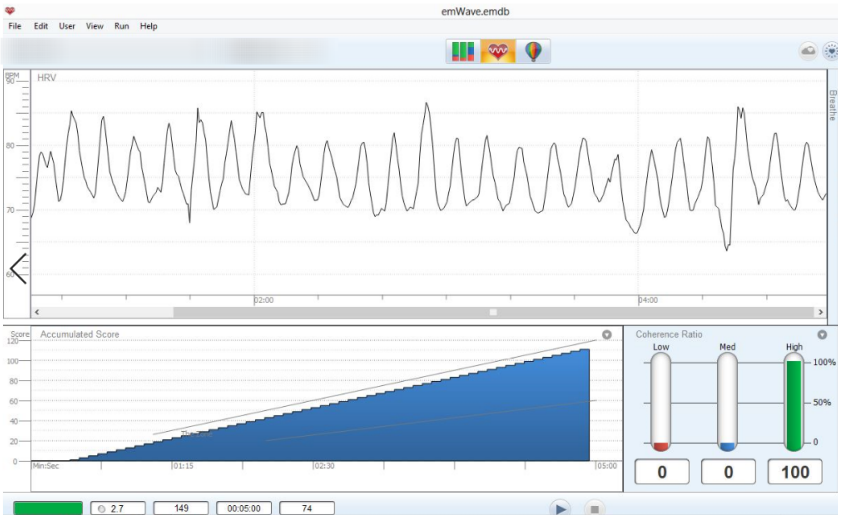

Fig. 3.2 Heart rate variability of one subject during intervention

Based on the coherence ratio result, in the baseline session conducted before intervention, all subjects obtained high scores for VLF which indicates the incoherent heart. Referring to the coherence ratio scoring, the mean score for all subjects for HF during baseline is 22.22% while after given intervention, the mean score is 86.76%. After given intervention, the HF scores of subject increased significantly and ANOVA is done to see the improvement of the result. The result obtained is $p<0.05$. This shows that HRVB is effective towards the subject. Table 3.1 below shows the coherence ratio mean score of all subjects for the 5 sessions of HRV data taken.

Table 3.1 Mean scores of coherence ratio HRV data collections for all subjects

Data Collection Sessions	Scores of each sessions (%)		
	VLF	LF	HF
Baseline	60.56	17.22	22.22
Interventions	4.54	8.7	86.76

According to previous research, when a subject is in the condition of fight-flight which is the sympathetic nervous system, this means the subject is high in VLF (Dana et al., 2010). This research is similar to our finding as in Table 3.1 where subject high in VLF during the baseline. This also shows that subject is stress and could not relax well. However, after given the intervention, the coherence level increase and HF is high as seen in the figure above. When HF increases, this proves that biofeedback training able to make the subject relax and increase in parasympathetic nervous system. According to the result of the study using HRV data, this shows a positive change in the level of heart coherence of the subject from the baseline to intervention for all 5 sessions.

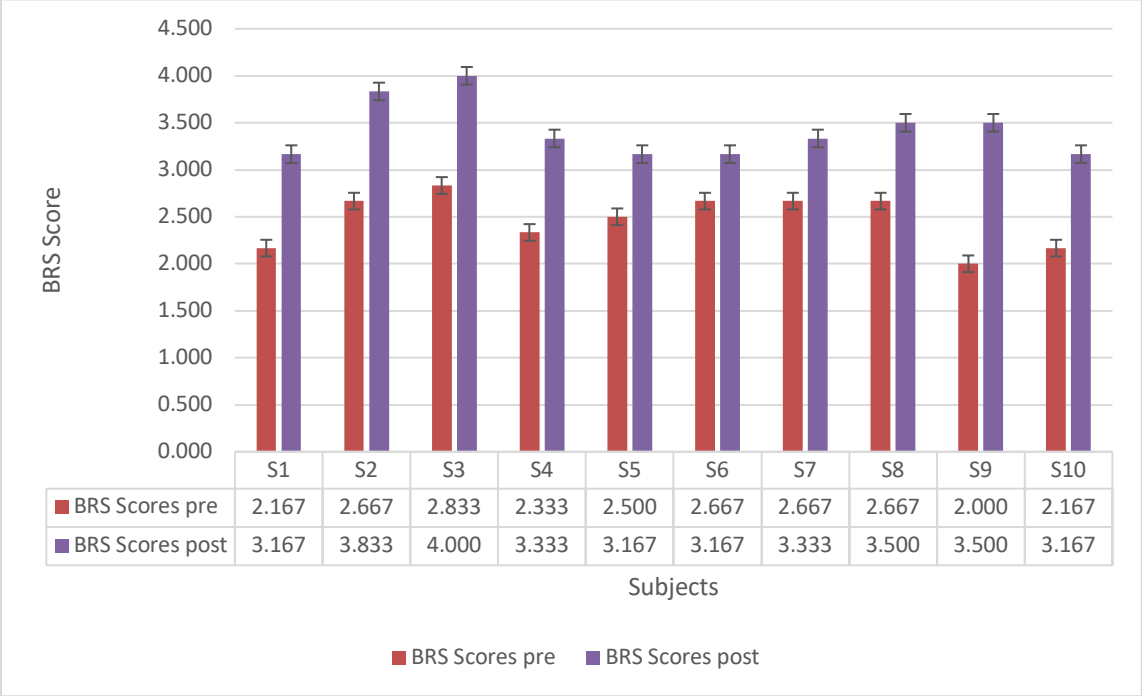

Figure 3.3 BRS score of all subject pre and post 5 sessions of intervention

In Figure 3.3, a comparison between the BRS score pre and post intervention is shown. From the graph, the BRS score of each of the students increases significantly. The level of resilience of each of the subjects is also increased from low to normal resilience. This finding proves that the intervention given to the subject has a positive impact and able to build up their resilience level. Besides that, the findings support the first objective of this study which is to determine the impact of biofeedback of HRV on resilience.

4. Conclusion

In conclusion, heart rate variability study gives significant improvements in building resilience by considering the effect of biofeedback training on the subject. This research provides an important opportunity is advancing the application of biofeedback as a non-clinical method of self-regulation in enhancing human wellness. With the aid of HRV biofeedback technique, this research is prospectively able to enhance the development of resilience through the use of modern technologies.

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